Announcement Effects in Emerging Market Inflation Targeting Regimes

Christopher P. Ball[1,2] and Javier Reyes[3]

[this draft: September 2006]

Abstract:

When emerging market adopt inflation targeting (IT) regimes many do so to stabilize inflation. They often announce a current inflation target and a future, lower target that will be reached over years. This kind of announcement is new for IT regimes since developed economies generally adopt IT only after inflation is stable. This paper investigates the implications of taking these announced future changes seriously. Using a dynamic small open economy model with a fully credible central bank we find that unannounced and announced changes in the inflation target produce very different transition paths in the economy. Unannounced disinflation leads to an immediate economic slowdown but a credit expansion while announced disinflation leads to an immediate boom but a credit crunch, followed by a slowdown. Inflation also deviates from its target in very different ways under the two policies. This suggests that researchers need to reconsider using realized and targeted paths of inflation to measure of central bank credibility and effectiveness during inflation stabilization programs since in our model the central bank is always credible.

JEL classifications: E42, E52, F31, F41

Key words: Inflation Targeting, Expectations, Inflation Stabilization, Credit Channels.

[1] Department of Economics School of Business, Quinnipiac University, Christopher.Ball@quinnipiac.edu
[2] Corresponding author.
[3] Sam M. Walton College of Business, University of Arkansas, E-mail: jreyes@walton.uark.edu

1. Introduction

What is an inflation target other than the target for inflation that the central bank announces? Is there any difference between an inflation targeting (IT) central bank announcing that it will lower its inflation target at a specified date in the future and it simply lowering its inflation target now? While developed economies tend to adopt IT once inflation is stable, many emerging markets adopt IT to disinflate. And, they frequently do so by announcing a path of future, lower targets in addition to the publicly stated immediate targets that they are currently pursuing.

The IT literature is largely silent on the effects of announcing target changes since research has mostly focused on developed economy experience with IT. In developed economies, targets are rarely changed. Once inflation is stable, the relevant question is whether targets should be short, medium, or long-range. Answering that question is a matter of addressing policy lags and structural issues in the economy. What happens when policy makers pursue current targets and announce future lower ones was not an issue of concern until emerging markets began adopting IT in recent years.

This paper investigates the implications of taking these announced future changes seriously. We employ a continuous time, dynamic small open economy model with optimizing individuals that enjoy perfect foresight. The central bank is assumed to use an IT regime and enjoys full credibility at all times. In this framework we study two different policies: one where the central bank simply lowers its inflation target, and one where the central bank announces a future lowering of its inflation target. We call the first policy "unannounced" and the second "announced" to fit common experience, but the real difference is that the first policy is completely unanticipated by individuals in the economy while the second policy is fully anticipated. We find that the policies produce very different transition paths in the economy. For example, the unannounced policy leads to an immediate economic slowdown but a credit expansion while the announced policy leads to an immediate boom but a credit crunch, followed by a slowdown.

Table 1 contains information on adoption dates and inflation target changes in a number of emerging market IT countries. Brazil, Chile, the Czech Republic, Hungary, Mexico and Poland all gradually decreased short-run targets (i.e., annually adjusted targets) while simultaneously announcing mid and/or long run lower targets for specific future dates. In contrast, Korea adopted IT in 1998 and drastically lowered its inflation target in one fell swoop from around 9% in 1998 to around 3% in 1999.

Mexico and Korea make excellent examples of the two extreme policy we consider. Korea seems to fit the unannounced case fairly well and Mexico the announced case. While this is encouraging for our model's relevance to the real world, it also suggests that the empirical literature should take central bank announcement effects into account when explaining emerging market IT data. We return to these issues in section 3.3 of the paper.

Our work builds on the work of Lahiri and Vegh (2001, 2003, 2005) which in turn build on Calvo and Vegh (1995 and 1996). Calvo and Vegh (1995 and 1996) aimed at better understanding the effectiveness of paying interest on money in order to reduce inflation, a phenomenon observed in many emerging markets. Their 1995 work is in an open economy framework with flexible prices and focuses on the difference between permanent and temporary increases in the policy interest rate. Their 1996 work studies a closed-economy with sticky prices á la Calvo (1983) and concludes that increasing the policy rate can lower inflation but at the cost of a recession, a result consistent with our unannounced case.

Lahiri and Vegh (2003)[4] use a similar model to the one in Calvo and Vegh (1995) to investigate the feasibility of raising interest rates to delay a Krugman-type balance of payments crisis. Lahiri and Vegh (2001) study an open economy with two traded goods, one of which is produced using an imported input subject to a credit-in-advance constraint while the other is produced using domestic labor. They include a banking sector and a transaction cost technology to support demand deposits. This opens a number of credit channels in their model. Finally, Lahiri and Vegh (2005) focus on the output costs associated with increasing interest rates.

This line of work has proved very insightful concerning the links between government controlled interest rates, currency value, credit channels, and the output effects associated with interest rate policies in emerging markets. We continue to focus on emerging market issues and also borrow heavily from this line of work in using a banking sector and a transactions cost technology to generate credit channels. Additionally, we focus more on the implications for an economy's path of inflation.

Our most serious departure from the Calvo and Vegh and Lahiri and Vegh papers is in terms of monetary regimes. They study the traditional monetary arrangements of either a flex (i.e., money supply rule) or a fixed exchange rate regime or some combination thereof (like dirty floats and fear of floating). Although, these are historically important regimes for emerging market, IT has grown in importance for emerging markets in recent years and we focus on it here.

We also hope that our work contributes to the IT research focusing on small open economies. Gali and Monacelli (2002), Parrado (2004) and Parrado and Velasco (2002) are forerunners in this field. We follow their lead in analyzing the effects of IT regimes on an economy although we do not focus on finding optimal policies or compare IT against other regimes. While our focus on announced versus unannounced policy changes is novel in the above line of work, it is not new in and of itself. The recognition that anticipations matter follows most prominently from the work of Sargent and Wallace (1981). It also played a role in earlier papers on controlling the nominal interest rate like Auernheimer and Contreras (1995). We know of no other papers on IT that focus on these issues. This is surprising given that the modern consensus seems to be that central banks guide the economy as much through their influence on expectations as through the direct channels of policy variables (Woodford, 2005). Our work reintroduces the more traditional role of expectations into the IT models. We find that expectations matter and can matter a lot.

From an empirical and policy perspective, our results suggest that distinguishing between credibility failures and announcement effects is important. Koltan and Navratil (2003), for example, evaluate the performance of IT in the Czech Republic along a number of lines, including inflation relative to its target. They identify four possible reasons that explain why inflation may miss its immediate inflation target: policy was wrong, the forecast was wrong, the bank intentionally missed target due to other shocks (i.e., activating an escape clause), the bank was simply unable to fulfill its mandate. Our work implies an additional possible reason: the announcement effect of a credible central bank. In practice the reasons why a short-run target is not met are probably a mix of the above, and, as noted by Koltan and Navratil (2003), exact causes are hard to untangle. The closest work we've found to addressing the announcement issue we're raising is Gurkaynak, Sack and Swanson (2005)

[4] While this paper was published in 2003, it is based on their 2000 NBER Working Paper 7734 of the same title. Thus, in terms of model development, it precedes their 2001 work.

who look at the response of asset prices to US Fed policy actions versus statements. Our theoretical work is thus a call for more empirical work along these lines and hopefully in an emerging market context as well.

2. The Model

In our model individuals are blessed with perfect foresight, have access to world capital markets, consume traded and nontraded ("home") goods, use banks to hold interest-earning demand deposits, and there are transaction costs. The traded good is produced using an imported input subject to a credit-in-advance constraint. The home good sector is demand determined with a fixed endowment in the long run. Home good prices are sluggish and adjust according to a Calvo (1983) pricing mechanism.

This arrangement provides a role for banks to borrow from individuals, lend to firms, and hold required reserves and government bonds. The result is a credit channel through which the central bank can control interest rates and influence consumer and firm behavior directly. This is important for an IT central bank where the primary policy tool is the interest rate adjusted according to a Taylor-type rule.

Within this framework we conduct two policy experiments, both lowering inflation and the inflation target by the same amount across steady states. In the first experiment, the central bank simply lowers the inflation target. This policy is unannounced and unanticipated. In the second experiment the central bank announces that at a future date, *T,* the inflation target will be lowered. For both cases, we assume the central bank is fully credible.

2.1 Individuals

Individuals have the following lifetime utility function that is assumed to be separable in its arguments and over time.

$$W = \int_0^\infty u\left(c_{t,T}, c_{t,H}\right) e^{-\rho t} dt \tag{1}$$

where c_T and c_H represent consumption of the traded and non-traded (i.e., "home") good, respectively, and ρ is the subjective rate of time preference which is constant and assumed equal to the constant world real interest rate.

In addition to making consumption decisions, individuals hold interest-bearing real demand deposits, *h*, defined in terms of the traded good which is the numeraire for this economy. These are held to reduce non-negative transaction costs, captured by

$$s_t = \psi(h_t). \tag{2}$$

The transaction technology is assumed to be convex so that real demand deposits reduce transactions costs[5].

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[5] Formally: $\psi\left(h\right) \geq 0,\ \psi'\left(h\right) \leq 0, \psi''\left(h\right) > 0, and\ \psi'\left(h^*\right) = \psi\left(h^*\right) = 0$. Following Lahiri and Vegh (2001), a simple function that satisfies these conditions is $\psi\left(h\right) = h^2 - ah + \kappa \qquad h \in \left[0, a/2\right]$.

Finally, individuals have access to international capital markets and hold net real assets, a, that yield world real interest rate, r. It follows that their lifetime budget constraint is[6]

$$a_0 + \int_0^{\infty} \left(\tau_t + \frac{y_{t,H}}{\varepsilon_t} + \Omega_{t,T} + \Omega_{t,B} \right) e^{-rt} dt = \int_0^{\infty} \left(c_{t,T} + \frac{c_{t,H}}{\varepsilon_t} + I_t^d h_t + s_t \left(h_t \right) \right) e^{-rt} dt \qquad (3)$$

where $I^d = i - i^d$ which is the net return on demand deposits, i is the nominal interest rate, i^d is the return on deposits, τ is the government lump-sum transfer, ε denotes the real exchange rate, y_H is the home good endowment, Ω_T and Ω_B are the profits from the traded good sector and banking sector, respectively, that accrue to individuals in this economy.

Individuals maximize lifetime utility (1) subject to constraint (3). The first order conditions for the individual's problem are

$$U_T\left(c_T\right) = \lambda \qquad (4)$$

$$\varepsilon_t U_H\left(c_H\right) = \lambda \qquad (5)$$

where subscripts T and H denote derivatives with respect to traded and home good consumption, respectively. It follows immediately from condition (4) that traded good consumption is constant (piecewise linear) over time. Home good consumption, on the other hand, will fluctuate with the real exchange rate, by (5). Combining these expressions determines the real exchange rate as the relative value of home and traded goods from the individual's perspective

$$\varepsilon_t = \frac{U_T\left(c_T\right)}{U_H\left(c_H\right)} \qquad (6)$$

where the real exchange rate is defined by the relative price of traded to home goods. Assuming the law of one price holds for traded goods and keeping the foreign price of traded goods constant at unity, the definition of the real exchange rate becomes

$$\varepsilon_t \equiv \frac{E_t}{P_{t,H}} \qquad (7)$$

where E_t is the nominal exchange rate. Open economy interest parity also holds for this economy and, given the law of one price along with constant world prices, can be written

$$i_t = r + \hat{E}_t \qquad (8)$$

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[6] The flow constraint is: $\dot{a}_t = ra_t - I_t^d h_t - c_{t,T} - \frac{c_{t,H}}{\varepsilon_t} - s_t\left(h_t\right) + \tau_t + \frac{y_{t,H}}{\varepsilon_t} + \Omega_{t,T} + \Omega_{t,B}$

where $\hat{E}\left(\equiv\left(\frac{dE}{dt}\right)\left(\frac{1}{E}\right)\right)$ is the expected – and actual, given perfect foresight – rate of currency depreciation.

The final first order condition from the individual's problem yields the following implicitly defined demand for domestic deposits as a function of the relative return for deposits,

$$-s'(h_t) = I^d . \tag{9}$$

2.2 Supply Side

The supply side of the economy is defined by traded and home good sector production. Home goods are assumed to be given by a constant endowment, $\bar{y}_H$. This is the industry's long-run constant level of production. In the short-run, output ($y_{t,H}$) is demand determined and home prices are assumed to adjust slowly according to a Calvo (1983) pricing mechanism. The home good sector can thus be summarized by the following equation

$$\dot{\pi}_t = -\theta\left(y_{t,H} - \bar{y}_H\right) \tag{10}$$

where $\pi_t\left(\equiv\left(\frac{dP_H}{dt}\right)\left(\frac{1}{P_H}\right)\right)$ is the rate of home good price inflation and a dot above a variable denotes its time derivative.

Traded good firms are captured by a representative firm that faces a credit-in-advance constraint in importing intermediate goods for production. This generates a demand for loans from the banking sector. Specifically, firms import good x to produce good y_T according to the following production technology

$$y_{t,T} = Ax_t^{\eta} \qquad \eta \in (0,1) \tag{11}$$

where η is a constant parameter and A is a constant technology parameter[7].

The credit-in-advance constraint takes the following form

$$l_t \geq \phi p_x x_t \qquad \phi > 0 \tag{12}$$

where $l_t\left(\equiv \frac{L_t}{E_t}\right)$ denotes real loans from domestic banks. The world relative price of the imported good in terms of good y_T is p_X and is assumed constant (set to unity) for simplicity. In this paper we are not interested in the effect of world relative price fluctuations on domestic production. Our interest is in the domestic credit channel created by this constraint since firms obtain loans at lending rate, i^l. The lending spread for firms is $I_t^l = i_t^l - i_t$.

[7] Technology is not a part of our story but we use it scale variables in our MATLAB simulated graphs and thus include it here for completeness.

Firms also have real financial wealth which is the difference between the amount of foreign bonds they hold, *b*, and their domestic loans: $a_{t,T} = b_{t,T} - l_t$. Incorporating both into the production technology (12) and the credit constraint (13) the lifetime budget constraint[8] is

$$\int_0^\infty \Omega_{t,T} e^{-rt} dt = a_{0,T} + \int_0^\infty \left(A x_t^\eta - x_t \left(1 + I_t^l \phi \right) \right) e^{-rt} dt \tag{13}$$

where the RHS of equation (13) represents the firm's present discounted value of dividends taking the paths of the world real interest rate, *r*, the interest spread on loans, I^l, and the initial stock of financial assets, $a_{0,T}$, as given.

The firm's problem is then to maximize the RHS of (13) with respect to the imported input, *x*. The first order condition for this problem is

$$\eta A x_t^{\eta-1} = 1 + I_t^l \phi \tag{14}$$

which can be rearranged to express the firm's demand for imported inputs in terms of the cost of credit to firms

$$x_t = \left(\frac{A\eta}{1 + I_t^l \phi} \right)^{1/1-\eta}. \tag{15}$$

Firm derived demand for loans can then be found by substituting (15) into credit constraint (12), resulting in the following expression:

$$l_t = \phi \left(\frac{A\eta}{1 + I_t^l \phi} \right)^{1/1-\eta}. \tag{16}$$

The firm's demand for loans (and for the imported good) is decreasing and convex in the lending spread[9].

2.3 Banking System

To facilitate the firms' need for credit and individuals' need for demand deposits, the domestic economy has a perfectly competitive banking system. The banking system receives deposits (*H*) from individuals and holds a fraction δ of those deposits as reserves (*M*). In terms of spreads relative to the nominal interest rate, banks pay individuals $I^d \left(\equiv i - i^d \right)$ on

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[8] The flow constraint is $\dot{a}_{t,T} = r a_{t,T} + y_{t,T} - x_t - I_t^l l_t - \Omega_{t,T}$

[9] $\dfrac{dl}{dI^l} = \dfrac{-\phi^2}{(1-\eta)\left(1 + I_t^l \phi\right)} \left(\dfrac{A\eta}{1 + I_t^l \phi} \right)^{1/1-\eta} < 0$ & $\dfrac{d^2 l}{d\left(I^l\right)^2} = \dfrac{2\phi^3}{(1-\eta)\left(1 + I_t^l \phi\right)^2} \left(\dfrac{A\eta}{1 + I_t^l \phi} \right)^{1/1-\eta} > 0$

deposits, earn $I^l\left(\equiv i^l - i\right)$ on loans (L) to firms, and $I^g\left(\equiv i^g - i\right)$ on loans (G) to the government. In this environment, M is high powered money and is held by banks at opportunity cost i. Finally, banks' assets, $M + L + G$, must equal their liabilities, H.

A bank's profit maximization problem is to

$$\max_{\{L_t,G_t,H_t\}} \Omega_B = I_t^l L_t + I_t^g G_t + I_t^d H_t - i_t M_t \tag{17}$$

subject to

$$M_t - \delta H_t = 0 \tag{18}$$

$$H_t - M_t - L_t - G_t = 0 \tag{19}$$

where the first constraint is the reserve requirement and the second is the balance sheet restated.

Three first order conditions result:

$$i_t^l = i_t^g \tag{20}$$

$$I_t^d + I_t^l\left(1-\delta\right) = \delta i_t \tag{21}$$

$$I_t^d + I_t^g\left(1-\delta\right) = \delta i_t \tag{22}$$

For future reference it is useful to note that combining these first order conditions links the return on deposits to both the interest on loans to firms and to the government.

$$i_t^g\left(1-\delta\right) = i_t^d \tag{23}$$

Replacing i^g with i^l generates the link to firms. This close relationship becomes important since the government uses i^g as its policy tool in meeting its inflation objectives. By (20) and (16) changing the government's interest rate affects firm behavior, i.e., the credit channel for firms. By (23) and (10) changing the government's interest rate affects individual behavior as well.

Some final restrictions to support the existence of such a banking system in this model are important to discuss here. First, $Id \geq 0$ is required for banks to prefer borrowing from individuals instead of the open market (we assume this holds at equality too). This implies, in turn that $i - i^d \geq 0$. To make lending to firms and the government more appealing than lending in the open market also requires $I^g\left(= I^l\right) = i^g - i \geq 0$. We thus focus on a domestic environment where $i^d \leq i \leq i^g$ and $0 \leq i^g - i \leq \delta i^g$. Both of these conditions are met when the rates are bid to the following equality by perfect competition: $i^g = i + \delta i^g$.

2.4 Government

The government of this economy is composed of two parts. The first is the monetary authority which we'll call the central bank. The central bank's liabilities are the high-powered money (M) held by domestic banks. The assets are government bonds (G) –

actually net bonds in amount in private hands – and international reserves $R\left(\equiv ER^{*}\right)$. The remaining part of the government is the fiscal branch.

For the government as a whole, the lifetime constraint[10] is

$$\int_{0}^{\infty} \tau_t e^{-rt} dt = R_0 + \int_{0}^{\infty} \left(\dot{m}_t + \hat{E}_t m_t + \dot{g}_t + \left(\hat{E}_t - i_t^g \right) g_t \right) e^{-rt} dt \tag{24}$$

which says that the government's discounted lifetime flow of transfers must equal it's initial international reserve stock plus the discounted lifetime flow of revenues from money creation and domestic lending. The transfer is assumed to adjust endogenously so that this constraint holds at all times.

The government's monetary policy is defined by an IT regime. IT here means that the central bank adjusts the policy tool, i^g, to meet its inflation target according to a Taylor-type interest rate rule.

$$\frac{di_t^g}{dt} = \gamma\left(\pi_{t,H} - \bar{\pi}_H\right) \tag{25}$$

where γ is a constant parameter and $\bar{\pi}_H$ is the target. Equation (25) establishes the government interest rate as a state variable in this economy.

Three things should be noted here. First, the target is assumed to be piecewise constant. Second, this rule assumes what is sometimes called a strict inflation targeting regime. That is, an output gap is not included the interest rate rule. Third, the rule is defined in terms of home-good inflation, not overall inflation which includes the nominal exchange rate depreciation as well. This is to avoid fear of floating type behavior (Ball and Reyes, 2006).

2.5 Perfect Foresight Equilibrium

Combining constrains from each sector of the economy, individuals (3), firms (12), banks (17), (18), and (19), and the government, (24), yields the economy's overall flow resource constraint or balance of payments equation.

$$\dot{w}_t = rw_t + y_{t,T} - c_{t,T} - s\left(h_t\right) \tag{26}$$

where $w\left(\equiv b + b_T + R\right)$ is the economy's net wealth (i.e., individuals' net international asset holdings, traded good firms' net international asset holdings, and the government's international asset holdings).

From equation (4) of the individual's utility maximization problem traded good consumption is constant along the perfect foresight equilibrium path. Using this, we can

[10] The flow constraint is $\dot{R}_t = rR_t + \dot{m}_t + \hat{E}_t m_t + \dot{g}_t + \left(\hat{E}_t - i_t^g\right) g_t - \tau_t$ where $g \equiv g^G - g^{CB}$ and g^G is the real amount issues and g^{CB} the amount held at the central bank. g is thus the real value of net liabilities to the private sector.

rewrite the lifetime economy resource constraint to solve for the perfect foresight equilibrium level of traded consumption.

$$\overline{c}_T = w_0 + \int_0^{\infty} \left(y_{t,T} - s\left(h_t\right)\right) e^{-rt} dt \tag{27}$$

which says that the economy's consumption is equal to its initial endowment of net wealth plus the discounted value of traded good production less transactions costs.

On the home goods side of the economy, domestic market clearing must hold at all points in time

$$c_{t,H} = y_{t,H} \qquad \textit{for all } t \tag{28}$$

and along the perfect foresight path, output equals its long-run constant endowment level, so home consumption must also be constant at this level

$$\overline{c}_{ss,H} = \overline{y}_H \tag{29}$$

where *ss* denotes steady state. This implies that the real exchange rate must also be constant

$$\overline{\varepsilon}_{ss} = \frac{U_T\left(\overline{c}_T\right)}{U_H\left(\overline{y}_H\right)} \tag{30}$$

By interest rate rule (25) it also follows that, along the perfect foresight equilibrium path, the government interest rate, i_g, is constant. Thus, home good inflation is at its target level.

$$\pi_{ss,H} = \overline{\pi}_H \tag{31}$$

From differentiating the definition of the real exchange rate, (7), with respect to time and from (31) it follows that that the exchange rate is constant along the perfect foresight path and that home goods inflation and the rate of nominal exchange rate depreciation are equal:

$$\hat{E}_{ss} = \pi_{ss,H} = \overline{\pi}_H \,. \tag{32}$$

This, combined with open economy interest parity equation (8), implies that the nominal interest rate is constant along the perfect foresight path as well.

$$i_{ss} = r + \hat{E}_{ss} \tag{33}$$

By condition (23) and the constancy of both the government interest rate and nominal rates, it follows that both the return on deposits, i^d, and the deposit spread are constant as well

$$I_{ss}^d = i_{ss} - i_{ss}^d \tag{34}$$

By deposit demand equation (9), it follows that real demand deposits are also constant

$$-s'(h_{ss}) = I_{ss}^d . \tag{35}$$

All interest rates are thus constant in steady state in this economy. It follows from (16) that firms' demand for loans are constant as are demand for inputs by (15) and thus traded output by (13). Combining these results with (35) allows us to rewrite the traded good consumption function (27) in terms of constant values for output and demand deposits

$$\overline{c}_{ss,T} = w_0 + \frac{1}{r}\left(y_{ss,T} - s(h_{ss})\right) \tag{36}$$

Finally, given the constant variables determined in above it follows from (24) that government transfers are also constant.

2.6. Dynamic System

The system's dynamics are captured by three differential equations. The first equation governs the motion of prices and combines equation (10) with home-goods market clearing

$$\dot{\pi}_t = -\theta\left(c_{t,H} - \overline{y}_H\right). \tag{37}$$

The second equation comes is the central bank's interest rate rule, equation (25). This rule governs the motion of the interest rate on government bonds which is the central bank's policy tool.

The final equation is found by differentiating first order condition (5) and the equilibrium real exchange rate (7) with respect to time. Next, use open economy interest parity to substitute out for nominal exchange rate depreciation and banking optimality condition (21). Rearrange to obtain

$$\dot{c}_{t,H} = -\frac{U_H(c_H)}{U_{HH}(c_H)}\left[I_t^d + i_t^g(1-\delta) - r - \pi_{t,H}\right] \tag{38}$$

These three equations define a dynamic system in three unknowns (π_H, i^g, and c_H). The system has one state variable, i^g. To determine stability, we linearize around steady state. The zero trace and negative Jacobian of the linearized system indicates that indeed the system has one negative and two positive roots as required for a saddle solution. We also find that the variables approach the solution of the steady state monotonically. The details are shown in Appendix A.

3. Policy Experiments

The government now lowers its inflation target in order to lower inflation and adjusts interest rates according to rule (25). We consider both the cases of an anticipated and an unanticipated change in the inflation target.

All of our results are solved for analytically. Nevertheless, we've included simulated graphs of the paths of each variable. These were simulated using parameters chosen to match those found in the literature relating to emerging markets. Appendix B contains further details on the simulation. To keep the experiments comparable, we use the same parameterization and the same decline in the inflation target from 10% to 5% which is a relevant range for most of the emerging markets when they actually used IT to stabilize inflation in their economies. Graphically, the shock always occurs at date $t = \tau$. In the unanticipated case, date $t = \tau$ is when the inflation target is lowered. The unanticipated results are depicted in Figure 1. In the anticipated case, date $t = \tau$ is when the central bank announces that the target will be lowered at date T, shown in Figure 2.

Before discussing the analysis in detail, it is worth noting that traded good production exceeds consumption in all steady states. This is due to the presence of transaction costs that are defined in terms of the traded good. A fraction of traded production is always devoted to transaction costs and deposited in banks. One can think of firms producing this good, exporting it and then individuals depositing the domestic currency value of the proceeds. In that case there will be a small trade surplus in the initial steady state. Alternatively, one can merely assume this portion of the traded good is converted domestically into demand deposits in which case there is no trade surplus. In either case, the country does not lend as a result of the surplus since the proceeds from the exports are instead deposited domestically. Thus there is no change in net foreign assets under either assumption. We use the second interpretation because it simplifies matters in terms of presentation by allowing one to start with zero net exports and zero net foreign wealth but otherwise has no effect on any results. Below then, when we refer to "traded good production" technically we mean "traded good production less transaction costs".

3.1. Unanticipated Permanent Reduction in the Inflation Target

Consider the case where the government permanently lowers the inflation target and individuals in the economy are not anticipating this change. It is clear that, in the new steady state, home good inflation and nominal interest rates will be lower but home good consumption will be at its constant long run level. The government's interest rate is a predetermined variable and does not change at the initial instant of this policy shift. Since the policy rate, i^g, and home inflation, π^H, must approach steady state from opposite directions along the saddle path[11], it follows that π^H must initially fall to a level below its new steady state value (i.e., the new targeted level) to induce interest rates to fall. This drop in inflation is generated by a sudden collapse in home good consumption. According to Calvo-pricing equation (37) this forces the rate of inflation adjustment to increase so that it rises to its new steady state value. These paths can be seen in Figure 1.

As interest rates decline, by equations (11) and (15), traded good production increases to its higher level in the new steady state. Upon impact of the policy change, individuals re-optimize taking this new production path into consideration, as determined by equation (36). This causes a one-time upward jump in traded consumption. The initial increase in traded consumption takes place prior to the increase in production and thus the economy runs a short-lived trade deficit until traded production reaches the level of consumption of that good. In the new steady state traded consumption is higher than it was in initial steady state but home consumption returns to its original, constant level. As a result, by equation (6), the real exchange rate is lower in the new steady state. It's transition path demonstrates an initial

[11] See Appendix equations (A.12) and (A.13).

drop due to the upward jump in traded good consumption and fall in home good consumption but then increases to steady state following the path of home good consumption. That this would be so follows from differentiating equation (6) with respect to time. After the one-time drop in c^T, the real exchange rate follows the same path as c^H.

The drop in home good demand determined production is immediate while the increase in traded good production is gradual, following the fall in interest rates. Thus there is initially a drop in the economy's GDP. Given that the fall in home good consumption exceeds the increase in traded good consumption, utility falls on impact and then rises with the path of home goods. That utility is higher in the new steady state follows from the observation that home good consumption is the same across steady states while traded good consumption has increased. Measured in terms of GDP or utility, there is an economic slowdown initially. While we do not prove it rigorously, we do find that for the normal range of parameterizations lifetime discounted utility is higher after the policy change. This is the common result that lower inflation is welfare enhancing. Here it matters for traded production in particular.

Following the shock, the country runs a trade deficit until traded good production reaches the level of traded good consumption. The new steady state exhibits a trade surplus reflecting the increase in traded good production due to lower nominal interest rates. This surplus is used in the new steady state to service the debt that was acquired during the transition leaving the current account in balance, as is generally the case.

3.2. Anticipated Permanent Reduction in the Inflation Target

When the central bank announces its policy change in advance, the results are quite different. The steady states are qualitatively the same since all initial values are identical and the change in the inflation target are the same. In the new steady state home inflation is lower, interest rates are lower, and home consumption remains unchanged. Traded consumption increases across steady states and thus the real exchange rate is lower. The transition is not the same, however. These paths can be seen in Figure 2.

At date $t = \tau$, the central bank announces that the inflation target will be lowered at date T. Individuals understand that in the new steady state, relative prices – reflected in the path of the real exchange rate – will adjust so that home good consumption is relatively more expensive. As a result, home good consumption is cheap at date $t = \tau$ relative to date T and thereafter in the new steady state. Consumption of the home good thus increases today. This triggers an increase in home good inflation, by equation (37). For future reference, note that this increases inflation above its current target as is clear in Figure 2. This increase in inflation causes the central bank to raise interest rates according to their interest rate rule in equation (25). The increase in interest rates raises the cost of borrowing funds in this economy causing a decrease in the production of the traded good, following equation (15) which indicates the decline in firms' demand for loans and thus inputs. This may very well be part of the reason that countries such as Mexico observed a credit crunch despite its growing economy (Tornell et al., 2003). In an economy where the central bank is announcing future targets during a period of disinflation, the output cost of this policy is masked by the home good consumption boom that exceeds the decline in traded good production.

If an outsider were to observe nothing but the data from this country during the early transition they would likely conclude that the central bank is facing credibility problems since it is consistently failing to meet its target. If they were to consider the announced target, then the initial increase in inflation would appear that much worse. In pure credibility terms, as often measured by the difference between actual inflation and its targeted level at a point in time, the central bank would appear to have problems everywhere but in steady state. This would be an incorrect conclusion however. It is precisely because the central bank enjoys full credibility in this model that the consumption boom occurs in the first place. If individuals didn't believe the announced policy, they would not attempt to exploit the intertemporal relative price difference of home goods.

Despite the traded good production contraction, production is higher in the new steady state for the same reasons as in the previous experiment. The present value of the entire path of traded production increases and this causes consumption of the traded good to increase to a new, permanent level upon impact of the policy announcement. As a result, consumption of both goods increases and there is a boom in terms of GDP and utility. These paths are off saddle paths that take the economy to the point where all variables will be on the new steady state's saddle path at exactly the time the new policy (future target) comes into effect. At that point, the economy does enter a brief economic slowdown during the initial phase of its transition to the new steady state. Finally, the economy still runs a trade deficit initially that is later offset by a surplus used to service the debt that was acquired at the beginning.

3.3. Selected Country Experiences

The predicted behavior of the inflation rate relative to the target is actually quite similar to that observed in the data for the countries in Table 1: Chile, the Czech Republic, Hungary, Korea, Mexico, and Poland. This is generally true for the paths of realized and targeted inflation in light of what we know about announcements in these economies in Table 1. Rather than discuss all of the economies in detail, we focus on the two countries where our results are potentially borne out most clearly: Korea and Mexico. In terms of our model and what we know about these countries from Table 1, Korea represents the unannounced case and Mexico the announced. Figure 3 includes the realized and targeted inflation rate in Korea and Mexico. Additionally, given the debate in Mexico over the credit crunch, we've included the credit in each country.

First compare the upper right panel in Figure 1 with the case of Korea in Figure 3. The paths in the data from early 1998 until late 2000 closely resemble the predictions of our model for an unannounced decrease in the target. Inflation falls rapidly and then approaches its new steady state level from below. Secondly, comparing the upper right panel in Figure 2 with the case of Mexico in Figure 3, the data resembles our predictions once again. Here the difference between an announcement and a current target comes into play. From Table 1 we know that in 1999 Mexico announced that the target in 2003 would be three percent. Our predictions in Figure 2 are that there will be an increase in inflation above the immediate target following a credible announcement of this type. Assuming for a moment that the Mexican government enjoyed full credibility, then this announcement effect would explain the increase in inflation above the twelve percent immediate target around early 1999 in Figure 3. The subsequent decline in realized inflation follows our predictions as well, but the current target in Mexico was ratcheted downward over time until the announced target is reached. We make no predictions about such a specific policy but the model could easily be modified to include multiple anticipated changes in the target.

It is not news that Mexico suffered a credit crunch in the late nineties following the Tequilla crisis of 1994. Tornell et al. (2003) and others argue that this was a particularly long credit crunch and resulted from Mexico's inefficient banking sector. While Mexico's banking sector inefficiency is surely a problem, our model suggests that Mexico's actions under its new IT regime in 1999 may also have played a role in determining the path of central bank credit seen in Figure 3. Our model predicts a credit crunch following the announcement of a future lower inflation target. This prediction is not inconsistent with the decline in Mexico following the announcement in 1999 of a lower 2003 target. In contrast to this result, the model prediction for the unannounced case is a credit boom. This too matches the data in Figure 3 for Korea.

We do not claim to have explained the data. This is not an empirical paper. We merely suggest that the effects of credibly announcing versus not announcing target changes should not be ignored in examining the data. The paths of these same variables for the remaining countries in Table 1 are presented in Appendix C. The model predictions are generally born out for each country, but not as starkly as they are for Mexico and Korea. What exactly this implies about these country experiences or about our model is a question we leave for future, more empirically oriented research. At this point we merely hope to convince researchers of the importance of the issue.

3.4. Additional Implications

The predictions of the model should also serve as a warning to IT central banks that consider announcing future target changes during a disinflation program. When the target reduction is fully anticipated, the model predicts that during the early years of transition, the realized inflation rate will initially exceed the current target. As a result, the central bank may temporarily lose credibility in the eyes of outsiders. This may be an important issue for emerging markets that adopt IT to lower inflation and gain credibility.

Broader political economy implications can be drawn from comparing these experiments as well. A first lesson is that announcing policies would be more challenging to a central bank in terms of credibility. Initially this is because inflation rises above its short-term target. Later, as the date of the new target's implementation nears, this is because of the ensuing recession. These challenges are avoided by not announcing the policy change. If the strength of the central banker is an issue, then this would be an argument for an unannounced and, more importantly, unanticipated shock rather than an announced (and anticipated) gradualistic approach. This calls into question the general recommendation that emerging markets adopting IT should emphasize announcements and communication with the public. Generally the move to IT coincides with an institutional move to greater transparency, but perhaps this need not imply that these countries go overboard in terms of communicating future policy moves to the public until they have gained credibility. Such issues have only recently gained more attention from researchers[12].

4. Conclusion

Unlike their developed economy counterparts, emerging markets have not generally waited to adopt IT until after inflation is low and stable. On the contrary, IT has been increasingly adopted in emerging markets in order to lower and stabilize inflation. This raises the question of what policy challenges such an approach might pose. In this paper we

[12] See Woodford (2005) for an excellent discussion of the role of central bank communication.

have looked at an often adopted policy in these economies of announcing future lower inflation targets as a tool in IT disinflation programs. The logic for announcement derives from the institutional emphasis IT regimes place on transparency and communication. While these are welcome institutional changes in many emerging markets, when used in the way we discuss here, they come with additional implications for key variables in the economy. Many of these implications may be welcomed, but there are side effects that may challenge the credibility of an otherwise fully credible IT central bank. Policy makers should be aware of these challenges so that they are able to make well informed decisions regarding whether to announce future policy changes or not.

In this paper we have studied a model in which the disinflation policy is always successful and the central bank always enjoys full credibility, but the transition to a lower-inflation steady state can differ substantially depending on whether the policy change was announced (and anticipated) or not. In our model an unannounced (and unanticipated) change leads to an immediate recession. Inflation drops rapidly and undershoots its new, lowered target. This is accompanied by a large drop in home good consumption but a credit boom due too the decline in interest rates during transition to the new steady state. An announced (and anticipated) change leads to an immediate economic boom. This is accompanied by a credit crunch as interest rates rise during transition to fight the increase in inflation that results from the home good consumption boom. These paths are very different in the same economy. The announced path can lead to additional challenges to the central bank. And these are challenges central banks should be aware of.

Although the predictions appear quite extreme at first, they are not inconsistent with emerging market IT experience at all. Actually, the predictions fit very well the cases of Korea for an unannounced change in the inflation target and Mexico for an announced change. This suggests room for future empirical work testing for the effects of announcing future policy shifts in the way we discuss. It also suggests that it would be dangerous for empirical studies to pass judgment on either the success or failure of IT in emerging markets at this point. At the very least, deviations of realized inflation from current target may not indicate anything concerning the credibility of and hence success of IT until after inflation is stabilized. We hope that the model presented in this paper serves as an initial framework within which to begin thinking about these issues which will continue to be important as emerging markets go forward with IT regimes.

References

Agenor, Pierre-Richard. 2002. "Monetary Policy under Flexible Exchange Rates: An Introduction to Inflation Targeting." In *Inflation Targeting: Design, Performance, Challenges*, ed. by Norman Loayza and Raimundo Soto, Central Bank of Chile (Santiago: 2002).

Apergis, Nicholas, Stephen Miller, Alexandros Panethimitakis and Athanasios Vavvakidis. 2005. Inflation Targeting and Output Growth: Empirical Evidence for EU. International Monetary Fund, Working Paper WP/05/89.

Aurelio, Marcela. 2006. Targeting Inflation and the Fiscal Balance: What is the Optimal Policy Mix? The Federal Reserve Bank of Kansas City, Economic Research Department, Research Working Paper, RWP 06-07.

Ball, Christopher P. and Javier Reyes. 2006. Inflation Targeting or Fear of Floating in Disguise? A Broader Perspective. Forthcoming in *Journal of Macroeconomics*.

Blanchard, Olivier. 2005. Fiscal Dominance and Inflation Targeting: Lessons from Brazil. in F. Giavazzi, I. Goldfajn, and S. Herrera, eds., *Inflation Targeting, Debt, and the Brazilian Experience, 1999 to 2003*, Cambridge: MIT Press.

Caballero, Ricardo J. and Arvind Krishnamurthy. 2003. "Inflation Targeting and Sudden Stops." National Bureau of Economic Research, NBER Working Paper 9599.

Calvo, Guillermo and Carlos A. Vegh. 1995. Fighting Inflation with High Interest Rates: The Small Open Economy Case under Flexible Prices. *Journal of Money, Credit and Banking*, February, 27 (1): 49-66.

Calvo, Guillermo and Carlos A. Vegh. 1995. Disinflation and Interest-Bearing Money. *The Economic Journal*, November, 106 (439): 1546-1563.

Cecchetti, Stephen G. and Michael Ehrmann. 1999. Does Inflation Targeting Increase Output Volatility? An International Comparison of Policymakers' Preferences and Outcomes. National Bureau of Economic Research, Working Paper 7426.

Cecchetti, Stephen G. and Junhan Kim. 2003. Inflation Targeting, Price-Path Targeting and Output Variability. National Bureau of Economic Research, Working Paper 9672.

Gali, Jordi and Tomassi Monacelli.2005. Monetary Policy and Exchange Rate Volatility in a Small Open Economy. Review of Economic Studies (72): 707-734.

Gurkaynak, Refet S., Brian Sack and Eric T. Swanson. 2005. Do Actions Speak Louder Than Words? The Response of Asset Prices to Monetary Policy Actions and Statements. International Journal of Central Banking. May 1(1): 55 – 93.

Hungarian National Bank. 2000. *Monetary Policy in Hungary*. Monetary Policy Department of the National Bank of Hungary, Edited by Ilona Bozo.

King, Robert, Charles Plosser and Sergio Rebelo. 1988. Production, Growth, and Business Cycles. I. The Basic Neoclassical Model. *Journal of Monetary Economics*. March (21): 195 – 232.

Kotlan, Viktor and David Navratil. 2003. Inflation Targeting as a Stabilisation Tool: Its Design and Performance in the Czech Republic. *Czech Journal of Economics and Finance*, 53: 220 – 242.

Lahiri, Amartya and Carlos A. Vegh. 2001. Living with the Fear of Floating: An Optimal Policy Perspective. National Bureau of Economic Research. Working Paper 8391, July.

Lahiri, Amartya and Carlos A. Vegh. 2005. Output Costs, Currency Crises, and Interest Rate Defense of a Peg. National Bureau of Economic Research. Working Paper 11791, November.

Lahiri, Amartya and Carlos A. Vegh. 2003. Delaying the Inevitable: Interest Rate Defense and Balance of Payments Crises. *Journal of Political Economy*, April, 111 (2): 404-424.

Masson, Paul R., Miguel A. Savastano, and Sunil Sharma. 1997. "The Scope for Inflation Targeting in Developing Countries." International Monetary Fund, Washington, D.C., IMF Working Paper WP/97/130.

Mishkin, Frederic S. 2000. "Inflation Targeting in Emerging Market Countries." National Bureau of Economic Research, NBER Working Paper 7618.

Mishkin, Frederic S. and Miguel A. Savastano. 2001. "Monetary Policy Strategies for Latin America." *Journal of Development Economics*, Vol. 66: 415 – 444.

Parrado, Eric. 2004. Inflation Targeting and Exchange Rate Rules in an Open Economy. International Monetary Fund, IMF Working Paper WP/04/21 (February).

Parrado, Eric and Andres Velasco. 2002. Optimal Interest Rate Policy in a Small Open Economy. NBER Working Paper No. 8721 (Cambridge, Massachusetts: National Bureau of Economic Research).

Sargent, Thomas J. and Neil Wallace. 1981. Some Unpleasant Monetarist Arithmetic. Federal Reserve Bank of Minneapolis, *Quarterly Review*, Fall: 1 – 17.

Tornell, Aaron. 2003.Liberalization, Growth and Financial Crises. UCLA Economics Online Papers 276, UCLA Department of Economics (October).

Woodford, Michael. 2005. Central Bank Communication and Policy Effectiveness. National Bureau of Economic Research. Working Paper 11898, December.

Table 1: Announced Targets in Selected Emerging Market IT Countries

Country and index targeted	Date of Adoption	Target Rate (or Range)		Horizon (Reference Period)	Policy Tool	Additional Target	Horizon (Reference Period)
Czech Republic		**low**	**high**				
	Dec. 1997	5.5%	6.5%	Dec. 1998			
	Nov. 1998	4.0%	5.0%	Dec. 1999			
net inflation index	Dec. 1997	3.5%	5.5%	Dec. 2000			
	April 2000	2.0%	4.0%	Dec. 2001	2 W repo rate	none	
	April 1999	1.0%	3.0%	Dec. 2005			
CPI band	April 2001	3.0%	5.0%	Jan. 2002			
		2.0%	4.0%	Dec. 2002			
CPI	Jan 2006	3.0%		until Euro			
Hungary						Exchange Rate	
	June 2001	7.0%	8.0%	Dec. 2001		15%	
	June 2001	3.5%	5.5%	Dec. 2002		15%	4 May 2001 - 4 June 2003
CPI	Dec. 2001	3.5%	5.5%	Dec. 2003	MNB base rate	15%	
	Oct. 2002	3.5%	5.5%	Dec. 2004		15%	
	Oct. 2003	3.0%	5.0%	Dec. 2005		15% & increase level	4 June 2003 - present
	Nov. 2004	3.5%	5.5%	Dec. 2006		15%	
Poland						Exchange Rate	
	April 1998		9.50%	Dec. 1998	28-day maturity (NBP reference rate), lombard rate, & rediscount rate	12.5	
	June 1998	8%	8.50%	1999		12.5	June 1998 - March 1999
CPI	Sept. 1998	< 4.0%		2003		12.5	
	March 1999	6.60%	7.80%	Dec. 1999		12.5	
	1999	5.40%	6.80%	Dec. 2000		15	March 1999
	Jan. 2004	1.50%	3.50%	continuous		none	2000
Slovakia						Exchange Rate	
	Sept. 2004	3%	4%	Dec. 2005			
Harmonized CPI	Sept. 2004	<2.5%		Dec. 2006	mixed	Managed Float	until Euro adoption
	Sept. 2004	<2%		Dec. 2007			
	Sept. 2004	<2%		Dec. 2008			
Brazil						Medium Term CPI (broad)	
	mid 1999	6.00%	10.00%	Dec. 1999			
	mid 1999	4.00%	8.00%	Dec. 2000			
	mid 1999	2.00%	6.00%	Dec. 2001			
	Jan. 2001	2.00%	6.00%	Dec. 2002		Announce in 1999 the targets for 2000 and 2001 and continues to announce that target for two years	
CPI (broad)	Jan. 2003	8.50%		Dec. 2003	Selic Rate (over night rate)		
	Jan. 2003	3.00%	8.00%	Dec. 2004			
	Jan. 2003	2.00%	7.00%	Dec. 2005			
	Jul. 2004	5.10%		Dec. 2005			
	Jan. 2005	2.00%	7.00%	Dec. 2006			
Chile						Exchange Rate	
	Jan. 1991	15.0%	20.0%	Dec. 1991			
	Jan. 1992	15.0%		Dec. 1992			
	Jan. 1993	10.0%	12.0%	Dec. 1993			
	Jan. 1994	9.0%	11.0%	Dec. 1994			
	Jan. 1995	8.5%		Dec. 1995		Abandoned the "Exchange Rate Band System" in 1999	
CPI	Jan. 1996	6.5%		Dec. 1996	Interbank daily rate		
	Jan. 1997	5.5%		Dec. 1997			
	Jan. 1998	4.5%		Dec. 1998			
	Jan. 1999	4.2%		Dec. 1999			
	Jan. 2000	3.5%		Dec. 2000			
	Jan. 2001…	2.0%	4.0%	mid-term			
Mexico						Medium Term CPI	
	Jan. 1999	9.0%	11.0%	Dec. 1999			
	Jan. 2000	6.5%	8.5%	Dec. 2000	Current account of comercial banks at the Central Bank ("Corto")	Announced in 1999 a medium term target for inflation of 3% for the year 2003	
CPI	Jan. 2001	5.5%	7.5%	Dec. 2001			
	Jan. 2002	3.5%	5.5%	Dec. 2002			
	Jan. 2003	2.0%	4.0%	Dec. 2003			
	Jan. 2004 …	2.0%	4.0%	mid-term			
Korea						Monetary Target (M3)	
	Jan. 1998	8.0%	10.0%	Dec. 1998			
	Jan. 1999	2.0%	4.0%	Dec. 1999		13% - 14%	1999
CPI	Jan. 2000	1.5%	3.5%	Dec. 2000	Overnight call rate	7% - 10%	2000
	Jan. 2001	2.0%	4.0%	mid-term		6% - 10%	2001
	Jan. 2002	2.0%	4.0%	mid-term		8% - 12%	2002
	Jan. 2003	2.0%	4.0%	mid-term			
CPI* (core)	Jan. 2004 …	2.5%	3.5%	mid-term			

Source: Country central banks.

Figure 1: Unanticipated Permanent Decline in Inflation Target

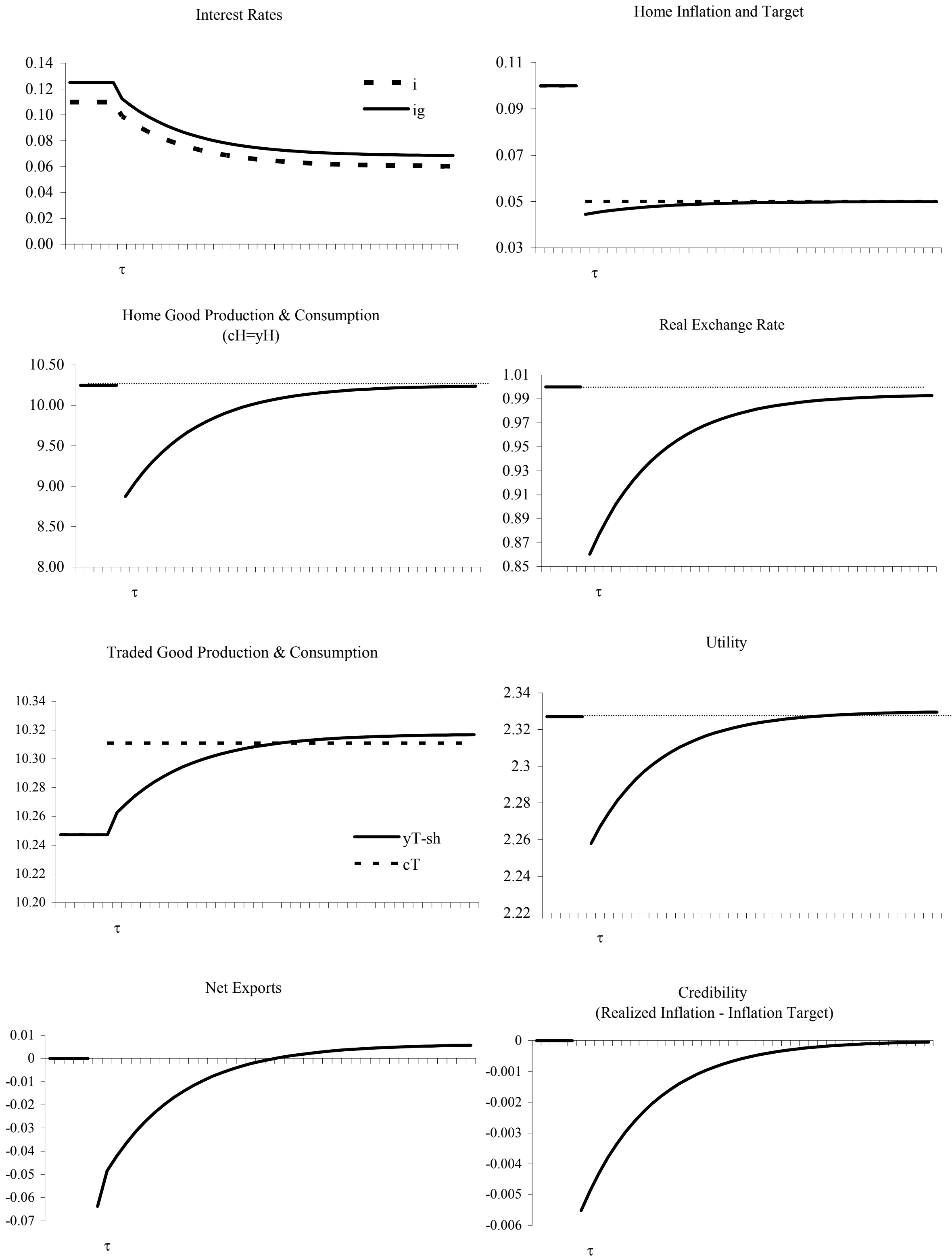


Figure 2: Anticipated Permanent Decline in Inflation Target

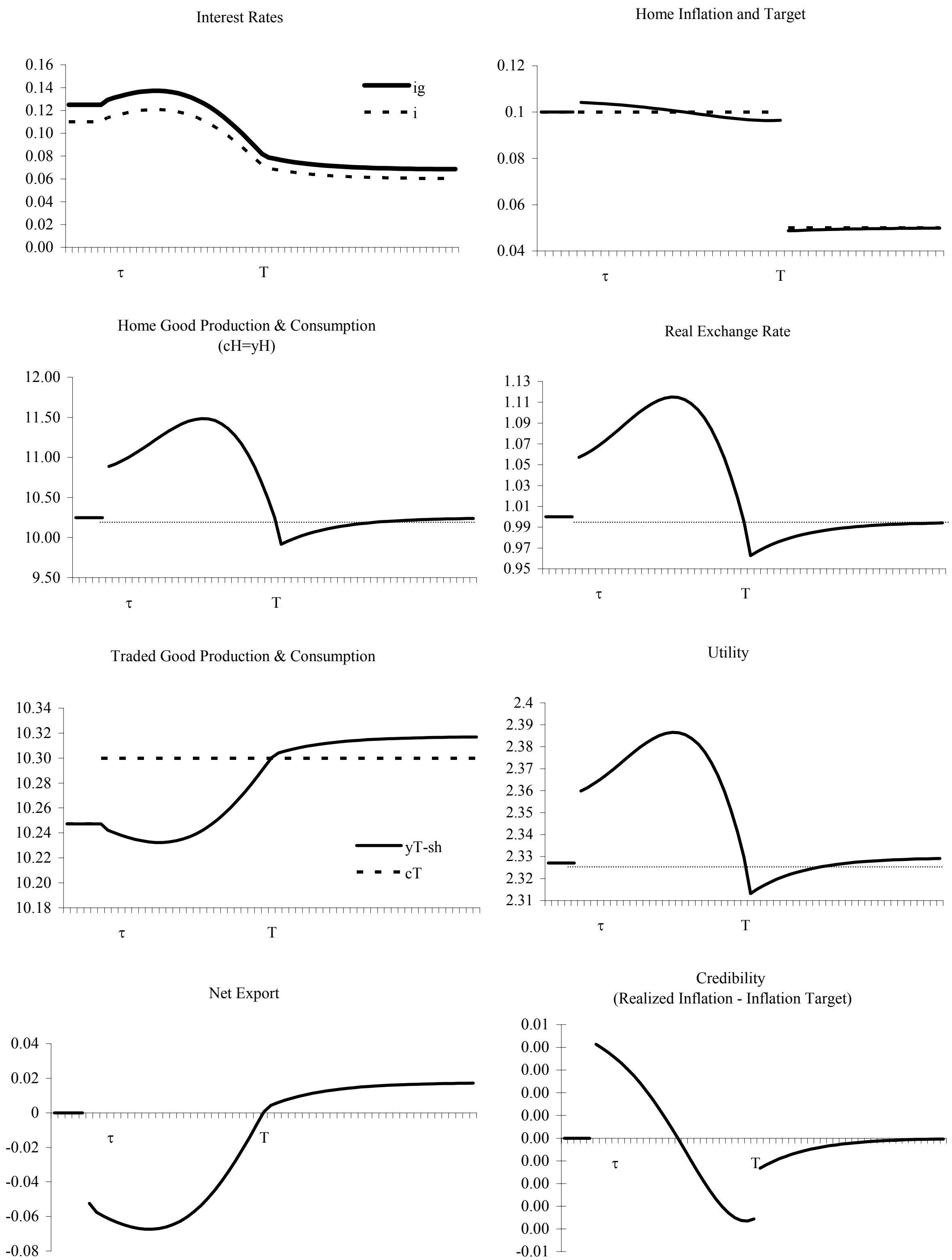
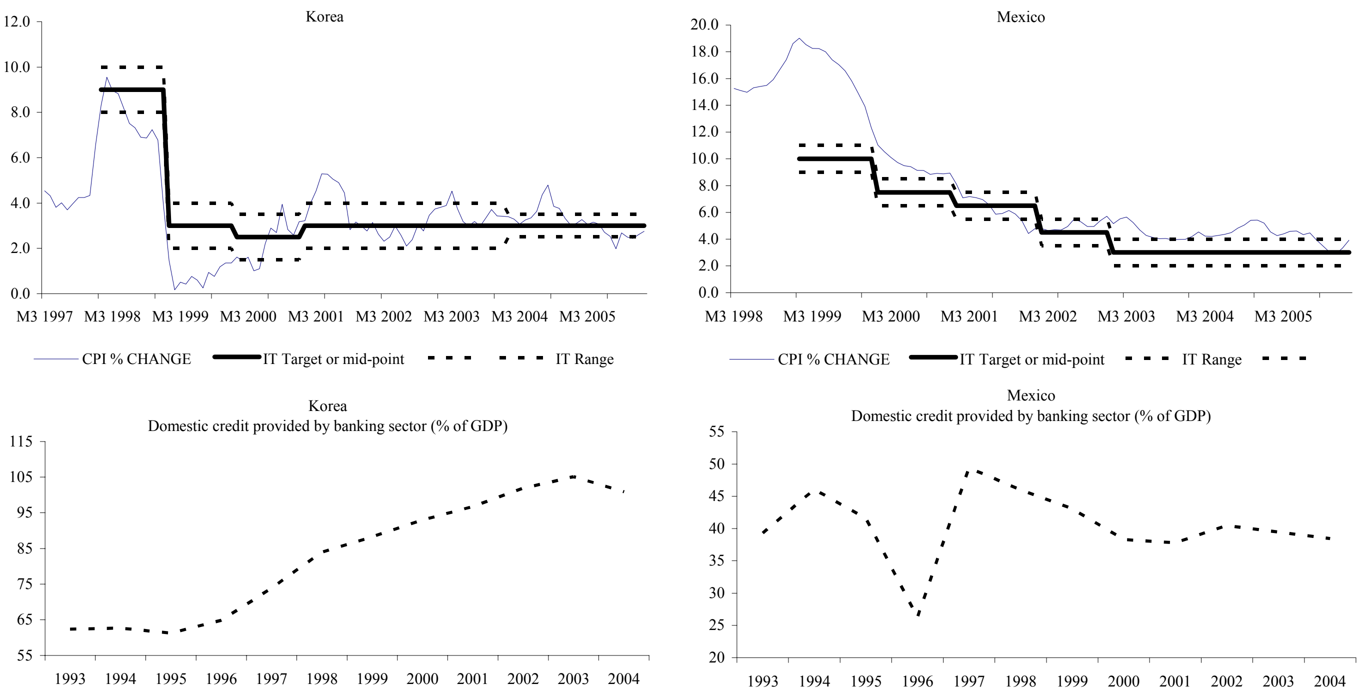


Figure 3: Credit, Realized and Targeted Inflation in Korea and Mexico

Source: IMF (IFS Statistics), World Bank (World Development Indicators) and countries central banks



Appendix A: Dynamic System Stability

The dynamic system is defined by equations (40), (41) and (42) , rewritten here for convenience.

$$\frac{di_t^g}{dt} = \gamma\left(\pi_{t,H} - \bar{\pi}_H\right) \tag{A.1}$$

$$\dot{c}_{t,H} = -\frac{U_H\left(c_H\right)}{U_{HH}\left(c_H\right)}\left[I_t^d + i_t^g\left(1-\delta\right) - r - \pi_{t,H}\right] \tag{A.2}$$

$$\dot{\pi}_t = -\theta\left(c_{t,H} - \bar{y}_H\right) \tag{A.3}$$

Using subscript ss to denote steady state, these equations imply that the system's steady state is given by

$$\pi_{ss} = \bar{\pi} \tag{A.4}$$

$$i_{ss}^g = \frac{r + \bar{\pi}_H - I_{ss}^d}{1-\delta} \tag{A.5}$$

$$c_{ss,H} = \bar{y}_H \tag{A.6}$$

Linearizing the system around stead state yields:

$$\begin{bmatrix} di_t^g \big/ dt \\ \dot{c}_{t,H} \\ \dot{\pi}_t \end{bmatrix} = \begin{bmatrix} 0 & 0 & \gamma \\ \frac{-U_H\left(\bar{y}_H\right)}{U_{HH}\left(\bar{y}_H\right)}\left(1-\delta\right) & 0 & \frac{-U_H\left(\bar{y}_H\right)}{U_{HH}\left(\bar{y}_H\right)} \\ 0 & -\theta & 0 \end{bmatrix} \begin{bmatrix} i_t^g - i_{ss}^g \\ c_{t,H} - \bar{y}_H \\ \pi_t - \bar{\pi} \end{bmatrix} \tag{A.7}$$

The coefficient matrix's trace is again zero. Next we show that that its determinant is negative.

$$\begin{vmatrix} 0 & 0 & \gamma \\ \frac{-U_H\left(\bar{y}_H\right)}{U_{HH}\left(\bar{y}_H\right)}\left(1-\delta\right) & 0 & \frac{-U_H\left(\bar{y}_H\right)}{U_{HH}\left(\bar{y}_H\right)} \\ 0 & -\theta & 0 \end{vmatrix} = -\theta\frac{-U_H\left(\bar{y}_H\right)}{U_{HH}\left(\bar{y}_H\right)} < 0 \tag{A.8}$$

Together with the zero trace, this implies that the system has one negative and two positive roots. The system is thus saddle path stable and the variables approach the solution monotonically. Lastly, the solution is unique since there is only one state variable, i^g.

Let δ_1 be the negative root. Solving the following system allows us to obtain the eigenvector associated with this root.

$$\begin{bmatrix} -\delta_1 & 0 & \gamma \\ \frac{-U_H\left(\bar{y}_H\right)}{U_{HH}\left(\bar{y}_H\right)}\left(1-\delta\right) & -\delta_1 & \frac{-U_H\left(\bar{y}_H\right)}{U_{HH}\left(\bar{y}_H\right)} \\ 0 & -\theta & -\delta_1 \end{bmatrix} \begin{bmatrix} v_{11} \\ v_{12} \\ v_{13} \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix} \tag{A.9}$$

where v_{11}, v_{12}, and v_{13} are the elements of the eigenvector associated with the negative root.

For future reference, note that from (A.18) we can determine the following relationships

$$\frac{v_{11}}{v_{13}} = \frac{\gamma}{\delta_1} < 0,$$
$$\frac{v_{12}}{v_{13}} = -\frac{\delta_1}{\theta} > 0. \qquad \text{(A.10)}$$

Next, set to zero the constants corresponding to the unstable roots and solve (A.7). The solution is:

$$\begin{aligned} i_t^g - i_{ss}^g &= A_1 v_{11} e^{\delta_1 t}, \\ c_{t,H} - c_{ss} &= A_1 v_{12} e^{\delta_1 t}, \\ \pi_t - \overline{\pi} &= A_1 v_{13} e^{\delta_1 t}. \end{aligned} \qquad \text{(A.11)}$$

We can use solutions (A.11) and relationships (A.10) to determine the relative directions from which each variable approaches steady state.

$$\frac{i_t^g - i_{ss}^g}{\pi_t - \overline{\pi}} = \frac{v_{11}}{v_{13}} < 0 \qquad \text{(A.12)}$$

$$\frac{c_{t,H} - c_{ss}}{\pi_t - \overline{\pi}} = \frac{v_{12}}{v_{13}} > 0 \qquad \text{(A.13)}$$

(A.12) tells us that the policy interest rate and inflation must approach steady state from opposite directions. (A.13) says that home good consumption and home-good inflation must approach from the same direction. These are useful in establishing the time paths in Figure 4.

To determine A_1 we use the fact that ig is predetermined in this system. Since eigenvectors are determined up to a scalar, we can set $v_{11} = 1$ and solve for A_1 at date t = 0. From (A.20), we have

$$i_0^g - i_{ss}^g = A_1 \qquad \text{(A.23)}$$

which is an expression that will be useful in analyzing the effects of inflation stabilization.

Appendix B: Notes on the Simulation

While this paper is not intended to be in the vein of calibration models taken to data, we do simulate our model in Matlab[13] to generate the time paths displayed in Figures 1 and 2. Every result and diagram in our paper is first derived analytically. Only then do we employ Matlab.

We use a log linear utility function with equal weights on home and traded good consumption:

$$u\left(c_{t,T}, c_{t,H}\right) = \alpha \log\left(c_{t,T}\right) + \left(1-\alpha\right)\log\left(c_{t,H}\right) \tag{B.1}$$

For the transactions cost technology we use the functional form referenced in footnote 5:

$$\psi\left(h\right) = h^2 - ah + \kappa \qquad h \in \left[0, a/2\right] \tag{B.2}$$

Parameter[14]	Value
α – c_T share in utility in equation (B.1)	0.5
a – constant in transactions cost technology in equation (B.2)	1.1
δ – required reserve ratio for banks in equation (18)	0.12
θ – speed of Calvo-type inflation adjustment in equation (10)	0.001
r – constant world real interest rate	0.01
γ – interest rate responsiveness to inflation in interest rate rule (25)	2
η - concavity of traded production function, (11)	0.5
φ - percent of import covered in CIA constraint for y_T, (12)	1

The values of κ in equation (B.2) and A in equation (11) were both determined within the program. These are determined such that the value of *s(h)* is positive and c_T was kept greater than unity so that the logarithmic utility of c_T was well defined. These were each determined at the outset of the program once the other basic parameters were given. The values used in this version of the paper are $A =$ 21 and $\kappa =$ 0.4.

We solve for the unanticipated paths in a straightforward manner by essentially solving the system exactly as we do in Appendix A. Since solving for the variables in the anticipated case is the novel contribution of our work, it is worth noting how this is done.

We first solve the complete dynamic system in the original steady state to obtain the relevant eigenvectors for each key variable (c_H, π, and i_g). We then use the values of the key variables in the new steady state to find the intercept and gradient of the new saddle surface. Given these eigenvectors and solution paths for each variable, we know c_H and π can jump. We search for a combination of jumps in these two variables such that the off-saddle path they follow leads to a point on the new saddle surface. To find that path and ensure they "hit" the new saddle, for each value of c_H and π along their transition path, we use the new saddle's gradient and intercept to calculate an i_g that corresponds to the i_g that would result if

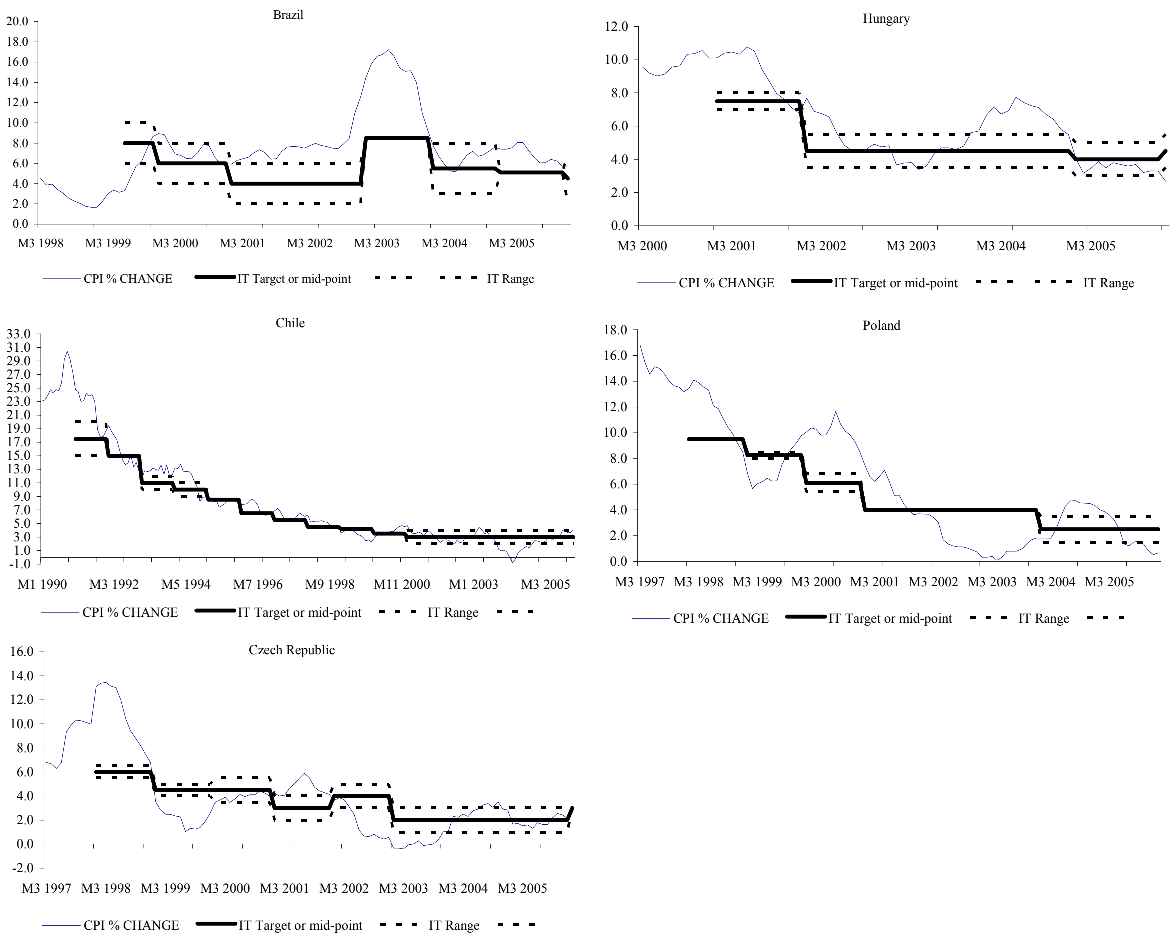
[13] Matlab code and accompanying Excel files are available upon request from the authors.

[14] When possible we have used parameters that are consistent with the literature. We follow Blanchard (2004) and Aurelio (2006) for world real interest rate, r, nd tradables share in consumption, α. The required reserve ratio, δ, is appropriate for Hungary (Hungarian Nation Bank, 2000, p. 92). Interest response to inflation, γ, is consistent with Apergis, Miller, Panethimitakis and Vavvakidis (2005) who use a range from 1.69 to 2.13. The concavity of the production function, η, is consistent with the real business cycle literature's share of labor in production (see King, Plosser and Rebelo, 1988). We chose a to keep (B.2) positive, choose the speed of inflation adjustment, θ, to provide long enough dynamics for graphing purposes, and set the CIA constraint, φ, to one for simplicity. All of our results are robust to a very wide range of values in parameters.

c_H and π were actually on the saddle surface already. Once this predicted i_g converges to the actual i_g, we know we are on the new saddle surface. In this way, we can plot the off saddle-paths the variables follow upon announcement and until the new target comes into effect.

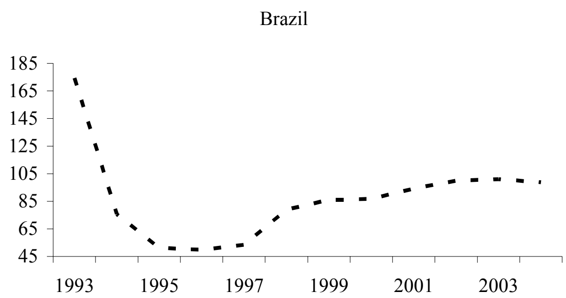
Appendix C: Figures for Countries in Table 1.

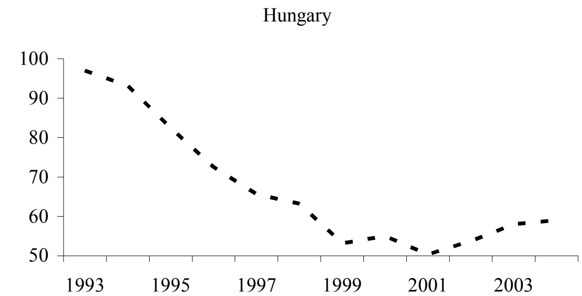
Figure C.1: Realized and Actual Inflation in Selected Emerging Market IT Countries

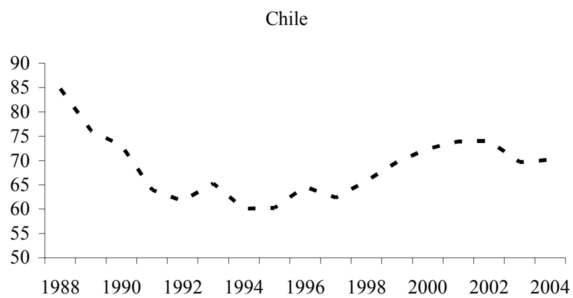


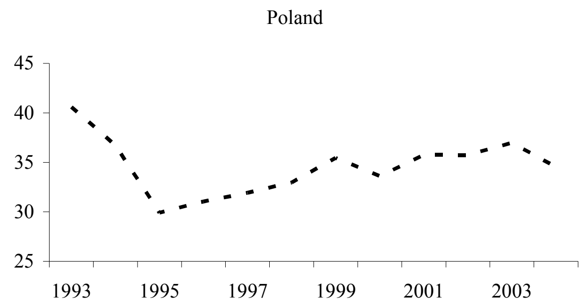
Source: IFS Statistics and countries central banks

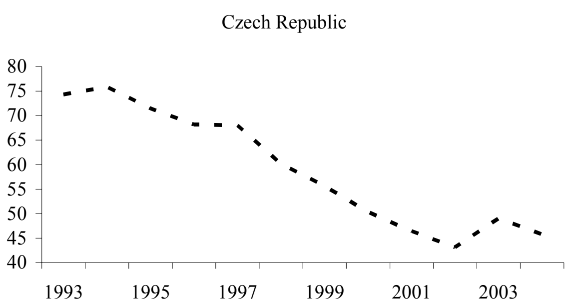
Figure C.2: Credit in Selected Emerging Market IT Countries











Source: World Bank (World Development Indicators)