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

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

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Resumen

Este trabajo presenta una evaluación crítica del uso de metas de inflación como un régimen de política monetaria para mercados emergentes. Se muestra que esta política, entendida como un compromiso estricto con un objetivo de inflación de IPC (Indice de Precios al Consumidor), comparte muchas características con el uso de metas de tipo de cambio y es completamente distinta de un régimen de tipo de cambio flexible bajo reglas de crecimiento de dinero. Aunque en menor medida que los compromisos cambiarios, las metas de inflación son vulnerables a ataques especulativos. Además, su desempeño es inferior a una meta cambiaria cuando la sostenibilidad de la política es limitada. Por último, y de manera poco sorpresiva, su desempeño relativo bajo shocks exógenos está condicionado por la naturaleza y dirección de las perturbaciones. Dada la falta de una ventaja obvia sobre las metas de tipo de cambio, la verdadera atracción de las metas de inflación parece ser que da mayor discrecionalidad otorgada a la autoridad. Ello, en el contexto de muchos mercados emergentes, debe ser una causa de preocupación.

Abstract

This paper presents a critical appraisal of inflation targeting as a monetary policy regime for emerging markets. It is shown that this policy, if understood as a strict commitment to a CPI inflation target, shares many features with exchange rate targeting and is quite different from flexible exchange rates under money growth rules. Inflation targets are vulnerable to speculative attacks, although less so than exchange rate targets. They perform worse than exchange rate targets when policy sustainability is limited. And their relative performance under exogenous shocks, not surprisingly, depends on the nature and direction of those shocks. Given this lack of an obvious advantage over exchange rate targets, the real attraction of inflation targets may be that they give the policymaker discretion. This, in the context of many emerging markets, has to be a cause for concern.

This paper is a chapter of the forthcoming book Inflation Targeting: Design, Performance, Challenges, edited by Norman Loayza and Raimundo Soto, Santiago, Chile.
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1 INTRODUCTION

Inflation targeting has in recent years been adopted by the central banks of several advanced economies including Australia, Canada, Finland, New Zealand, Spain, Sweden, and the UK. The policy is widely perceived as having been successful, see the discussions in Leiderman and Svensson (1995), McCallum (1996) and Bernanke et al. (1999). It is now increasingly being implemented by emerging economies. Following recent currency crises several of them have had to let their currencies float. In designing a new permanent monetary policy framework, a view has emerged that for emerging economies the option of simply fixing the exchange rate is no longer viable[1], and that 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. 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, 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 one is that for emerging markets the (real) exchange 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,b) and Levy-Yeyati and Sturzenegger (1999), who find that the actual behavior of many emerging economies' exchange rate regimes, while

[1] There is no unanimity on this by any means. See e.g. Frankel (1999).

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 among them, is fiscal dominance. In most emerging markets the government budget remains a source of instability while seigniorage may still be an important source of government financing. The reasons include a weak fiscal revenue base, a rudimentary tax collection system, the contingent bailout liabilities attached to 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. As an example, the Brazilian crisis of 1999 was by most accounts caused by unsustainable fiscal policies.

As I will show in Section 2 of this paper, under conditions of fiscal inconsistencies inflation targets are vulnerable to speculative attacks. Fiscal policy is one reason, among many others, why the sustainability of emerging markets inflation targets cannot be taken for granted in the same way as in the industrialized economies which have used this policy. The next part of the paper, Section 3, explores the consequences of limited sustainability in a full-fledged sticky price small open economy model. It concludes that the defense of an inflation target against the inflationary bias resulting from a perceived lack of sustainability, or temporariness, requires a more volatile and distortionary monetary policy, and results in lower welfare. These results, in the author's view, should be first and foremost in the mind of many an emerging markets policymaker when deciding on the suitability of different monetary regimes. This is also stressed in a recent paper by Mendoza (2000). On the other hand however there is the result well known to every student of open economy macroeconomics that when an economy is subject to real shocks flexible exchange rates allow for a more effective countercyclical monetary policy. This is the basis of a number of recent papers including Schmidt-Grohe and Uribe (2000) and Chang, Cespedes and Velasco (2000) who argue that inflation targeting is superior to exchange rate targeting. This question is addressed in the next part of this paper, Section 4. Using the analytical apparatus developed for the previous exercise, it analyzes the dynamic response of the economy to a number of shocks including real and money demand shocks. It is found that the superiority of one or the other regime in the welfare sense depends on a number of factors including not only the nature of shocks but also their direction. Further, the logic which is often implied in the policy debate, namely that given the “flexibility” of exchange rates under inflation targeting the nominal exchange rate can quickly bring the real exchange rate to a new equilibrium, is mostly false. This is one of the fallacies of the popular debate on this subject, which bases conclusions for the ”flexible rates” of 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 targeting. 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 vastly different, and depends very sensitively on the exact nature of the shocks. It seems premature to draw final conclusions at this point.

But then this may miss the real point behind the attractiveness of inflation targeting entirely. 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), there is reason to believe that many emerging markets central bankers pursuing inflation targets do not consider themselves to be vulnerable to crises, and that they are willing to see very much larger short-run nominal exchange rate movements than what is consistent with their 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 then the comparison with a rigidly fixed exchange rate is really not fair, and it should more properly be compared with a “dirty peg”. That however is a regime which long ago ceased to be respectable in emerging markets, and especially in Latin America, precisely because of its lack of commitment to a nominal anchor was found many times to give rise to credibility and time inconsistency problems. It seems to me that, at least as far as emerging markets with their long history of monetary mismanagement are concerned, rules at one point won the debate versus discretion. It now looks as though discretion has made a comeback, albeit under a more respectable and fashionable name, inflation targeting. Fashion aside, this is a mystery, except perhaps for the strongest of the emerging markets such as Chile.

The following three sections contain a set of theoretical models of a monetary small open economy. The emphasis for this paper is on the economic intuition, which is discussed with the help of computations of dynamic time paths. Rigorous definitions of equilibria, as well as some actually quite important computational and mathematical aspects, are omitted except where they are relevant to the intuition. At the appropriate places the reader is referred to the original papers, Kumhof, Li and Yan (2000), Kumhof (2000a) and Kumhof (2000b), for the technical detail.

2 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". However, if the policymaker is committed to the inflation target this is not at all obvious. 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. In addition to making that point, this section investigates whether quantitatively there is much difference in the behavior of economic variables between inflation targeting and exchange rate targeting under conditions which must ultimately lead to a speculative attack.

The key ideas can be presented with a simple microfounded balance of payments crises model along the lines of Calvo (1987). The additional element needed is non-tradable goods, which 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. In order to continue to meet the inflation target the central bank has to permit a contraction of the money supply. 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, unlike a collapsing exchange rate target, not instantaneous. 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 Morande and Schmidt-Hebbel (1999), contagion-driven speculative pressure on inflation targets did occur in Mexico, Chile and Israel (among others) 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 which 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, the traditional definition of a floating exchange rate regime. More generally, it will be shown that 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 which targets the inflation rate this weight is far greater than zero.

The rest of this section is organized as follows. Subsection 2.1 develops the model. Subsection 2.2 calibrates it and discusses computed solution paths. Subsection 2.3 concludes. Computational aspects of the model solution can be found in the original paper, Kumhof, Li and Yan (2000).

2.1 The Model

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

2.1.1 Consumers

Consumers maximize lifetime utility derived from the consumption of tradable and non-tradable 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

$$Max \quad \int_0^\infty \left(\gamma \ln c_t^* + (1-\gamma) \ln c_t\right) e^{-rt} dt \ . \qquad [2.1]$$

Consumers receive fixed endowments of tradable and non-tradable goods y^* and y, and government lump-sum transfers g_t. The nominal exchange rate and the price level of non-tradable 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 $m_t = M_t/E_t$, with total asset holdings $a_t = b_t + m_t$. Real money balances in terms of non-tradable 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:[2]

$$i_t = r + \varepsilon_t \ . \qquad [2.2]$$

Consumers face a cash-in-advance constraint on consumption $m_t \geq \alpha \left(c_t^* + \frac{c_t}{e_t} \right)$, which will be shown to hold with equality in equilibrium. Their lifetime budget constraint is

$$a_0 + \int_0^\infty \left(y^* + \frac{y}{e_t} + g_t \right) e^{-rt} dt = \int_0^\infty \left(c_t^* + \frac{c_t}{e_t} + i_t m_t \right) e^{-rt} dt \ . \qquad [2.3]$$

First-order conditions are

$$\frac{c_t}{c_t^*} = e_t \frac{1-\gamma}{\gamma} \ , \qquad [2.4]$$

$$\frac{\gamma}{c_t^*} = \lambda(1 + \alpha i_t) \ . \qquad [2.5]$$

This implies real money demands

$$m_t = \alpha c_t^* \gamma^{-1} \ , \qquad [2.6]$$

$$n_t = \alpha c_t (1-\gamma)^{-1} \ . \qquad [2.7]$$

Defining $\mu_t = \dot{M}_t/M_t$, equation (2.6) implies $\dot{m}_t/m_t = (\mu_t - \varepsilon_t) = \dot{c}_t^*/c_t$.

2.2 Definition of the Inflation Rate

At the heart of a paper on open economy inflation targeting has to be a definition of what we mean by "the inflation rate". For if all goods were tradable and purchasing power parity prevailed, there would be no difference between inflation targeting and exchange rate targeting. That clearly misses the point. All countries which 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 non-tradable goods

[2] See Bansal and Dahlquist (2000) on evidence supporting uncovered interest parity in emerging markets.

with price level P_{N_t}. With our normalization $P_t^* = 1$ a natural definition of the CPI P_t is therefore the consumption based price index:

$$P_t = (E_t)^\gamma (P_{N_t})^{1-\gamma} \gamma^{-\gamma}(1-\gamma)^{-(1-\gamma)} . \qquad [2.8]$$

In rate of change form this is:

$$p_t = \gamma\varepsilon_t + (1-\gamma)\pi_t . \qquad [2.9]$$

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

2.3 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 $\bar{p}$, the post-crisis steady state rate of CPI inflation being determined by a balanced budget requirement. We assume full central bank monetary accommodation at time 0, which implies a constant E and jumps in P_N and P on impact.[3]

The case of P_t as the only target variable in a perfect foresight environment corresponds to what King and Wolman (1996) call "perfect inflation targeting". They show, in a closed economy setting, that it can be achieved either by manipulation of the money supply (as in our model) or by an interest rate feedback rule with a very strong interest rate response to deviations of P_t from its target path. There is an equivalent interest rate policy in our economy, too, but given (3) interest rate policy is of course 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

$$h_0 + \int_0^\infty (\dot{m}_t + \varepsilon_t m_t - g_t)\, e^{-rt} dt = 0 . \qquad [2.10]$$

[3] This appears to us 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 will be assumed to be equal to zero:[4]

$$h_t \geq 0 \quad \forall t \ . \qquad [2.11]$$

In equilibrium the nontradable goods market must clear:

$$c_t = y \quad \forall t,$$

which implies $\mu_t = \pi_t \ \forall t$. The economy's overall resource constraint can now be derived as

$$f_0 + \frac{y^*}{r} = \int_0^\infty c_t^* e^{-rt} dt \ , \qquad [2.12]$$

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

2.4 Crisis Dynamics

Assume that the economy is in an initial (subscript I) steady state with (for simplicity) zero net foreign assets $f_I = 0$ and zero inflation, with 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 $rh_I = g_I$. 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 (subscript T) steady state is reached is endogenous. The same is true for final steady state inflation $p_T = \varepsilon_T = \pi_T$, which is a function of $c_T^* = y^* + rf_T$ by $p_T = \gamma\bar{g}/\alpha(y^* + rf_T) > p_I$. The government's rule for the growth rate of the nominal money supply and therefore for non-tradables inflation $\pi_t = \mu_t$ is, given the inflation target, a function of ε_t. After differentiating the first-order conditions, the system can therefore be written as:

$$\frac{\dot{c}_t^*}{c_t^*} = \frac{1}{1-\gamma}(p_t - \varepsilon_t) \ , \qquad [2.13]$$

$$\dot{\varepsilon}_t = \frac{1+\alpha i_t}{\alpha(1-\gamma)}(\varepsilon_t - p_t) \ . \qquad [2.14]$$

4 See Obstfeld (1986) for a discussion of (2.10) and (2.11). The latter is highly relevant for emerging economies, which as documented by Calvo and Reinhart (2000b) lose access to international capital markets during balance of payments crises.

Perfect foresight requires that the path of ε_t and therefore of c_t^* be continuous at T. This system has one zero and one positive eigenvalue. The mathematical and computational aspects are discussed in Kumhof, Li and Yan (2000), where it is shown that a unique solution exists and how it can be computed.

To compute dynamic equilibrium paths we assign parameter values according to Table 2.1. The time unit for calibration of stock-flow ratios is a quarter. Some parameters will be calibrated using Brazilian data, Brazil being 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 this has mostly fluctuated between 10% and 15%, which after adjusting for US inflation suggests using r = 10%. The inverse velocity α is set equal to the ratio of real monetary base to quarterly absorption in Brazil in 1996.[5] A 50% share of tradables in consumption is empirically reasonable, see De Gregorio, Giovannini and Wolf (1994). The nontradables and tradables endowments are normalized to 1 for simplicity. This yields a normalized initial level of quarterly real GNP of 2. The parameters α and γ imply $m_I = 0.6$. Central bank foreign exchange reserves h_I 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 Vegh (1995). However, see Ogaki and Reinhart (1998) and Eckstein and Leiderman (1992) for examples of estimates closer to one.

Solution paths for inflation targeting $\bar{p} = 0$ are presented as the solid lines in Figure 2.1 below and compared to balance of payments crises under exchange rate targeting $\bar{\varepsilon} = 0$ (broken lines).[6]

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

[6] The latter are trivial to compute. We therefore omit the detail.

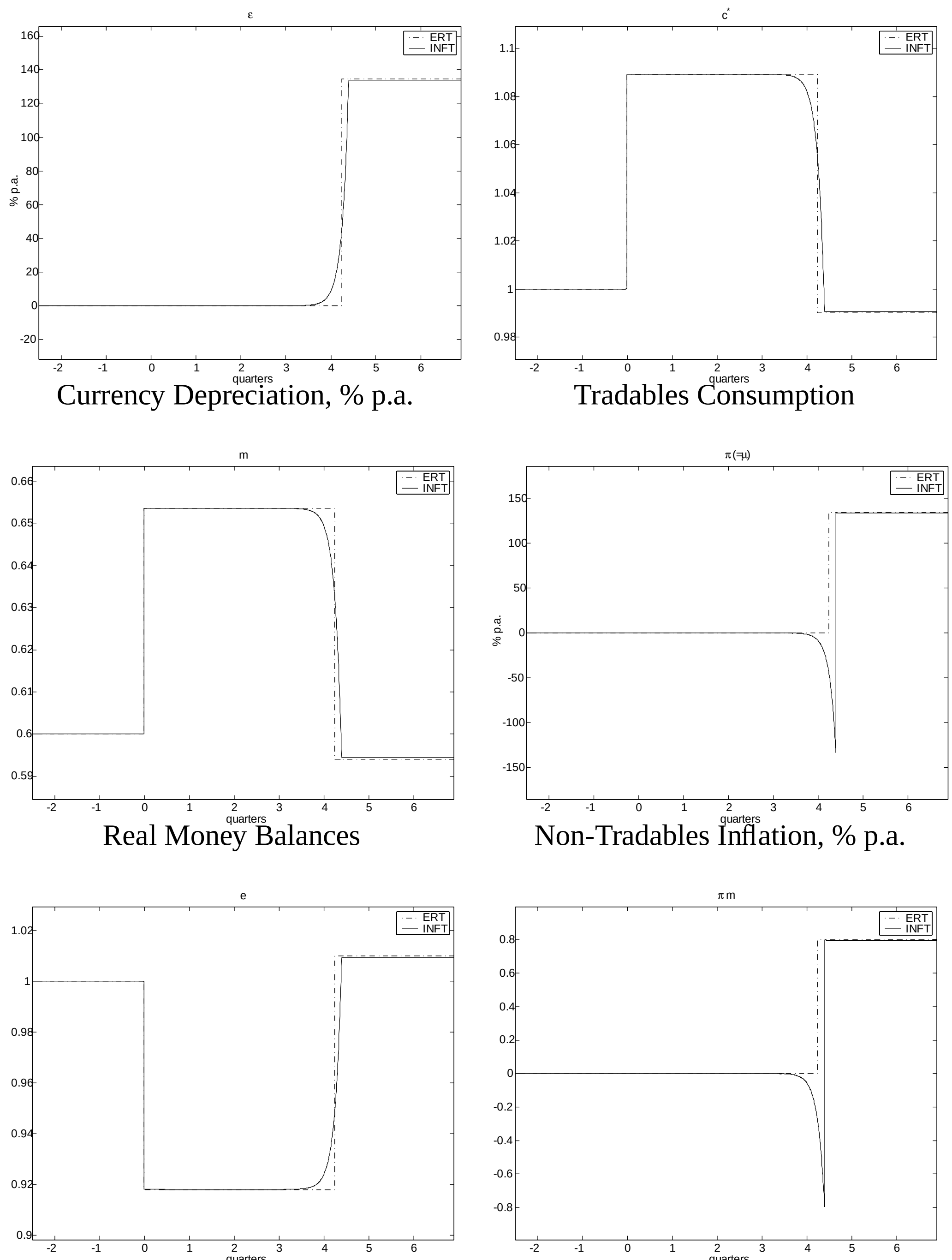
Parameter	Value	Description
p_I	0% p.a.	Initial inflation target
$\bar{p}$	0% p.a.	New inflation target
————	————	————————————
g_I	0.02	Initial primary deficit
$\bar{g}$	0.20	New, permanent primary deficit
————	————	————————————
r	10% p.a.	Real international interest rate
β	10% p.a.	Subjective discount rate
α	0.3	Inverse velocity
γ	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

Table 2.1

2.5 Dynamics of the Speculative Attack

Figure 2.1 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. However 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. The central bank, if it is fully committed to defending the inflation target, 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 2.1:

$$\dot{m}_t + \varepsilon_t m_t = \mu_t m_t = \pi_t m_t \ . \qquad [2.15]$$



Currency Depreciation, % p.a.
Tradables Consumption
Real Money Balances
Non-Tradables Inflation, % p.a.
Real Exchange Rate
Seigniorage

Figure 2.1

Although there may be an increase in the inflation tax component of seigniorage $\varepsilon_t m_t$ in the final stages of the program, 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 due to a steep drop in private sector asset demands is the speculative attack.

Figure 2.1 also allows us to infer a more general result regarding the vulnerability of different monetary regimes to speculative attacks. The figures show that the inflation target $\bar{p} = 0$ collapses later than the exchange rate target $\bar{\varepsilon} = 0$. Given that government deficit related reserve losses per period are assumed to be equal, this must be due to smaller reserve losses attributable to the speculative attack. Under a money targeting rule[7] $\bar{\mu} = 0$ an attack would become completely impossible, meaning reserve losses attributable to a speculative attack would be zero. The crisis would therefore happen even later. The conclusion is that, among the class of monetary policy rules which 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. Under inflation targeting that weight is lower than under exchange rate targeting, but it is far greater than zero. To explore this further we computed the cumulative time T stock equivalent of flow reserve losses under inflation targeting, which equals $\int_0^T \pi_t m_t e^{r(T-t)} dt$, and expressed it as a fraction of the instantaneous reserve losses under exchange rate targeting for different weights γ of the exchange rate in the price index. This fraction is increasing in γ, and for our policy experiment it is almost exactly equal to γ at 0.49.

2.6 Summary

Inflation targeting is in practice 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. This paper has shown that such

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7 This is equivalent to targeting the non-tradable goods price in the present model.

crises have quite similar dynamics to the collapse of a fixed exchange rate regime, with two important exceptions. One is that the attack takes place over a short time period as opposed to instantaneously. The other is that reserve losses attributable to the attack are smaller, and increasing in the share of tradable goods in total consumption.

The possibility of speculative attacks under inflation targeting is acknowledged by policymakers in some, but by no means all, emerging economies currently implementing this policy. Morande 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, and by Uribe, Gomez and Vargas (2000), for Colombia. But unless the Chilean hard line is pursued it is difficult to see how credibility of the target can be established given that the commitment to it is contingent on the absence of speculative 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, more specifically the public's belief that monetary policy is not sustainable and therefore temporary, is the subject of the next section.

3 LIMITED SUSTAINABILITY

This section assesses the theoretical implications of using an unsustainable (in the eyes of the public) 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.[8] Results can be compared with those of the well established literature on exchange rate targeting and policy temporariness, e.g. Calvo and Vegh (1993, 1999).

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 in order 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 non-hyperbolic steady state. See Kumhof (2000a,b) for details.

It is shown that forward looking inflation targeting alone results in indeterminacy of equilibrium paths (non-uniqueness). 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 nevertheless, the monetary authority is forced to reduce the rate of

[8] The literature so far contains only very few thorough microfounded treatments of inflation targeting in open economies. Svensson (2000) makes far stronger assumptions than this paper, and does not use a fully specified dynamic general equilibrium model. Parrado (1999) uses a set-up related to Svensson (2000) to study the performance of monetary policy rules under exogenous shocks but full credibility. Calvo (1999), who describes inflation targeting as a “badly defined monetary system”, assumes that the target is the price level of nontradable goods alone. Bencivenga, Huybens and Smith (1997) work with a very different set-up, an OLG model with one tradable good.

currency depreciation through a tight monetary policy. Especially towards the end of the program this leads to very large current account deficits, real appreciations and domestic recessions, in excess of those observed under exchange rate targeting. In addition, after the collapse there is a temporary contraction in tradables consumption. 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 due to the need for an especially tight monetary policy. And the need to use the exchange rate in this way leads to an exacerbated real appreciation clashing with the secondary (if that is what it is) exchange rate or competitiveness objective.

The rest of the section is organized as follows. Subsection 3.1 develops the model. Subsection 3.2 calibrates the model and evaluates the effects of unsustainable exchange rate targeting and inflation targeting programs. Subsection 3.3 concludes.

3.1 The Model

Consider a small open economy which 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 nontradable goods producing firms.

3.1.1 Households

Households maximize lifetime utility, which depends on their consumption of homogenous 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 2.

Aggregate nontradables consumption is given by

$$c_t = \left(\int_0^1 c_t(j)^{\frac{\theta-1}{\theta}} \right)^{\frac{\theta}{\theta-1}} , \qquad [3.1]$$

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

$$c_t(j) = c_t \left(\frac{P_{N_t}(j)}{P_{N_t}} \right)^{-\theta} , \qquad [3.2]$$

where the price index of nontradables P_{N_t} is

$$P_{N_t} = \left(\int_0^1 P_{N_t}(j)^{1-\theta} \right)^{\frac{1}{1-\theta}} . \qquad [3.3]$$

Households' objective function is

$$Max \sum_{t=0}^{\infty} \left(\frac{1}{1+r} \right)^t \left[\gamma \ln(c_t^*) + (1-\gamma) \ln(c_t) + \kappa \int_0^1 \ln(1 - l_t(j)) dj \right] . \qquad [3.4]$$

Log consumption utility is a standard assumption in this literature, see Bergin and Feenstra (2000) or King and Wolman (1996). The nominal and real exchange rate 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:

$$\frac{e_t}{e_{t-1}} = \frac{1+\varepsilon_t}{1+\pi_t} . \qquad [3.5]$$

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 $\int_0^1 W_t(j) l_t(j) dj$ and nominal lump-sum profit distributions $\int_0^1 \Pi(j) dj$. They hold two kinds of assets, real international bonds b_t and real money balances $m_t = M_t/E_t$, with total assets $a_t = b_t + m_t$. Uncovered interest parity is assumed to hold:

$$(1 + i_t) = (1 + r)(1 + \varepsilon_{t+1}) . \qquad [3.6]$$

Households face a cash-in-advance constraint on consumption which will be shown to hold with equality in equilibrium. When this is incorporated into their lifetime budget constraint one obtains

$$(1+r)b_{-1}+\frac{m_{-1}}{1+\varepsilon_0}+\sum_{t=0}^{\infty}\left(\frac{1}{1+r}\right)^t\left(g_t+y^*+\frac{\int_0^1 W_t(j)l_t(j)dj}{E_t}+\frac{\int_0^1 \Pi_t(j)dj}{E_t}\right) \quad [3.7]$$
$$=\sum_{t=0}^{\infty}\left(\frac{1}{1+r}\right)^t\left(\left(c_t^*+\frac{\int_0^1 P_{N_t}(j)c_t(j)dj}{E_t}\right)\left(1+\alpha\frac{i_t}{1+i_t}\right)\right) .$$

The household's problem is to maximize (3.4) subject to (3.7). The first-order conditions, apart from (3.7), are

$$\frac{\gamma}{c_t^*}=\lambda(1+\alpha\frac{i_t}{1+i_t}) , \quad [3.8]$$

$$\frac{c_t}{c_t^*}=e_t\frac{1-\gamma}{\gamma} , \quad [3.9]$$

$$w_t(j)=\frac{\kappa c_t(1+\alpha\frac{i_t}{1+i_t})}{(1-\gamma)(1-l_t(j))} , \quad [3.10]$$

where λ is the constant multiplier of the lifetime budget constraint (3.7), 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 (3.8) shows that the current account is driven by intertemporal substitution due to variations in the effective price of consumption, via either changes in nominal interest rates or in inverse velocity α. Equation (3.9) equates the marginal rate of substitution between tradables and nontradables to their relative price, the real exchange rate. Equation (3.10) 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.

3.1.2 Definition of the Inflation Rate

The consumption based price index is defined as in Section 2. Foreign inflation will still be set equal to zero in this section, but in Section 4 we will allow for it to be nonzero. The general formula for the index is therefore

$$P_t=(E_tP_t^*)^{\gamma}\left(P_{N_t}\right)^{1-\gamma}\gamma^{-\gamma}(1-\gamma)^{-(1-\gamma)} . \quad [3.11]$$

In rate of change form this is:

$$(1+p_t) = (1+\varepsilon_t)^{\gamma}(1+\pi_t^*)^{\gamma}(1+\pi_t)^{1-\gamma} \ , \qquad [3.12]$$

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

Inflation targeting will be defined as a target path for P_t. It should be noted that several recent papers have advocated nontradable goods price targeting. That is because such a policy, under sticky prices, replicates the flexible price equilibrium. This line of argument is not pursued further here because, while theoretically very interesting, it is not considered practically relevant for emerging markets. There are two reasons for this. First, there is the obvious difficulty of constructing such an index. This is not just because of limited data availability in emerging markets, but more fundamentally because the clean separation into tradable flexible price and nontradable sticky price goods made for analytical purposes by the model has no easily identifiable counterpart in the real world. The more serious difficulty with nontradable goods price targeting is however policy credibility. It should be borne in mind that several Latin American countries have in the past been found to manipulate price indices to "meet" policy targets. 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.

3.1.3 Technology and Pricing

Purchasing power parity is assumed to hold for tradable goods, and their international price level is normalized to one. The preliminary judgement is that this seems justified on the basis of the empirical evidence on tradables pass-through for emerging markets. In Kumhof, Li and Yan (2000) we survey this so far very sparse evidence, which finds far higher pass-through coefficients than in industrialized countries.

Nontradable goods producing firms have linear production functions

$$y_t(j) = l_t(j), \quad j \in [0,1] \ . \qquad [3.13]$$

They are price takers in the labor market and monopolistically competitive in the goods market, taking into account goods demand (3.2).[9] Firms distribute all nominal profits $\Pi_t(j)$ to households in a lump-sum fashion:

$$\Pi_t(j) = P_{N_t}(j)c_t(j) - W_t(j)l_t(j) \ . \quad [3.14]$$

Following Calvo (1983), it is assumed that firms only get 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 each period there is a probability $(1-\delta)$ that any firm will be able to change its price. The interval between price changes for an individual firm is therefore a random variable. However, with a continuum of firms $(1-\delta)$ also represents the fraction of firms that can change prices in any period. Together with the assumption of lump-sum profit distributions to 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 non-zero steady state inflation. While this possibility does not affect the original Calvo (1983) specification, the fully microfounded version needs to be modified. We allow today's price setters to both choose today's price level, and to change their price by the steady state inflation rate π_{ss} every period thereafter. Without this assumption steady state nontradables output would be increasing in steady state inflation despite the presence of the monetary distortion to the consumption-leisure choice.

Following Rotemberg (1987) and Walsh (1998), it is further assumed that each firm j which 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

9 This set-up is chosen for ease of exposition. It is formally equivalent to one where firms reside in heterogenous households.

future periods t, $P_{N_t}(j)$, and its optimal prices in those periods, $P_{N_t}^{+}$:

$$\frac{1}{2}E(t)\left(\sum_{i=0}^{\infty}\left(\frac{1}{1+r}\right)^{i}\left(\ln P_{N_{t+i}}(j)-\ln P_{N_{t+i}}^{+}\right)\right) \ . \qquad [3.15]$$

Here $E(t)$ denotes the expectations operator, conditional on information available at time t. The optimal price $P_{N_t}^{+}$ is the period t profit maximizing price taking as given the current aggregate price level P_{N_t}. It does not have a firm specific index because all firms determining this price will choose identically. The monopolistic competitor's period t profit maximization problem solving for $P_{N_t}^{+}$ is

$$\underset{P_{N_t}(j)}{Max}\ P_{N_t}\left(c_t\left(\frac{P_{N_t}(j)}{P_{N_t}}\right)^{1-\theta}-c_t\left(\frac{P_{N_t}(j)}{P_{N_t}}\right)^{-\theta}w_t(j)\right) \ . \qquad [3.16]$$

We define the markup $\mu=\theta/(\theta-1)$ and let the optimal choice of relative price be $Q_t\equiv P_{N_t}^{+}/P_{N_t}$. In equilibrium, which is defined more rigorously in Kumhof (2000a), firms' determination of the period t optimal price is assumed to be consistent with labor demand (3.10). Then the solution to this problem becomes

$$Q_t=\left(\frac{\mu\kappa}{1-\gamma}\right)\frac{c_t\left(1+\alpha\frac{i_t}{1+i_t}\right)}{1-c_tQ_t^{-\theta}} \ . \qquad [3.17]$$

Returning to the firm's intertemporal problem (3.15), we now have $P_{N_t}^{+}=Q_tP_{N_t}$. Using this and the exogenous arrival rate of price changing opportunities $(1-\delta)$, the firm's objective function becomes

$$\underset{P_{N_t}(j)}{Min}\ \frac{1}{2}\left(\sum_{i=0}^{\infty}\left(\frac{\delta}{1+r}\right)^{i}\left(\ln\left[P_{N_t}(j)(1+\pi_{ss})^{i}\right]-\ln Q_tP_{N_t}\right)\right) . \qquad [3.18]$$

Let X_t be the optimal choice of $P_{N_t}(j)$, again identical for all firms, and let $Z_t\equiv X_t/P_{N_t}$. This can be shown, after some algebra, to satisfy

$$Z_t=\left((Z_{t+1})\frac{(1+\pi_{t+1})}{(1+\pi_{ss})}\right)^{\left(\frac{\delta}{1+r}\right)}(Q_t)^{1-\frac{\delta}{1+r}} \ . \qquad [3.19]$$

On the other hand, the price index satisfies $P_{N_t}^{1-\theta}=\delta P_{N_{t-1}}^{1-\theta}+(1-\delta)X_t^{1-\theta}$, and therefore

$$1=\delta\left(\frac{1+\pi_{ss}}{1+\pi_t}\right)^{1-\theta}+(1-\delta)\left(Z_t\right)^{1-\theta} \ . \qquad [3.20]$$

It is immediate that the last two equations imply $Q_{ss} = 1$, which means that steady state nontradables output and consumption are given by

$$c_{ss} = \frac{1}{1 + \frac{\kappa\mu}{1-\gamma}(1 + \alpha\frac{i_{ss}}{1+i_{ss}})} \; . \qquad [3.21]$$

This depends negatively on the steady state nominal interest rate due to the distortion in the consumption-leisure choice introduced by the presence of money. Because realistic calibrations of emerging economies must take this rate to be far above zero, this implies that steady state nontradables output is far below the Friedman rule optimum. When equations (3.19) and (3.20) are log-linearized one obtains 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, $\hat{y}_t = \ln(y_t) - \ln(y_{ss})$. We have, again after some algebra:

$$\beta_1 \hat{\pi}_{t+1} - \hat{\pi}_t = -3\beta_2 \hat{c}_t - 2A\beta_2 \hat{\varepsilon}_{t+1} \; , \qquad [3.22]$$

where $\beta_1 = 1/(1 + r)$, $\beta_2 = \frac{1-\delta}{\delta(2+\theta)}(1 - \frac{\delta}{1+r})$, $A = \alpha/(1 + i_{ss} + \alpha i_{ss})$. In levels form:

$$\frac{(1 + \pi_{t+1})^{\beta_1}}{(1 + \pi_t)}(1 + \pi_{ss})^{1-\beta_1} = \left(\frac{e_t c_t^{*\frac{1-\gamma}{\gamma}}}{c_{ss}}\right)^{-3\beta_2} \left(\frac{1 + \varepsilon_{t+1}}{1 + \varepsilon_{ss}}\right)^{-2A\beta_2} \; . \qquad [3.23]$$

Equations (3.5), (3.8), and (3.23), plus an equation determining λ through first order condition (3.8) and the aggregate budget constraint (see below), constitute the system of equations which 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 exogenous monetary policy target. Under exchange rate targeting this target is ε_t while the inflation rate p_t is endogenous. Under inflation targeting ε_t becomes endogenous and must be replaced in all equations, according to (3.12), by $(1 + \varepsilon_t) = (1 + p_t)^{\frac{1}{\gamma}}/(1 + \pi_t)^{\frac{1-\gamma}{\gamma}}$, with p_t as the new target.

3.1.4 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:

$$(1+r)h_{-1} - \frac{m_{-1}}{1+\varepsilon_0} + \sum_{t=0}^{\infty} \left(\frac{1}{1+r}\right)^t m_t \frac{i_t}{1+i_t} = \sum_{t=0}^{\infty} \left(\frac{1}{1+r}\right)^t g_t \ . \qquad [3.24]$$

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

$$(1+r)f_{-1} + y^* \left(\frac{1+r}{r}\right) = \sum_{t=0}^{\infty} \left(\frac{1}{1+r}\right)^t c_t^* \ , \qquad [3.25]$$

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

3.2 Uniqueness of Equilibrium Paths

The question of unique convergent equilibrium paths is discussed here because it is of more than academic interest. What is at stake is that a monetary policy rule or "nominal anchor" is only useful if 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 our small open economy contains one unit root and is therefore situated at a non-hyperbolic steady state. The reader is referred to Kumhof (2000a,b) for the technical details. It is shown there that the dynamic system can be represented by the laws of motion for three variables, c_t^*, e_t, and π_t, characterized by one unit root, one root inside, and one outside the unit circle. For both inflation targeting and exchange rate targeting π_t is a free variable. The unit root is attributable to net foreign assets and therefore 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

$$e_t = e_{t-1}\left(\frac{1+\varepsilon_t}{1+\pi_t}\right) = e_{t-1}\left(\frac{1+p_t}{1+\pi_t}\right)^{\frac{1}{\gamma}} \ . \qquad [3.26]$$

For e_t to be predetermined ε_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 in general exchange rate rules **do** specify a path for **levels** of the exchange rate $\{E_t\}_{t=0}^{\infty}$, such targets are consistent with a unique convergent equilibrium path. However, the same is not evident from the policy debate about inflation targeting, where policy rules are often implied to be pure forward looking rules for the rate of change of the price level $\{p_t\}_{t=1}^{\infty}$, and where price level surprises are dealt with by the rule of ”letting bygones be bygones”. This implies indifference about today's p_t, meaning **any** real exchange rate is possible today, and of course this 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 $\{P_t\}_{t=0}^{\infty}$, and this is how this paper will define inflation targeting from here on.

3.3 Policy Experiments and Calibration

Under the assumptions of the model, particularly full lump-sum redistribution of seigniorage, it follows immediately that 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. Without sustainability problems the choice of nominal anchor is immaterial for the outcome.

The focus in what follows is therefore on programs which are characterized by a perceived lack of sustainability. The public may simply 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 2. However, in the present sticky price case this would greatly complicate the model and computations without adding much additional insight.

It is assumed that the economy starts with and is expected by the public to eventually revert to a high exchange rate target ε^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 $\varepsilon^L = p^L$.[10] In the experiments discussed below ε^L or p^L is, without loss of generality, maintained for a fixed period $t \in [0, T_\varepsilon)$ or $t \in [0, T_p)$, where $T_\varepsilon = T_p = T$ equals 4 or 12 quarters.

For the interpretation of these policy experiments, it is important to understand that monetary policy under CPI inflation targeting is different 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*. It is clear from (3.12) that, because the exchange rate has to be consistent with the CPI inflation target given the behavior of nontradables inflation, this precludes an independent exchange rate target. This in turn means that 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 therefore be endogenously determined.

Table 3.1 summarizes the parameter values chosen for the calibration exercise. The time unit is a quarter. A specification with a policy duration of $T = 12$ quarters and firms' probability $\delta = 0.75$ of not being able to change their price, corresponding to an average contract length of one year, is chosen as the benchmark case. In other dimensions the calibration reflects the likely magnitude of an inflation targeting program in today's emerging economies. The steady state inflation rate is 40%, with a target inflation rate of 10% that is very close to the current Brazilian and Mexican targets. We set $r = 10\%$, $\alpha = 0.3$, and $\gamma = 0.5$ as in the last section. The utility function parameter $\kappa = 2.47$ is taken from King and Wolman (1996). The functional form of the utility function is also close to King and Wolman (1996), except that aggregate consumption is here split into tradables

[10] 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.

and nontradables components, and that labor is heterogeneous. Initial net foreign assets are assumed to be zero.

Parameter	Value	Description
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
θ	4.33	Own price demand elasticity
δ	0.75	Probability of not being able to change price
α	0.3	Monetary base to consumption ratio (Brazil)
γ	0.5	Share of tradables in consumption
κ	2.47	Leisure coefficient in utility function
f_0	0	Initial net foreign assets

Table 3.1

3.4 Discussion of Solutions

In Figure 3.1 the solid line represents the exchange rate targeting program (ET) and the dashed line the inflation targeting program (IT). The unit along the horizontal axis is quarters, with 0 representing the time of announcement of the program. Note also that because this is a forward looking model the value of the exchange rate or inflation target before time 0 is in fact immaterial.

The two policies in general perform very similarly 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. 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 non-credible exchange rate targeting. The very much lower nominal interest rate drives up tradables consumption and causes a larger current account deficit. And the combination of relatively high nontradables inflation and low currency depreciation appreciates the real exchange rate very rapidly, ultimately reaching around 20%. This is accompanied by a very deep nontradables recession - output falls by over 20%.

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. However, upon the collapse of the program 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. Following the collapse there will therefore also be a temporary tradables recession and a positive current account.

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, during the transition, in a far slower and mostly negative rate of money growth, resulting 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, which as mentioned before may be thought of as one reason for the lack of sustainability. In both cases there is a severe contraction in this source of government revenue, from around 2.5% of initial real absorption to less than 1%. In the case of inflation targeting the necessary monetary contraction is so severe that seigniorage actually turns negative during the transition.

Figures 3.2 and 3.3 analyze different degrees of price stickiness and of policy duration. When price adjustment is faster than in the benchmark case ($\delta = 0.5$) but policy duration is the same, an inflation target based policy looks very similar to an exchange rate based policy during much of the program, except again for a few months before and after the collapse.

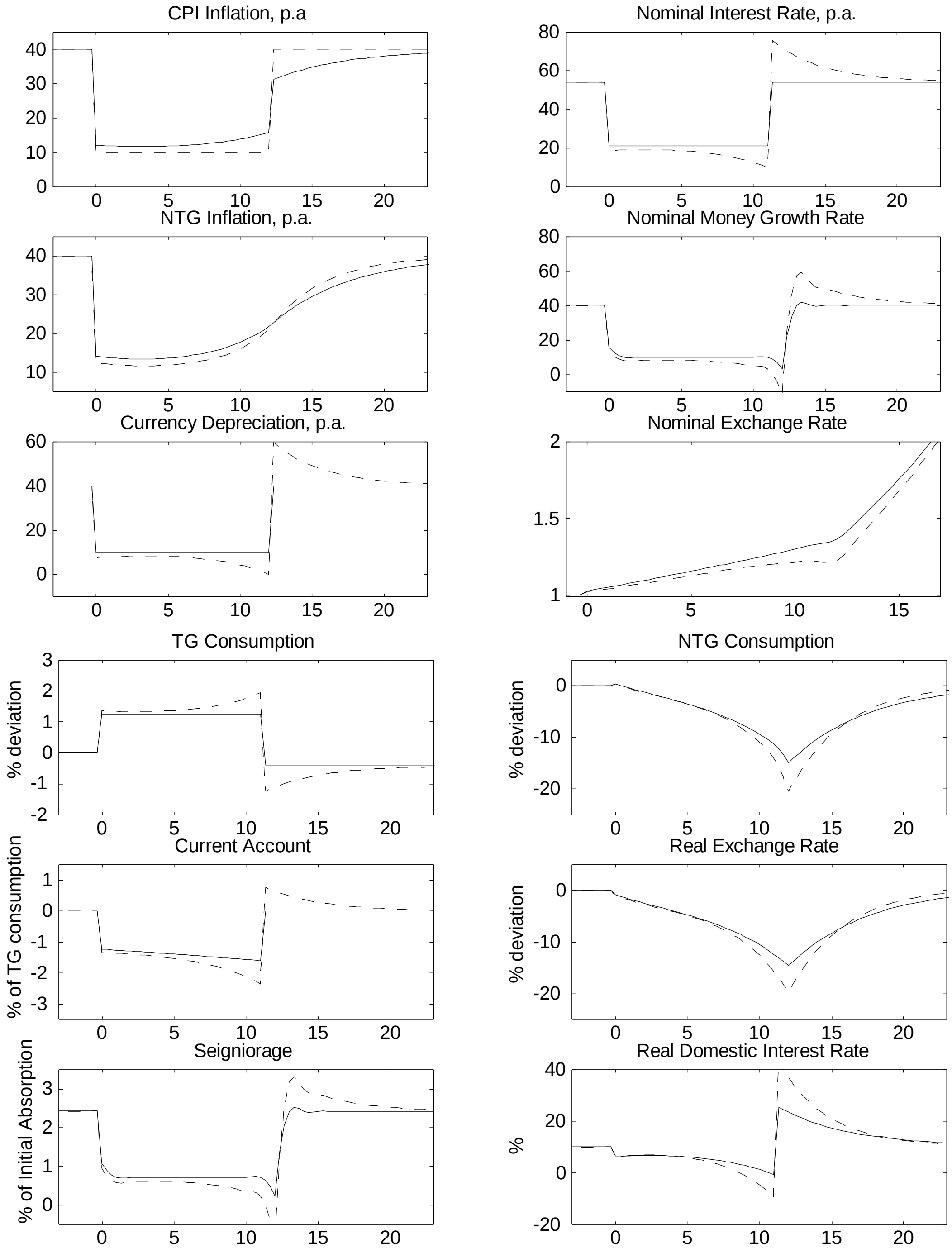


Figure 3.1: Benchmark (__= ET, - - = IT)

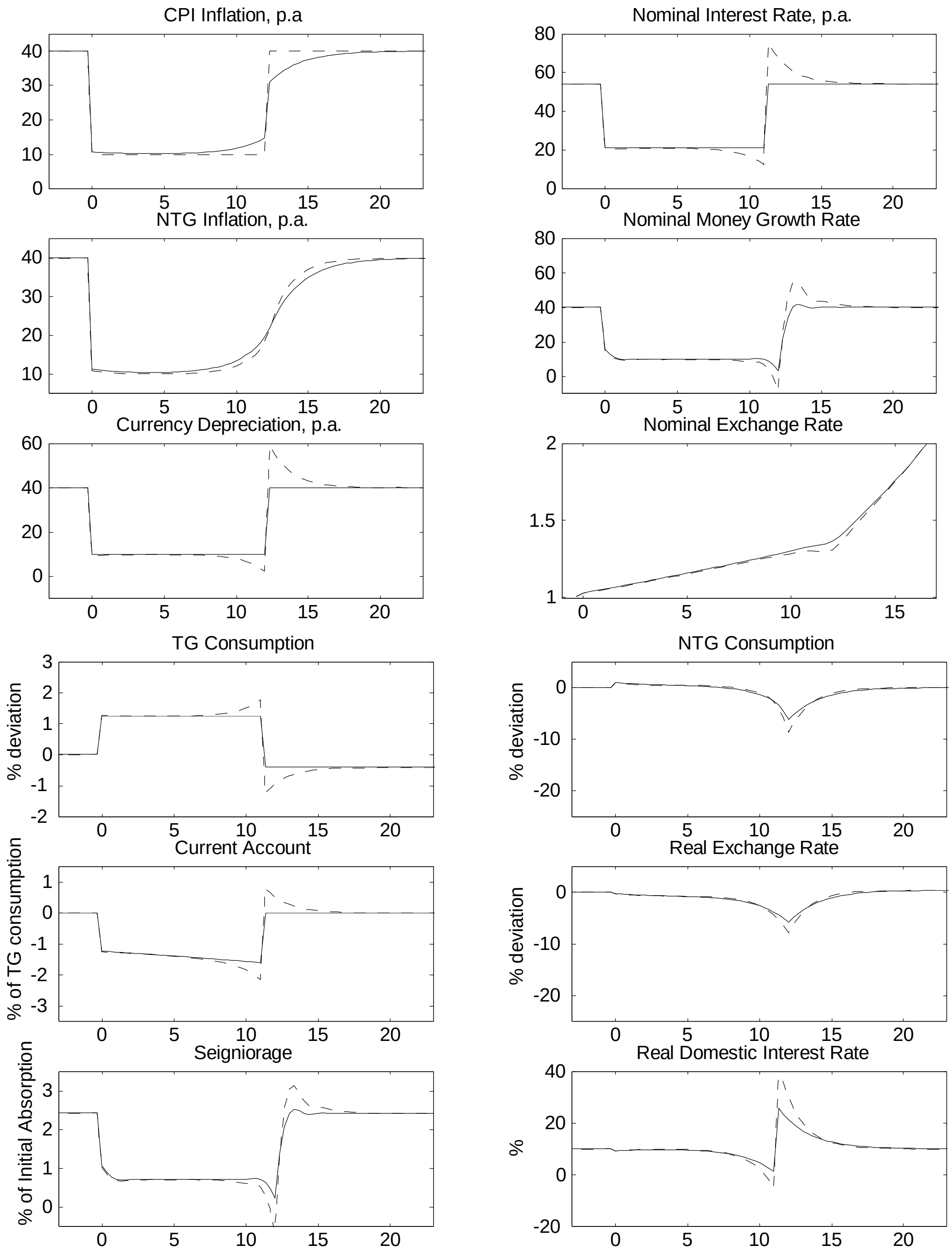


Figure 3.2 : More Flexible Prices (__ = ET, - - = IT)

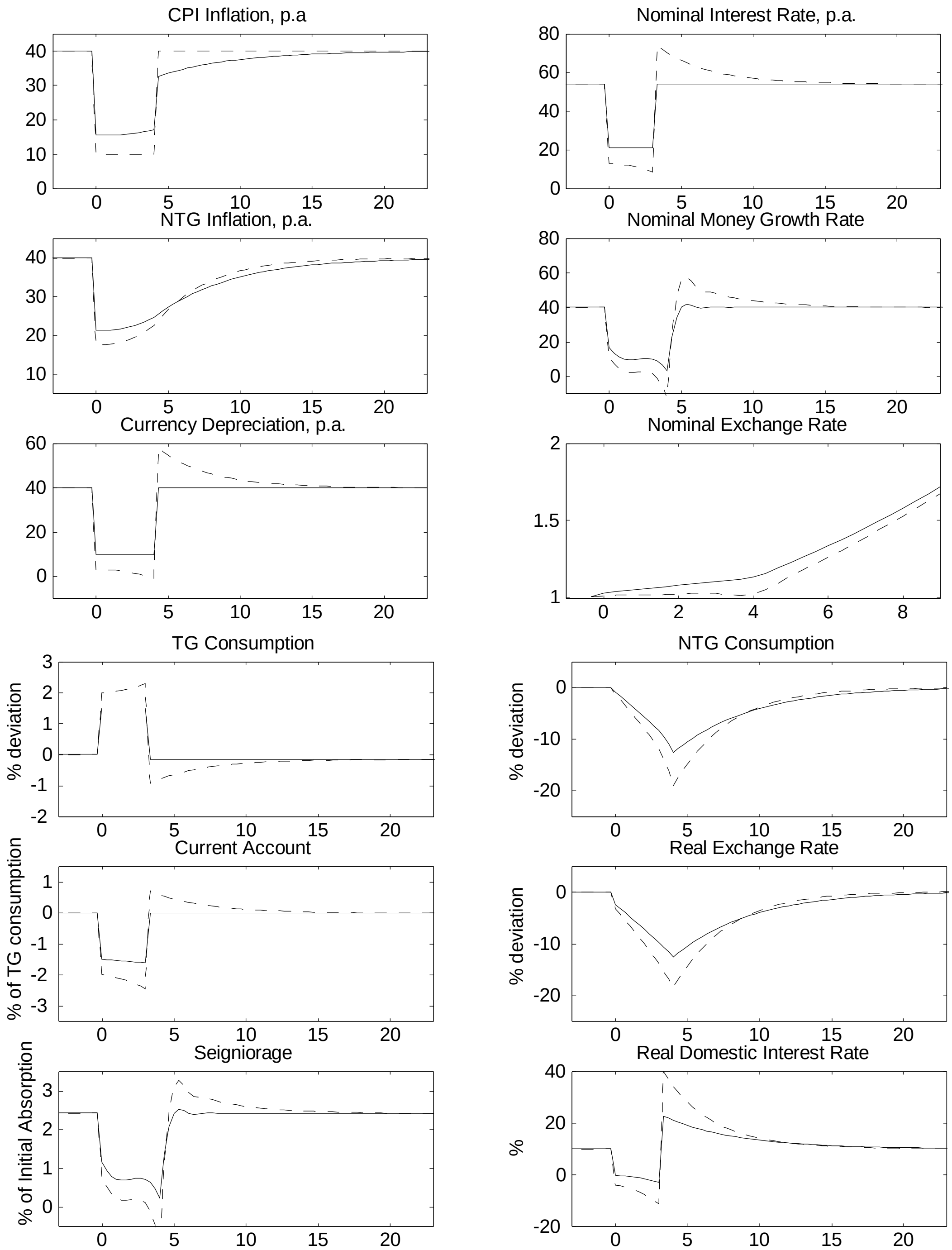


Figure 3.3 : Lower Policy Duration (__ = ET, - - = IT)

3.5 Some Data - Mexico 1997-2000

Mexican inflation rates and real exchange rate for the most recent period are consistent with the story told by our model. The first graph below shows the Mexican annual inflation target plotted against currency depreciation (3-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 in the following months the inflation target was not met. 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 graph shows, a very pronounced real appreciation.

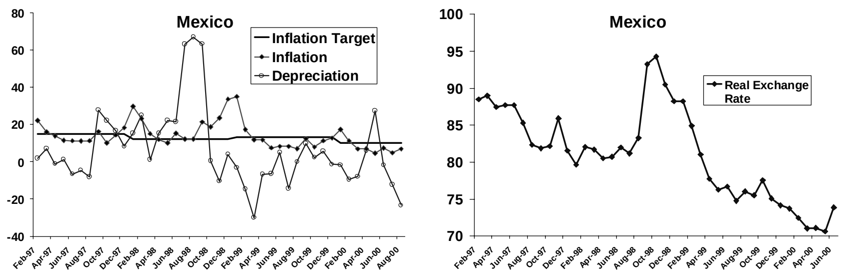


Figure 3.4

3.6 Welfare

The welfare loss of an unsustainable program is defined, following Lucas (1987), as the percentage reduction η in the pre-stabilization steady state streams of tradables and nontradables consumption $\bar{c}^*_{ss}$ and $\bar{c}_{ss}$ which makes households indifferent between the reduced constant streams of consumption, with leisure unchanged, and the streams of consumption and leisure obtained as a result of the stabilization program $\{c^*_t, c_t, (1-l_t(j)), j \in [0,1]\}_{t=0}^{\infty}$. Then η is given by

$$\gamma \ln(\bar{c}^*_{ss}) + (1-\gamma)\ln(\bar{c}_{ss}) + \kappa \ln(1-l_{ss}) + \ln(1-\frac{\eta}{100}) = \qquad [3.27]$$

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

For a staggered price economy this computation is complex as at any time there is a large number of cohorts of firms and workers which are characterized by different relative prices and therefore equilibrium labor supply. The solution is therefore approximated by evaluating utility for a total of the 30 most recent cohorts, which accounts for more than 99.99% of the overall distribution of relative prices. Figures 3.5a and 3.5b present the results. Figure 3.5a holds policy duration at its benchmark value of $T = 12$ quarters and varies δ between 0.4 and 0.8. Figure 3.5b holds δ 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 δ falls below 0.5. Programs suffering from very low sustainability involve smaller losses as distortions are limited to a very short period.

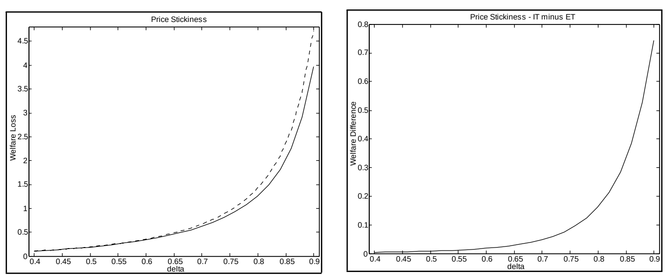


Figure 3.5a

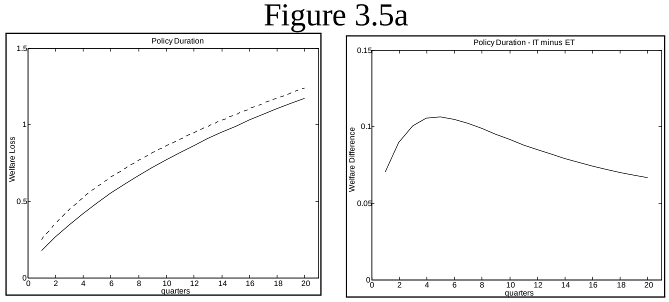


Figure 3.5b

3.7 Summary

The conclusion of this section regarding inflation targeting is that its performance is slightly inferior to exchange rate targeting. Pure forward looking inflation targeting gives rise to indeterminacy of equilibrium paths (non-uniqueness). And inflation targeting performs somewhat worse than exchange rate targeting when 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 - we will see this again in the following section. The performance of two heavily exchange rate driven price indices as targets of monetary policy turns out to be very similar. The only differences are due to differences in the extent of exchange rate dependence, which in a small and very open economy are not that large.

But there is also a lesson in the inferior performance of inflation targeting. Policy temporariness or lack of policy sustainability is rarely studied when evaluating different monetary policy rules, and as we will see in the next section it produces different rankings between 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 where lessons learned in the industrialized world are applied to emerging markets, potentially overlooking important characteristics which distinguish the latter. In many of the successful case stories in industrialized economies, sustainability was either not a big issue to start with, or monetary policy changes were combined with fiscal improvements which alleviated or removed them. Whether lasting improvements are likely to be observed in emerging economies must at this point remain open to question. And even if they are ultimately achieved, a perceived lack of sustainability in the transition period, until the public is finally "convinced", may give rise to the above described dynamics for a prolonged period.

Caution is therefore called for when applying the lessons learned from existing inflation targeting programs to a new and very different economic environment.

4 EXOGENOUS SHOCKS

In this section we will assume perfect sustainability of monetary policy and evaluate the performance of different monetary regimes under exogenous shocks. The framework used is identical to that of Section 3, except that we now allow for time varying real international interest rates r_t, international inflation π_t^*, inverse velocity α_t, and tradables income y_t^*, where the latter can be interpreted as a simplified representation of terms of trade shocks. The other difference is that a third monetary policy, money growth rate targets, 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. We will in fact see that the behavior of inflation targets is much more similar 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 adhered to, the reason being that the latter tightly constrains exchange rate flexibility. Of course this would not be true if what was really meant by inflation targeting is discretionary monetary policy.

Emerging economies, much more so than industrialized countries, frequently face the problem of adjusting to very large exogenous shocks, and it is in these situations, much more so than over the course of an ordinary business cycle, that the choice of exchange rate regime is deemed especially critical. The methodology employed here does in fact lend itself to studying the adjustment mechanism to large exogenous shocks, with the help of impulse responses as in Section 3. A full stochastic business cycle analysis requires a different methodology. The reader is referred to Schmidt-Grohe and Uribe (2000), who conduct such an analysis for the case of Mexico.

Four shocks will be analyzed in detail. They are meant to be purely illustrative. In Figure 4.1 we analyze a 5% permanent decrease in tradables endowment y_t^*, which can be interpreted as a negative terms of trade shock. Figure 4.2 analyzes a jump of the real international interest rate from 10% to 15%, followed by a gradual return to 10%, and Figure

4.3 a jump in international inflation from 4% to 8%, again followed by a gradual return to its original value. Figure 4.4 shows the consequences of a permanent 10% increase in money demand via an increase in the parameter α.

In the figures the first panel shows the exogenous shock and the remaining panels show the induced response of the economy.

4.1 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 interest rate shocks require large initial downward jumps in tradables consumption, which under fixed exchange rates requires an accompanying deep nontradables recession because the real exchange rate is predetermined. This 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 remains closer to steady state output at all times. However, inflation targeting patently does not give the economy much greater real exchange rate flexibility. The reason is most importantly that exchange rate depreciation is constrained by the requirement of meeting the inflation target. Under exchange rate targeting the flexibility of the nontradables inflation rate allows the real exchange rate adjustment to be accomplished almost as quickly. The real counterpart of this is that there is also a nontradables recession under inflation targeting. Of course inflation targeting does represent some improvement over exchange rate targeting in terms of real exchange rate flexibility. What may be a little more surprising is that ex-post that is not necessarily an advantage in welfare terms - see the next section on this.

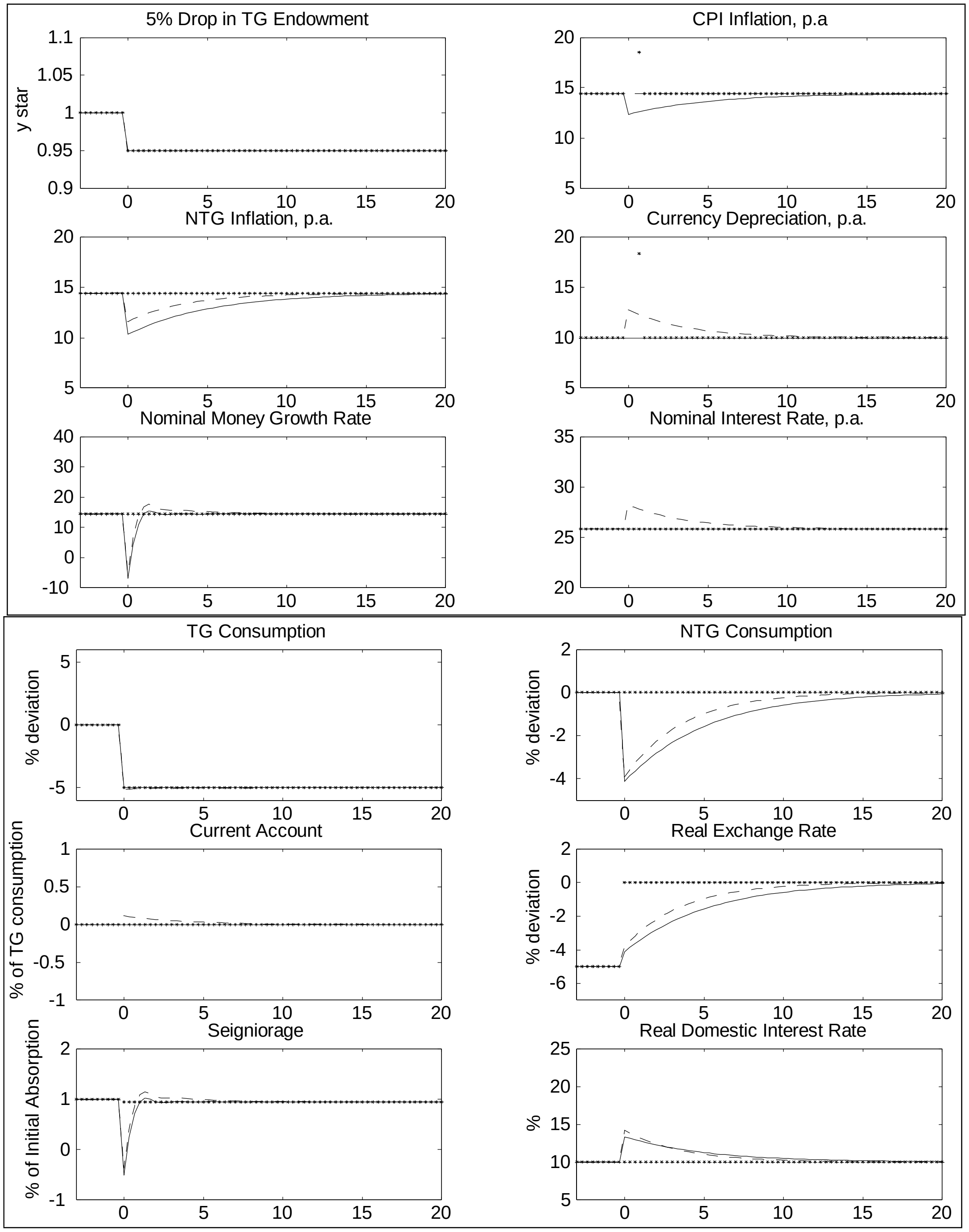


Figure 4.1 : Tradables Endowment Shock (__ = ET, - - = IT, ... = MT)

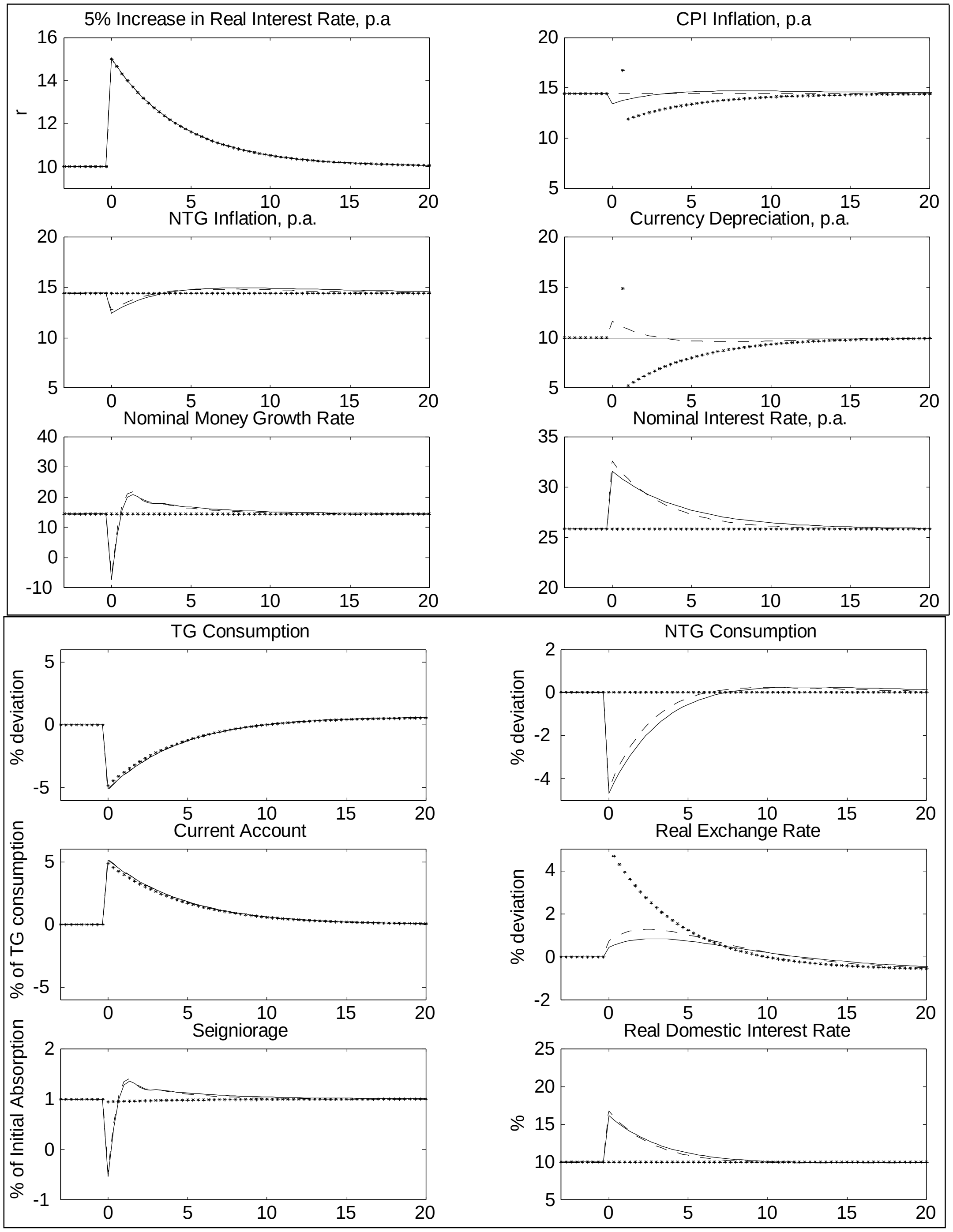


Figure 4.2 : Real International Interest Rate Shock (__ = ET, - - = IT, ... = MT)

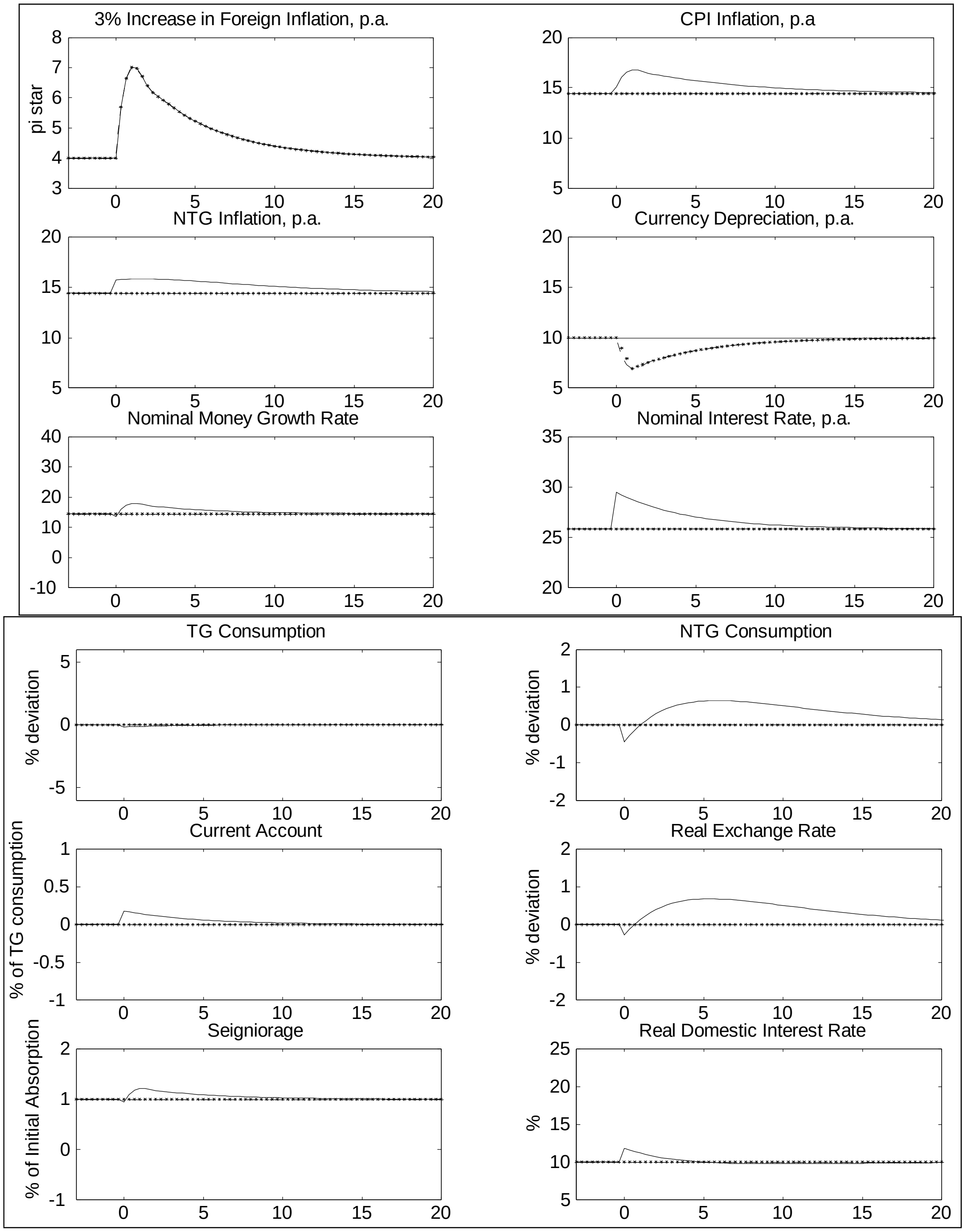


Figure 4.3 : International Inflation Shock (__ = ET, - - = IT, ... = MT)

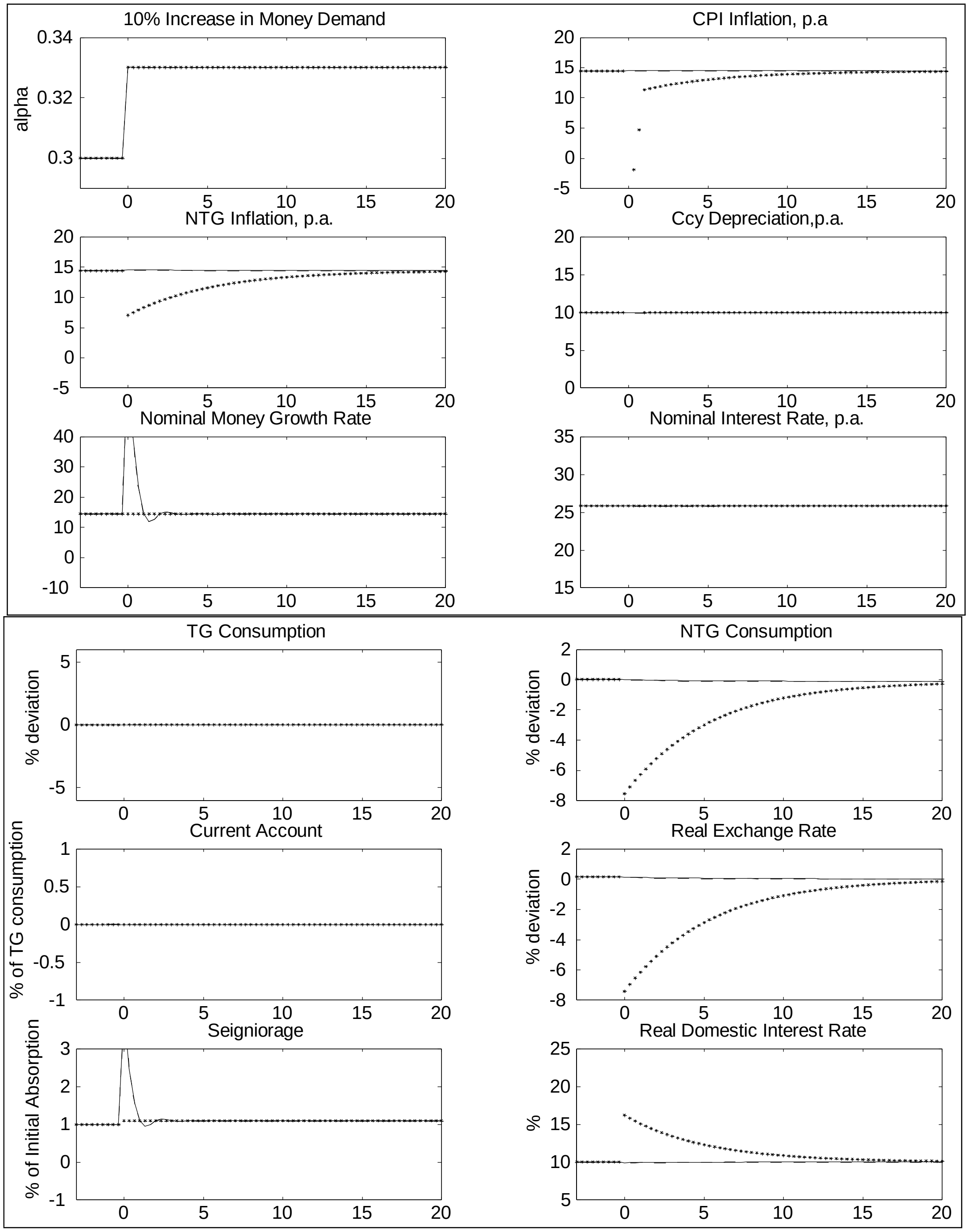


Figure 4.4 : Increase in Inverse Velocity (__ = ET, - - = IT, ... = MT)

On the other hand, the money growth rate targeting case corresponds exactly to our intuition about flexible exchange rates. Here the real exchange rate can instantaneously jump to a new level, leaving the nontradables 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 which exactly offsets the higher real interest rate, leaving the nominal interest rate constant at all times.

The one case where inflation targeting is just as effective as money targeting and clearly superior to exchange rate targeting is a foreign inflation shock. Both regimes respond with a downward and exactly offsetting jump in 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. However, 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 are however small compared to those of a real interest rate change.

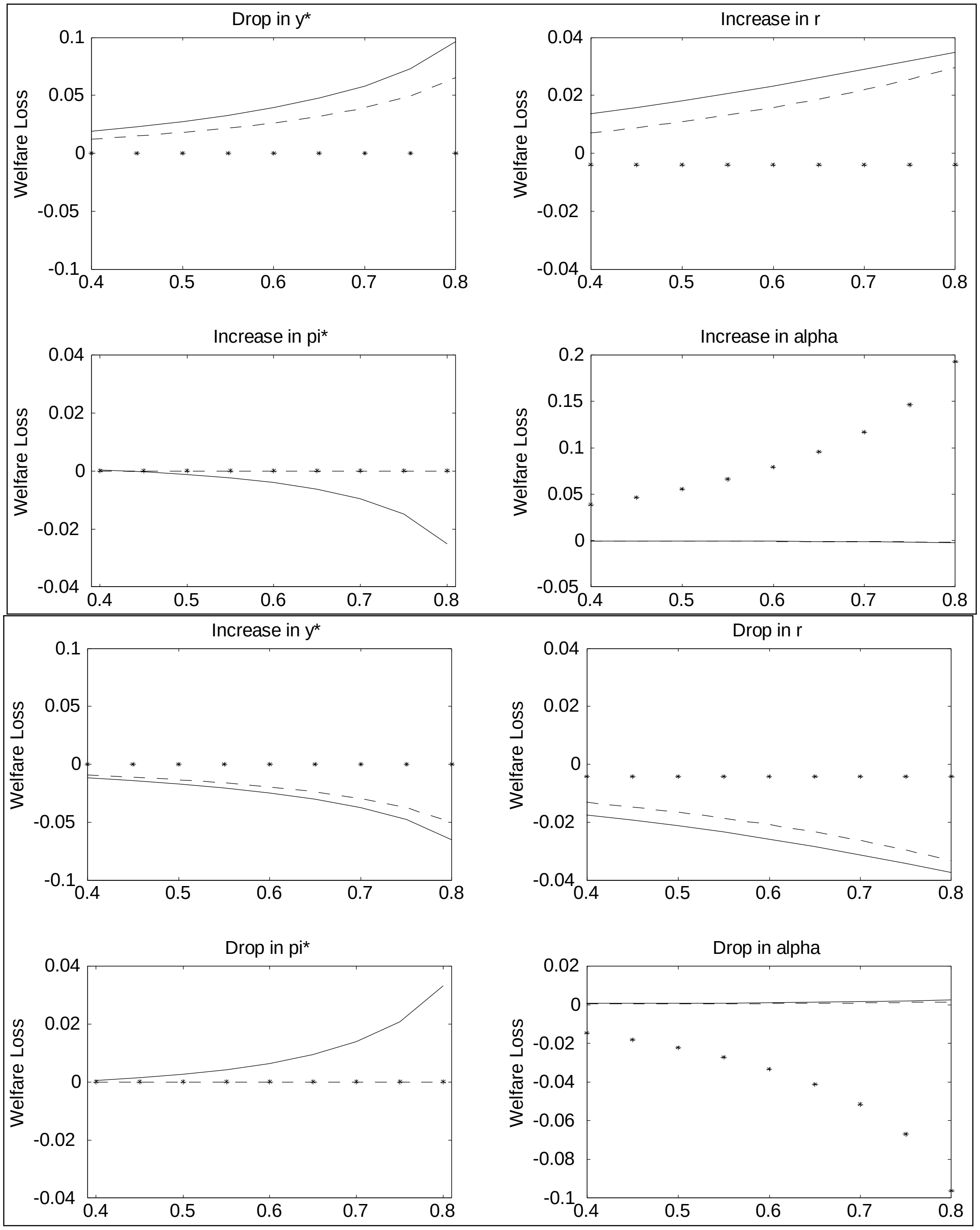
It is part of conventional wisdom in open economy macroeconomics that "flexible exchange rates" perform badly under money demand shocks. Figure 4.4 shows that this is indeed true for money targeting, where an increase in money demand leads to a deep nontradables recession. Because monetary accomodation is ruled out, this 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 targets to volatility in the velocity of money, which is very common empirically, is the main reason why this monetary regime is no longer practised in all but a handful of countries. However, the same is not at all true when "flexible exchange rates" stands for inflation targeting. An inflation target performs almost identically to an exchange rate target, this time to its advantage. The reason is that under both regimes the monetary authority is not prevented from satisfying the increase in money demand by injecting extra money.

To summarize, purely in terms of the adjustment process 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 we now turn to welfare analysis.

4.2 Welfare

Figure 4.5 summarizes the welfare results. They were computed by the same method as in Section 3. The benchmark against which welfare is evaluated assumes that the economy either 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 it does. The latter applies to the tradables endowment shock, where for long-run steady state purposes tradables consumption is assumed to immediately and permanently drop by 5%, and to the money demand shock where nontradables consumption is assumed to immediately drop to the lower level consistent with a 10% increase in inverse velocity.

The first four panels of Figure 4.5 show the welfare results for the four exogenous shocks studied above, 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 more 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 accomodation of higher money demand. But an ambiguity arises under foreign inflation shocks, where exchange rate targeting involves lower welfare losses, and in fact welfare gains over the benchmark case, at higher degrees of price stickiness. This points to an important qualification of the Mundell-Fleming logic.



Drop in y*
Increase in r
Increase in pi*
Increase in alpha
Increase in y*
Drop in r
Drop in pi*
Drop in alpha
Welfare Loss
0.1
0.05
0
-0.05
-0.1
0.04
0.02
-0.02
-0.04
0.2
0.15
-0.06
-0.08
0.4
0.5
0.6
0.7
0.8

Figure 4.5

The key point is that a sticky price cash-in-advance monetary economy is subject to pre-existing distortions, namely markups and deviations from the Friedman rule. In an emerging economy with high steady state inflation the latter is very significant. It can be computed that our economy, which features 14.4% steady state inflation, has a steady state nontradables output more than 5% below what would be possible at the Friedman rule. This means that exogenous shocks which 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 it is straightforward to generate others. Here we study the effects of the same four shocks with opposite signs. Exchange rate targeting now performs best of all regimes under foreign real shocks, due to the greater boom in nontradables output needed to generate domestic inflation and a real appreciation. The conclusion from this exercise is that, for an ex-post welfare ranking of monetary regimes, what matters is not only the nature of exogenous shocks but also their direction. Of course the magnitude of welfare losses under negative shocks exceeds that of welfare gains under equal-sized positive shocks by a small amount. In a business-cycle analysis such as Schmitt-Grohe and Uribe (2000) one will therefore find some advantage of inflation targeting over exchange rate targeting, but it is clear from the above analysis that this will be quite small except for extreme degrees of price stickiness.

The picture that emerges from this analysis is very complex, and clearly does not point in one direction as far as the best choice of monetary regime is concerned. As always, what matters are the properties of the entire set of shocks to which a particular economy is subject. This is simply a question of fact, which every country has to answer for itself.

4.3 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 where 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 inferior under an increase in money demand because they do not allow monetary accomodation. Second, in a welfare sense the argument misses the fact that shocks which require a temporary nontradables consumption boom are beneficial, because pre-existing 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 inflation targeting in this world is clearly not "flexible exchange rates". Except for a foreign inflation shock 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.

5 CONCLUSION

This paper compares inflation targeting with other monetary regimes, especially exchange rate targeting, along various dimensions. The emphasis is very clearly on the environment facing emerging markets, as for example I do not purport to make statements about policy sustainability with regard to any other group of countries. 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. It was shown that both exchange rate targets and inflation targets are vulnerable to speculative attacks. While this vulnerability is somewhat smaller for inflation targeting, on the other hand the monetary policy required to defend a vulnerable inflation target was shown to lead to somewhat greater distortions and welfare losses. And an inflation target behaves very similarly to an exchange rate target under many exogenous shocks. It is very unclear at this point whether inflation targeting is a superior policy in the face of such shocks without precisely identifying the nature of all shocks facing a particular country.

I will restate here the conjecture I 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 where we can be comfortable with discretion?

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