

# A CRITICAL VIEW OF INFLATION TARGETING: CRISES, LIMITED SUSTAINABILITY, AND AGGREGATE SHOCKS

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Inflation targeting has recently been adopted by the central banks of several advanced economies, including Australia, Canada, Finland, New Zealand, Spain, Sweden, and the United Kingdom. The policy is widely perceived as having been successful (see the discussions in Leiderman and Svensson, 1995; McCallum, 1996; Bernanke and others, 1999), and it is now increasingly being implemented by emerging economies. In response to recent currency crises, several emerging economies have had to let their currencies float. A view has emerged that for these economies, the option of simply fixing the exchange rate is no longer viable and that in the design of a new, permanent monetary policy framework, the choice is between a fixed exchange rate with an extremely strong form of commitment (such as a currency board or full dollarization) and flexible exchange rates.<sup>1</sup> Several important emerging economies, such as Brazil and Mexico, have chosen the latter. Given the well-known problems associated with choosing a monetary aggregate as the nominal anchor, they have opted for an inflation target.

This transplants inflation targeting to a new and quite different economic environment. It also assigns it a new task, namely, the attainment and maintenance of low inflation rates in a historically highly inflationary environment, starting from double digit inflation rates. The suitability of inflation targeting for such environments was first discussed in Masson, Savastano, and Sharma (1997). They find that the policy is unsuitable for most emerging markets, based on two objections. The main criticism is that for emerging markets the exchange

1. This view is not unanimous. See, for example, Frankel (1999).  
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rate remains an important additional objective of monetary policy, which is bound to lead to conflicts with the inflation target. Strong empirical support for this view can be found in Calvo and Reinhart (2000a, 2000b) and Levy-Yeyati and Sturzenegger (1999), who find that the actual behavior of many emerging economies' exchange rate regimes, while officially classified as floating, in fact resembles that of noncredible pegs. The second objection to inflation targeting, which may no longer be applicable to all emerging markets but certainly is to a majority of them, is fiscal dominance. In such economies the government budget remains a source of instability, and seigniorage often continues to be an important source of government financing. The reasons include a weak fiscal revenue base, a rudimentary tax collection system, the contingent bailout liabilities associated with weak banking systems, and simple overspending at the federal or regional level. There is often no political consensus that low inflation should be the overriding objective of monetary policy. For example, the Brazilian crisis of 1999 was by most accounts caused by unsustainable fiscal policies.

As I show in section 1 of this paper, inflation targets are vulnerable to speculative attacks under conditions of fiscal inconsistencies. Fiscal policy is one reason why the sustainability of inflation targets in emerging markets cannot be taken for granted in the same way as in the industrialized economies that have used this policy. Section 2 explores the consequences of limited sustainability in a full-fledged sticky price small open economy model. The section concludes that the defense of an inflation target against the inflationary bias resulting from a perceived lack of sustainability (modeled as policy temporariness) requires a more volatile and distortionary monetary policy, and it leads to lower welfare. These results should be of great importance for policymakers in emerging markets as they evaluate the suitability of different monetary regimes, a point that is also stressed by Mendoza (2001). As is well known to every student of open economy macroeconomics, however, flexible exchange rates allow for a more effective countercyclical monetary policy when an economy is subject to real shocks. This is the basis of a number of recent papers, including Schmitt-Grohé and Uribe (2001), Céspedes, Chang, and Velasco (2000), Parrado and Velasco (2001), and Galí and Monacelli (2000), which argue that inflation targeting is superior to exchange rate targeting. This question is addressed in section 3. Using the analytical apparatus developed for the previous exercise, I analyze the dynamic response of the economy to real and money demand shocks. I find that the superiority of one or the other regime in terms of welfare depends on a number of factors, including not only the

nature of shocks but also their direction. Furthermore, the analysis discredits the logic that is often implied in the policy debate, namely, that the flexibility of exchange rates under inflation targeting allows the nominal exchange rate to quickly bring the real exchange rate to a new equilibrium. This is one of the fallacies of the popular debate on this subject, which bases conclusions for the supposedly flexible exchange rates under inflation targeting on the results of an earlier literature on flexible rates under money targeting. In fact, the attainment of a new equilibrium real exchange rate happens at a very similar speed under exchange rate and inflation targeting when the latter is understood as a strict target for the level of inflation as opposed to a flexible interest rate rule. This assumption, which is critical for the results of section 3, seems appropriate for many emerging markets because they have to demonstrate credibility through the at least initially strict adherence to a target (see, for example, the discussion in Morande and Schmidt-Hebbel, 1999).<sup>2</sup> The conclusion from this exercise is that the performance of inflation targeting and exchange rate targeting under perfect policy sustainability and exogenous shocks is not very different.

This discussion, however, may miss the real point behind the attractiveness of inflation targeting. The theoretical results derived in this paper are based on the assumption that when a central bank targets the inflation rate, its commitment to that target is just as serious as the commitment to an equivalent exchange rate target. As documented in more detail in Kumhof, Li, and Yan (2000), many emerging market central bankers who are pursuing inflation targets apparently do not consider themselves to be vulnerable to currency crises, and they are willing to accept much larger short-run nominal exchange rate movements than is consistent with a strict inflation target. There is talk of constrained discretion, and of letting bygones be bygones. If one is willing to simply assume that, despite discretion, the perceived sustainability of the monetary regime in the eyes of the public is unaffected, it is really no wonder that inflation targeting would outperform exchange rate targeting. But in that case, the comparison of inflation targeting with a rigidly fixed exchange rate is really not fair and it should more properly be compared with a dirty peg. That regime, how-

2. An additional problem with flexible interest rate rules, on which I do not dwell further in this paper, is that many popular versions of such rules are subject to nonuniqueness problems. The discussion in section 2 on pure forward-looking inflation targeting versus price level rules is related to this point.

ever, has long since ceased to be respectable in emerging markets, especially in Latin America, precisely because its lack of commitment to a nominal anchor was frequently found to give rise to credibility and time inconsistency problems. Given the long history of monetary mismanagement in emerging markets, the debate about rules versus discretion was at some point decided in favor of rules. It now looks as though discretion has made a comeback, albeit under the more respectable and fashionable name of inflation targeting. Fashion aside, this trend is a mystery, except perhaps in the case of the strongest of the emerging markets, such as Chile.

The paper presents a set of theoretical models of a monetary small open economy. The emphasis is on the economic intuition, which is discussed with the help of computations of dynamic time paths. Rigorous definitions of equilibria, as well as computational and mathematical details, are omitted except where they are relevant to the intuition. Where appropriate, the reader is referred to the original papers (Kumhof, Li, and Yan, 2000; Kumhof, 2000a, 2000b) for technical details.

## **1. CURRENCY CRISES**

In the policy debate about inflation targeting, it is often claimed that a major advantage of this monetary regime is that it does not leave an economy vulnerable to a speculative attack. The logic is that a run on reserves can be averted because the central bank can simply let the exchange rate go. This is not at all obvious, however, if the policymaker is strictly committed to the inflation target. The reason is that in a small open economy the exchange rate is a very important component of the price index, and exchange rate management becomes necessary to achieve the inflation target. This commitment to intervene in the foreign exchange market makes a speculative attack possible. This section explores that point and further investigates whether inflation targeting and exchange rate targeting are quantitatively very different with respect to the behavior of economic variables under conditions that must ultimately lead to a speculative attack.

The key ideas can be presented with a simple microfounded balance-of-payments crisis model along the lines of Calvo (1987). The additional element needed is nontradable goods; this allows a natural specification of the consumer price index, the variable targeted in all current inflation targeting regimes. It is shown that once reserves are sufficiently low, exchange rate depreciation starts to exceed the inflation target in anticipation of the crisis. The central bank then has to

permit a contraction of the money supply to continue to meet the inflation target. This generates domestic deflation and sharply accelerating reserve losses in the final phase of the program. In calibrated experiments this final phase is very short but not instantaneous, unlike under a collapsing exchange rate target. Nothing in this logic depends on the inevitability of the crisis displayed by our model, and the principle can therefore easily be extended to second-generation balance-of-payments crisis models (see the arguments in Krugman, 1996). In fact, as described by Carstens and Werner (1999) and Morandé and Schmidt-Hebbel (1999), contagion-driven speculative pressure on inflation targets did occur in Mexico, Chile, and Israel in the second half of 1998.

This theory has important consequences for monetary policy in small open economies. The only way to completely rule out speculative attacks is to choose a target that does not involve any commitment to central bank intervention in the foreign exchange markets. One possibility is a target growth rate for the quantity of nominal money balances, which is the traditional definition of a floating exchange rate regime. Generally, the greater the weight of the exchange rate in the nominal target variable, the greater is the vulnerability to a speculative attack. For an open economy that targets the inflation rate, this weight is far greater than zero.

The rest of this section is organized as follows. Subsection 1.1 develops the model. Subsection 1.2 calibrates it and discusses computed solution paths, and subsection 1.3 concludes. Computational aspects of the model solution can be found in the original paper (Kumhof, Li, and Yan, 2000).

## 1.1 The Model

Consider a small open economy that consists of a government and representative price-taking, infinitely lived consumers. For tradable goods, purchasing power parity holds and their international price is constant and normalized to one. Nontradable goods prices are flexible. Time is continuous. Lower and upper case letters represent real and nominal quantities, respectively.

### Consumers

Consumers maximize lifetime utility derived from the consumption of tradable and nontradable goods,  $c_t^*$  and  $c_t$ . Their personal discount rate equals the constant real international interest rate,  $r$ , to

ensure the existence of a steady state. The objective function is

$$\text{Max} \int_0^{\infty} \left[ \gamma \ln(c_t^*) + (1 - \gamma) \ln(c_t) \right] e^{-rt} dt . \quad (1)$$

Consumers receive fixed endowments of tradable and nontradable goods,  $y^*$  and  $y$ , and government lump-sum transfers,  $g_t$ . The nominal exchange rate and the price level of nontradable goods are denoted by  $E_t$  and  $P_{N_t}$ , respectively, and the real exchange rate by  $e_t = E_t/P_{N_t}$ . Consumers hold two types of assets, real international bonds,  $b_t$ , and real money balances,  $m_t = M_t/P_{N_t}$ , with total asset holdings of  $a_t = b_t + m_t$ . Real money balances in terms of nontradable goods are  $n_t = M_t/P_{N_t}$ . The rate of currency depreciation is denoted by  $\varepsilon_t = \dot{E}_t/E_t$ , and uncovered interest parity is assumed to hold,  $i_t = r + \varepsilon_t$ , where  $i_t$  is the nominal interest rate on international bonds. Consumers face a cash-in-advance constraint on consumption,  $m_t \geq \alpha (c_t^* + c_t/\varepsilon_t)$ , which will be shown to hold with equality in equilibrium. Their lifetime budget constraint, incorporating the cash-in-advance constraint, is

$$\alpha_0 + \int_0^{\infty} \left( y^* + \frac{y}{e_t} + g_t \right) e^{-rt} dt = \int_0^{\infty} \left( c_t^* + \frac{c_t}{e_t} \right) (1 + \alpha i_t) e^{-rt} dt . \quad (2)$$

First-order conditions are

$$\frac{c_t}{c_t^*} = e_t \frac{1 - \gamma}{\gamma} \quad \text{and} \quad (3)$$

$$\frac{\gamma}{c_t} = \lambda (1 + \alpha i_t) . \quad (4)$$

This implies real money demands  $n_t = \alpha c_t (1 - \gamma)^{-1}$  and  $m_t = \alpha c_t^* \gamma^{-1}$ . If  $\mu_t = \dot{M}_t/M_t$ , then the latter means that  $\dot{m}_t/m_t = (\mu_t - \varepsilon_t) = \dot{c}_t^*/c_t^*$ .

### Definition of the Inflation Rate

A paper on inflation targeting in an open economy has to consider the appropriate definition of the aggregate inflation rate. For example, if all goods were tradable and purchasing power parity prevailed, there would be no difference between inflation targeting and exchange rate targeting. All countries that have implemented inflation targeting have chosen as their target a version of the consumer price index (CPI),

which is based on a goods basket of both tradable goods with price level  $E_t P_t^*$  and nontradable goods with price level  $P_{N_t}$ . Given the normalization  $P_t^* = 1$ , a natural definition of the CPI  $P_t$  is therefore the consumption-based price index:

$$P_t = (E_t)^\gamma (P_{N_t})^{1-\gamma} \gamma^{-\gamma} (1-\gamma)^{-(1-\gamma)}. \tag{5}$$

In rate-of-change form, this is

$$p_t = \gamma \varepsilon_t + (1-\gamma) \pi_t, \tag{6}$$

where  $p_t = \dot{P}_t / P_t$  and  $\pi_t = \dot{P}_{N_t} / P_{N_t}$ .

### Government and Aggregate Budget Constraint

The government’s policy consists of a specification of the path of lump-sum transfers,  $\{g_t\}_{t=0}^\infty$ , of an initial condition,  $P_0$ , for the CPI and of the initial (unsustainable) target rate of CPI inflation,  $\bar{p}$ , with the post-crisis steady-state rate of CPI inflation being determined by a balanced-budget requirement. I assume full central bank monetary accommodation at time 0, which implies a constant  $E$  and jumps in  $P_N$  and  $P$  on impact.<sup>3</sup>

The case in which  $P_t$  is the only target variable in a perfect foresight environment corresponds to what King and Wolman (1996) call perfect inflation targeting. They show that in a closed economy setting, the target can be achieved either by manipulation of the money supply (as in this model) or by an interest rate feedback rule with a very strong interest rate response to deviations of  $P_t$  from its target path. The economy described in the present model has an equivalent interest rate policy, but given uncovered interest parity, interest rate policy is indistinguishable from exchange rate policy. Taylor (2000) suggests that a money instrument may, in fact, be more appropriate for emerging markets.

Let  $h_t$  be the government’s foreign exchange reserves. Then the government’s lifetime budget constraint is

$$h_0 + \int_0^\infty (\dot{m}_t + \varepsilon_t m_t - g_t) e^{-rt} dt = 0. \tag{7}$$

3. This appears to be the most reasonable assumption. Calvo and Reinhart (2000a) and Reinhart (2000) show that central banks in emerging economies continue to resist large swings in nominal exchange rates.

There is a minimum level of net foreign assets, which for simplicity is assumed to be equal to zero:  $h_t \geq 0 \quad \forall t$ .<sup>4</sup>

In equilibrium the nontradable goods market must clear:  $c_t = y \quad \forall t$ , which implies  $\mu_t = \pi_t \quad \forall t$ . The economy's overall resource constraint can now be derived as

$$f_0 + \frac{y^*}{r} = \int_0^{\infty} c_t^* e^{-rt} dt, \quad (8)$$

with current account  $\dot{f}_t = r f_t + y^* - c_t^*$ .

## 1.2 Crisis Dynamics

Assume that the economy is in an initial steady state (subscript  $I$ ) with, for simplicity, zero net foreign assets ( $f_I = 0$ ), zero inflation, a constant level of foreign exchange reserves,  $h_I$ , and a balanced budget. In this steady state,  $p_I = \varepsilon_I = \pi_I = 0$  and  $r h_I = g_I$ . Now assume that the government starts to pursue an inconsistent fiscal policy at  $t = 0$ , with the inflation target kept at  $\bar{p} = 0$  and  $g$  permanently increased to  $\bar{g} = 10\%$  of output. The time  $T$  at which the final steady state (subscript  $T$ ) is reached is endogenous. The same is true for final steady-state inflation,  $p_T = \varepsilon_T = \pi_T$ , which is a function of  $c_T^* = y^* + r f_T$  by  $p_T = \gamma \bar{g} / \alpha (y^* + r f_T) > p_I$ .

The mathematical and computational aspects of solving the model are discussed in Kumhof, Li, and Yan (2000). Parameter values are assigned according to table 1. Some parameters are calibrated using Brazilian data, since Brazil was one of the first emerging economies to adopt inflation targeting. For an emerging market, the real marginal cost of borrowing in international capital markets,  $r$ , is assumed to be given by the real Brady bond yield. In Brazil the nominal Brady yield has mostly fluctuated between 10 and 15 percent, which after adjusting for U.S. inflation suggests using  $r = 10$  percent. The inverse velocity,  $\alpha$ , is set equal to the ratio of the real monetary base to quarterly absorption in Brazil in 1996.<sup>5</sup> A 50 percent share of tradables in consumption is empirically reasonable (see De Gregorio, Giovannini, and Wolf, 1994). The nontradables and tradables endowments are normalized to 1. The parameters  $\alpha$  and  $\gamma$  imply  $m_I = 0.6$ . Central bank foreign

4. See Obstfeld (1986) for a discussion of this condition. It is highly relevant for emerging economies, which lose access to international capital markets during balance-of-payments crises, as documented by Calvo and Reinhart (2000b).

5. Brazilian absorption data are only available with a long lag.

**Table 1. Parameter Values for Dynamic Equilibrium**

<i>Parameter</i>	<i>Value</i>	<i>Description</i>
$p_I$	0% p.a.	Initial inflation target
$\bar{p}$	0% p.a.	New inflation target
$g_I$	0.02	Initial primary deficit
$\bar{g}$	0.20	New permanent primary deficit
$r$	10% p.a.	Real international interest rate
$\beta$	10% p.a.	Subjective discount rate
$\alpha$	0.3	Inverse velocity
$\gamma$	0.5	Share of tradable goods
$y$	1	Nontradables endowment
$y^*$	1	Tradables endowment
$f_I$	0	Initial net foreign assets
$h_I$	0.8	Initial reserves

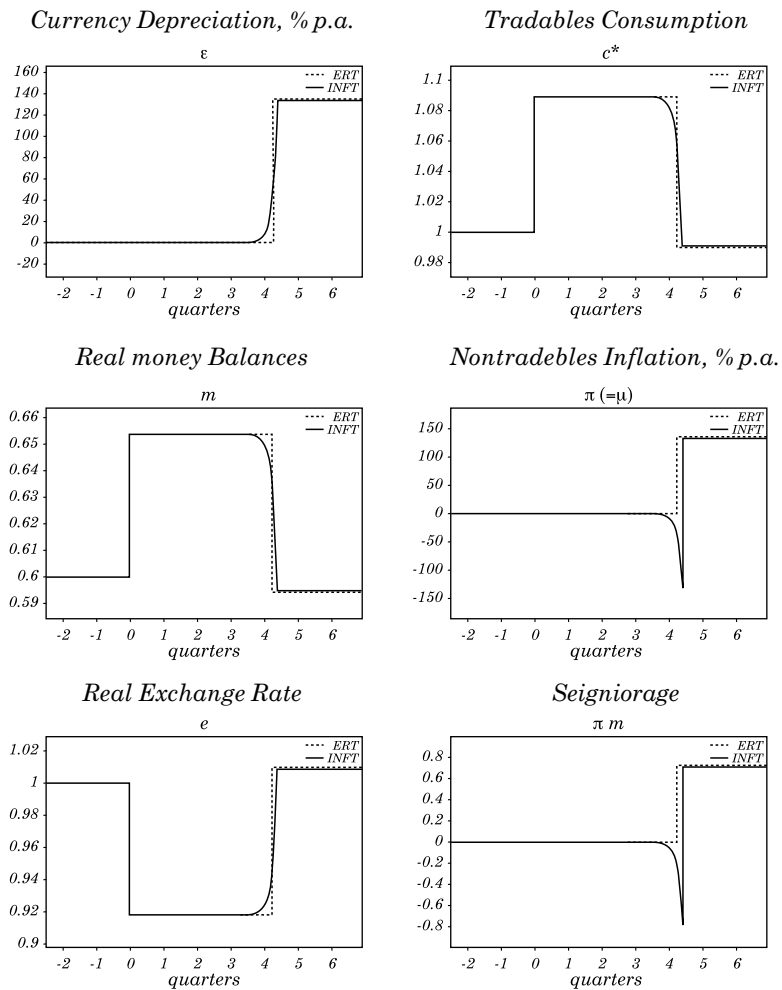
exchange reserves,  $h_p$ , are set at 0.8, based on the  $h/m$  ratio in Brazil in 1996. The logarithmic specification of the utility index is somewhat restrictive, as it implies an intertemporal elasticity of substitution of one. Empirical estimates of this elasticity are typically below one, as in Reinhart and Végh (1995), but Ogaki and Reinhart (1998) and Eckstein and Leiderman (1992) provide examples of estimates closer to one.

Figure 1 presents solution paths for inflation targeting  $\bar{p} = 0$  (the solid lines) and compares these to balance-of-payments crises under exchange rate targeting  $\bar{\epsilon} = 0$  (broken lines). The figure shows that the dynamics generated by collapsing exchange rates and inflation targets are quite similar. The collapse of the exchange rate target in a continuous time model happens instantaneously, while under inflation targeting reserve losses occur as flows. But for practical purposes this is not very different, because almost all reserve losses are concentrated in about one month before the end of the program. During that period the beginning exchange rate depreciation tends to drive the CPI inflation rate up. If the central bank is fully committed to defending the inflation target, it is then forced to allow a monetary contraction which generates an offsetting domestic deflation. The key to understanding the associated flow reserve losses is the seigniorage term in the government's budget constraint, which is shown as the final panel of figure 1:

$$\dot{m}_t + \varepsilon_t m_t = \mu_t m_t = \pi_t m_t .$$

Although in the final stages of the program the inflation tax compo-

**Figure 1. Crisis Dynamics under Inflation and Exchange Rate Targeting**



Source: Author's calculations.

ment of seigniorage,  $\varepsilon_t m_t$ , may increase, money demand falls so fast that overall seigniorage declines steeply, thereby accelerating reserve losses above those caused by the primary deficit,  $\bar{g}$ . This rapid reserve loss owing to a steep drop in private sector asset demands is the speculative attack. Figure 1 can also be used to infer a more general result regarding the vulnerability of different monetary regimes to specula-

tive attacks. The figure shows that the inflation target,  $\bar{p} = 0$ , collapses later than the exchange rate target,  $\bar{\varepsilon} = 0$ . This must be due to smaller reserve losses attributable to the speculative attack, given that reserve losses related to the government deficit per period are assumed to be equal. Under the money-targeting rule  $\bar{\mu} = 0$ , an attack would be completely impossible, meaning that reserve losses attributable to a speculative attack would be zero.<sup>6</sup> The crisis would therefore happen even later. The conclusion is that within the class of monetary policy rules that target the growth rate of a single nominal variable, vulnerability to a speculative attack increases with the weight of the exchange rate in the target. That weight is lower under inflation targeting than under exchange rate targeting, but it is far greater than zero.

### 1.3 Summary

Inflation targeting is a commitment to achieve a certain path of the consumer price index. Given that in a small open economy this index is strongly influenced by the exchange rate, foreign exchange market intervention becomes a necessary part of monetary policy. That makes balance-of-payments crises possible. Such crises have quite similar dynamics to the collapse of a fixed exchange rate regime, with two important exceptions: the attack takes place over a short time period as opposed to instantaneously, and reserve losses attributable to the attack are smaller and increasing in the share of tradable goods in total consumption.

Policymakers in some, but by no means all, emerging economies that are currently implementing inflation targeting recognize the possibility of speculative attacks under this policy. For Chile, Morandé and Schmidt-Hebbel (1999) explicitly acknowledge the necessity of potentially heavy foreign exchange market intervention to defend the inflation target. Carstens and Werner (1999) state that Mexico's transition to full inflation targeting is slow precisely because policymakers find that they must allow frequent large shocks to the exchange rate to lead to deviations from the inflation target. On the other hand, this problem is not explicitly acknowledged by Tombini and Bogdanski (2000) for Brazil or by Uribe, Gomez, and Vargas (2000) for Colombia. Unless a country pursues the Chilean hard line, however, it is difficult to see how the credibility of the target can be established, given that otherwise the commitment to the target is contingent on the absence of specu-

6. The money-targeting rule is equivalent to targeting the nontradable goods price in the present model.

lative pressure. This should be a point of concern, because credibility of the nominal anchor continues to be a much more critical issue for monetary policy in emerging economies than it is in advanced economies. This lack of credibility, or more specifically the public's belief that monetary policy is not sustainable and is therefore temporary, is the subject of the next section.

## **2. LIMITED SUSTAINABILITY**

This section assesses the theoretical implications of using what the public perceives to be an unsustainable and therefore temporary inflation target to maintain a low rate of inflation in a small open economy with open capital account and sticky nontradable goods prices. Results can be compared with those of the well-established literature on exchange rate targeting and policy temporariness.<sup>7</sup>

The model builds on that of the last section, the main difference being that nontradables prices are now assumed to be sticky. A discrete time set-up is used to apply a convenient new computable general equilibrium method to the computation of equilibrium paths. This method has wide applicability to small open economy models, which are typically characterized by a personal discount rate equal to an exogenous world real interest rate, and consequently a nonhyperbolic steady state.<sup>8</sup>

The analysis shows that forward-looking inflation targeting alone results in indeterminacy of equilibrium paths (nonuniqueness). This problem does not arise if inflation targeting is defined as fixing the path of the price level. The main results of the section are driven by the fact that the consumer price index, which is the target variable in all current inflation-targeting regimes, is an average of relatively sticky domestic nontradable goods prices and more flexible, exchange-rate-driven tradable goods prices.

Limited sustainability of an inflation target is represented as public expectations that a low inflation period will be of limited duration, expectations which are assumed to be validated by the policymaker in equilibrium. As a result, nontradable goods inflation stays above the target at all times. In order to meet the target, the monetary authority is forced to reduce the rate of currency depreciation through a tight monetary policy. Especially toward the end of the program, this leads

7. See, for example, Calvo and Végh (1993, 1999).

8. See Kumhof (2000a, 2000b) for details.

to very large current account deficits, real appreciations, and domestic recessions in excess of those observed under exchange rate targeting. In addition, tradables consumption temporarily contracts after the collapse. The welfare losses of unsustainable inflation targeting exceed those of exchange rate targeting, the more so the higher is the degree of price stickiness.

These conclusions are closely related to the arguments of Masson, Savastano, and Sharma (1997). The seigniorage-driven negative fiscal effect of a lower inflation target is even worse than under exchange rate targeting as a result of the need for an especially tight monetary policy. The need to use the exchange rate in this way leads to an exacerbated real appreciation, clashing with the competing exchange rate or competitiveness objective.

The rest of the section is organized as follows. Subsection 2.1 develops the model. Subsection 2.2 discusses the uniqueness of equilibrium paths. Subsection 2.3 calibrates the model and computes the effects of unsustainable exchange rate targeting and inflation targeting programs on the paths of economic variables. Subsection 2.4 evaluates the welfare consequences of these policies. Subsection 2.5 concludes.

## 2.1 The Model

Consider a small open economy that consists of a government, a representative price-taking, infinitely lived household, and a continuum, indexed by  $j \in (0, 1)$ , of monopolistically competitive, infinitely lived firms that produce nontradable goods.

### Households

Households maximize lifetime utility, which depends on their consumption of homogeneous tradable goods,  $c_t^*$ , heterogeneous nontradable goods,  $c_t(j)$ ,  $j \in (0, 1)$ , and utility from leisure aggregated over heterogeneous occupations  $[1 - l_t(j)]$ ,  $j \in (0, 1)$ , where 1 is the fixed endowment of time per occupation and  $l_t(j)$  is heterogeneous labor. Their personal discount rate equals the constant real international interest rate,  $r > 0$ , as in section 1.

Aggregate nontradables consumption is given by

$$c_t = \left[ \int_0^1 c_t(j)^{\theta-1/\theta} \right]^{\theta/\theta-1}, \quad (9)$$

with elasticity of substitution  $\theta > 1$ . Let  $P_{N_t}(j)$  be the price of individual good  $c_t(j)$ . Then cost minimization implies

$$c_t(j) = c_t \left[ \frac{P_{N_t}(j)}{P_{N_t}} \right]^{-\theta}, \quad (10)$$

where the price index of nontradables  $P_{N_t}$  is

$$P_{N_t} = \left[ \int_0^1 P_{N_t}(j)^{1-\theta} \right]^{1/1-\theta}. \quad (11)$$

Households' objective function is

$$\text{Max} \sum_{t=0}^{\infty} \left( \frac{1}{1+r} \right)^t \left\{ \gamma \ln(c_t^*) + (1-\gamma) \ln(c_t) + \kappa \int_0^1 \ln[1-l_t(j)] dj \right\}. \quad (12)$$

Log consumption utility is a standard assumption in this literature.<sup>9</sup> Leisure utility is aggregated over all occupations. This means that the objective function 12 is that of the overall household sector, where households perfectly share through a set of contingent securities their idiosyncratic labor income risk. For every occupation,  $j$ , there is then a single household facing a single firm, which gives rise to a bilateral monopoly (whereas a continuum of households per occupation would give rise to a monopsony). It is well known that the allocation under a bilateral monopoly is indeterminate unless additional assumptions are made. I impose the competitive outcome, which makes the solution of this model identical to one in which firms are operated by yeoman farmers, as in Woodford (1996).

The nominal and real exchange rates are denoted by  $E_t$  and  $e_t = E_t/P_{N_t}$ . The rate of currency depreciation is  $\varepsilon_t = (E_t - E_{t-1})/E_{t-1}$  and nontradables inflation is  $\pi_t = (P_{N_t} - P_{N_{t-1}})/P_{N_{t-1}}$ . The real exchange rate evolution is governed by

$$\frac{e_t}{e_{t-1}} = \frac{1 + \varepsilon_t}{1 + \pi_t}. \quad (13)$$

9. See Bergin and Feenstra (2000); King and Wolman (1996).

Households receive a constant endowment of tradable goods,  $y^*$ , and government lump-sum transfers in terms of tradables,  $g_t$ . From firms they receive nominal wages,  $\int W_t(j) l_t(j) dj$ , and nominal lump-sum profit distributions,  $\int \Pi_t(j) dj$ . They hold two kinds of assets, real international bonds,  $b_t$ , and real money balances,  $m_t = M_t / E_t$ , with total assets of  $a_t = b_t + m_t$ . Uncovered interest parity is assumed to hold:  $(1 + i_t) = (1 + r)(1 + \varepsilon_{t+1})$ . Households face a cash-in-advance constraint on consumption  $m_t \geq \alpha(c_t^* + c_t / e_t)$ . It can be verified that this constraint holds with equality in equilibrium. When this is incorporated into their lifetime budget constraint, one obtains

$$\begin{aligned}
 (1+r)b_{-1} + \frac{m_{-1}}{1+\varepsilon_0} + \sum_{t=0}^{\infty} \left(\frac{1}{1+r}\right)^t & \left[ g_t + y^* + \frac{\int W_t(j) l_t(j) dj}{E_t} + \frac{\int \Pi_t(j) dj}{E_t} \right] \\
 = \sum_{t=0}^{\infty} \left(\frac{1}{1+r}\right)^t & \left\{ \left[ c_t^* + \frac{\int P_{N_t}(j) c_t(j) dj}{E_t} \right] \left( 1 + \alpha \frac{i_t}{1+i_t} \right) \right\}.
 \end{aligned} \tag{14}$$

The household’s problem is to maximize 12 subject to 14. The first-order conditions are 14 and

$$\frac{\gamma}{c_t^*} = \lambda \left( 1 + \alpha \frac{i_t}{1+i_t} \right), \tag{15}$$

$$\frac{c_t}{c_t^*} = e_t \frac{1-\gamma}{\gamma}, \text{ and} \tag{16}$$

$$w_t(j) = \frac{\kappa c_t \{ 1 + \alpha [ i_t / (1 + i_t) ] \}}{(1-\gamma)[1-l_t(j)]}, \tag{17}$$

where  $\lambda$  is the constant multiplier of the lifetime budget constraint, equation 14, equal to the shadow value of lifetime wealth, and

$w_t(j) = W_t(j)/P_{N_t}$  is the real wage in terms of nontradables in occupation  $j$ . Equation 15 shows that the current account is driven by intertemporal substitution owing to variations in the effective price of consumption, via either changes in nominal interest rates or in inverse velocity,  $\alpha$ . Equation 16 equates the marginal rate of substitution between tradables and nontradables to their relative price, the real exchange rate. Equation 17 equates the marginal consumption utility of extra nontradables earnings to the marginal disutility of additional labor supply, adjusted for the monetary distortion to the consumption-leisure choice.

### Definition of the Inflation Rate

The consumption-based price index is defined as in section 1. Foreign inflation is still set equal to zero in this section, but in section 3 below, I allow for it to be other than zero. The general formula for the index is therefore

$$P_t = (E_t P_t^*)^\gamma (P_{N_t})^{1-\gamma} \gamma^{-\gamma} (1-\gamma)^{-(1-\gamma)}. \quad (18)$$

In rate of change form this is

$$(1 + p_t) = (1 + \varepsilon_t)^\gamma (1 + \pi_t^*)^\gamma (1 + \pi_t)^{1-\gamma}, \quad (19)$$

where  $p_t = (P_t - P_{t-1})/P_{t-1}$  and  $\pi_t^* = (P_t^* - P_{t-1}^*)/P_{t-1}^*$ .

Inflation targeting is defined as a target path for  $P_t$ . Several recent papers advocate targeting nontradable goods prices, because under sticky prices, such a policy replicates the flexible price equilibrium. While theoretically very interesting, I consider this line of argument to be practically not very relevant for emerging markets for two reasons. First, constructing such an index is obviously difficult both because the availability of data in emerging markets is limited and, more fundamentally, because the model's clean separation of tradable goods with flexible prices and nontradable goods with sticky prices has no easily identifiable counterpart in the real world. The second—and more serious—difficulty with nontradable goods price targeting is policy credibility. Several Latin American countries have manipulated price indexes to meet policy targets in the past. That danger will be perceived to be far more serious with a new and badly understood index. The simple consumer price index,  $P_t$ , has a clear advantage in this respect.

## Technology and Pricing

Purchasing power parity is assumed to hold for tradable goods, and their international price level is normalized to one. This seems justified on the basis of the empirical evidence on tradables pass-through for emerging markets. Kumhof, Li, and Yan (2000) survey the limited evidence currently available, which finds far higher pass-through coefficients in emerging markets than in industrialized countries.

Firms producing nontradable goods have linear production functions,  $y_i(j) = l_i(j)$ , where  $j \in (0, 1)$ . They are price takers in the labor market and monopolistically competitive in the goods market, taking into account the goods demand defined in equation 10. Firms distribute all nominal profits  $\Pi_i(j)$  to households in a lump-sum fashion.

Following Calvo (1983), it is assumed that firms have infrequent opportunities to change their prices and that these opportunities arrive as exogenous processes, are independent across firms, and for each firm are independent of their last occurrence. Specifically, it is assumed that in each period the probability that any firm will be able to change its price is  $1 - \delta$ . The interval between price changes for an individual firm is therefore a random variable. With a continuum of firms, however,  $1 - \delta$  also represents the fraction of firms that can change prices in any period. Together with the assumptions of lump-sum profit distributions to households and perfect sharing of labor income risk among households, this implies that firm-specific uncertainty does not translate into aggregate income uncertainty for households. The model can therefore be solved under perfect foresight.

When the model is calibrated for a typical emerging market, it will display nonzero steady-state inflation. This possibility does not affect the original Calvo (1983) specification, but the fully microfounded version needs to be modified. I therefore allow today's price setters to both choose today's price level and change their price by the steady-state inflation rate,  $\pi_{ss}$ , every period thereafter, as in Yun (1996). Without this assumption, steady-state nontradables output would depend on steady-state inflation because of relative price dispersion effects. This would create an undesirable long-run monetary nonneutrality.

Following Rotemberg (1982) and Walsh (1998), it is further assumed that each firm,  $j$ , that does get an opportunity to change its price sets it to minimize a quadratic loss function that depends on the discounted sum of expected percentage differences between its prices in future periods,  $t$ , namely,  $P_{N_t}(j)$ , and its optimal prices in those periods,  $P_{N_t}^+$ . Let

$(1+r_t^n) = (1+r_t)(1+\varepsilon_{t+1})/(1+\pi_{t+1})$ , and let  $R_{0,i} = \prod_{s=0}^{i-1} (1+r_s^n)^{-1}$  for  $i \geq 1$ , ( $R_{0,0} = 1$ ) be the period  $i$  discount factor for nontradables. Then firms' problem is

$$\text{Min } \frac{1}{2} E(t) \left\{ \sum_{i=0}^{\infty} R_{0,i} \left[ \ln P_{N_{t+i}}(j) - \ln P_{N_{t+i}}^+ \right]^2 \right\}. \quad (20)$$

Here  $E(t)$  denotes the expectations operator, conditional on information available at time  $t$ . The optimal price,  $P_{N_t}^+$ , is the period  $t$  flexible price profit-maximizing price taking as given the current aggregate price level  $P_{N_t}$  and labor supply equation 17. It does not have a firm-specific index because all firms determining this price will choose identically. I define the markup  $\mu = \theta / (\theta - 1)$  and let the optimal choice of relative price be  $Q_t \equiv P_{N_t}^+ / P_{N_t}$ .

Equation 20 implies  $P_{N_t}^+ = Q_t P_{N_t}$ . When this is combined with the exogenous arrival rate of price changing opportunities  $(1 - \delta)$ , the firm's objective function becomes

$$\text{Min}_{P_{N_t}(j)} \frac{1}{2} \left\langle \sum_{i=0}^{\infty} \delta^i R_{0,i} \left\{ \ln \left[ P_{N_t}(j) (1 + \pi_{ss})^i \right] - \ln Q_{t+i} P_{N_{t+i}} \right\}^2 \right\rangle \quad (21)$$

The first-order condition of this problem can be combined with the aggregate price index  $P_{N_t}^{1-\theta} = \delta P_{N_{t-1}}^{1-\theta} + (1-\delta) X_t^{1-\theta}$ , where  $X_t$  is the optimal choice of  $P_{N_t}(j)$ , and log-linearized to obtain the familiar new-Keynesian Phillips curve. Let log deviations be denoted by a hat above the relevant variable. For rates of price change,  $x$ ,  $\hat{x}_t = \ln(1+x_t) - \ln(1+x_{ss})$ , while for all other variables,  $y$ ,  $\hat{y}_t = \ln(y_t) - \ln(y_{ss})$ . Again after some algebra, this yields

$$\beta_1 \hat{\pi}_{t+1} - \hat{\pi}_t = -3\beta_2 \hat{c}_t - 2A\beta_2 \hat{\varepsilon}_{t+1}, \quad (22)$$

where  $\beta_1 = 1 / (1+r)$ ;  $\beta_2 = [(1-\delta) / \delta(2+\theta)]$ ; and  $A = \alpha / (1+i_{ss} + \alpha i_{ss})$ .

Equations 13, 15, and 22, plus an equation for determining  $\lambda$  through first-order condition 15 and the aggregate budget constraint (see below), constitute the system of equations that governs the dynamic behavior of this economy. Starting from an initial steady state, this system will be subjected to a shock in the form of a change in the exog-

enous monetary policy target. Under exchange rate targeting, this target is  $\varepsilon_t$ , while the inflation rate,  $p_t$ , is endogenous. Under inflation targeting,  $\varepsilon_t$  becomes endogenous and must be replaced in all equations, according to equation 19, by  $(1 + \varepsilon_t) = (1 + p_t)^{1/\gamma} / (1 + \pi_t)^{(1-\gamma)/\gamma}$ , with  $p_t$  as the new target.

Finally, it can be shown that  $Q_{ss} = 1$ , which means that steady-state nontradables output and consumption are given by

$$c_{ss} = l_{ss} = \frac{1}{1 + [(\kappa\mu)/(1 - \gamma)] \{1 + \alpha [i_{ss} / (1 + i_{ss})]\}} \quad (23)$$

This depends negatively on the steady-state nominal interest rate, because of the distortion in the consumption-leisure choice introduced by the presence of money. Realistic calibrations of emerging economies must take this rate to be far above zero, which implies that steady-state nontradables output is far below the Friedman rule optimum.

### Government and Aggregate Budget Constraint

It is assumed that the government redistributes to households, over their lifetime, the proceeds from money creation and its initial net wealth:

$$(1 + r)h_{-1} - \frac{m_{-1}}{1 + \varepsilon_0} + \sum_{t=0}^{\infty} \left(\frac{1}{1 + r}\right)^t m_t \frac{i_t}{1 + i_t} = \sum_{t=0}^{\infty} \left(\frac{1}{1 + r}\right)^t g_t \quad (24)$$

This implies that monetary policy has no wealth effects. The economy's overall budget constraint is then obtained as

$$(1 + r)f_{-1} + y^* \left(\frac{1 + r}{r}\right) = \sum_{t=0}^{\infty} \left(\frac{1}{1 + r}\right)^t c_t^* \quad (25)$$

with current account  $f_t - f_{t-1} = r f_{t-1} + y^* - c_t^*$ .

### 2.2 Uniqueness of Equilibrium Paths

The existence of unique convergent equilibrium paths is of more than academic interest. A monetary policy rule or nominal anchor is only useful if it makes (rational) expectations converge on a unique equilibrium path, given the sequence of shocks to which the economy is subjected. This is a nontrivial exercise for the present case, as the small

open economy contains one unit root and is therefore situated at a nonhyperbolic steady state.<sup>10</sup> It can be shown that the dynamic system can be represented by the laws of motion for three variables,  $c_t^*$ ,  $e_t$ , and  $\pi_t$ , characterized by one unit root, one root inside the unit circle, and one outside. Under both inflation targeting and exchange rate targeting,  $\pi_t$  is a free variable. The unit root is attributable to net foreign assets and thus to  $c_t^*$ , which is a free variable but can be tied down by the lifetime budget constraint. The requirement for saddle path convergence is therefore that the real exchange rate be a predetermined variable. Remember that

$$e_t = e_{t-1} \left( \frac{1 + \varepsilon_t}{1 + \pi_t} \right) = e_{t-1} \left( \frac{1 + p_t}{1 + \pi_t} \right)^{1/\gamma}. \quad (26)$$

For  $e_t$  to be predetermined,  $\varepsilon_t$  must be determined by monetary policy at all times under exchange rate targeting, while  $p_t$  must be determined at all times under inflation targeting. Because exchange rate rules generally do specify a path for levels of the exchange rate,  $\{E_\tau\}_{\tau=t}^\infty$ , such targets are consistent with a unique convergent equilibrium path. The same is not evident from the policy debate about inflation targeting, however, given that policy rules are often implied to be pure forward-looking rules for the rate of change of the price level,  $\{p_\tau\}_{\tau=t+1}^\infty$ , and price level surprises are dealt with by the rule of letting bygones be bygones. This implies indifference about  $p_t$ , meaning that any real exchange rate is possible today; and, of course, the story repeats itself at any future time. This is not consistent with a unique convergent equilibrium path. What is required is a target path for price levels,  $\{P_\tau\}_{\tau=t}^\infty$ , and this is how inflation targeting is defined in the remainder of the paper.

### 2.3 Policy Experiments, Calibration, and Discussion of Solution Paths

Under the assumptions of the model, particularly full lump-sum redistribution of seigniorage, a permanent, sustainable reduction in an exchange rate target or inflation target results in an instantaneous downward jump in nontradable goods inflation at an unchanged real exchange rate. In the absence of sustainability problems, the choice of

10. See Kumhof (2000a, 2000b) for the technical details.

nominal anchor is immaterial for the outcome. This section therefore focuses on programs that are characterized by a perceived lack of sustainability. The public simply may not believe, and cannot be forced to believe, that the government will permanently maintain the lower level of public spending required by lower seigniorage revenue. Following the literature on exchange rate targeting, this is modeled as policy temporariness, and the public's expectations are taken to be exogenous. It is not conceptually difficult to endogenize expectations for the case of fiscal problems, along the lines of section 1. In the present case of sticky prices, however, this would greatly complicate the model and computations without adding much insight.

It is assumed that the economy starts with and is expected by the public to eventually revert to a high exchange rate target,  $\varepsilon^H$ , or inflation target,  $p^H$ . The public expects a new lower target  $\varepsilon^L < \varepsilon^H$  or  $p^L < p^H$  to be temporary, where  $\varepsilon^H = p^H$  and  $\varepsilon^L = p^L$ .<sup>11</sup> The experiments discussed below maintain  $\varepsilon^L$  or  $p^L$ , without loss of generality, for a fixed period  $t \in [0, T_\varepsilon)$  or  $t \in [0, T_p)$ , where  $T_\varepsilon = T_p = T$  equals four or twelve quarters.

Monetary policy under CPI inflation targeting differs from money or exchange rate targeting in one very important respect. While a central bank can directly control either the growth rate of nominal money balances or the rate of change of the exchange rate, the CPI must be controlled indirectly. As set out in equation 19, the exchange rate has to be consistent with the CPI inflation target given the behavior of nontradables inflation, which precludes an independent exchange rate target. The nominal money supply must be set so as to achieve this exchange rate. There can therefore be no announced target rate for the direct instruments of monetary policy, as both are subordinated to the CPI target. Their dynamic time paths will be endogenously determined.

Table 2 summarizes the parameter values chosen for the calibration exercise. The time unit is one quarter. The benchmark case is specified as a policy duration of  $T = 12$  quarters and firms' probability of not being able to change their price of  $\delta = 0.75$ , corresponding to an average contract length of one year. In other dimensions, the calibration reflects the likely magnitude of an inflation targeting program in today's emerging economies. The final steady-state inflation rate is 40 percent, with a target inflation rate of 10 percent, which is very close to the current Brazilian and Mexican targets. I set  $r = 10$  percent,  $\alpha = 0.3$ ,

11. Assumptions about the public's expectations are restricted by the requirement that nonnegative nominal interest rate paths must obtain in equilibrium. For the inflation targeting case, this rules out certain extreme beliefs.

**Table 2. Parameter Values for Calibration Exercise**

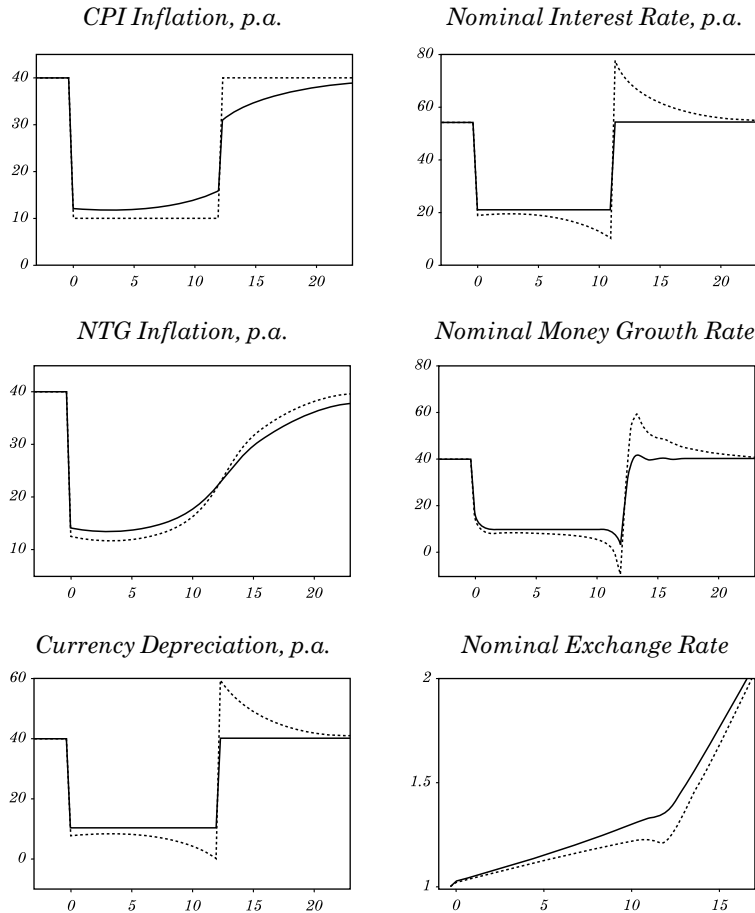
<i>Parameter</i>	<i>Value</i>	<i>Description</i>
$T$	4 /12 quarters	Duration of temporary programs
$\varepsilon^H = p^H$	40% p.a.	Steady state exchange rate / inflation targets
$\varepsilon^L = p^L$	10% p.a.	Transitional exchange rate / inflation targets
$r$	10% p.a.	International real interest rate
$\theta$	4.33	Own price demand elasticity
$\delta$	0.75	Probability of not being able to change price
$\alpha$	0.3	Monetary base to consumption ratio (Brazil)
$\gamma$	0.5	Share of tradables in consumption
$c_{ss}$	1/3	Proportion of time working in steady state
$f_0$	0	Initial net foreign assets

and  $\gamma = 0.5$ , as in the previous section. The functional form of the utility function is close to King and Wolman (1996), except that aggregate consumption is here split into tradables and nontradables components and labor is heterogeneous. Initial net foreign assets are assumed to be zero.

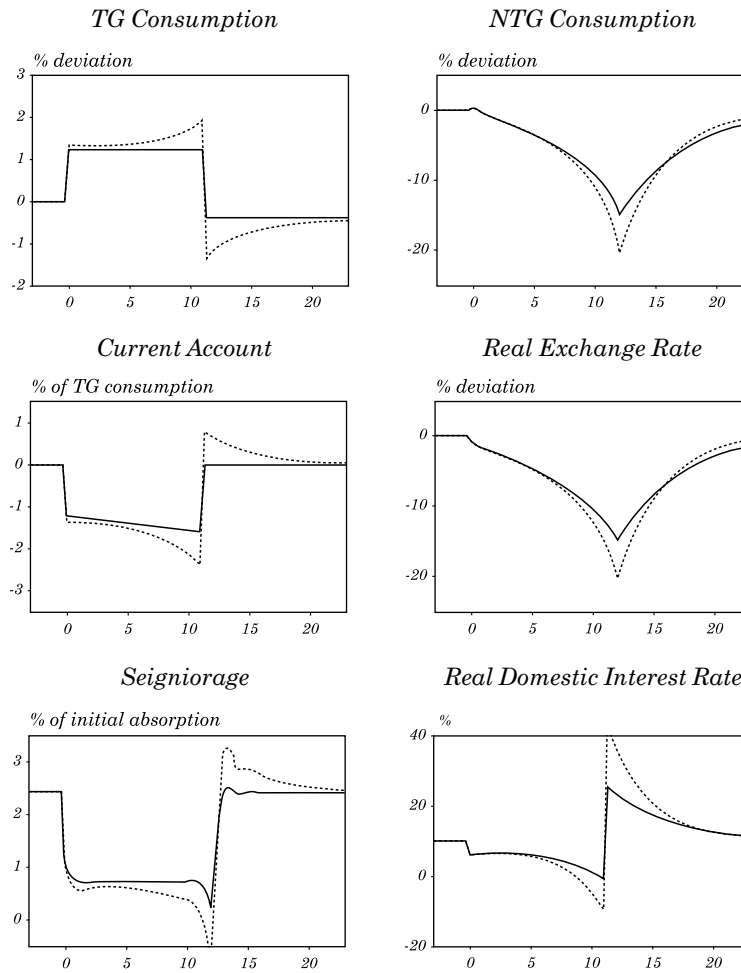
In figure 2 the solid line represents exchange rate targeting (ET) and the dashed line inflation targeting (IT). The unit along the horizontal axis is quarters, with 0 representing the time of announcement of the program. Because this is a forward-looking model, the value of the exchange rate or inflation target before time 0 is, in fact, immaterial.

The performance of the two policies is generally very similar in the initial phase of the program, but strong differences emerge around the time of collapse. Limited sustainability in both cases implies that in anticipation of a future collapse of the program, nontradable goods inflation never drops to the new lower target. However, maintaining CPI inflation at its target requires that the average of nontradable goods inflation and currency depreciation equals the lower target. The exchange rate therefore has to compensate by depreciating more slowly than the CPI inflation rate. In some cases this effect may be so extreme that the currency actually has to appreciate for much of the transition. This significantly exacerbates the real effects observed under noncredible exchange rate targeting. The very much lower nominal interest rate drives up tradables consumption and causes a larger current account deficit. Furthermore, the combination of relatively high nontradables inflation and low currency depreciation appreciates the real exchange rate very rapidly, by ultimately around 20 percent. This is accompanied by a very deep nontradables recession, in which output falls by over 20 percent.

**Figure 2. Solutions for Benchmark Case**



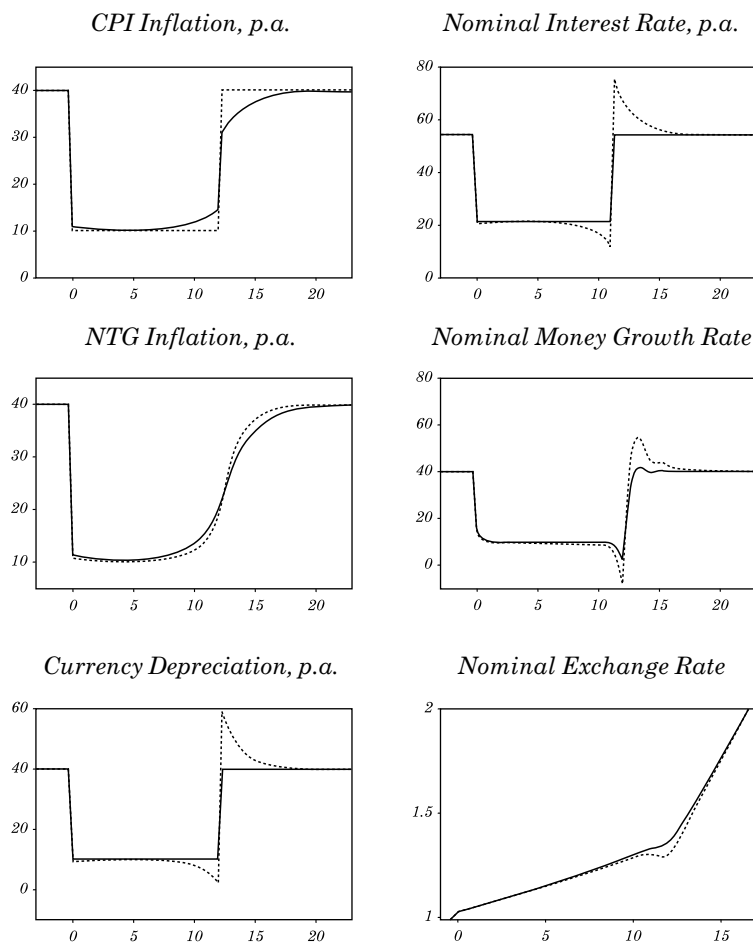
All of these effects become particularly severe just before the collapse of the program, when nontradables inflation rises more quickly in anticipation of the imminent reversion to a high-inflation regime. On the collapse of the program, however, the higher steady-state inflation rate is not immediately attained in that sector, where inflation now approaches the higher target from below. This requires a large upward jump in the rate of currency depreciation and nominal interest rate at that time, after which they approach the new higher target from above. A temporary tradables recession and a positive current account therefore follow the collapse.

**Figure 2. (continued)**

Source: Author's calculations.

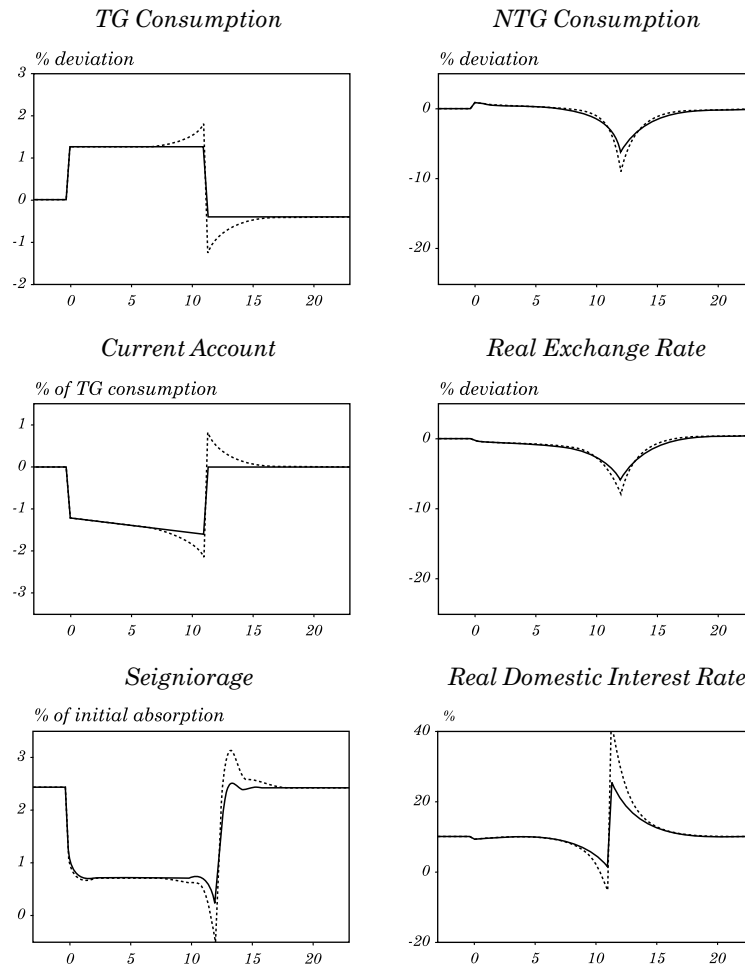
These distortions are the result of the monetary policy required to sustain a low CPI inflation rate in the face of a public perception of limited sustainability. When nontradables inflation fails to drop to the lower target, monetary tightening to reduce exchange rate depreciation is the endogenous policy response. This is reflected in a far slower and mostly negative money growth rate during the transition, which results

**Figure 3. Solutions for More Flexible Prices**



in a more appreciated path of the nominal exchange rate. Monetary policy under inflation targeting therefore requires much larger swings in money growth and therefore also in seigniorage income. Both cases feature a severe contraction in this source of government revenue, from around 2.5 percent of initial real absorption to less than 1 percent. In the case of inflation targeting, the necessary monetary contraction is so severe that seigniorage actually turns negative during the transition.

Figures 3 and 4 analyze different degrees of price stickiness and policy duration. When price adjustment is faster than in the bench-

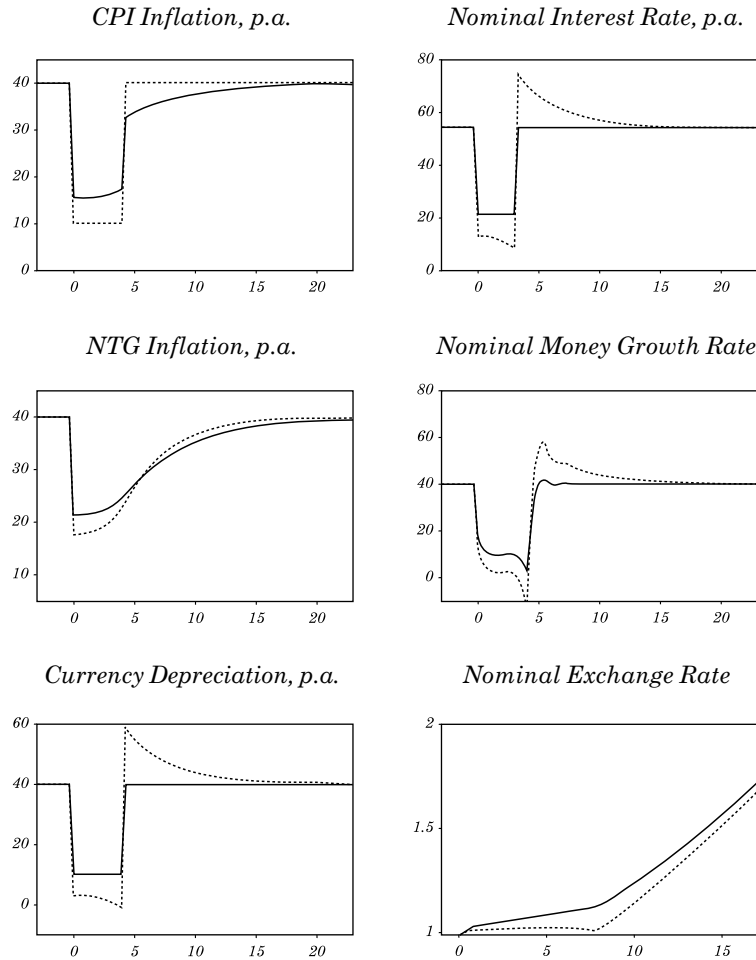
**Figure 3. (continued)**

Source: Author's calculations.

mark case ( $\delta = 0.5$ ) but policy duration is the same, the policy based on an inflation target looks very similar to that based on the exchange rate during much of the program, except again for a few months before and after the collapse.

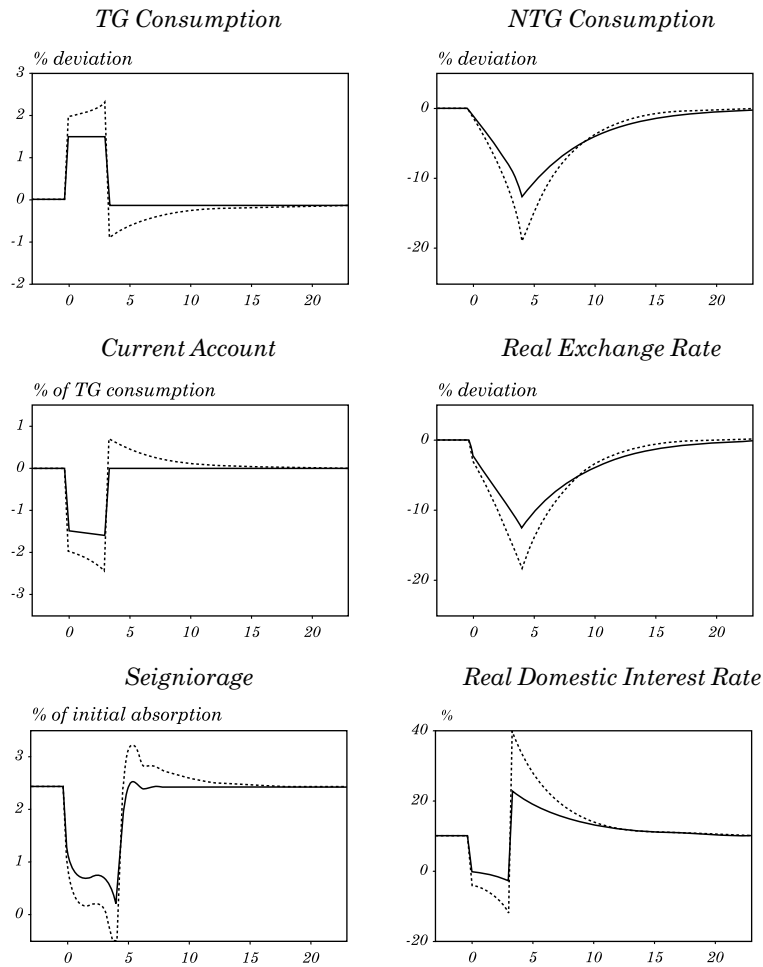
I conclude this subsection with some supporting evidence, using Mexican data for 1997–2000. Figure 5 below shows that Mexican inflation rates and real exchange rate data are consistent with the above story. It shows

**Figure 4. Solutions for Shorter Policy Duration**



the Mexican annual inflation target plotted against currency depreciation (three-month moving average) and CPI inflation. During the Russian crisis, the exchange rate was allowed to depreciate far faster than what was consistent with the inflation target, and high pass-through ensured that the inflation target was not met in the following months. Ever since then, exchange rate depreciation has almost continuously been below the inflation target to ensure that it was met. The result was, as the second panel shows, a very pronounced real appreciation.

Figure 4. (continued)

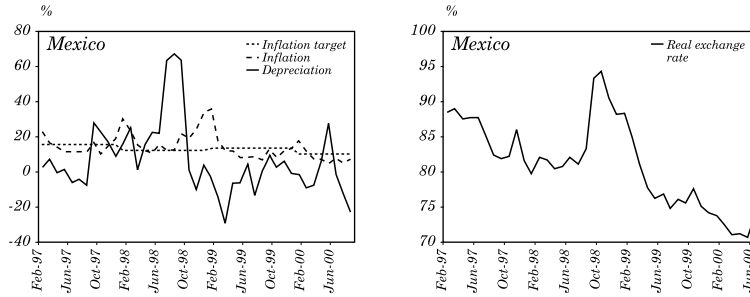


Source: Author's calculations.

## 2.4 Welfare

The welfare loss of an unsustainable program is defined, following Lucas (1987), as the percentage reduction,  $\eta$ , in the prestabilization steady-state streams of tradables and nontradables consumption,  $\bar{c}_{ss}^*$  and  $\bar{c}_{ss}$ , that makes households indifferent between the reduced constant streams of consumption, with leisure unchanged, and the streams of consump-

**Figure 5. Mexico - Inflation and Real Exchange Rate**

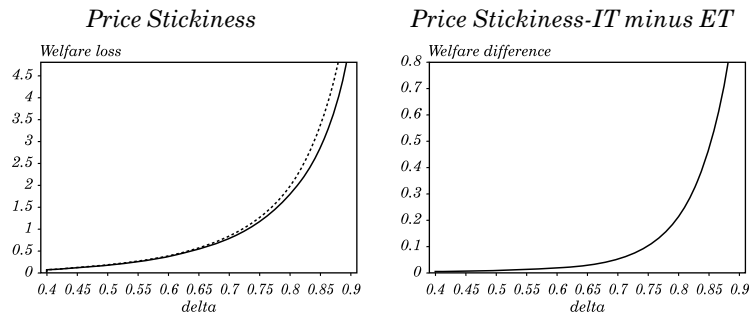


tion and leisure obtained as a result of the stabilization program  $\{c_t^*, c_t, [1 - l_t(j)], j \in (0, 1)\}_{t=0}^{\infty}$ . This computation is complex for the above economy, as at any time there is a large number of cohorts of firms and workers characterized by different relative prices and equilibrium labor supply. The solution is therefore approximated by evaluating utility for the thirty most recent cohorts, which account for more than 99.99 percent of the overall distribution of relative prices. Figures 6 and 7 present the results. Figure 6 holds policy duration at its benchmark value of  $T = 12$  quarters and varies  $\delta$  between 0.4 and 0.8. Figure 7 holds  $\delta$  at its benchmark value and varies policy duration between 1 and 20 quarters. The main result is that unsustainable inflation-targeting programs always involve slightly larger welfare losses than unsustainable exchange-rate-targeting programs. The difference is largest for high price stickiness. Overall losses become very small as  $\delta$  falls below 0.5. Programs suffering from very low sustainability involve smaller losses, as distortions are limited to a very short period.

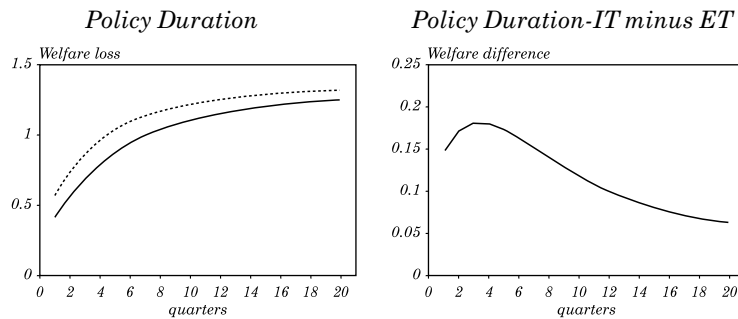
### 2.5 Summary

The analysis presented in this section indicates that the performance of inflation targeting is slightly inferior to that of exchange rate targeting when fiscal sustainability is limited. Nominal and real variables display larger and more persistent deviations from their steady-state values under inflation targeting, and welfare is lower.

Perhaps one should stress the similarities more than the differences. The performance of two target price indexes that are heavily driven by the exchange rate turns out to be very similar. The only differences are due to differences in the extent of exchange rate dependence, which are not that large in a small and very open economy.

**Figure 6. Welfare Losses and Price Stickiness**

Source: Author's calculations.

**Figure 7. Welfare Losses and Policy Duration**

Source: Author's calculations.

Nevertheless, the inferior performance of inflation targeting carries an important lesson. Lack of policy sustainability is rarely studied in evaluations of different monetary policy rules, although it produces different rankings among policies than the more conventional analysis of monetary policy performance under exogenous shocks. The latter is, of course, the relevant concern for industrialized countries, where inflation targeting originated. But that is precisely the problem with the current debate, in which lessons learned in the industrialized world are applied to emerging markets while important characteristics that distinguish the latter are potentially overlooked. In many of the successful cases in industrialized economies, either sustainability was not a big issue to start with, or monetary policy changes were combined with fiscal improvements that improved sustainability. Whether lasting improvements are likely to be observed in emerging economies must at this point re-

main open to question. Even if such improvements are ultimately achieved, a perceived lack of sustainability in the transition period, until the public is finally convinced of the program's feasibility, may give rise to the above described dynamics for a prolonged period. Caution is therefore in order when applying the lessons learned from existing inflation targeting programs to a new and very different economic environment.

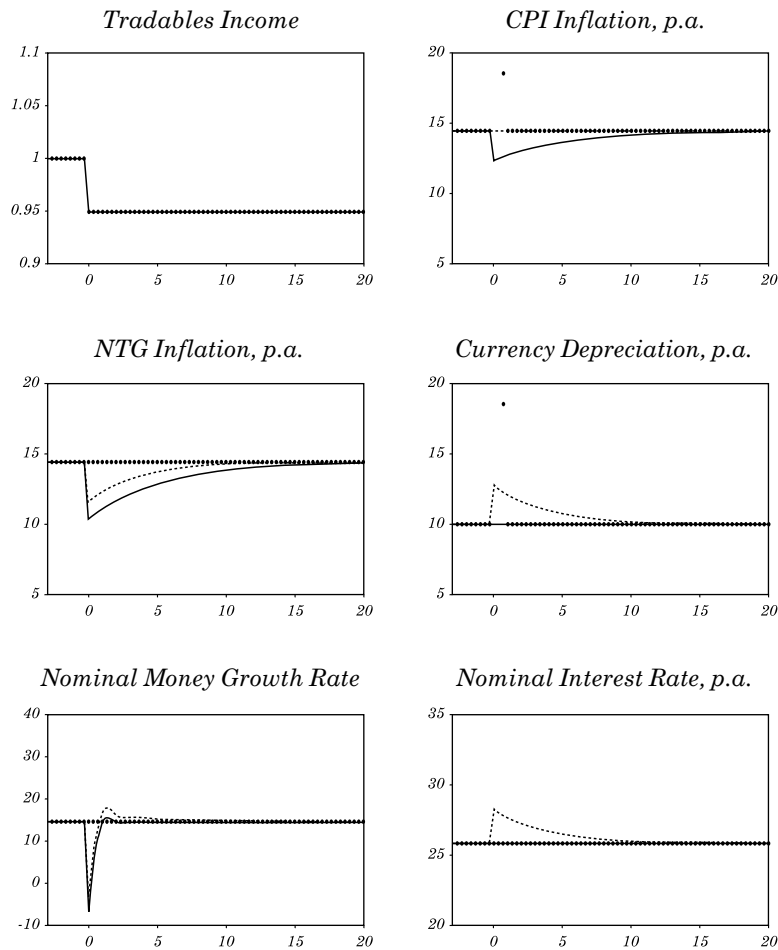
### 3. EXOGENOUS SHOCKS

This section assumes perfect sustainability of monetary policy and evaluates the performance of different monetary regimes under exogenous shocks. The framework used is identical to that of section 2, except that I now allow for time-varying real international interest rates,  $r_t$ , international inflation,  $\pi_t^*$ , inverse velocity,  $\alpha_t$ , and tradables income,  $y_t^*$ , where the latter can be interpreted as a simplified representation of terms-of-trade shocks. In addition, a third monetary policy, which targets the money growth rate, is analyzed. This permits another contribution to the policy debate, given that much of the economic intuition about flexible exchange rates derives from this case and not from inflation targeting. I conclude that the behavior of strict inflation targets is much closer to exchange rate targets than to this original notion of flexible exchange rates. The flexibility of exchange rates is largely an illusion if an inflation target is rigidly pursued, since that target tightly constrains exchange rate flexibility. Of course, this is not the case if what is really meant by inflation targeting is discretionary monetary policy.

Emerging economies, much more than industrialized countries, frequently face the problem of adjusting to very large exogenous shocks, and it is in these situations that the choice of exchange rate regime is deemed especially critical. The methodology employed here lends itself to studying the adjustment mechanism to large exogenous shocks, with the help of impulse responses as in section 2. A full stochastic analysis requires a different methodology. Schmitt-Grohé and Uribe (2001) conduct such an analysis for the case of Mexico.

Four shocks are analyzed in detail. Figure 8 presents a 5 percent permanent decrease in tradables endowment,  $y_t^*$ , which can be interpreted as a negative terms-of-trade shock. Figure 9 analyzes a jump of the real international interest rate from 10 percent to 15 percent, followed by a gradual return to 10 percent, and figure 10 shows a jump in international inflation from 4 percent to 8 percent, again followed by a gradual return to its original value. Figure 11 illustrates the consequences of a permanent 10 percent increase in money demand via an increase in

**Figure 8. Tradables Endowment Shock: 5% Drop in TG Endowment**

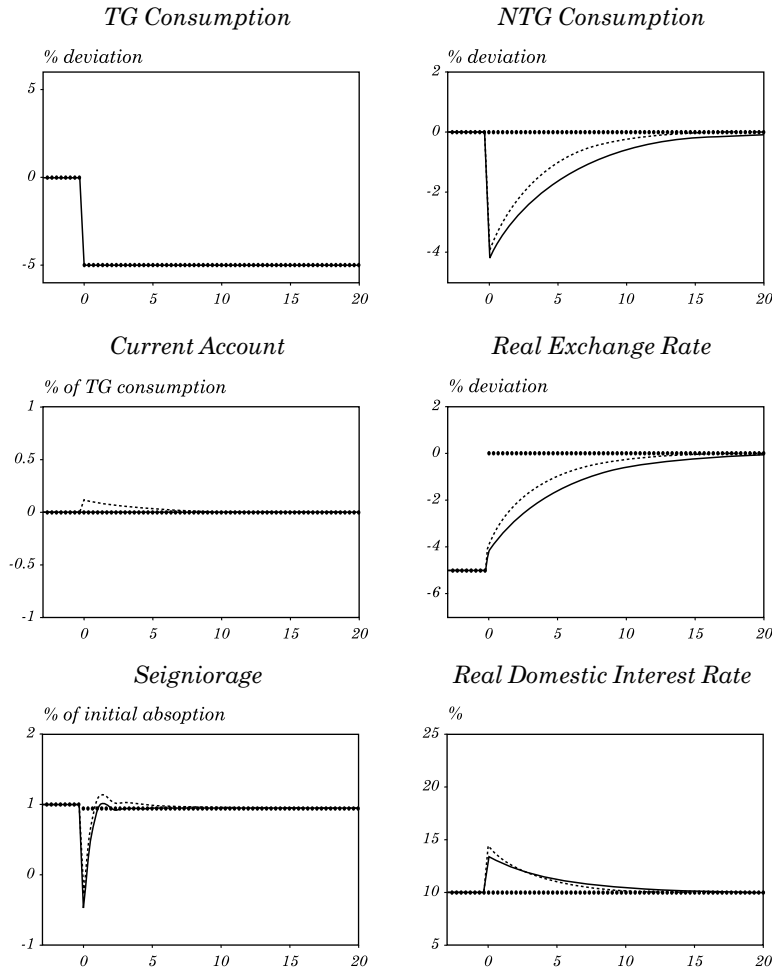


the parameter  $\alpha$ . In the figures, the first panel shows the exogenous shock and the remaining panels show the induced response of the economy.

### 3.1 Discussion of Solutions

What is most striking about these results is just how similarly inflation targets and exchange rate targets perform under foreign real shocks. Negative shocks to tradables income (terms-of-trade shocks) and real

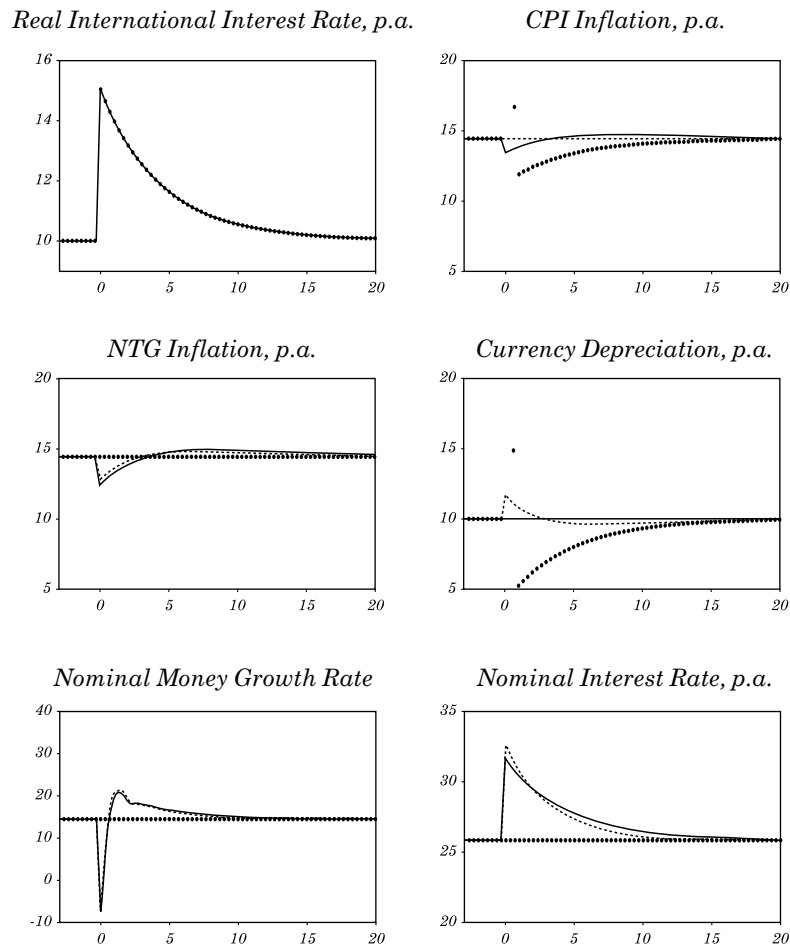
Figure 8. (continued)



Source: Author's calculations.

interest rate shocks require large initial downward jumps in tradables consumption. Under fixed exchange rates this requires an accompanying deep nontradables recession, because the real exchange rate is predetermined. The recession eventually leads to the required real exchange rate depreciation through a slowdown in nontradables inflation. More nominal—and therefore real—exchange rate flexibility would ensure that the nontradables sector remained closer to steady-state output at all times.

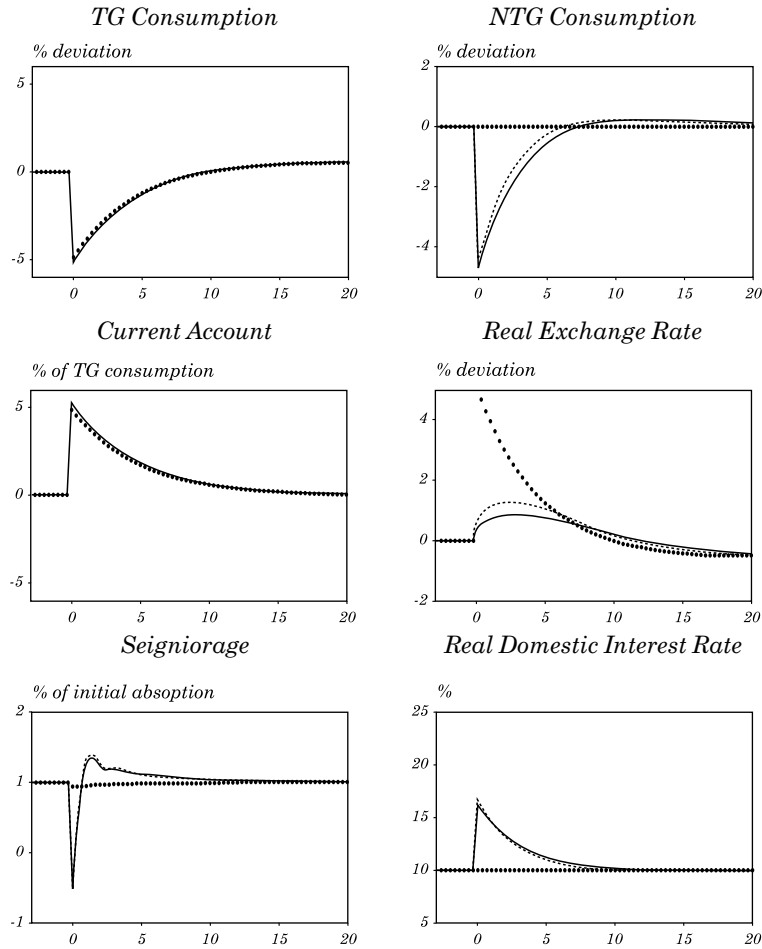
**Figure 9. Real International Interest Rate Shock: 5% Increase in Real Interest Rate**



However, strict inflation targeting does not give the economy much greater real exchange rate flexibility, most importantly because exchange rate depreciation is constrained by the requirement of meeting the inflation target. The real counterpart of this is that there is also a nontradables recession under inflation targeting.

In contrast, the money growth rate targeting case corresponds exactly to our intuition about flexible exchange rates. The real exchange rate can instantaneously jump to a new level, leaving the nontradables

Figure 9. (continued)

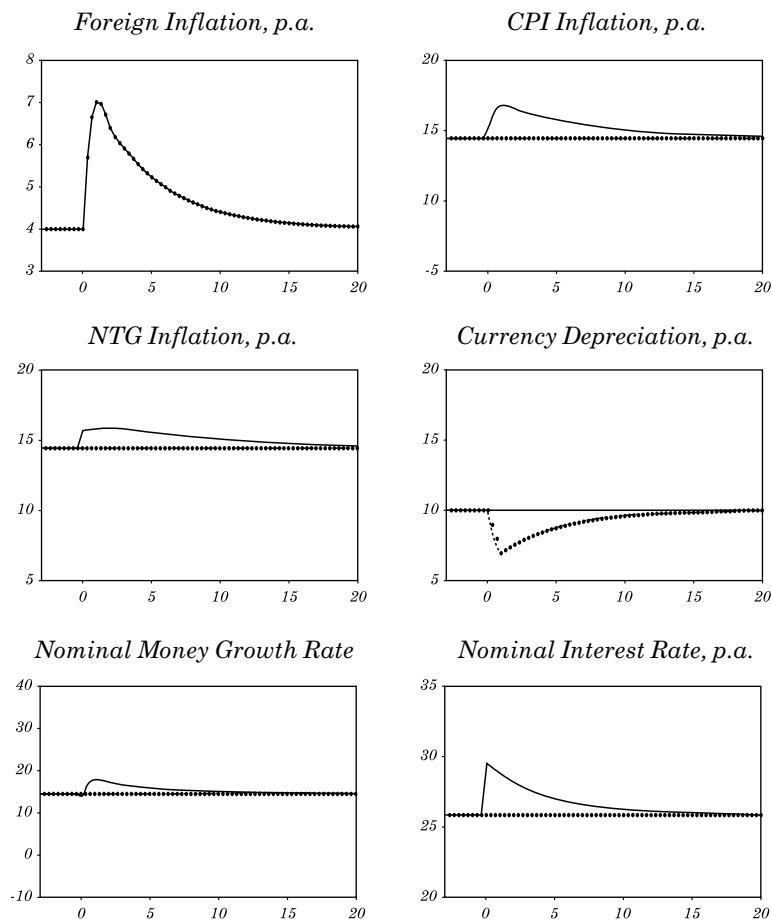


Source: Author's calculations.

sector at its steady-state level at all times. Under a real interest rate shock, overshooting of the exchange rate permits a subsequently low rate of depreciation that exactly offsets the higher real interest rate, leaving the nominal interest rate constant at all times.

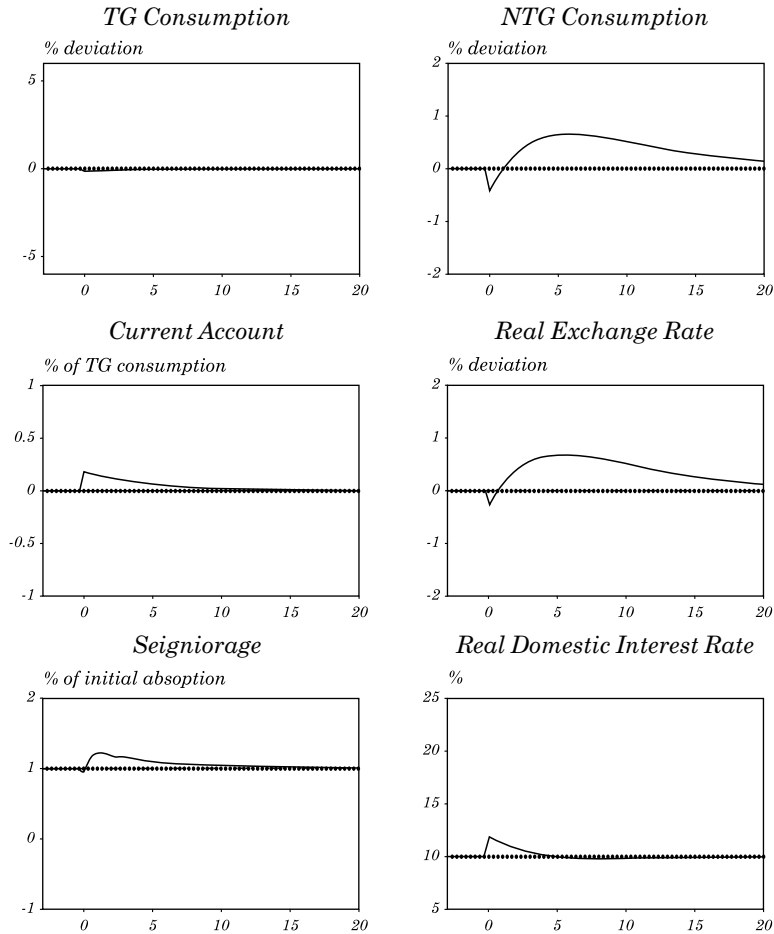
The one case in which inflation targeting is just as effective as money targeting and clearly superior to exchange rate targeting is a foreign inflation shock. Both inflation-targeting and money-targeting regimes respond with a downward and exactly offsetting jump in

**Figure 10. International Inflation Shock: 3% Increase in Foreign Inflation, p.a.**



exchange rate depreciation, leaving the nominal interest rate and all real variables unchanged. The response of an exchange rate target is quite complex. On impact the higher nominal interest rate depresses nontradables output through the consumption-leisure distortion. This leads to slower nontradables than foreign inflation, so that the real exchange rate starts to depreciate and the nontradables recession quickly turns into a prolonged expansion. The real effects, however, are small compared to those of a real interest rate change.

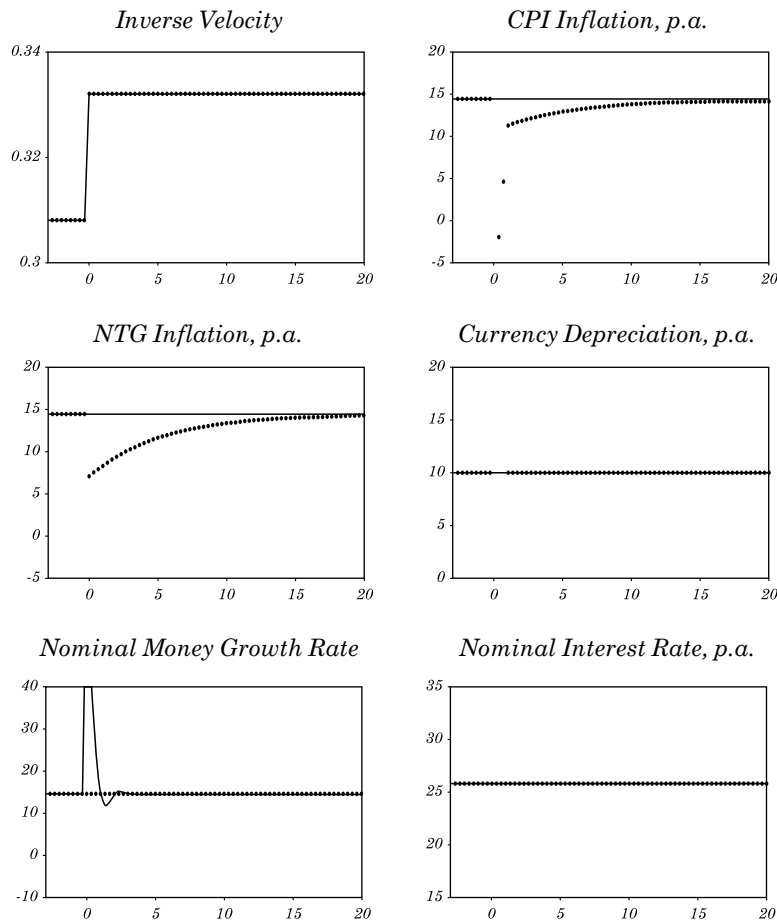
Figure 10. (continued)



Source: Author's calculations.

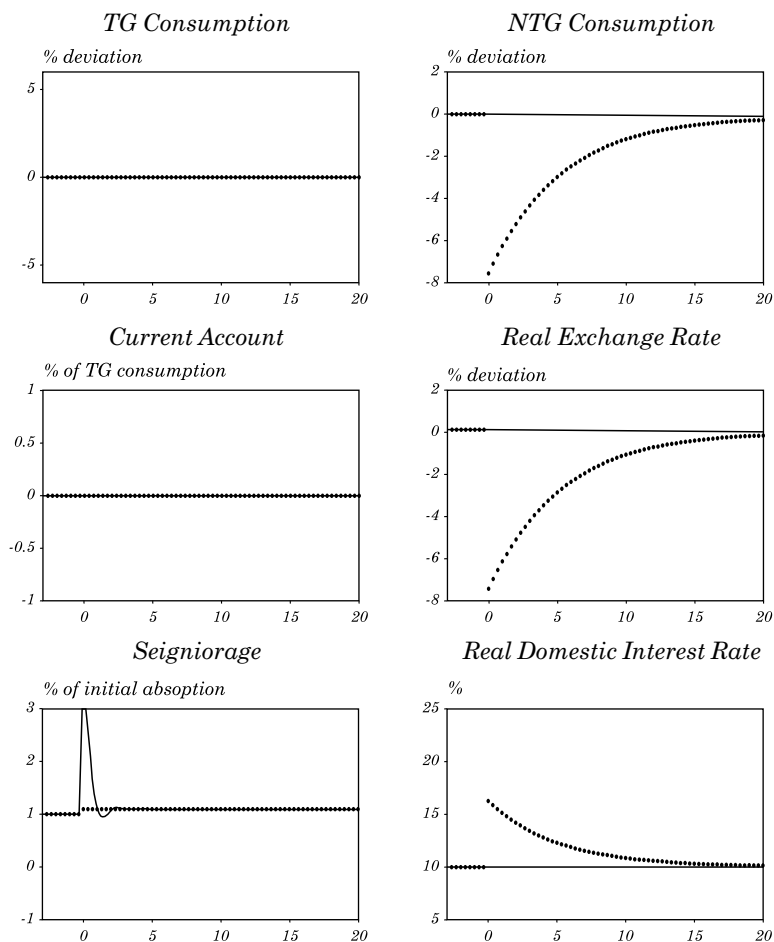
Conventional wisdom in open economy macroeconomics holds that flexible exchange rates perform badly under money demand shocks. Figure 11 shows that this is indeed true for money targeting, in that an increase in money demand leads to a deep nontradables recession. Because monetary accommodation is ruled out, the recession is necessary to generate the slowdown in nontradables inflation that brings real money balances in terms of nontradables into line with higher steady-state demand. The vulnerability of money tar-

**Figure 11. Increase in Inverse Velocity: 10% Increase in Money Demand**



gets to volatility in the velocity of money, which is very common empirically, is the main reason why this monetary regime is no longer practiced in all but a handful of countries. The same is not at all true, however, when flexible exchange rates stand for inflation targeting. An inflation target performs almost identically to an exchange rate target, this time to its advantage. Under both regimes, the monetary authority is not prevented from satisfying the increase in money demand by injecting extra money.

**Figure 11. (continued)**



Source: Author's calculations.

To summarize, purely in terms of the adjustment to exogenous shocks, the differences between inflation targeting and exchange rate targeting appear small. The one exception is a foreign inflation shock. To further quantify the differences, I now turn to welfare analysis.

### 3.2 Welfare

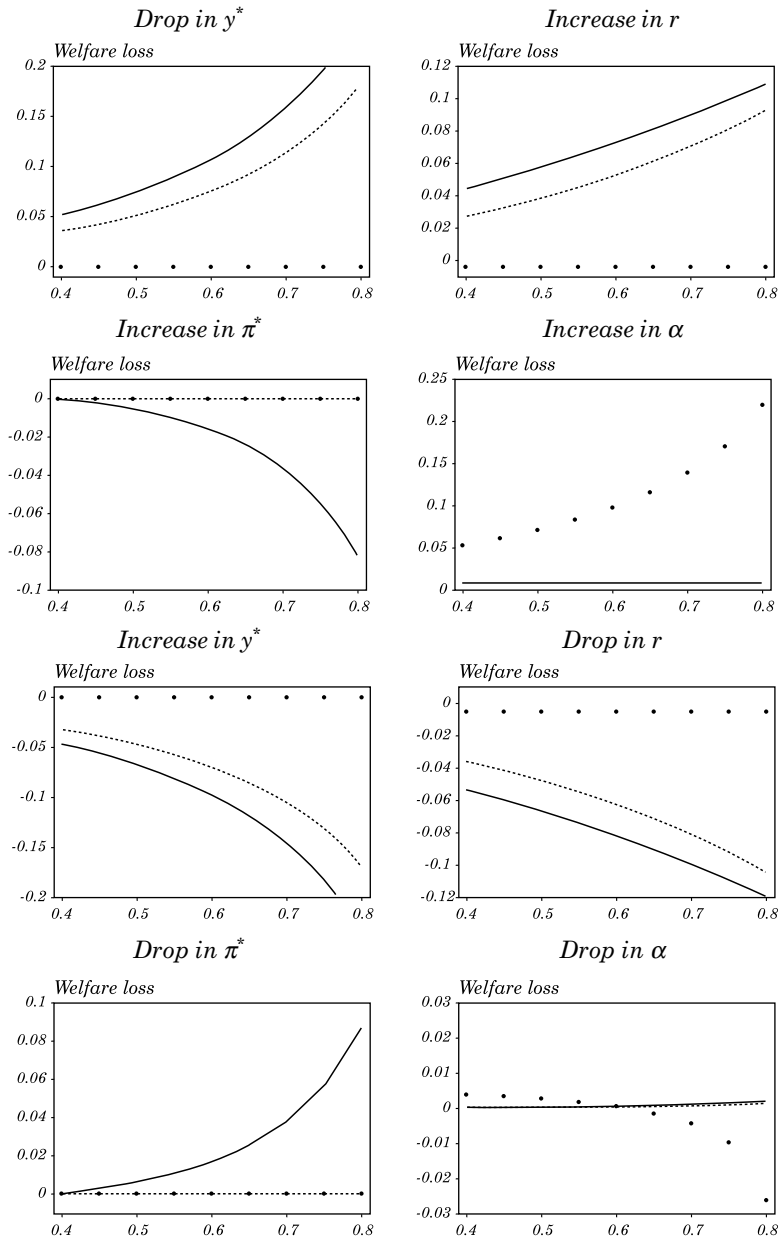
Figure 12 summarizes the welfare results, which were computed

by the same method as in section 2. The benchmark against which welfare is evaluated assumes either that the economy stays at its initial steady state if the shock has no effect on the steady state except through the unit root in tradables consumption or that it immediately jumps to a new long-run steady state if the shock does have such an effect. The latter case applies to the tradables endowment shock, where for the purpose of computing a long-run steady-state tradables consumption is assumed to immediately and permanently drop by 5 percent, and to the money demand shock, where nontradables consumption is assumed to immediately drop to the lower level consistent with a 10 percent increase in inverse velocity.

The first four panels of figure 12 show the welfare results for the four exogenous shocks studied in the previous subsection, for different degrees of price stickiness. The Mundell-Fleming logic appears to be strongly confirmed when one compares money targeting and exchange rate targeting. Inflation targeting, as indicated before, performs much like exchange rate targeting except under foreign inflation shocks. Money targets are superior to exchange rate targets under negative real shocks such as the tradables endowment shock and the real interest rate shock because they permit an instantaneous adjustment of the real exchange rate. They are inferior under an increase in money demand because they do not permit central bank accommodation of higher money demand. An ambiguity arises under foreign inflation shocks, in which case exchange rate targeting involves lower welfare losses and even welfare gains at higher degrees of price stickiness. This points to an important qualification of the Mundell-Fleming logic.

The key point is that a sticky price cash-in-advance monetary economy is subject to preexisting distortions, namely markups and deviations from the Friedman rule. The latter is very significant in an emerging economy with high steady-state inflation. The above model economy, which features 14.4 percent steady-state inflation, has a steady-state nontradables output more than 5 percent below what would be possible at the Friedman rule. This means that exogenous shocks that require an increase in nontradables output in the transition can actually lead to welfare gains. The only example of this in the four scenarios studied so far is the foreign inflation shock under exchange rate targeting, but as shown in the final four panels of the figure, generating other examples is straightforward. These panels illustrate the same four shocks with opposite signs. Exchange rate targeting now performs best of all the regimes under foreign real shocks, as a result of the greater boom in nontradables output needed to generate domestic infla-

**Figure 12. Welfare Losses for Four Exogenous Shocks**



Source: Author's calculations.

tion and a real appreciation. The magnitude of welfare losses under negative shocks exceeds that of welfare gains under equal-sized positive shocks by a small amount. Consequently, Schmitt-Grohé and Uribe (2001), who analyze expected utility based on stochastic shock processes estimated from Mexican data, find some advantage of inflation targeting over exchange rate targeting. The above discussion demonstrates why this difference is found to be quite small except under extreme degrees of price stickiness.

### **3.3 Summary**

This section has analyzed the performance of three different monetary regimes—exchange rate targeting, inflation targeting, and money targeting—in the presence of four exogenous shocks—shocks to tradables endowment (terms of trade), real international interest rates, foreign inflation, and money demand. Both the dynamic response of real and nominal variables and the welfare consequences of shocks were discussed.

The most important results concern the Mundell-Fleming logic regarding the relative performance of fixed and flexible exchange rates under real and money demand shocks. First, except for a foreign inflation shock (in which case the results are ambiguous), the logic is confirmed insofar as money targets are superior to exchange rate targets under negative real shocks because they permit instantaneous real exchange rate adjustment, and they are inferior under an increase in money demand because they do not allow monetary accommodation. Second, the argument misses the fact that shocks that require a temporary nontradables consumption boom are beneficial in a welfare sense, because preexisting distortions in a sticky-price monetary economy make steady-state nontradables output suboptimal. Third, and most importantly for this paper, the most appropriate label for strict inflation targeting is not flexible exchange rates. Except for a foreign inflation shock, strict inflation targeting behaves much more like an exchange rate target than a money target, with the inflation target imposing a very tight limit on exchange rate flexibility.

## **4. CONCLUSION**

This paper compares inflation targeting with other monetary regimes, especially exchange rate targeting, along various dimensions. The emphasis is on the environment facing emerging markets. The conclusions of the analysis are ambiguous, much more so than the

current tide of opinion against exchange rate targeting would lead one to believe. Both exchange rate targets and inflation targets are vulnerable to speculative attacks. While this vulnerability is somewhat smaller for inflation targeting, the monetary policy required to defend a vulnerable inflation target leads to somewhat greater distortions and welfare losses. In addition, an inflation target behaves very similarly to an exchange rate target under many exogenous shocks.

I restate here the conjecture made in the introduction. It may be provocative, but that is the point. An honest debate about the advantages of inflation targeting for emerging markets should probably be the old debate about rules versus discretion. With at most a few years of a reasonably successful track record in most of the countries concerned, are we really at a point at which we can be comfortable with discretion?

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