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Carmen M. Reinhart
R. Todd Smith

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ABSTRACT

During the past decade a number of countries imposed capital controls that had two distinguishing features: they were asymmetric, in that they were designed principally to discourage capital inflows, and they were temporary. This paper studies formally the consequences of these policies, calibrates their potential effectiveness, and assesses their welfare implications in an environment in which the level of capital inflows can be sub-optimal. In addition, motivated by the fact that these types of controls have often been left in place after the dissipation of the shock that lead to the controls being implemented, the paper evaluates the welfare cost of procrastination in removing these types of controls.

Carmen M. Reinhart
School of Public Affairs
University of Maryland
College Park, MD 20742
and NBER

R. Todd Smith
Research Department
700 19th Street NW
International Monetary Fund
Washington, DC 20431,
University of Alberta,
and NBER
Tel: 202-623-6362
Fax: 202-623-6339
smithrt@gpu.srv.ualberta.ca

1. Introduction

There have been various episodes in the past decade when capital inflows to countries were very large relative to the size of the economies (Table 1). This can be a serious problem if the inflows are temporary, and there in fact are many instances of substantial reversals of capital inflows (Figure 1). This paper studies a form of capital control that a group of countries used in the 1990s to manage this potential problem. These capital controls had two distinguishing characteristics: they were *asymmetric* and they were intended to be *temporary*.

The asymmetry of the capital controls stemmed from the fact that they were targeted at discouraging capital inflows but posed little barrier to capital outflows. In fact, in several countries—notably Brazil, Chile, and Colombia—the asymmetry of the controls was reinforced by simultaneously lifting some long-standing controls on capital outflows. The types of controls that were imposed on capital inflows varied across countries; they included both outright quantitative restrictions and various forms of taxes.[1] The Czech Republic (1995) utilized quantitative limits on short-term foreign borrowing. Brazil (1993-97) used an explicit tax in tandem with outright prohibition or minimum stay restrictions for certain types of inflows. Both types of controls in Brazil varied considerably over time in terms of which types of inflows they applied to and, for the explicit taxes on inflows, the tax rates also varied across time. Malaysia (1994) used outright prohibitions on certain types of inflows and, as in Thailand (1995-97), placed restrictions on domestic banks' offshore borrowing. Chile (1991-98) and Colombia (1993-98) relied mainly on a specific type of indirect tax—a non-remunerated deposit requirement at the central bank—that applied to various types of inflows, but mostly shorter-term inflows. Chile also utilized minimum stay requirements to limit inflow reversals.

The reason for the temporariness of the inflow controls has varied across countries, although a common thread was the aim of stopping or slowing what was perceived as temporary inflows of capital—"short-term inflows." At one extreme, the Malaysian authorities explicitly stated in January 1994 that restrictions on capital inflows were to be implemented and that they would be temporary.[2] In most other instances the authorities were not as explicit about the duration of the policy, but it was apparent that the measures were a response to a temporary shock. This shock was reflected in a surge in capital inflows, a significant increase in the current account deficit, and a surge in economic

activity, particularly personal consumption expenditures (see Ariyoshi *et. al* (2000), Reinhart and Smith (1998)). Temporariness was manifested also in the tightness of the controls being varied in synch with cyclical developments—when inflows slowed the restrictions were eased or lifted. [3] [4]

Also noteworthy about recent experiences with capital inflow controls is that the controls were implemented in a very different economic environment than is usually the case when capital controls are implemented. This may be important because empirical studies often conclude that capital controls lose their effectiveness relatively quickly, but these studies do not usually differentiate between controls on inflows and controls on outflows. [5] There is reason to believe that the effectiveness of capital controls is not symmetric and, in particular, that controls on inflows may be more effective than controls on outflows. One reason is that controls on outflows are usually resorted to during balance-of-payments crises. In these circumstances, the imposition of controls, in and of itself, may send a signal that worse times are to come.[6] In contrast, countries that have recently imposed controls on capital inflows did so under more normal economic circumstances. While rate-of-return differentials were often still an incentive to evade the controls, these differentials were generally much smaller than during crises. Finally, some recent empirical studies that focus specifically on controls on inflows find that they may have been effective in terms of altering the composition and/or the level of inflows (Ariyoshi *et. al* (2000), Reinhart and Smith (1998), Montiel and Reinhart (1999), De Gregorio *et al.* (2000)).

There are several possible reasons why policymakers might want to impose controls on capital inflows (*e.g.,* Dooley (1996)). The reason considered in this paper underlies many of the country experiences discussed above. Namely, taxing capital inflows can be helpful in curbing an excessive temporary increase in economic activity, and particularly private consumption, that is being financed to a large extent by capital inflows. This possibility has been widely discussed in the context of exchange rate crises. For instance, Feldstein (p.6,1999) notes that "[w]hile access to more foreign debt could raise domestic investment, experience shows that countries that seek substantially more foreign debt frequently invest those funds in relatively unproductive ways…." The approach taken in the present paper is to study capital inflow restrictions in a dynamic general equilibrium model in which certain shocks can result in temporarily excessive domestic consumption financed by capital inflows. By "excessive" it is meant that private consumption and foreign debt are, at least

temporarily, higher than in the Pareto efficient allocation. Capital inflow restrictions in the model are therefore a natural application of the Theory of Second Best.

In the model, the shocks that can lead to excessive capital inflows are temporary changes in the foreign interest rate and, secondly, temporary changes in domestic monetary policy. These shocks have previously been identified as being important for explaining surges in capital inflows to developing countries (*e.g.*, Calvo *et al.* (1993), Eichengreen and Rose (1998), and Frankel and Rose (1996)). The paper considers two underlying "distortions" that are responsible for why these shocks can have these consequences. First, the paper considers a monetary distortion as in the literature on "temporary stabilizations" (Calvo (1986), Calvo and Vegh (1993), Calvo *et al.* (1995), and Rebelo and Vegh (1995)). Second, the paper considers an environment in which the social cost of foreign debt exceeds the private cost. Several authors have discussed this type of externality. For instance, Harberger (1986) argues that the risk premium on foreign debt is increasing in the *level* of foreign debt, Chang and Velasco (1999) emphasize that the social and private costs of *short-term* foreign debt might be different, and Furman and Stiglitz (1998) discuss various reasons why private accumulation of foreign debt might have adverse effects on others in the economy.

There is a large literature on capital controls. Nonetheless, as Dooley (1996) emphasizes, while there is a well-developed literature dealing with the economic effects of capital controls, there is little work that studies the possible merits of capital controls in an environment with well-defined motives for capital controls. This paper studies such an environment that is motivated by recent experiences in developing countries. There is also a literature (beginning with Calvo (1986)) that is concerned with the economic effects of temporary reductions in inflation rates. This type of policy change is one of the "shocks" considered in the paper, but the focus below is very different from these other studies. Most importantly, the focus below is on the positive and normative consequences of taxing capital inflows in an environment in which some domestic and foreign shocks can produce an inefficient level of capital inflows. In contrast, the literature on temporary policy changes is an inherently positive analysis—the aim is to explain the behavior of macroeconomic aggregates during actual domestic stabilization policies.[7]

A main finding of the paper is that the tax rate on capital inflows must be high in order to have much effect on the capital account balance. For instance, a reduction in the capital account

balance by five percent of GDP would require a tax rate on interest payments on foreign debt on the order of 85 percent for one year or 60 percent for two years.[8] More moderate capital account adjustments, of (say) one or two percent of GDP for one year, still require tax rates in excess of 60 percent. These tax rates are high, but so are the tax rates that have been imposed in countries that have been successful in curbing capital inflows.

A second main finding is that for reasonable parameterizations, while an appropriately set tax on foreign borrowing can be quite effective in offsetting some types of shocks that can cause welfare losses, the economic benefit (measured relative to GDP) of taxing capital inflows are at best modest, and usually quite small. In particular, when "overborrowing" is due to just the monetary distortion discussed above, the welfare benefits (expressed in terms of a discounted stream of private consumption) of even very large shocks are typically within one percent of GDP. When there is an externality associated with foreign borrowing, the welfare benefits of taxing capital inflows are substantially larger, but they are generally still within two percent or so of GDP for even very large shocks. Further, consistent with the point made previously, the tax rate required to produce these modest welfare benefits is high. It is shown that these modest potential benefits of taxing capital inflows can easily be lost, or even reversed (*i.e.*, welfare losses), if the tax rate is not sufficiently close to the optimal tax rate.

A third component of the analysis builds on the fact that many of the countries implementing the types of capital controls that are considered in the paper leave them in place longer than the period of time that the offending shock lasts. This procrastination in the removal of controls may be due to a concern that capital inflows will surge if controls are removed too soon. It may also be because "…a control system, once established, is likely to take on a life of its own…Thus, controls designed to mitigate a temporary distortion might outlive the economic rationale on which they were established" (Dooley (p.642, 1996)). Whatever the reason, the calculations in the paper suggest that the welfare benefits of capital inflow taxes generally vanish after roughly twice the length of time that the initial shock lasts. This finding may therefore be helpful in gauging the costs associated with delaying the removal of capital inflow restrictions.

The format of the paper is as follows. Section 2 describes the model and illustrates the qualitative consequences of taxing capital inflows. Section 3 measures the magnitudes of tax rates

that are required to engineer significant reductions in capital inflows and measures the welfare consequences of capital inflow taxes. Section 4 studies externalities from foreign borrowing. Section 5 contains concluding comments.

2. A Model with Taxes on Capital Inflows

2.1. Model

Consider a small open economy with one traded good and one non-traded good. There are three assets available to home-country residents: the domestic currency (which is not held by foreigners); foreign bonds with (constant) instantaneous return $r^* > 0$ (in units of the traded good); and domestic bonds that yield $r_t > 0$ (in units of the traded good). Foreign and home real interest rates will differ in our model when a tax is levied on foreign borrowing. We focus on a tax, at rate $\gamma_t \in [0,1)$, applied to interest payments on foreign debt. The paper is concerned with *temporary* controls on capital inflows so $\gamma_t > 0$ only for an interval of time $t \in [0,T)$, where $T < \infty$. When the tax is in place, arbitrage will result in $r_t = r^*/(1-\gamma_t)$.

The representative agent in the home country has preferences:

$$\int_0^\infty e^{-\beta t} U(C_t, C_t^*)\, dt, \tag{1}$$

where C_t and C_t^* denote consumption of the non-traded and traded goods respectively, $\beta > 0$ is the subjective discount rate, and $U(C_t, C_t^*)$ is twice differentiable, strictly concave, and increasing in each of its arguments. As usual, it is assumed that $\beta = r^*$ which implies that steady-state consumption (in the absence of capital controls) is constant.

There is free trade in goods, and the world price of the traded good in units of foreign currency is P_t^*. The foreign rate of inflation is π^*, and thus the foreign nominal interest rate is $i^* = r^* + \pi^*$. The home-country currency price of the non-traded good is denoted P_t, and the home-country currency price of a unit of foreign currency is denoted E_t. The real exchange rate is therefore $e_t = E_t P_t^* / P_t$. The nominal exchange rate depreciates at rate ε and we assume $\varepsilon + \pi^* \geq 0$.

The representative agent's consumption purchases must satisfy a cash-in-advance constraint:

$$m_t \geq \alpha\,(C_t^* + C_t / e_t)\,, \tag{2}$$

where m_t is real cash balances and α is a positive constant. This constraint binds if the nominal interest rate on domestic bonds, i_t, is positive; the assumptions $\varepsilon + \pi^* \geq 0$ and $r^* > 0$ ensure this is the case.

Each period the representative agent in the home country receives an endowment of y units of the non-traded good and y^* units of the traded good. The agent's real net wealth at time t is $a_t \equiv m_t - b_t$, where b_t is net foreign debt. Thus, the budget constraint is:

$$\dot{a}_t = \frac{y}{e_t} + y^* - \frac{C_t}{e_t} - C_t^* - r_t\, b_t - (\pi^* + \varepsilon)\, m_t + \tau_t\,, \tag{3}$$

where τ_t is lump-sum transfers from the government. The appropriate interest rate in formulating (3) is the domestic rate because the paper only considers restrictions on capital *inflows*, and thus $r_t \geq r^*$.

Define the domestic market discount factor, D_t, as:

$$D_t = \exp\left(-\int_0^t r_s\, ds\right). \tag{4}$$

Multiply (3) by D_t, integrate, and impose the transversality condition to yield:

$$\int_0^\infty D_t \left(\frac{C_t}{e_t} + C_t^* + i_t\, m_t\right) dt = \int_0^\infty D_t \left(\frac{y}{e_t} + y^* + \tau_t\right) dt + a_0\,, \tag{5}$$

where $i = r + \pi^* + \varepsilon$. To motivate taxes on capital inflows, assume that the representative agent has an initial stock of debt, $b_0 > 0$. Without loss of generality, let $b_0 = m_0$ so that $a_0 = 0$. Using this, and (2) in (5), gives:

$$\int_0^\infty D_t \left(\frac{C_t}{e_t} + C_t^*\right)(1 + \alpha\, i_t)\, dt = \int_0^\infty D_t \left(\frac{y}{e_t} + y^* + \tau_t\right) dt\,. \tag{6}$$

The representative agent maximizes (1) subject to (6).

The consolidated budget constraint of the government/central bank in the home country is:

$$\dot{f}_t = r^*\, f_t + (\pi^* + \varepsilon)\, m_t + \dot{m}_t - \tau_t + \gamma_t\, r_t\, b_t\,. \tag{7}$$

Here, f_t is foreign exchange reserves (foreign bonds), and the final term on the right side is revenue from taxing capital inflows. This tax applies to interest payments on foreign debt. Alternatively, if the tax applied to a broader base—such as principal plus interest on foreign debt—the main

consequence would be that the tax rate that is necessary to generate a real interest rate of a given magnitude is lower. It is assumed that $f_t = 0 \; \forall \; t$, and thus net revenue from seigniorage and from taxing capital inflows is rebated (lump-sum) to home-country residents.

Equilibrium in the non-traded goods market and the money market require:

$$C_t = y\,, \tag{8}$$

$$m_t = m_t^s\,. \tag{9}$$

International capital markets allow the home country to intertemporally substitute traded goods endowments. Substituting (7) into (3), imposing (8)-(9), integrating the resulting equation forward, and imposing the transversality condition gives:

$$\int_0^\infty e^{-r^* t} C_t^* \, dt = \frac{y^*}{r^*} - b_0\,. \tag{10}$$

2.2. Qualitative Effects of Taxing Capital Inflows

When there are no taxes on inflows, arbitrage ensures $r_t = r^*$, for all t. Letting φ denote the Lagrange multiplier on (6), the first-order conditions are:

$$U_{C_t^*}(C_t, C_t^*) = \varphi(1 + \alpha\, i_t)\,, \tag{11}$$

$$U_{C_t}(C_t, C_t^*) = \frac{\varphi(1 + \alpha\, i_t)}{e_t}\,. \tag{12}$$

Equilibrium consumption is therefore $C_t = y$ and $C_t^* = y^* - r^*\, b_0$, and the (constant) equilibrium real exchange rate is $e = U_{C^*}(y, y^* - r^* b_0) / U_C(y, y^* - r^* b_0)$.

When there are taxes on capital inflows, the first-order conditions are:

$$U_{C_t^*}(C_t, C_t^*) = \exp\left(-\int_0^t (r_s - \beta)\, ds\right) \varphi\,(1 + \alpha\, i_t)\,, \tag{13}$$

$$U_{C_t}(C_t, C_t^*) = \exp\left(-\int_0^t (r_s - \beta)\, ds\right) \varphi\,(1 + \alpha\, i_t) \,/\, e_t\,. \tag{14}$$

For illustration purposes suppose that $\gamma_t = \gamma$ for all $t \in [0, T)$, and let $\hat{t} < T$ denote a future date for which foreign debt is strictly positive for all $t < \hat{t}$. Then, for all $t \in [0, \hat{t})$:

$$U_{C_t^*}(y, C_t^*) = \varphi\,(1 + \alpha i_t)\, \mathrm{e}^{-\gamma r^* t/(1-\gamma)}\,. \tag{15}$$

There are two main consequences of the capital inflow tax. First, asset-market arbitrage causes the home-country real and nominal interest rates to immediately jump upward so that foreign and home-country bonds offer the same net-of-tax real return to foreign investors. As a result, a higher effective price of current consumption (*i.e.*, $1+\alpha i_t$) causes the level of consumption to jump down. Second, as long as foreign debt is positive, the home-country real and nominal interest rates remain higher than foreign rates. This encourages the representative agent in the home country to substitute consumption intertemporally, exhibited by an increase in saving and an upward-sloping consumption path. If at some date $\hat{t}$ domestic savings are high enough that foreign debt has been eliminated, the home real interest rate falls to $r_t = r^*$.[9] Similarly, if the tax on inflows is removed when there exists positive foreign debt then the real interest rate falls to r^* at the moment the tax is lifted. In this case, foreign capital will finance the remaining foreign debt, $b_T > 0$, at an interest rate of r^*. In both cases the level of consumption after $\hat{t}$ or T, whichever comes first, is permanently higher than before the capital controls were imposed because debt servicing costs are permanently lower. Consequently, the imposition of a tax on capital inflows initially causes a real exchange rate depreciation, and then subsequently a real exchange rate appreciation beyond the level that would have prevailed had capital inflow taxes never been imposed.

3. Effectiveness of capital controls and their welfare consequences

3.1. Why are temporary taxes on inflows so high?

In practice, taxes on inflows are often levied at very high rates.[10] For instance, consider a three-month investment in Chile during 1995 earning 20 percent per annum. The unremunerated deposit requirement in that year was equivalent to a 50 percent tax rate on interest payments (see Ariyoshi *et. al* (2000)).

To provide insight into why tax rates tend to be high, we parameterize the model and consider some numerical exercises. Preferences are assumed to have the following form:

$$U(C_t, C_t^*) = \frac{(C_t)^{(1-q)(1-1/\eta)} (C_t^*)^{q(1-1/\eta)}}{1-1/\eta}, \ \eta > 0, \quad 0 \le q \le 1. \tag{16}$$

The parameter η measures the elasticity of intertemporal substitution, and q measures the share of traded goods in total consumption. For these preferences, optimal consumption satisfies:

$$C_t^* = \left(\frac{e^{(r-\beta)t} q \; y^{(1-q)(1-1/\eta)}}{\varphi \; [1+\alpha(r+\pi^*+\varepsilon)]} \right)^{\frac{1}{1-q(1-1/\eta)}} \quad , t < T \, , \tag{17}$$

$$C_t^* = \left(\frac{e^{(r-\beta)T} q \; y^{(1-q)(1-1/\eta)}}{\varphi \; [1+\alpha(r^*+\pi^*+\varepsilon)]} \right)^{\frac{1}{1-q(1-1/\eta)}} \quad , \; t \geq T \, , \tag{18}$$

where we define $r = r^* / (1 - \gamma)$. In writing these expressions it has been assumed (innocuously) that the country has strictly positive foreign debt throughout the period that controls are in place. Finally, substituting (17) and (18) into (11) and integrating yields:

$$\varphi = \left(\frac{c_1 + c_2}{(y^*/r^*) - b_0} \right)^{1-a} \, , \tag{19}$$

where:

$$c_1 = \left(\frac{q \; y^{(1-q)(1-1/\eta)}}{1+\alpha(r+\pi^*+\varepsilon)} \right)^{\frac{1}{1-a}} \quad \left(\frac{e^{-r^*T + (r-\beta)T/(1-a)} - 1}{-r^* + (r-\beta)/(1-a)} \right) , \tag{20}$$

$$c_2 = \left(\frac{q \; y^{(1-q)(1-1/\eta)}}{1+\alpha(r^*+\pi^*+\varepsilon)} \right)^{\frac{1}{1-a}} \quad \left(\frac{e^{-r^*T + (r-\beta)T/(1-a)}}{r^*} \right) , \tag{21}$$

and $a = q(1-1/\eta)$.

Chosen as a baseline parameterization is $r^* = \beta = 0.03$, $\pi^* + \varepsilon = 0.10$, $q = 0.4$, $\alpha = 0.15$, $\eta = 0.5$, and $T = 1$ (*i.e.*, one year). This baseline parameterization is reasonable in light of empirical estimates of these parameters.[11] The experiments considered are as follows. For a given parameterization, varying the tax rate γ will affect the interest rate and thus net foreign debt. One can therefore calculate what the value of the tax rate (or equivalently the real interest rate) must be in order to generate a specific level of foreign debt after the tax has been in place for T years.

For the baseline parameterization the tax rate required to reduce foreign debt by five percent of GDP is 88.9 percent and the associated real interest rate is 2.6 percent per month (in excess of 31 percent per annum).[12] These magnitudes for the required tax rate and real interest rate are only

significantly different if T is several years or if some of the preference parameters are implausible (see Figure 2). Moreover, the required tax rate and interest rate are high even for much smaller targeted adjustments in the amount of foreign debt, unless the size of the targeted adjustment is negligible (see final panel in Figure 2). Thus, we conclude that the magnitudes of the tax rate and the interest rate required to reduce the capital account balance by an economically significant amount over a few years are high. If the tax base were broadened so that the tax applied to (say) total capital inflows, b_t, then the required tax rate would be lower, but the required real interest rate would be the same. The reason that such a high interest rate is required is simply that intertemporal substitution in consumption is low for reasonable parameter values.

The parameter analysis shown in Figure 2 provides insight into the link between required tax rates and the values of the various parameters. The required tax rate is decreasing in T simply because there is a longer period of time available to reduce foreign debt by any given amount. Greater intertemporal substitution reduces the required tax rate because this makes consumption (and thus foreign borrowing) more sensitive to interest rates. The ratio of the effective price of consumption (*i.e.*, $1+\alpha i_t$) when the tax is in place to this price after the tax is removed is a measure of how big the distortion is that is caused by the tax. Thus, since this ratio is increasing in α but decreasing in the domestic inflation rate, the required tax rate tends to be lower when α is larger or when the domestic inflation rate is lower. Finally, the required tax rate is increasing in the traded goods share because when this share is large, equilibrium consumption of traded goods is less sensitive to variations in their price.

3.2. Welfare effects of temporary capital controls

The above numerical experiments show that the tax on capital inflows must be high to produce modest adjustments in the capital account. But the motivation for engineering these adjustments with public policy is not apparent. As discussed above, countries that have implemented such measures have done so largely to deal with temporarily lower foreign interest rates and an associated increase in capital inflows and domestic consumption. This motive for restricting capital inflows is present in the model because a temporary decrease in the foreign interest rate (for example) causes domestic consumption to rise by more than is Pareto efficient. To see why, recall

that the effective price of current consumption at a point in time is $1+\alpha i_t$. Suppose that the foreign real interest rate is constant, and consider a temporary decrease in foreign inflation. Thus, since $i_t = i_t^* + \varepsilon$, a temporary decrease in the foreign nominal interest rate (for a given exchange-rate policy and real interest rate) causes home consumption to increase temporarily. But, since resource constraints, the real interest rate, and the discount rate are unaffected by the shock, ideally the consumption path should not change. Hence, in the absence of any policy response, the response of consumption to the temporary foreign shock is welfare reducing.[13] Note that the parameter α may be a potentially important determinant of the welfare benefits of capital controls.

To identify the appropriate response by the home government we solve for the optimal tax rate on foreign borrowing in light of various shocks. This permits straightforward calculation of the welfare benefit of the optimal tax over no policy response.

Another relevant question is how close the real consumption allocation under the optimal tax policy is to the Pareto efficient allocation. This calculation requires solving a social planner's problem—maximization of (1) subject to resource and technology constraints. The cash-in-advance constraint is usually not included in the set of constraints the planner faces, based on the idea that the planner can freely re-allocate consumption without being subject to transactions costs, such as cash-in-advance constraints, that arise with decentralized exchange. The issue could be subtler, however, if the cash-in-advance constraint reflects a deep "technology" for converting units of output (endowments in our model) into consumption, that even a planner must respect. The simplest interpretation of the Pareto efficient real consumption allocation identified below is the solution to a planner's problem that does not require that cash-in-advance constraints are respected (just resource constraints). This is consistent with Calvo (1986) and related literature. However, we point out that exactly the same consumption allocation is the unique solution to a planner's problem subject to cash-in-advance constraints (and thus individual money demands), provided the planner can manipulate the home inflation rate each period to offset nominal interest rate shocks.[14]

3.2.1. Foreign Shocks

The first experiment considered involves a temporary decrease in the foreign nominal interest rate. This could arise either because of a temporary decrease in the foreign real interest rate or the

foreign inflation rate. The case of a decrease in the foreign real interest rate produces a somewhat more complicated optimal tax problem because the Pareto efficient consumption path in the home country is upward sloping. In comparison, the Pareto efficient consumption path is flat when there is instead a temporary decline in the foreign inflation rate. In this case, the optimal tax problem is to minimize the reaction of consumption to the shock. This tax problem is still a fairly complicated problem because the tax affects the domestic real interest rate and that alters the slope of the consumption path. The discussion below focuses mainly on a foreign inflation shock rather than the case of a temporary decrease in the foreign real interest rate, but the main differences in the conclusions from the two types of shocks will be discussed.

Suppose therefore that the foreign inflation rate temporarily decreases from π^* to $\tilde{\pi}^*$ during $[0,T)$. For now we limit attention to the case of a constant tax rate γ imposed during $[0,T)$. The marginal utility of wealth is:

$$\varphi = qy^{(1-q)(1-1/\eta)}\left(\frac{c_1 + c_2}{(y^*/r^*) - b_0}\right)^{1-a}, \tag{22}$$

where:

$$c_1 = \left(\frac{e^{-r^*T+(r-\beta)T/(1-a)} - 1}{[1+\alpha(r+\tilde{\pi}^*+\varepsilon)]^{1/(1-a)}[-r^* + (r-\beta)/(1-a)]}\right), \tag{23}$$

$$c_2 = \left(\frac{e^{-r^*T+(r-\beta)T/(1-a)}}{r^*[1+\alpha(r+\pi^*+\varepsilon)]^{1/(1-a)}}\right). \tag{24}$$

One can therefore write social welfare as:

$$W_0 = \left(\frac{y^{(1-q)(1-1/\eta)}}{1-1/\eta}\right)\left(\frac{qy^{(1-q)(1-1/\eta)}}{\varphi}\right)^{\frac{a}{1-a}}\left[\left(\frac{e^{-\beta T + a(r-\beta)T/(1-a)} - 1}{(-\beta + a(r-\beta)/(1-a))[1+\alpha(r+\tilde{\pi}^*+\varepsilon)]^{a/(1-a)}}\right) + \left(\frac{e^{-\beta T + a(r-\beta)T/(1-a)}}{\beta[1+\alpha(r^*+\pi^*+\varepsilon)]^{a/(1-a)}}\right)\right]. \tag{25}$$

There is no closed-form solution for the optimal (constant) tax rate associated with maximizing this welfare function. We therefore use a numerical optimization algorithm to determine the optimal tax rate. The welfare benefit under the optimal tax is computed as the amount of additional traded-goods income that would be required for the agent to be just as well off were the tax rate equal to zero. This stream of traded goods is discounted and expressed as a percentage of current annual GDP.

For the baseline parameterization and a fall in the foreign nominal interest rate of nine percentage points the welfare benefit of taxing capital inflows is 0.0024 percent of GDP. The optimal tax rate is 36.2 percent. Thus, for even a large foreign shock, a fairly high tax rate is required and it generates only small welfare benefits. The necessity of a high tax rate is consistent with the message of section 3.1. Moreover, this conclusion is not sensitive to the parameterization: across a wide range of parameterizations the welfare benefits peak at about 0.1 percent of GDP (see Figure 3). The optimal tax rate is much higher for these peak welfare benefits—reaching 65 percent for welfare gains of 0.1.percent of GDP. Note that the welfare benefits of an inflow tax are exactly zero when $\alpha = 0$, because in this case the distortion in consumption decisions caused by the temporary fall in the foreign nominal interest rate disappears. For similar reasons, the welfare benefits are even smaller than in the baseline when intertemporal substitution in consumption is lower, T is smaller, or the share of traded goods q is larger.[15] Finally, the welfare benefits associated with a shock to the foreign *real* interest rate are (slightly) *lower* than those associated with a purely nominal interest rate shock (of the same order of magnitude as the real shock).

If the actual tax rate is different from the optimal tax rate, then the tax could produce welfare losses. For the baseline parameterization, welfare losses occur when the tax rate reaches about 50 percent (compared to an optimal tax rate of just over 36 percent). The magnitude of welfare losses could reach over 50 percent of GDP, although losses generally do not rise above a few percent of GDP until the tax rate gets quite close to unity (giving rise to a very high real interest rate).

Welfare losses in the absence of taxing capital inflows occur because both the *intratemporal* and *intertemporal* marginal rates of substitution in consumption are distorted by the shock to the foreign nominal interest rate. To see this, note that the socially optimal allocation of consumption is $C_t = y$ and $C_t^* = y^* - r^* b_0$. In the decentralized economy, however, consumption of traded goods rises for the duration of the shock because the effective price of consumption falls. This is the intertemporal distortion. The magnitude of this intertemporal distortion can be significantly affected by the parameter η. However, estimates of intertemporal elasticities of substitution are small, and thus the magnitude of the intertemporal distortion is small.

The intratemporal distortion arises because, whereas equilibrium consumption of non-traded goods is equal to y in all periods, consumption of traded goods rises for the duration of the shock.

Thus, the intratemporal marginal rate of substitution of the two consumption goods is distorted by the shock. This intratemporal distortion in consumption could be generalized by allowing for different factors, say α and α^*, applied to non-traded and traded goods respectively in the cash-in-advance constraint. Including just this additional generality in our model will not affect the welfare calculations because equilibrium consumption of non-traded goods is always equal to y; this implies that only α^* can affect welfare.[16] However, if the supply of non-traded goods is endogenous then both α and α^* would matter for welfare. Endogenizing production would, of course, complicate the analysis, but purely from the perspective of consumption distortions it is not clear whether the welfare benefits of capital controls would be any larger. On the one hand, the intratemporal distortion would actually be reduced by a temporary decline in the foreign nominal interest rate because it would bring the ratio $(1+\alpha^*(i^*+\varepsilon))/(1+\alpha(i^*+\varepsilon))$ closer to unity.[17] On the other hand, the intertemporal distortion would be exacerbated simply because when the supply of non-traded goods is endogenous then the shock introduces an intertemporal distortion in consumption of both types of consumption goods. Nonetheless, even if the response of non-traded goods consumption to the shock was of the same order of magnitude as traded goods consumption, it appears that the welfare benefits would still be small since the elasticity of intertemporal substitution in consumption is small. To illustrate, if one simply assumes that all goods are tradable in the above model, then the intratemporal distortion is zero and the intertemporal distortion applies to all consumption goods. As Figure 3 suggests (*i.e.*, as $q \to 1$), the welfare benefits in this case are even lower than in our baseline case.

One further issue to consider in evaluating the above welfare conclusions is that attention has been limited to a constant tax rate. It is possible that a constant tax rate could be a poor tax policy in response to the types of shocks being considered. To assess this possibility, we calculated how much of the gap between the Pareto optimal allocation and the competitive equilibrium when inflows are not taxed is closed under the optimal *constant* tax rate. For the range of parameterizations shown in Figure 3 the constant tax rate policy narrows this gap by 75-96 percent. The finding that the optimal constant tax rate is quite effective in correcting for distortions caused by a shock to the foreign nominal interest rate holds true for other shocks we consider below. In summary, even with a first-best tax policy the welfare benefits would not be much greater than for a constant tax rate.[18]

The preceding discussion suggests an alternative metric for measuring the benefit of (constant) taxes on foreign borrowing. Specifically, the benefit from imposing the optimal (constant) tax rate amounts to better than 75 percent of welfare losses that the shock causes. By this metric, the benefit of a constant tax on foreign borrowing is high in the sense that, when the tax rate is set appropriately, the tax is successful in offsetting most of the welfare losses from the types of shocks we consider. This conclusion is perfectly consistent with our finding of small welfare benefits measured as a percent of GDP, because the shock is producing only small welfare losses. If a shock produces larger welfare losses—either because the shock is larger (as discussed in section 3.2.2) or the shock is more distorting of private sector behavior (as discussed in section 4)—then a (constant) tax on foreign borrowing could be more valuable when viewed from both of these angles. In these circumstances, the tax is able to offset much of the adverse consequences of the shock and this has large benefits in economic terms. The remainder of the paper will shed light on the likelihood of such circumstances.

3.2.2. Domestic Monetary Stabilizations

A motive for taxing capital inflows can also arise from a purely domestic "shock", namely, a temporarily lower domestic inflation rate. A number of studies use models like the one used in this paper to explain consumption booms, the deterioration of external accounts, and other macroeconomic regularities in countries that temporarily reduce their inflation rates (see Calvo (1986), Calvo and Vegh (1993), Calvo *et al.* (1995), and Rebelo and Vegh (1995)).

This type of event is of interest for the present paper for two reasons. First, the existing literature is concerned with explaining macroeconomic regularities surrounding these events. In contrast, this paper's focus is normative: the focus is on the welfare benefit of using taxes on capital inflows to prevent excessive consumption financed by capital inflows. Second, the magnitude of the shocks considered in this literature are much larger than reasonable foreign shocks, and thus it is of interest to determine whether the welfare benefits are small for even very large shocks.

The shock considered in this second experiment is Rebelo and Vegh's (1995) "benchmark parameterization," which involves a temporary decrease in the rate of devaluation from an annual rate of $\varepsilon = 1.84$ to $\varepsilon = 0.0$ (a fixed exchange rate) during the time interval $[0, T]$. This parameterization is chosen by the authors because they consider Argentina to be a good reference

case and this policy change corresponds closely to the situation in Argentina in the decade prior to the Convertibility Plan (which fixed the exchange rate).

Although this domestic shock is about 20 times larger than the foreign shock considered above, the welfare benefit under the optimal tax policy is about 350 times larger for the baseline parameterization, and this result is reasonably robust to alternative parameter values (Figure 4). In economic terms, however, the welfare benefit amounts to just 0.84 percent of current GDP for the baseline parameterization. Again, the required tax rate, at 91 percent, is high. A larger value of T does increase the welfare benefits of taxing foreign borrowing. For instance, when $T = 2.5$, which is the case considered by Rebelo and Vegh, the welfare benefits are 1.84 percent of GDP (the optimal tax rate is 82 percent in this example).[19] This is a significant welfare benefit, but it is not huge when viewed in the context of the magnitudes of movements in macroeconomic variables associated with this event—in the model, the stock of foreign debt, for instance, rises by 44 percent during the life of the shock. Some alternative parameterizations, and particularly a larger value of α, increase these welfare benefits, but significant differences from our baseline parameterization contradict empirical evidence on these parameter values.

3.3. Procrastination in the removal of controls

Countries implementing the types of capital controls that are considered in this paper often leave them in place longer than the shock lasts, apparently because of a concern that capital inflows will rebound if controls are lifted too soon. This "addictiveness" is, of course, costly because there is no benefit to a higher domestic real interest rate after the shock has dissipated.

Let $\hat{T} > T$ represent the date when the tax on capital inflows is eliminated. Then, for the case of a shock to the world nominal interest rate, the marginal utility of wealth is:

$$\varphi = \left(\frac{c_1 + c_2 + c_3}{(y^*/r^*) - b_0} \right)^{1-a}, \tag{26}$$

where:

$$c_1 = \left(\frac{e^{-r^*T + \gamma r T/(1-a)} - 1}{[1 + \alpha(r + \tilde{\pi}^* + \varepsilon)]^{1/(1-a)} [-r^* + \gamma r/(1-a)]} \right), \tag{27}$$

$$c_2 = \left(\frac{e^{-r^*\hat{T} + \gamma r\hat{T}/(1-a)} - e^{-r^*T + \gamma rT/(1-a)}}{[1+\alpha(r+\pi^*+\varepsilon)]^{1/(1-a)}[-r^* + \gamma r/(1-a)]} \right), \tag{28}$$

$$c_3 = \left(\frac{e^{-r^*\hat{T} + \gamma r\hat{T}/(1-a)} - 1}{[1+\alpha(r^*+\pi^*+\varepsilon)]^{1/(1-a)} r^*} \right). \tag{29}$$

Welfare is therefore:

$$W_0 = \left(\frac{y^{(1-q)(1-1/\eta)}}{1-1/\eta}\right)\left(\frac{q\, y^{(1-q)(1-1/\eta)}}{\varphi}\right)^{\frac{a}{1-a}} \left[\left(\frac{e^{-\beta T + a\gamma rT/(1-a)} - 1}{(-\beta + a\gamma r/(1-a))[1+\alpha(r+\tilde{\pi}^*+\varepsilon)]^{a/(1-a)}} \right) \right.$$

$$\left. + \left(\frac{e^{-\beta\hat{T} + a\gamma r\hat{T}/(1-a)} - e^{-\beta T + a\gamma rT/(1-a)}}{(-\beta + a\gamma r/(1-a))[1+\alpha(r+\pi^*+\varepsilon)]^{a/(1-a)}} \right) + \left(\frac{e^{-\beta T + a\gamma rT/(1-a)}}{\beta[1+\alpha(r+\pi^*+\varepsilon)]^{a/(1-a)}} \right) \right]. \tag{30}$$

The welfare function for the case of a temporary stabilization involves minor changes to (30).

Using (30) and the optimal tax rate from section 3.2. we calculate the value of $\hat{T}$ such that the welfare benefit of the tax on inflows is exactly zero. Table 2 reports $\hat{T}$ expressed as a ratio to T. It is clear that, *for both types of shocks,* the welfare benefit typically disappears after just less than twice the number of years that the shock lasted. After that point, of course, the welfare benefit of the tax is negative. The reason $\hat{T}$ is roughly the same for both types of shocks even though the welfare benefit of taxes is different is that the optimal tax rate is higher when the welfare benefit is higher, and thus procrastination reduces the welfare benefit at roughly the same rate per unit of time.

4. Externalities and the overborrowing distortion

The source of the welfare benefit of a tax on capital inflows above is that a temporary shock to interest rates causes excessive consumption and foreign borrowing due to a monetary distortion. Although the inflow tax is quite effective in offsetting the adverse consequences of the shock, these welfare benefits are small when measured relative to GDP because the quantitative significance of this distortion is, for reasonable parameter values, small.

Rebelo and Vegh (1995) study temporary reductions of inflation rates in a generalized open-economy model that includes endogenous production and a flexible transactions technology. These generalizations complicate the transmission mechanism linking a shock to social welfare, but the fundamental distortion is the same. As a result, the over-reaction of consumption and foreign

borrowing to the shocks considered above are not likely to be significantly altered. In fact, for the temporary stabilization "shock" discussed above quarterly consumption in the model considered by Rebelo and Vegh increases by between 5 and 10 percent from its steady state level, whereas in the model studied above consumption rises by about 18 percent relative to the steady state. As a result, because our primary interest is measuring the potential welfare benefit of taxes on capital inflows as a policy response to excessive consumption and capital inflows, within this type of model the welfare calculations discussed above may be generous.

An alternative approach is to alter the distortion underlying excessive consumption and capital inflows. This section of the paper considers an extension to the model that relates over-borrowing to a difference between the private and social costs of foreign borrowing. Specifically, imagine that there are a large number of households in the domestic economy that individually consider the real interest rate to be exogenous to their consumption-borrowing decisions. However, at the economywide level, the cost of funds is an increasing function of the level of indebtedness of the economy. Thus, in the absence of capital controls, the real return required by foreigners for lending to the domestic economy is $r(b_t)$, where $r(b_t)$ is an increasing function.

For tractability the numerical experiments focus on the case of a discrete function $r(b_t)$.[20] In particular, the experiment studied has two main components. First, there is a temporary decrease in the foreign inflation rate during $[0, T)$ (below we also discuss the case of temporary monetary stabilizations). As above, this shock tends to raise consumption of agents in the domestic economy and increase economywide indebtedness, b_t. Second, it is assumed that if the level of indebtedness exceeds a threshold level at some (endogenous) time $T_1 \in (0, T)$, then the required real return demanded by foreigners rises from r^* to $\tilde{r}$, where $\tilde{r} > r^*$. This higher interest rate persists until time T when the initial shock is reversed and the consumption path jumps downward (thereby reversing the course of foreign debt).[21] If capital controls are to have substantially greater welfare benefits than in the earlier analysis then this would have to be because they discourage borrowing and consequently prevent the economywide cost of financing from increasing.

In the absence of capital controls, aggregate debt for $t \in (0, T_1)$ satisfies:

$$b_t = e^{r^* t} b_0 - \left(\frac{y^*}{r^*}\right)(e^{r^* t} - 1) + \left(\frac{q y^{(1-q)(1-1/\eta)}}{\varphi[1+\alpha(r^* + \tilde{\pi}^* + \varepsilon)]}\right)^{\frac{1}{1-q(1-1/\eta)}} \left(\frac{e^{r^* t} - 1}{r^*}\right) \tag{31}$$

Debt in the presence of capital controls behaves similarly except that the nominal interest rate in the denominator of the third term reflects the effect of capital controls on the domestic real interest rate and the marginal utility of wealth φ is also affected. In all experiments it is verified that the debt level under the optimal tax never reaches the threshold level during $(0, T]$.

The welfare benefits of capital controls are calculated using the same procedure as above for the two types of shocks.[22] For comparison with the earlier findings, the main focus is on the baseline parameterization. Various values for T_1 (and thus implicitly various threshold debt levels) and $\tilde{r}$ are considered. We use as a baseline $\tilde{r} = 0.035$ and $T_1 = 0.5$.

For the case of a foreign inflation shock, the main conclusion is that the welfare benefits of capital controls are magnified considerably: they are more than 50 times larger than the earlier welfare calculations for the baseline case (Table 3). Nonetheless, the absolute level of the welfare benefit is still small, amounting to just 0.12 percent of current GDP. The optimal (constant) tax rate, at 36 percent, is of a similar magnitude to that found for the model without the foreign debt externality. A larger value of $\tilde{r}$ increases welfare benefits, but they remain small. For example, if $\tilde{r} = 0.045$—*i.e.*, a 50 percent increase in the real interest rate in the home country—the welfare benefit increases to 0.37 percent of current GDP (the optimal tax rate is close to the baseline case of 36 percent).[23] The welfare benefit for all parameterizations considered in Figure 3 never exceeds 0.4 percent of GDP.

For the case of temporary reductions in the domestic inflation rate, unless the externality is very large, the welfare benefits and optimal tax rates are not greatly affected. The reason is that the original distortion is not trivial, so a fairly small increase in the real interest rate due to debt accumulation does not greatly alter that conclusion. However, a large externality from debt accumulation does alter this conclusion to some degree. For the baseline case, the welfare benefits increase from 0.84 to 1.2 percent of GDP when $\tilde{r} = 0.045$, and a tripling of the real interest rate (not shown in Table 3) to $\tilde{r} = 0.09$ increases the welfare benefits to 2.3 percent.[24] The effects of other parameters mirrors the previous analysis, scaled roughly by the multiples reflected in Table 3 to

account for the externalities. Finally, consistent with the conclusion of section 3.1, the optimal tax rate is high—over 90 percent for the baseline case, which is very similar in magnitude to that observed for the model in the absence of the externality.

For this extended model we also calculated how much procrastination in the removal of the tax on inflows can be tolerated before the welfare benefits vanish. The only exception to the earlier conclusion of just less than twice the period of time as the shock itself lasts is for the foreign shock. In that case, the amount of procrastination that can be tolerated is slightly greater for some parameterizations.

5. Concluding remarks

There are four main findings of this paper. First, temporary controls on capital inflows are only likely to be effective if the controls are highly punitive and the associated domestic real interest rates are high. Second, the use of capital inflow taxes to inhibit inefficient private sector borrowing abroad generally has a relatively small welfare benefit when measured relative to GDP. Third, because there is potential for only modest welfare benefits of taxing capital inflows, if the tax rate on capital inflows is not sufficiently close to the optimal tax rate then these welfare benefits could be lost and may in fact be negative (welfare losses). Fourth, the potential welfare benefits can also be lost, or even reversed, in a relatively short period of time when there is procrastination in removing the capital inflow tax.

The analysis in the paper is centered on well-defined distortions that, in tandem with a shock to domestic or foreign interest rates, are the ultimate causes of excessive capital inflows. This possibility is of interest because several experiences with controls on inflows were motivated in part by a concern that a surge in capital inflows was being used mainly to finance excessive private consumption. The calculations are a direct measure of the welfare benefits of using taxes on capital inflows in these circumstances.

There are, of course, other distortions and associated reasons why capital inflows might be inefficiently large. For example, Summers (1988) has suggested that it might be desirable for governments temporarily to stem capital inflows if the inflows are purely speculative. Krugman (1987) suggests that this sort of policy might also be desirable if capital inflows cause a real exchange rate appreciation that has hysteresis effects on exports. Taxing capital inflows might also

be desirable if capital inflows distort the incentives and decisions of financial intermediaries, or if large reversals of capital inflows can cause financial and balance-of-payments crises (see Dooley (1996)). It would be interesting in future research to study in a general equilibrium framework the potential welfare benefit of taxes on capital inflows when these types of distortions are present. An interesting question in this regard is whether there are substantial welfare benefits of taxes on inflows in these environments, in contrast to the findings of this paper.

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Notes.

[1] For further details on country experiences see Reinhart and Smith (1998) and Ariyoshi *et. al* (2000).

[2] Malaysia introduced controls in January 1994 and removed them in August 1994.

[3] Controls that are intended as permanent might be called "temporary" if they lose their effectiveness over time. Controls of this type are the focus of the literature on "leaky controls" (*e.g.* Gros (1987)). These types of controls probably create different incentives and thus may not fit well into the class of capital controls considered in this paper.

[4] There are earlier historical instances where countries sought to restrict capital inflows temporarily, but these instances are considerably more isolated than the experience in the 1990s. One of the better known instances involved Switzerland in the late 1970s in which substantial capital inflows—partly because of German residents' desire to escape a new withholding tax in Germany—prompted the Swiss National Bank to impose a 100 percent reserve requirement on non-residents' bank deposits in Switzerland. The result was a negative nominal interest rate on foreign deposits in Swiss banks as these banks demanded a fee to accept foreign deposits.

[5] Dooley (1996) surveys the literature on capital controls. Mathieson and Rojas-Suarez (1993) review the empirical evidence on the effectiveness of capital controls (see also Ariyoshi *et. al* (2000)).

[6] See Bartolini and Drazen (1997) for a related analysis.

[7] In the context of domestic stabilizations, Calvo (1986) notes that capital controls could raise welfare because they restrict access to foreign capital and thus limit the response of consumption to the shock. Related, Calvo *et al.* (1995) compares the behavior of some macroeconomic variables with perfect capital mobility and no capital mobility.

[8] A reduction in the capital account balance of five percentage points of GDP, while substantial, is not an unrealistic target given the magnitudes of the capital inflows. For instance, the ratio of capital inflows to GDP reached 10.0, 16.7, and 17.2 percent in Chile, the Czech Republic, and Malaysia, respectively, on the eve of the introduction of capital controls in these countries.

[9] One can rule out the possibility that the increase in savings is so large that the home country

becomes a net creditor to the rest of the world (*i.e.*, one can rule out $b_t < 0$ for any $t < T$). The reason is that this circumstance would imply home-country investors have been accumulating foreign bonds; that is inconsistent with the assumption $r^* = \beta$. Thus, a tax on capital inflows will increase domestic interest rates and reduce or possibly eliminate foreign debt, but it could not result in the home country becoming a net creditor to the rest of the world..

[10] For discussion of the magnitudes of tax rates see Reinhart and Smith (1998).

[11] The ratio of M1 to private consumption (in percent) was 11.4 in Brazil in 1991, 10.7 for Chile in 1991, and 16.7 for Columbia in 1988 (data from IFS). The average share of traded goods in total consumption during 1978-1986 was 0.47 in Brazil and 0.32 in Columbia (see Ostry and Reinhart (1992)). Empirical studies for developing countries find that the degree of intertemporal substitution in consumption is generally below unity (Ostry and Reinhart (1992), Reinhart and Vègh (1995)).

[12] Unless otherwise noted, all references to the real interest rate are expressed as the monthly effective rate.

[13] As is well known, if the home-country nominal interest rate is constant in this type of model the competitive equilibrium is Pareto efficient. It follows that if a shock to nominal interest rate is permanent, the equilibrium path of consumption will be Pareto efficient.

[14] Of course, the latter interpretation raises the question of why, in the decentralized economy, the home government does not just manipulate the domestic inflation rate rather than impose taxes on foreign borrowing in response to a domestic or foreign interest rate shock. There may be compelling practical reasons why taxes are a more direct, and possibly simpler to interpret, response to the types of temporary shocks we consider.

[15] A higher domestic inflation rate (than the baseline) would also reduce the welfare benefits. As Figure 2 suggests, different values of this variable do not have much effect on required tax rates, and therefore the magnitude of the domestic inflation rate has only a small effect on the welfare benefits of taxes on inflows.

[16] Specifically, α affects the relative price of traded and non-traded goods, but not equilibrium consumption or social welfare.

[17] Of course introducing a labor-leisure choice or physical capital would introduce other intra-temporal distortions that would alter the welfare benefits (or costs) of controls. This paper is concerned with the welfare benefits of controls that are aimed at limiting excessive consumption and overborrowing. As discussed below, introducing a variety of extensions to the model produces less volatile consumption and foreign debt dynamics than our model.

[18] There exists no closed-form solution to the optimal tax problem. It is possible to show that a tax rate that is a linear function of time is not optimal; the optimal tax rate is therefore a non-linear function of time.

[19] The welfare benefits peak at 5.68% of GDP for T=19.2, or nearly two decades, and are decreasing in T after this point.

[20] There is no closed-form solution for a continuous interest rate function.

[21] The higher real interest rate on impact tends to reduce consumption but leads to higher debt servicing costs. In all of the experiments considered below the debt level continues to increase after the real interest rate increases. Note that if the real interest rate remains at the higher level after the initial shock is reversed then in this model consumption and foreign debt would, in the absence of a policy response, increase indefinitely. This seems to be an uninteresting situation and thus we do not explore it further.

[22] The nine-percentage point decrease in the foreign nominal interest rate is, of course, a large shock in practice. However, focusing on a smaller shock would not greatly affect the welfare findings because most of the welfare benefit comes from avoiding the increase in real interest rates.

[23] For higher values of $\tilde{r}$ (and the other parameters set at the baseline parameterization) there do not exist perfect foresight equilibria in which the debt level at T_1 in the absence of controls exceeds the debt level at T under optimal taxation of foreign borrowing.

[24] In contrast to the case of a shock to the foreign inflation rate (see previous note), there do exist perfect foresight equilibria for quite high values of $\tilde{r}$. The reason is that the shock is much larger, so even a large increase in the real interest rate is not likely to reduce the debt level below the debt level that prevails at the same point in time but when inflows are taxed.

Table 1: Recent Surges in Capital Inflows
(Net long-term international private capital inflows as a percentage of GDP)

country	*inflow episode*[*]	*cumulative inflows/GDP at end of episode*	*largest annual inflow*
Argentina	1991-94	9.7	3.8
Brazil	1992-94	9.4	4.8
Chile	1989-94	25.8	8.6
Colombia	1992-94	16.2	6.2
Hungary	1993-94	41.5	18.4
India	1992-94	6.4	2.7
Indonesia	1990-94	8.3	3.6
Korea	1991-94	9.3	3.5
Malaysia	1989-94	45.8	23.2
Mexico	1989-94	27.1	8.5
Morocco	1990-94	18.3	5.0
Pakistan	1992-94	13.0	4.9
Peru	1991-94	30.4	10.8
Philippines	1989-94	23.1	7.9
Poland	1992-94	22.3	12.0
Sri Lanka	1991-94	22.6	8.2
Thailand	1988-94	51.5	12.3
Tunisia	1992-94	17.6	7.1
Turkey	1992-93	5.7	4.1
Venezuela	1992-93	5.4	3.3

[*] The period during which the country experienced a significant surge in net private capital inflows.

Sources: World Bank; *World Economic Outlook*, various issues (Washington: International Monetary Fund); *International Financial Statistics*, (Washington: International Monetary Fund).

Table 2: Years That Controls Are Left in Place Before Welfare Benefits Vanish
(as a ratio (x) to the duration of the shock)

Foreign shock

T	x	η	x	α	x	q	x
0.5	1.27	0.1	1.76	0.1	1.76	0.1	1.79
1	1.76	0.5	1.77	0.3	1.77	0.3	1.77
2	1.73	1.5	1.77	0.5	1.79	0.5	1.77
3	1.75	2.5	1.77	0.7	1.84	0.7	1.77
4	1.74	3.5	1.77	0.9	1.88	0.9	1.71

Domestic shock

T	x	η	x	α	x	q	x
0.5	1.77	0.1	1.70	0.1	1.72	0.1	1.75
1	1.74	0.5	1.74	0.3	1.81	0.3	1.74
2	1.73	1.5	1.77	0.5	1.91	0.5	1.73
3	1.74	2.5	1.78	0.7	2.01	0.7	1.73
4	1.75	3.5	1.79	0.9	2.10	0.9	1.72

Table 3: Debt Externalities and the Welfare Benefits of Taxes on Inflows

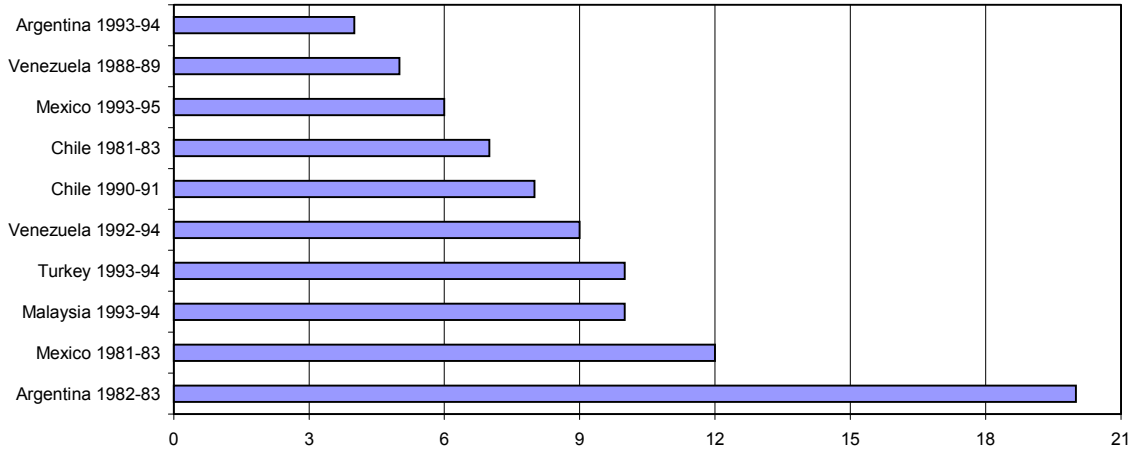
Foreign Shock

T_1	Benefit	Relative to no Externality	$\tilde{r}$	Benefit	Relative to no Externality
0.25	0.186	77.5	0.031	0.0268	11.15
0.5	0.124	51.67	0.035	0.124	51.67
0.75	0.063	26.25	0.041	0.2713	113.04
1.00	0.0024	1.00	0.045	0.369	153.75

Domestic Shock

T_1	Benefit	Relative to no Externality	$\tilde{r}$	Benefit	Relative to no Externality
0.25	1.02	1.21	0.031	0.865	1.02
0.5	0.96	1.14	0.035	0.961	1.14
0.75	0.9	1.07	0.041	1.08	1.28
1.00	0.841	1.00	0.045	1.2	1.42

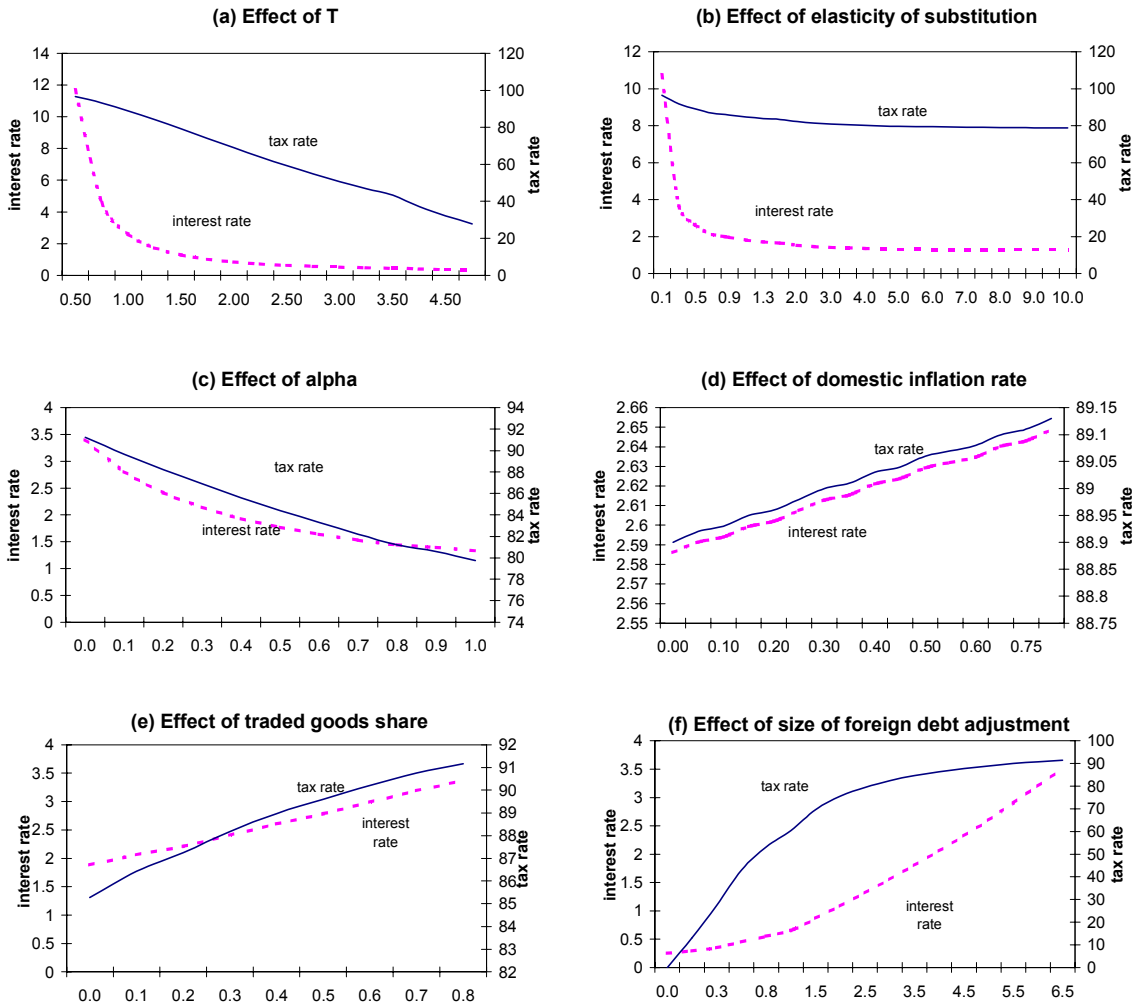
Figure 1: Large Reversals in Net Private Capital Flows
(in percent of GDP)



Notes: Net capital flows includes short-term and long-term flows.

Source: *World Economic Outlook* , various issues (Washington: International Monetary Fund).

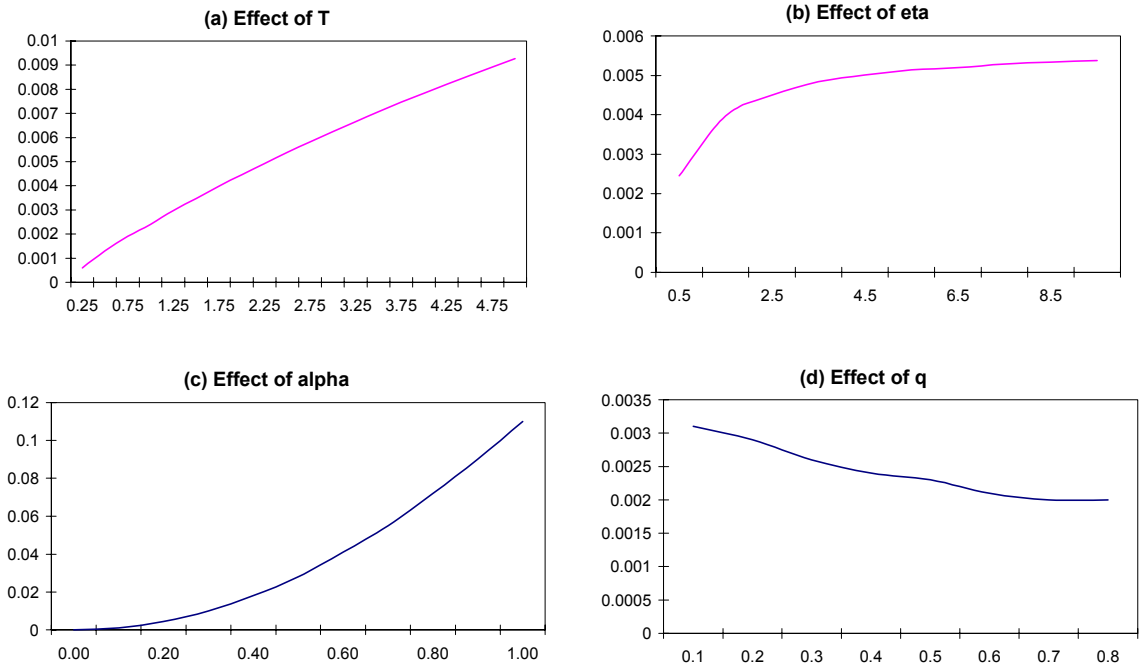
Figure 2: Tax Rate and Interest Rate Required to Reduce Foreign Debt by Five Percent of GDP



Notes: The tax rate (interest rate) for the baseline parameterization is 88.94% (2.6% monthly), and assumes a reduction of foreign debt by five percent of GDP.

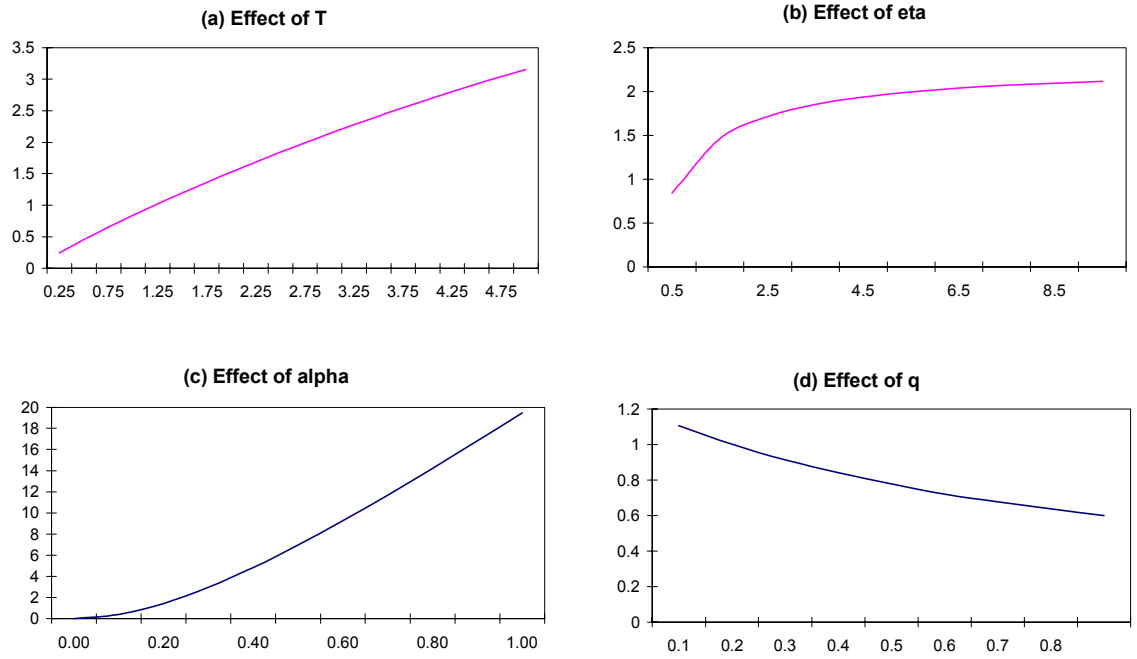
The baseline parameterization is $q = 0.4, \alpha = 0.15, \beta = r = 0.03, i^* = 0.13,$ $\eta = 0.5, y = y^* = 1, b_0 = 1$, and $T = 1$.

Figure 3: Welfare Benefit of Taxes: World Nominal Rate Falls 9 Percentage Points



Notes: The welfare benefit for the baseline parameterization (see notes to Figure 2) is 0.0024 percent of GDP.

Figure 4: Welfare Benefit of Taxes: Temporary Domestic Stabilization



Notes: The welfare benefit for the baseline parameterization is 0.841 percent of GDP. The baseline parameterization is as in Figure 2 with a rate of devaluation that temporarily falls from 1.84 (annually) to zero.