Exchange Rate Crises and Fiscal Solvency

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Abstract

This paper combines insights from generation-one currency crisis models and the Fiscal Theory of the Price Level (FTPL) to create a new generation-one type model. Fiscal solvency is the fundamental generating crises, as in generation-one models. The initial fixed-exchange-rate policy entails risks, both to its sustainability and to the real value of government debt. The risks are due to stochastic surplus shocks and an upper bound on the present value of surpluses. Stochastic surplus shocks, changes in expectations of future fiscal commitments, and changes in the policy parameters can raise current desired debt or reduce expected future surpluses. Should the government's desired debt exceed the present-value of expected future surpluses, agents refuse to lend into this position of insolvency. The sudden stop of capital inflows creates a crisis. Equilibrium can be restored with some combination of policy switching and debt devaluation to restore fiscal solvency. The model can explain a wider variety of crises than generation one models, including those involving sovereign default. It is applied to explain crises in Argentina (2001), Mexico (1994-95), and Southeast Asia (1997), which did not fit the stylized facts of generation one models.

Key Words: Currency Crises, Generation One Currency Crisis Models, Fiscal Theory of the Price Level, Policy Switching, Passive Fiscal Policy, Active Fiscal Policy, Sovereign Default

JEL Codes: F31, F33, E42, E44, E63

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1 Introduction

The generation one model of exchange rate crises (Krugman 1979, Flood and Garber 1984) provided invaluable insights into the causes of exchange rate crises, offering an explanation for many of the crises of the 1980's, in which government budget deficits and declining reserves played prominent roles. Yet, the model failed to explain many crises after 1990, including those with obvious fiscal roots (Argentina 2001), as well as those with less obvious fiscal roots (Mexico, 1994-95; Southeast Asia 1997). The model failed to explain the Argentine crisis because the central role for reserves implies that a currency-board country should have been immune from a speculative attack. It failed to explain crises in Mexico and Southeast Asia because these countries did not have government budget deficits, and because Mexico sterilized the effects of the speculative attack on its money supply.

These failures led researchers to modify the generation one model with specifics, which would allow it to explain particular crises, and to develop new generations of exchange rate crisis models. New generation models do not use fiscal solvency as a fundamental determinant of crises. We argue that many exchange rate crises, including many of those which occurred in the 1990's, can be explained in a model which retains fiscal insolvency as the fundamental generating the crisis. From a policy perspective, it important to understand the impact of policy on crisis risk.

We develop a "generation-one" type exchange rate crisis model which can explain a wider variety of crises than the original by using insights from both the original model and the "Fiscal Theory of the Price Level" (FTPL). The model presented here is a conditional policy-switching model, as was the original, in which monetary policy switched from fixed exchange rates to flexible once fixed became infeasible. The initial policy mix in this model does not require government deficits financed by declining reserves. Instead, it combines passive fiscal policy and fixed exchange rates, supported by active monetary policy.[1] Under passive fiscal policy the government surplus adjusts to past debt assuring intertemporal budget balance for any initial value of real debt. Temporary stochastic shocks to the primary surplus create permanent changes in debt, as in Barro's (1979) optimal tax-smoothing model, ultimately requiring adjustment in the primary surplus to service the debt. The stochastic shocks can originate in the private sector, as with a banking crisis which increases expected future government expenditures, or in the public sector with an unexpected change in taxes or spending. Shocks to both the current surplus and the expected present-value of future surpluses are possible.

In the absence of any additional constraints, this policy-mix is viable indefinitely. However, a series of negative stochastic shocks could require very large values for future surpluses to service the debt, and every government faces limits on its abilities to raise taxes. These limits imply an upper bound on the present value of future surpluses, and equivalently on debt. When fiscal policy is subject to stochastic shocks and an upper bound on debt, there is risk that the initial policy mix might not be indefinitely viable. Therefore, the first significant departure from generation one models is replacement of the assumption of government

[1] Leeper (1991) demonstrated that for equilibrium to exist, both monetary and fiscal policy cannot be active.

spending financed by declining reserves and yielding inevitable crisis, with the assumption of a policy mix yielding crisis risk.[2]

We show that any shock which creates sufficient deterioration in the current or expected future fiscal position relative to the expected upper bound can create a crisis. The overall fiscal position becomes the determinant of a crisis. A crisis need not be preceded by money-financed government deficits, since shocks which deteriorate expected future fiscal positions or the upper bound can also create a crisis. We show that in equilibrium agents will not lend into a position for which they expect the government's intertemporal budget to be violated because they could not expect to receive the market rate of return. An endogenous sudden stop of capital flows, which prevents the government from borrowing to continue its desired fiscal policy, defines the crisis. The sudden stop of capital plays the role of the speculative attack on reserves in the generation one model and is an essential component of the fiscal solvency model.

Since the crisis is caused by fiscal insolvency, its resolution requires a policy response to restore solvency. In generation one models, solvency is achieved with increased seigniorage revenues, created by increased money growth. The second major departure from generation one models is that solvency can be restored through devaluation of nominal debt, created by currency depreciation. The model does not rule out an increase in seigniorage, but additional seigniorage is not necessary. Burnside, Eichenbaum, and Rebelo (2001, 2006) present evidence that debt devaluation played a larger role than increased seigniorage in

[2] Flood and Garber (1984) extend Krugman's (1989) original model to allow stochastic money growth to determine the exact timing, but not the inevitability of a crisis.

restoring fiscal solvency following many of the 1990's exchange rate crises. Although their model modifies the original generation one model to allow an unexpected increase in future government expenditures to cause an exchange rate crisis, it retains the central role for seigniorage created by money growth in restoring fiscal solvency.[3]

We consider several types of policy responses. The first is a promise of fiscal reform, with a switch to active fiscal policy as in the literature on the "Fiscal Theory of the Price Level" (FTPL). With active fiscal policy, monetary policy must be passive, requiring exchange rate flexibility. The switch creates larger near-term surpluses, which serve to raise the expected present-value surplus. If the present-value surplus is still too low relative to debt after the policy switch, exchange rate depreciation, reducing the real value of outstanding government debt, is necessary to restore fiscal solvency. Since depreciation is possible, interest rates rise in anticipation of the crisis. Post-crisis seigniorage does not have to rise, and if the monetary authority's inflation target does not change, then the monetary authority must sterilize the effect of the speculative attack on the money supply.

Previous papers have shown that fiscal policy switching from passive to active can create an exchange rate crisis. Sims (1997) considers a switching probability conditioned on outstanding government debt, and Daniel (2001b) analyzes an unexpected decrease in the present-value of future surpluses. Other policy-switching models include those of Davig and Leeper (2006) and Davig, Leeper, and Chung (2007), who consider the implications of stochastic policy-switching in a closed economy. This paper presents a dynamic model in which

[3] The dynamics of crisis timing relies on particular assumptions about the time path of money growth. In the model presented here, money growth is not central.

policy-switching is neither a one-time unexpected event nor a stochastic event occurring without a crisis according to some, possibly conditional, probability. Instead, policy switching is one way that a government can choose to respond to a sudden stop in capital flows. The policy switch allows currency depreciation and restores fiscal solvency, resolving the crisis. The government's expected response affects expectations and defines the dynamics leading up to the crisis. When the government responds with policy switching, the resulting model is a dynamic FTPL model of exchange rate crises.

FTPL policy switching is not the only possible response to the sudden stop of capital flows. A government could devalue and repeg at a lower exchange rate, while maintaining the existing policy mix. We show, however, that such a policy implies a post-crisis period of instability with continued arbitrarily high depreciations. Alternatively, a government could receive an IMF loan to replace private capital flows, conditional on policy change which increases the present value of future surpluses, thereby restoring solvency. However, raising surpluses in the face of economic shocks which have reduced them could be politically and economically painful and might not be desirable when debt devaluation is available as a source of revenue. This could explain why IMF loans are often combined with exchange rate depreciation, allowing domestic-currency debt devaluation.

We use the model to explain several crises after 1990, which were arguably caused by fiscal shocks, but which the original generation-one model cannot explain. This demonstrates that fiscal solvency plays a greater role in causing exchange rate crises than the original generation one model would imply.

This paper is organized as follows. The next section presents the model. Section 3 characterizes the dynamics leading to exchange rate crises when they are caused by current fiscal shocks. Section 4 considers other causes of exchange rate crises, and Section 5 applies the model to several crises after 1990. Section 5 contains conclusions.

2 Model

2.1 Overview

In this section, we set up a simple model of a small open economy which we can use to address fiscal risk. The model contains four key assumptions. First, international creditors lend to a government only when they expect to receive the market rate of return. Second, the domestic government issues debt denominated in its own currency. Third, there is an upper bound on the value of government debt. Fourth, fiscal policy implies risk on government debt, reflecting the reality that a government's commitment to raise taxes to finance expenditures cannot be totally unconditional.

We fill out the model with enough structure to obtain an equation for the evolution of government debt over time. This requires specification of monetary and fiscal policy as well as government budget constraints. We assume that the monetary authority has a price level target, fixing the exchange rate, and that the fiscal authority follows a rule relating the current surplus to past debt. The rule is subject to stochastic shocks, giving fiscal policy risk. The rule we choose is simple and does not require full specification of a general equilibrium model. However, any rule with fiscal risk could be used to complete the model. The government's flow budget constraint, combined with the fiscal rule, determines the expected behavior of debt over time. To keep the model simple, we set output growth to zero.[4]

2.2 Goods and Asset Markets

We assume that there is a single good in the world, implying that goods markets equilibrium requires the law of one price. Normalizing the world price level at unity and assuming no world inflation implies yields an equilibrium price level in the small open economy equal to the exchange rate.

The **first key assumption** in the model is that international creditors are willing to buy and sell the small economy's government bonds as long as its interest rate, i_t, satisfies interest rate parity. Interest rate parity can be derived as the Euler equation for a representative world agent when the covariance of the country's interest rate with world-agent consumption is zero, or when the world agent is risk neutral. Under the additional assumption that the world interest rate (i) is constant, interest rate parity can be expressed as

$$\frac{1}{1+i_t} = \left(\frac{1}{1+i}\right) E_t \frac{S_t}{S_{t+1}}, \tag{1}$$

where E_t denotes the expectation conditional on time t information, and S_t denotes the exchange rate and equivalently the domestic price level. The interest rate can rise above the world interest rate when there is some possibility of an exchange rate crisis which will be resolved with depreciation.[5]

[4] This can be modified, as we do in the section where we apply the model to explain actual crises.
[5] When we consider the possibility of default, the interest rate parity equation must be modified such that expected returns on domestic debt, conditional on the possibility of default, equal world returns.

2.3 Monetary Policy

Monetary policy is assumed to have a fixed exchange rate (price level) target.[6] When there is no possibility of a change in the exchange rate in the next period, interest rate parity, from equation (1), implies that the domestic interest rate equals the world rate.

2.4 Fiscal Policy

2.4.1 Government Flow Budget Constraint

The **second key assumption** is that government bonds are denominated in domestic currency.[7] This assumption is based on work by Jeanne and Guscina (2006), who show that even in emerging markets, a substantial fraction of government debt is denominated in domestic currency. Additionally, Burnside, Eichenbaum, and Rebelo (2001, 2006) show that in several crises in the 1990's, debt devaluation was a larger source of government revenue than money growth.[8]

Letting G_t and T_t denote nominal government spending and tax revenue, respectively, the government's nominal flow budget constraint is given by

$$B_t + M_t = (1 + i_{t-1})\, B_{t-1} + M_{t-1} + G_t - T_t. \tag{2}$$

[6] We do not model the implementation of this target. It could be implemented in a model in which the monetary authority controls the nominal interest rate, controling expected inflation. Control of the price level could then be achieved with an unstable policy rule, whereby the price level must jump to assure equilibrium.

[7] We could allow some government bonds to be denominated in foreign currency with no substantive change to the analysis, as long as some bonds are denominated in domestic currency. Magnitudes would change with larger depreciation needed the smaller the fraction of domestic-currency debt in total debt.

[8] Their papers retain the central role of an increase in money growth in restoring fiscal solvency. In their model, the increase in money growth generates additional sources of fiscal revenue, including debt devaluation.

Defining real government debt (b_t) and the real primary surplus (s_t) as,

$$b_t = \frac{1}{P_t}\left[B_t + \frac{1}{1+i_t}M_t\right],$$
$$s_t = \frac{1}{P_t}\left[T_t + \frac{i_t}{1+i_t}M_t - G_t\right]$$

the government's flow budget constraint can be expressed as

$$b_t = \left[(1+i_{t-1})\left(\frac{S_{t-1}}{S_t}\right)b_{t-1} - s_t\right]. \tag{3}$$

Defining γ_t as real debt devaluation due to currency depreciation,

$$\gamma_t = \left(1 - \frac{S_{t-1}}{S_t}\right)(1+i_{t-1})\,b_{t-1},$$

and imposing interest rate parity from equation (1) yields[9]

$$b_t = (1+i)\,b_{t-1} - (\gamma_t - E_{t-1}\gamma_t) - s_t. \tag{4}$$

This reveals that interest-exclusive debt accumulates in response to expectations of depreciation which are not realized. Expectations of depreciation raise the interest rate, and when the depreciation does not occur, debt accumulates in response to the higher interest rate.

Optimization by the representative agent, together with the assumption that governments do not allow their debt to become negative in the limit, implies a government intertemporal budget constraint given by[10]

$$\lim_{T\to\infty} E_t b_{t+T}\left(\frac{1}{1+i}\right)^T = (1+i)\,b_{t-1} - (\gamma_t - E_{t-1}\gamma_t) - E_t\sum_{h=0}^{\infty} s_{t+h}\left(\frac{1}{1+i}\right)^h = 0. \tag{5}$$

[9] First, substitute for γ_t in equation (3) yielding $b_t = (1+i_{t-1})\,b_{t-1} - \gamma_t - s_t$. Then use interest rate parity to yield $(1+i_{t-1})\,b_{t-1} = \frac{(1+i)b_{t-1}}{E_{t-1}\left(\frac{S_{t-1}}{S_t}\right)}$, which implies $(1+i_{t-1})\,b_{t-1}E_{t-1}\left(\frac{S_{t-1}}{S_t}\right) = (1+i)\,b_{t-1}$. Noting that $(1+i_{t-1})\,b_{t-1}E_{t-1}\left(\frac{S_{t-1}}{S_t}\right) = E_{t-1}(1+i_{t-1})\,b_{t-1}\left(\frac{S_{t-1}}{S_t}\right) = (1+i_{t-1})\,b_{t-1} - E_{t-1}\gamma_t$. and substituting, the equation becomes $(1+i_{t-1})\,b_{t-1} - E_{t-1}\gamma_t = (1+i)\,b_{t-1}$. Solving for $(1+i_{t-1})\,b_{t-1}$ and substituting into the first equation above yields the expression in the text.

[10] Woodford (1994) derives of the constraint as an equilibrium condition for a closed economy.

Note that surprise depreciation ($\gamma_t - E_{t-1}\gamma_t > 0$) is a source of government revenue.

2.4.2 Upper Bound

The **third key assumption** is that there is an upper bound on the present value of future primary surpluses, equivalently on the current value of debt. We motivate this assumption with the realization that taxes are distortionary such that there exists an upper bound on the present value of taxes that the government can collect. Since the primary surplus must service the debt in the long run, the upper bound on the value of debt implies an upper bound on the value for the surplus in the long run.

The upper bounds on the long-run values for debt and the surplus are related according to

$$i\bar{b} = \bar{s}. \tag{6}$$

It is important to recognize that agents have no data which reveals the magnitude of this upper bound. Therefore, the upper bound is an expectational variable, subject to both political and economic shocks. We assume that changes in the expectation are rare and occur in response to a major political or economic event.

2.4.3 Fiscal Policy Rule

Fiscal policy is defined by the behavior of the primary surplus. We assume that the fiscal authority is able to commit to a surplus rule,[11] in which the surplus responds to its own lag and a linear combination of a long-run target value for the primary surplus and debt service

[11] The rule gives the government credibility, limiting the effect of negative fiscal shocks on the expected present value of future surpluses.

at the world interest rate. The surplus rule is given by[12]

$$
\begin{aligned}
s_t &= (1-\alpha)\, s_{t-1} + \alpha \left[(1-\lambda)\, \hat{s} + \lambda i b_{t-1}\right] + \nu_t, \\
\frac{i}{1+i} &< \alpha < 1, \qquad 0 \leq \lambda, \qquad 0 < \hat{s} \leq \bar{s} - \bar{\nu},
\end{aligned}
\tag{7}
$$

where $\hat{s}$ is the long-run target value for the primary surplus, $(1-a)$ measures persistence in the primary surplus, λ represents the responsiveness of the surplus to the value for debt service relative to its target value, and ν_t is a bounded, stochastic disturbance representing fiscal shocks $(-\bar{\nu} \leq \nu_t \leq \bar{\nu})$. The lagged value of the primary surplus reflects the desire to smooth the effect of shocks over time and is consistent with empirical evidence showing persistence in the primary surplus.[13]

Fiscal shocks (ν_t) contain all determinants of the surplus not explicitly included in the surplus rule, many of which would be explicit if the model were placed in a full general equilibrium context. Changes in ν_t represent changes in government spending and/or taxes in response to exogenous events like a war, natural disaster, or political change, as well as the optimal policy response to economic events like a business cycle. With this interpretation, policy authorities have some control over ν_t. They control the response to shocks, but not the shocks themselves. We generally assume that the conditional mean of ν_t is zero. However, we do consider a current shock to expected future surpluses, which has the interpretation of

[12]Recognizing that $\hat{s} = i\hat{b}$, the surplus rule can be written as

$$s_t = s_{t-1} + \alpha\,(1-\lambda)\,(\hat{s} - s_{t-1}) + \alpha\lambda i \left(b_{t-1} - \hat{b}\right).$$

This shows that the surplus increases when the long-run target value is above the current value and when debt is above the long-run target value.

[13]By treating the surplus as determined by equation (7), we are ignoring the effect of capital gains or losses on seigniorage revenue $\left(\frac{i_t}{1+i_t}\frac{M_t}{P_t}\right)$ under the assumption that the fiscal authority can adjust the surplus to offset these. We are also assuming that the government chooses real expenditures and taxes.

a non-zero mean for ν_t on particular future dates.

Equations (7) and (4), yield dynamic equations for the surplus and debt

$$s_t = (1-\alpha) s_{t-1} + \alpha (1-\lambda) \hat{s} + \alpha\lambda i b_{t-1} + \nu_t \tag{8}$$

$$b_t = (1+i-\alpha\lambda i) b_{t-1} - (1-\alpha) s_{t-1} - \alpha (1-\lambda) \hat{s} - \nu_t - \gamma_t + E_{t-1}\gamma_t. \tag{9}$$

Letting θ represent eigenvalues, which are assumed to be real and distinct, the characteristic equation is given by

$$(1-\alpha)(1+i) - \theta [1 + i (1-\alpha\lambda) + 1 - \alpha] + \theta^2 = 0.$$

Much of the literature on the optimal financing of stochastic government spending, when taxes are distortionary, can be framed in terms of the value for λ. When $\lambda = 1$, one root is unity, and the other is $(1-\alpha)(1+i)$, which is less than one under the assumptions in equation (7). Under this parameterization, the model is stable around a long-run equilibrium which has a unit root. Fiscal policy looks very much like Barro's (1979) tax-smoothing model in which transitory disturbances (ν_t) are optimally financed by a permanent increase in debt. The increased debt is serviced by a permanent increase in taxes raising the primary surplus. Permanent spending disturbances are immediately reflected in taxes and have no effect on the surplus.[14] Since debt is expected to reach a long-run equilibrium value, the government's intertemporal budget is balanced for any initial value of the price level. Therefore, a fiscal rule given by (8) with $\lambda = 1$ is passive fiscal policy.

[14]With this interpretation permanent spending changes have no effect on the evolution of debt, implying that this surplus rule does not nest the policy assumption in the original generation-one model. Barro's theoretical model has no surplus persistence, which appears empirically necessary.

Alternatively, when $\lambda = 0$, one eigenvalue is inside the unit circle, and the other is outside and equal to $1+i$. The model is saddlepath stable around a stationary long-run equilibrium. There are values for initial debt and the surplus, such that the debt eventually rises at the rate of interest. Since such a path violates the government's intertemporal budget constraint, there must be a jumping variable, which keeps the system on the saddlepath toward a long-run equilibrium. The jumping variable is the price level Therefore, the fiscal rule with this parameterization is consistent with Chari, Christiano and Kehoe's (1991) model in which price (and exchange rate) surprises optimally finance stochastic government spending. In their framework, unexpected changes in the price level are not distortionary and are therefore preferable to Barro's distortionary taxes. However, Kumhof (2004) develops a model in which price level jumps are distortionary, implying ambiguity about whether optimal policy should finance stochastic government spending with distortionary taxes or distortionary price level jumps. A fiscal rule with $\lambda = 0$ is active fiscal policy since intertemporal government budget balance is not attained for all initial values of the price level.[15]

This paper is not designed to resolve the optimal tax issue, and we note that different governments choose different policies. A government which chooses fixed exchange rates cannot choose $\lambda = 0$, because financing stochastic expenditure with price and exchange rate jumps is inconsistent with fixed exchange rates. A government which wants fixed exchange

[15]More generally, when $0 < \lambda < 1$, and there are no upper bounds, one root exceeds unity but is less than $1 + i$. The government's intertemporal budget constraint is satisfied, but the upper bound constraint is not. Since the system is saddlepath stable, a jumping variable could assure the upper bound constraint was satisfied for values of the initial surplus and debt below long-run equilibrium values, whereas the absence of a jumping variable would imply that the present value of surpluses would exceed their maximum feasible value. This suggests that we should call such fiscal policy active, when there is an upper bound.

rates could use Barro's tax smoothing model, setting $\lambda = 1$, as long as that policy implies that debt will remain below its long-run upper bound. If the government chooses this fiscal rule, and stochastic shocks cumulate driving debt toward its upper bound, then the government must have plans to change policy. We assume that agents know these plans and use them to form expectations.

The **fourth key assumption** is that fiscal policy entails risk. We assume that the government chooses to fix the exchange rate and follows a fiscal rule with $\lambda = 1$.[16] Shocks to the surplus, together with the upper bound, imply that the initial policy mix might not be viable indefinitely. We consider alternative assumptions about how the government plans to respond.

2.5 Stability and Dynamics in Equilibrium

2.5.1 Equilibrium with Initial Policy Mix

No Upper Bounds To facilitate understanding, consider equilibrium under the initial active fixed-exchange rate monetary policy ($\gamma_t = E_{t-1}\gamma_t = 0$) and passive fiscal policy ($\lambda = 1$) in the absence of upper bounds. Equilibrium under the initial policy mix in the absence of upper bounds is defined as:

Definition 1 *Given constant values for the world interest rate and price level, together with a surplus rule from equation (8) with $\lambda = 1$ and a monetary policy fixing the exchange rate, an equilibrium is a set of time series processes for the surplus, debt, and capital loss on debt, $\{b_t, s_t, \gamma_t\}_{t=0}^{\infty}$, such that the government's flow and intertemporal budget constraints, given by equations (9) and (5), hold, expectations are rational, and world agents expect to receive the return on assets determined by interest rate parity, equation (1).*

[16] A government could choose $\lambda > 1$, implying that the model is globally stable around a stationary long-run equilibrium. However, the path to the long run could imply sustained high surpluses, violating the upper bound on the present value of the surplus. This is explored in Daniel and Shiamptanis (2008).

Equations (8) and (9) with can be solved for the time paths for the surplus and debt as a function of initial values and the time path of shocks, $(\nu_t,\ \gamma_t - E_{t-1}\gamma_t)$. Under passive fiscal policy, the time paths for the surplus and debt are given by

$$\begin{aligned} s_t &= s_{-1} + \frac{\alpha\left[ib_{-1} - s_{-1}\right]\left[1 - \left[(1-\alpha)(1+i)\right]^{t+1}\right]}{1-(1-\alpha)(1+i)} \\ &\quad - \sum_{k=0}^{t}\left[\frac{\alpha i\left[1 - \left[(1-\alpha)(1+i)\right]^{t-k}\right](\gamma_k - E_{k-1}\gamma) + \left[i - \alpha(1+i)\left[(1-\alpha)(1+i)\right]^{t-k}\right]\nu_k^j}{1-(1-\alpha)(1+i)}\right], \end{aligned} \tag{10}$$

$$\begin{aligned} b_t &= b_{-1} + \frac{(1-\alpha)\left[ib_{-1} - s_{-1}\right]\left[1 - \left[(1-\alpha)(1+i)\right]^{t+1}\right]}{1-(1-\alpha)(1+i)} \\ &\quad - \sum_{k=0}^{t}\left[\frac{\left[\alpha - i(1-\alpha)\left[(1-\alpha)(1+i)\right]^{t-k}\right](\gamma_k - E_{k-1}\gamma_k) + \left[1 - \left[(1-\alpha)(1+i)\right]^{t+1-k}\right]\nu_k^j}{1-(1-\alpha)(1+i)}\right], \end{aligned} \tag{11}$$

where we have retained the shock $\gamma_t - E_{t-1}\gamma_t$ because it's value can be non-zero once upper bounds are introduced.

It is useful to represent the dynamics of the debt-surpus system using phase diagrams. Substituting for the current surplus from equation (7) into equation (4) and setting $\lambda = 1$ yields an equation for the real value of debt as a function of lagged values of debt and the surplus. Subtracting lagged values of the debt from this equation and lagged values of the surplus from equation (7) yields

$$\Delta s_t = s_t - s_{t-1} = \alpha\left[ib_{t-1} - s_{t-1}\right] + \nu_t \tag{12}$$

$$\Delta b_t = b_t - b_{t-1} = (1-\alpha)\left[ib_{t-1} - s_{t-1}\right] - (\gamma_t - E_{t-1}\gamma_t) - \nu_t \tag{13}$$

The phase diagram, with shocks at their expected values of zero, is given in Figure 1.

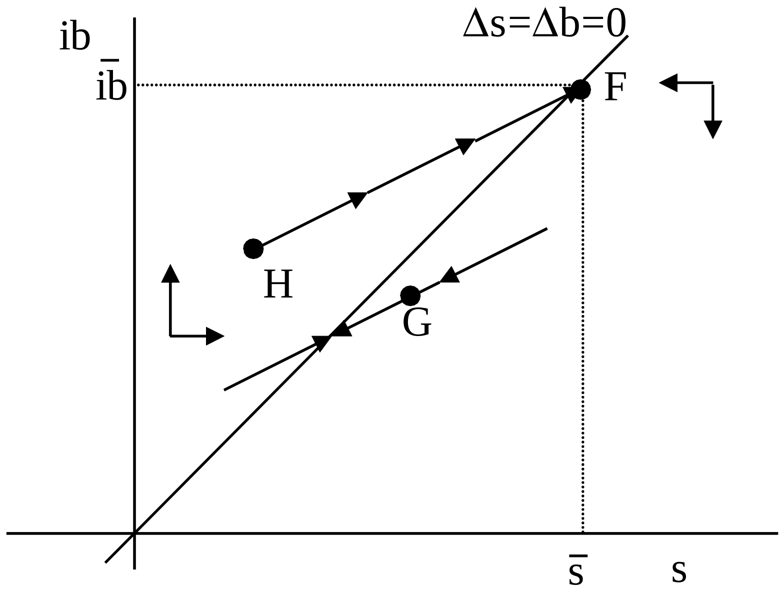

Figure 1: Passive Fiscal Policy

Note that the $\Delta b = 0$ and $\Delta s = 0$ schedules lie on top of each other with $s_t = ib_t$. Either fiscal shocks (ν_t), expectations of depreciation $(E_{t-1}\gamma_t)$, or surprise depreciation $(\gamma_t - E_{t-1}\gamma_t)$ move the system away from the $\Delta s = \Delta b = 0$ locus. Conditional on initial values, the system is always expected to reach a long-run equilibrium along the $\Delta s = \Delta b = 0$ locus with $s_t = ib_t$, implying that the present-value of government debt is not expected to explode in the limit. This assures government intertemporal budget balance (5) for any value for γ_t, confirming that the fiscal rule given by equation (12) is passive.

Passive fiscal policy permits active monetary policy to fix the exchange rate such that $\gamma_t = 0$. Rational expectations assure $E_{t-1}\gamma_t = 0$. When unexpected fiscal shocks (ν_t) move the system away from the $\Delta s = \Delta b = 0$ locus, say to point H, equations (12) and (13) can be used to show that the expected relationship between debt and surpluses along the adjustment path HF is given by

$$\frac{i\left(E_t b_{t+1} - b_t\right)}{E_t s_{t+1} - s_t} = \frac{i\left(1-\alpha\right) - E_t \nu_{t+1}}{\alpha + E_t \nu_{t+1}}. \tag{14}$$

Note that when the conditional mean of future fiscal shocks is zero, the slope of the adjustment path is constant, as drawn in Figure 1. However, negative expected future fiscal shocks effectively increase the slope of the adjustment path in periods for which they are expected, implying higher expected long-run values for the debt and surplus for given initial values.

The expected long-run effect of a shock on the debt and surplus can be determined by following the adjustment path, initialized by the current values of debt and the surplus, back to the $\Delta s = \Delta b = 0$ locus. Equivalently, the long-run effects can be obtained from equations (10) and (11) by taking the expected limits for values for the surplus and debt as $t \to \infty$. Shocks have long-run effects due to the unit root.

Equilibrium under the passive-fiscal-policy, fixed-exchange rate regime is always possible, even though it might require very large values for the surplus in the long run. This is because the system is always expected to return to the $\Delta s = \Delta b = 0$ locus, implying that conditions for equilibrium, including the government's intertemporal budget constraint, are always satisfied.

Upper Bounds Now, consider the implications of upper bounds for the dynamic behavior of the debt and surplus. We assume that the government maintains both its commitments to a fixed exchange rate and to the passive fiscal rule until equilibrium under the initial policy mix is no longer feasible. A similar assumption in generation-one crisis models, that money-financed government spending continues until no longer possible, has been criticized as suboptimal. Rebelo and Vegh (2002) have shown that it is optimal to abandon the fixed exchange rate regime as soon as failure becomes inevitable. We demonstrate below that under the policy assumed in this model, a crisis occurs as soon as it becomes inevitable, satisfying the optimality criteria in Rebelo and Vegh (2002).[17] Moreover, a country, which continues to follow the rule when crisis probability becomes positive, could receive favorable shocks and avoid the crisis.[18]

An upper bound on debt implies that there is an upper bound adjustment path above which there is no passive-fiscal policy active-monetary policy equilibrium. Consider a position for debt and the surplus above HF in Figure 1. In the absence of an upper bound, the system would be expected to travel to a position along the $\Delta s = \Delta b = 0$ locus above F. However, when long-run debt has an upper bound of $\bar{b}$, the long-run position implied by an initial position above HF is infeasible. Therefore, adjustment paths above HF cannot represent equilibrium paths and rational agents would not embark on such paths.

A crisis occurs when the passive-fiscal-policy, fixed-exchange-rate equilibrium becomes impossible. This occurs when shocks and/or expectations send the system above an upper bound adjustment path. The visible symptom in markets is a sudden stop in capital flows whereby agents refuse to lend as much as the government wants to borrow. To restore

[17] Note that a permanent increase in government spending, financed initially by declining reserves (increasing debt) is not optimal in the Barro tax smoothing model. As argued by Rebelo and Vegh (2002), the optimal response to the permanent increase in spending entails a zero surplus response. In this context the exchange rate must fail and seigniorage must increase immediately.

[18] Announcing a stronger fiscal rule, in the wake of negative fiscal shocks which increase the current deficit, is not likely to be credible.

equilibrium, thereby resolving the crisis, the real value of debt must fall and/or the expected present-value of surpluses must rise. To characterize the crisis as well as the dynamics leading up to a crisis in equilibrium, it is necessary to make assumptions about post-crisis policy.

2.5.2 Equilibrium under Active Fiscal and Passive Monetary Policy

We consider several post-crisis policy options. The first is a policy-switching response in which the fiscal authority switches to active fiscal policy and the monetary authority switches to passive policy as characterized by the "Fiscal Theory of the Price Level." In this section, we characterize equilibrium under active fiscal policy and passive monetary policy in the absence of upper bounds. The implications of upper bounds are discussed at the end of this section.

Definition 2 *Given constant values for the world interest rate and price level, together with a surplus rule from equation (8) with $\lambda = 1$ and a monetary policy setting $i_t = i$, an equilibrium is a set of time series processes for the surplus, debt, and capital loss on debt, $\{b_t, s_t, \gamma_t\}_{t=0}^{\infty}$, such that the government's flow and intertemporal budget constraints, given by equations (9) and (5), hold, expectations are rational, and world agents expect to receive the return on assets determined by interest rate parity, equation (1).*

The dynamic model for the equilibrium values of real debt and the real surplus is given by equations (12) and (13). One root is $1+i$ and the other is $1-\alpha$. This is a saddlepath stable model in which there are debt-surplus pairs for which the present-value of debt explodes in the limit, implying failure of the government's intertemporal budget constraint. To assure equilibrium, there must be one jumping variable to keep the system on the saddlepath. The monetary authority's interest rate target restricts $E_{t-1}\gamma_t = 0$, but places no restrictions on γ_t. Therefore, γ_t jumps, implying jumps in b_t from equation (4), to keep the system on the saddlepath.[19] Stochastic and symmetric[20] surprise appreciations and depreciations $(\gamma_t - E_{t-1}\gamma_t)$, finance positive and negative stochastic surplus shocks. Since the system does not reach an equilibrium for arbitrary starting values, this is an active fiscal rule. Under the assumption that the mean of ν_t is zero for all $t > n$, the solutions for the surplus and real debt with active fiscal policy are given by

$$s_t = \hat{s} + \left[(1-\alpha)(s_{-1} - \hat{s}) + \sum_{k=0}^{t} \left(\frac{1}{1-\alpha} \right)^k \nu_k \right] (1-\alpha)^t , \tag{15}$$

$$b_t = \left(\frac{\hat{s}}{i} \right) + \left(\frac{1}{\alpha + i} \right) \left\{ \left[(1-\alpha)(s_{-1} - \hat{s}) + \sum_{k=0}^{t} \left(\frac{1}{1-\alpha} \right)^k \nu_k \right] (1-\alpha)^{t+1} + (1+i)^{t+1} E_t \sum_{h=t}^{n} \frac{\nu_h}{(1+i)^h} \right\} . \tag{16}$$

Since the solutions contain only the stable root once $t > n$, there is no long-run effect of shocks; the expected value of the surplus infinitely far into the future is always $\hat{s}$.

When the mean of $\nu_t = 0$, these equations imply an equilibrium saddlepath relationship between debt and the surplus given by[21]

$$b_t = \left(\frac{1}{\alpha + i} \right) \left[\frac{1+i}{i} \alpha \hat{s} + (1-\alpha) s_t \right] . \tag{17}$$

The equations for the phase diagram can be computed by subtracting lagged values of the surplus and debt, respectively from equations (8) and (9) with $\lambda = 0$ to yield

$$\Delta s_t = s_t - s_{t-1} = \alpha \left[\hat{s} - s_{t-1} \right] + \nu_t, \tag{18}$$

[19]The requirement that the coefficient on the explosive root be zero implies:

$$b_{-1} - \left(\frac{1}{\alpha + i} \right) \left[\left(\frac{1+i}{i} \right) \alpha \hat{s} + (1-\alpha) s_{-1} \right] - \sum_{j=0}^{t} \left(\frac{1}{1+i} \right)^{j-1} \left[\gamma_j - E_{j-1}\gamma_j + \frac{1+i}{\alpha+i} \nu_j \right] = 0.$$

[20]In the active fiscal policy regime with no possibility of policy switching, prices jump in response to fiscal shocks to keep the surplus and debt on the saddlepath. With rational expectations, price surprises must be symmetric. See Daniel (2007).

[21]This requires jumps in γ_t to keep the coefficient on the unstable root equal to zero, yielding $\gamma_t = \frac{1+i}{\alpha+i}\nu_t$.

$$\Delta b_t = b_t - b_{t-1} = ib_{t-1} - (1-\alpha)\, s_{t-1} - \alpha \hat{s} - (\gamma_t - E_{t-1}\gamma_t) - \nu_t. \tag{19}$$

The phase diagram is given in Figure 2, and the saddlepath is labeled SP. The system travels along the saddlepath, labeled SP, to a long-run value for the surplus and debt at point F. Shocks which send the system away from the saddlepath must be offset by price surprises, revaluing debt to keep the system on the saddlepath.

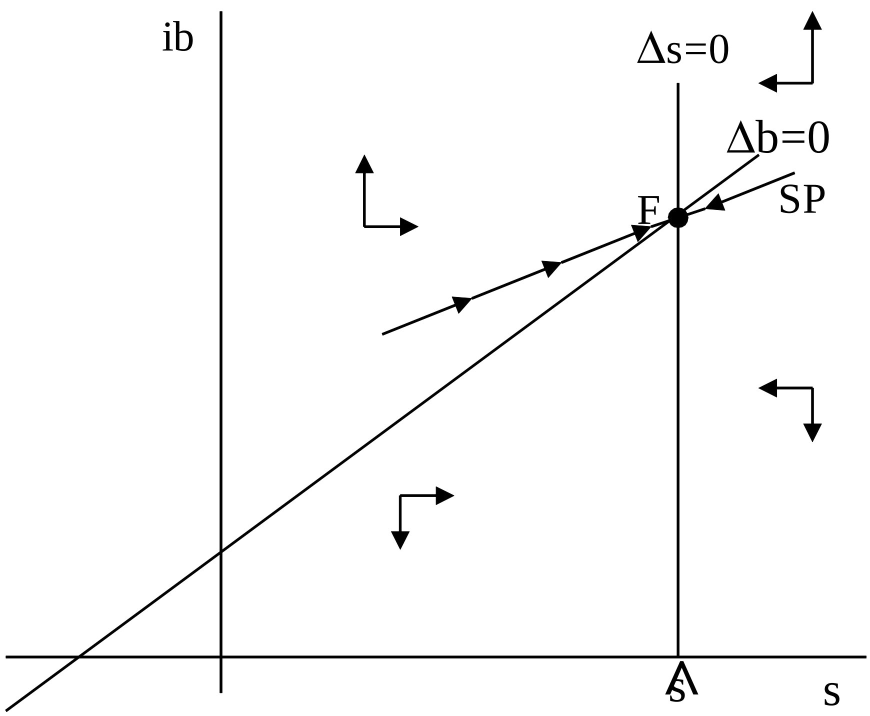

Figure 2: Active Fiscal Policy

Shocks other than current fiscal shocks

Expected future fiscal shocks Consider the effect of a current increase in expected future expenditures in period h such that $E_t\nu_h < 0$ where $h > t$. This future spending shock requires additional revenue to assure intertemporal budget balance. Price surprises generate revenue, whereas anticipated price changes do not, implying that a price increase on the date that expenditures rise cannot generate the necessary revenue. Therefore, the price must jump on the date on which the future spending becomes anticipated. The jump reduces real debt such that on the date the government increases spending, the associated increase in debt and reduction in the surplus return the system to the original saddlepath. Therefore, the increase in expected future government spending effectively moves debt below the saddlepath on the date the future spending becomes anticipated, as in

$$b_t = \left(\frac{1}{\alpha + i}\right)\left[\frac{1+i}{i}\alpha\hat{s} + (1-\alpha)\, s_t + (1+i)^{t+1}\, E_t \sum_{h=t}^{n} \frac{\nu_h}{(1+i)^h}\right]. \tag{20}$$

The system then follows the arrows of motion with the unstable root, implying falling debt and an increasing surplus, until the date on which the spending increase occurs. After the anticipated shocks have been realized, the surplus falls and debt increases returning the system to the saddlepath relationship given by equation (17).

Change in the parameters of the surplus rule Government actions or political instability could change agents' beliefs about the parameters of the surplus rule. A reduction in the magnitude of the target surplus, possibly due to a reduction in the upper bound, shifts $\Delta s = 0$ left and shifts SP down. The system reaches the new saddlepath with an unexpected price and exchange rate increase which reduces the real value of debt. A fall in the value of α, increasing the persistence of the surplus, increases the slope of the saddlepath, requiring an offsetting price surprise to move the system to the new saddlepath.

Upper Bounds Now, consider the role of upper bounds. The first implication of the upper bound is that the long-run value for the target surplus must be below the upper bound.

Additionally, the upper bound on debt implies that the passive-monetary policy active-fiscal policy regime is not viable indefinitely. When the system begins along the saddlepath at a point below F, it travels toward F over time. Saddlepath values of $ib > i\bar{b}$ are not feasible, implying that in the neighborhood of $i\bar{b}$, policy makers must have plans to respond when equilibrium under the current policy mix is not possible, possibly switching back to passive fiscal policy and active monetary policy. The upper bound on debt implies an upper bound on the long-run target value for the primary surplus. The assumption in equation (7) that $\hat{s} \leq \bar{s} - \bar{\nu}$ assures that under the initial fixed exchange rate policy mix, the system is not in the neighborhood where reverse switching becomes possible.

3 Exchange Rate Crisis with Policy Switching

The previous section characterized equilibrium, first, under passive fiscal policy and active monetary policy (Regime 1), and, second, under active fiscal policy and passive monetary policy (Regime 2) in the absence of upper bounds. In both cases, we noted that upper bounds imply that the initial policy mix might not be viable indefinitely. Therefore, in an equilibrium with upper bounds, agents must form rational expectations about how policy might change to assure equilibrium. In this section we consider an equilibrium in which policy is initially in Regime 1 with plans to switch to Regime 2 once equilibrium in Regime 1 is no longer feasible. The policy switching model can be viewed as a dynamic "Fiscal Theory of the Price Level" model of exchange rate crises.[22]

To allow Regime 1 to be initially viable, but subject to risk, we assume that the initial values satisfy $s_{t-1} < ib_{t-1} < \hat{s}$. This implies that debt is rising, and that debt service is low enough to place the system below the saddlepath to $\hat{s}$.

3.1 Equilibrium with Upper Bounds and Policy Switching

Definition 3 *Given constant values for the world interest rate and price level, an upper bound on the long-run value of debt, a policy mix, defined by a surplus rule from equation (8) with $\lambda = 1$ and a monetary policy fixing the exchange rate, which the government will maintain as long as possible, and plans for policy-switching in the event that the initial policy mix becomes infeasible, an equilibrium is a set of time series processes for the surplus, debt, and capital loss on debt, $\{b_t, s_t, \gamma_t\}_{t=0}^{\infty}$, such that the government's flow and intertemporal budget constraints, given by equations (9) and (5), hold, expectations are rational, debt does not exceed its upper bound in the long-run, and world agents expect to receive the return on assets determined by interest rate parity, equation (1).*

We define a crisis as a period $t = T$ in which there is no equilibrium under the initial fixed-exchange-rate, passive-fiscal-policy mix. The symptom in markets is that agents refuse to lend at any interest rate.

3.2 Exchange Rate Depreciation and Expectations

To determine expectations of exchange rate depreciation leading up to a crisis, it is necessary to look forward to determinants of equilibrium on the crisis date. Equilibrium requires that the system begin on the saddlepath to $\hat{s}$. For equilibrium conditions to be satisfied under the post-crisis policy combination, γ_t must be free to jump on the date of the crisis to place

[22] Daniel (2001b) presents a fiscal theory exchange rate crisis model in which an unanticipated shock causes the solvency crisis. Uribe(2006) presents a fiscal theory model in which the role of devaluation is to eliminate hyperinflation, not restore fiscal solvency. Sims (1997) presents an FTPL switching model with switching and exchange rate crisis conditioned on the level of government debt, and Cochrane (2003, 2005) notes that the FTPL can explain a currency crisis.

the system on the saddlepath associated with the fiscal authority's target surplus, equation (17). Additionally, equilibrium expectations of γ_t must be rational.

To determine the probability of a crisis next period and one-period-ahead expectations of capital loss due to exchange rate depreciation, it is useful to compare the value of debt along the saddlepath to the long-run target surplus $(\hat{s})$, given by (17), with the current value under passive policy, given by (13). Using equations (17) and (13), this distance at time t can be expressed as

$$\Omega_t = (\gamma_t - E_{t-1}\gamma_t) + \frac{1+i}{\alpha+i}\left[\delta_{t-1} + v_t\right]. \tag{21}$$

where δ_{t-1} is the state variable determining this vertical distance at time t and is given by

$$\delta_{t-1} = \frac{\alpha}{i}\left(\hat{s} - ib_{t-1}\right) + (1-\alpha)\left(s_{t-1} - ib_{t-1}\right). \tag{22}$$

The state variable determining the time t distance is known at time $t-1$, and therefore receives a $t-1$ subscript. In equation (21), the distance depends on the expectation of depreciation, on realizations of the surplus shock and depreciation, and on δ_{t-1}.

When faced with a crisis in which it cannot borrow the desired amount, the government announces a policy switch in which it sets $\lambda = 0$ in the fiscal rule, effectively replacing debt service with a long-run surplus target of $\hat{s} \leq \bar{s} - \bar{\nu}$. Since the post-crisis debt-surplus system is saddlepath stable, the distance between the value of debt along the saddlepath to $\hat{s}$ and its current value must be zero in order for the the post-crisis system to approach $\hat{s}$ in the long run.

We define a shadow value of depreciation, analogous to the shadow value of the exchange rate in generation one currency crisis models (Flood and Garber 1984). The shadow value of depreciation represents the reduction in the value of debt needed for the economy to reach the saddlepath to $\hat{s}$, equivalently to set $\Omega_t = 0$. The shadow value can be positive or negative.

Definition 4 *The* ***shadow value*** *of capital loss on debt due to default at time* t, $\tilde{\gamma}_t$, *is defined as the value of* γ_t *for which* $\Omega_t = 0$.

Setting $\Omega_t = 0$ in equation (21) and solving yields

$$\tilde{\gamma}_t = E_{t-1}\gamma_t - \frac{1+i}{\alpha+i}\left(\delta_{t-1} + v_t\right). \tag{23}$$

Using equations (4), (13), and (17), we can show that under the initial passive fiscal policy with $\gamma_t = 0$, δ_t evolves as

$$\delta_t = -\left(\alpha+i\right)E_{t-1}\gamma_t + \left(1+i\right)\left(\delta_{t-1} + \nu_t\right) - \alpha\left(\hat{s} - ib_t\right). \tag{24}$$

Using equations (23) and (24), the state variable determining the distance at time $t+1$ (δ_t) can be expressed in terms of the shadow rate of depreciation at time t as

$$\delta_t = -\left(\alpha+i\right)\tilde{\gamma}_t - \alpha\left(\hat{s} - ib_t\right). \tag{25}$$

Since we have assumed that the system is in a region for which $\hat{s} - ib_t > 0$, the state variable determining the distance in period $t+1$ (δ_t) could be negative even though the shadow rate of depreciation is negative today $\left(\tilde{\gamma}_t < 0\right)$. This is because the passive-fiscal-policy adjustment path is steeper than the saddlepath, so that, even in the absence of shocks and expected depreciation, debt rises relatively faster under passive fiscal policy, than under active in the region for which $\hat{s} - ib_t > 0$.

We assume that the fiscal authority never revalues in response to a crisis in which it cannot borrow. Instead, it chooses to reduce its post-crisis target surplus below $\hat{s}$ in the event that borrowing constraints bind and $\tilde{\gamma}_t > 0$. It is necessary to determine conditions under which borrowing constraints bind.

Assume that agents believe that the fiscal borrowing constraint will bind, creating depreciation if $\tilde{\gamma}_t > 0$.[23] We prove that this assumption is consistent with a rational expectations equlibrium below. This implies that the actual value for depreciation in the crisis period is given by

$$\gamma_t = \max\left\{\tilde{\gamma}_t, 0\right\}. \tag{26}$$

To solve for rational expectations of depreciation, define a critical value for ν_t, given by ν_t^*, as the minimum value for ν_t which sets $\gamma_t = 0$. Therefore, for $\nu_t < \nu_t^*$, $\gamma_t > 0$, and for $\nu_t \geq \nu_t^*$, $\gamma_t = 0$. Letting $f(v_t)$ be a bounded, symmetric, mean-zero distribution for ν_t, with bounds given by $\pm\bar{\nu}$, and using equations (23) and (26), the expectation for γ_t can be expressed as

$$E_{t-1}\gamma_t = \int_{-\bar{v}}^{\nu_t^*} \gamma_t f(\nu_t)\, d\nu_t = \int_{-\bar{v}}^{\nu_t^*} \left[-\frac{1+i}{\alpha+i}\left[\delta_{t-1} + v_t\right] + E_{t-1}\gamma_t\right] f(\nu_t)\, d\nu_t.$$

A solution for $E_{t-1}\gamma_t$ exists if there is a solution for ν_t^*. Defining $F(\nu_t^*)$ as the cumulative at ν_t^* and collecting terms on the expectation yields

$$\left[1 - F(\nu_t^*)\right] E_{t-1}\gamma_t = -\left(\frac{1+i}{\alpha+i}\right)\left[(\delta_{t-1}) F(\nu_t^*) + \int_{-\bar{v}}^{\nu_t^*} v_t f(\nu_t)\, d\nu_t\right]. \tag{27}$$

Substituting into equation (23), using equation (26), yields an expression for γ_t as

$$\left[1 - F(\nu_t^*)\right]\gamma_t = \max\left\{-\left(\frac{1+i}{\alpha+i}\right)\left[(\delta_{t-1}) + \int_{-\bar{v}}^{\nu_t^*} v_t f(\nu_t)\, d\nu_t + \left[1 - F(\nu_t^*)\right]\nu_t\right], 0\right\} \tag{28}$$

[23]The constraint could also bind with $\tilde{\gamma}_t < 0$, but given the assumption that the authorities never revalue, such a crisis would not entail depreciation.

Assume that the economy is in period $t = T$. To determine whether there exists an equilibrium expectation for one-period-ahead exchange rate depreciation $\left(E_T \gamma_{T+1}\right)$, it is necessary to determine whether there exists a solution for ν^*_{T+1}. Define $\chi_{T+1} = \int_{-\bar{v}}^{\nu^*_{T+1}} \upsilon_{T+1} f\left(\nu_{T+1}\right) d\nu_{T+1} + \left[1 - F\left(\nu^*_{T+1}\right)\right] \nu^*_{T+1}$. A solution for ν^*_{T+1} exists iff there exists a value for ν^*_{T+1}, satisfying $-\bar{v} \leq \nu^*_{T+1} \leq \bar{v}$, such that $\delta_T + \chi_{T+1} = 0$.

Lemma 1 *There is no equilibrium solution for ν^*_{T+1} when $\delta_T < 0$.*

Proof. The proof requires showing that $\chi_{T+1} \leq 0$ for all feasible values for ν^*_{T+1}. Let ν^*_{T+1} take on its smallest possible value of $-\bar{v}$, implying that $\chi_{T+1} = -\bar{v} < 0$. The derivative of χ_{T+1} with respect to ν^*_{T+1} is given by $1 - F\left(\nu^*_{T+1}\right)$. For $\nu^*_{T+1} < \bar{v}$, this is positive. Therefore, as ν^*_{T+1} rises, χ_{T+1} rises monotonically. Once ν^*_{T+1} takes on its largest possible value, given by $\bar{v}$, $1 - F\left(\bar{v}\right) = 0$, and χ_{T+1} takes on its maximum value of zero. Therefore, $\chi_{T+1} \leq 0$ for all feasible values of ν^*_{T+1}. This implies that when $\delta_T < 0$, there is no feasible value for ν^*_{T+1} which sets $\gamma_T = 0$ in equation (28). ■

Intuitively, if the system were allowed to continue into period $T+1$ with $\delta_T < 0$, then the probability of devaluation in period $T+1$, conditional on information in period T, would be unity. Taking expectations of equation (26), using equation (23) when the probability of devaluation is unity, yields

$$E_T \gamma_{T+1} = E_T \gamma_{T+1} - \frac{1+i}{\alpha+i} \delta_T, \qquad \nu^*_{T+1} = \bar{v}.$$

This equation has a solution for the expectation only if $\delta_T = 0$. When $\delta_T < 0$, there can be no value for devaluation such that it equals its expectation minus a negative gap.

Lemma 2 *When $\delta_T = 0$, the probability of a crisis with depreciation in period $T+1$ is unity and $E_T \gamma_{T+1} \geq \left(\frac{1+i}{\alpha+i}\right) \bar{\nu}$.*

Proof. When $\delta_T = 0$, $\chi_{T+1} = 0$, implying that $\nu^*_{T+1} = \bar{\upsilon}$. With ν^*_{T+1} equal to its upper bound, any realization of υ_{T+1} requires devaluation, implying that the probability of devaluation is unity. Together, a unitary probability of devaluation and $\delta_T = 0$ imply that $\gamma_{T+1} = \tilde{\gamma}_{T+1} = E_T \gamma_{T+1} - \left(\frac{1+i}{\alpha+i}\right) \nu_{T+1}$, which must be greater than or equal to zero for any realization of ν_{T+1}, including its upper bound value of $\bar{\upsilon}$. Therefore, $E_T \gamma_{T+1} - \left(\frac{1+i}{\alpha+i}\right) \bar{\nu} \geq 0$. With $E_T \gamma_{T+1} \geq \left(\frac{1+i}{\alpha+i}\right) \bar{\nu}$, $\gamma_{T+1} \geq 0$ for any realization of ν_{T+1}. ■

Note that with $\delta_T = 0$ expectations of depreciation $\left(E_T \gamma_{T+1}\right)$ and actual depreciation $\left(\gamma_{T+1}\right)$ can be arbitrarily large. However, when the government is following passive fiscal policy and active monetary policy, the probability that shocks will occur, such that δ_T takes on a value exactly equal to zero, is zero. Therefore, given passive fiscal policy and active monetary policy fixing the exchange rate, a crisis with a unitary probability and arbitrarily high expectations of devaluation has probability zero.

Lemma 3 *When $\delta_T > 0$, the probability of a crisis with devaluation in period $T+1$ is less than one, and equation (27) has a well-defined solution for $E_T \gamma_{T+1}$.*

Proof. When $\delta_T > 0$, equation (28) implies that $\chi_{T+1} < 0$, implying that $\nu^*_{T+1} < \bar{\upsilon}$. Therefore, the probability of a crisis with devaluation, given by $1 - F\left(\nu^*_{T+1}\right)$, is less than one. Equation (27) can be solved for $E_T \gamma_{T+1}$. ■

These three lemmas characterize feasible equlibrium positions under the initial policy mix, leading to the following proposition.

Proposition 1 *When $\delta_T \geq 0$, the equilibrium interest rate in period T adjusts for rational expectations of depreciation $\left(E_T\gamma_{T+1} \geq 0\right)$, and the government borrows its desired amount under passive fiscal policy. When $\delta_T < 0$, there is no interest rate in period T which can compensate agents for expectations of depreciation, implying that there is no equilibrium under the initial policy mix.*

Proof. For $\delta_T = 0$, Lemma 2 demonstrates that the probability of a crisis with depreciaiton is unity and provides a lower bound for the equilibrium expectation of depreciation. For $\delta_T > 0$, Lemma 3 demonstrates that the probability of a crisis with depreciation is less than one, and equation (27) can be used to solve for expected depreciation. For both cases, solutions for expected depreciation, together with equation (1) yield an equilibrium interest rate. For $\delta_T < 0$, Lemma 1 shows that there is no solution for expectations of depreciation. Therefore, there is no value of the interest rate which can compensate agents for lending, implying that these positions cannot satisfy the definition of equilibrium. ■

Proposition 2 *When $\delta_T < 0$, policy switching designed to set $\Omega_T = 0$, restores equilibrium.*

Proof. Policy switching restores equilibrium by setting $\Omega_T = 0$, placing the system on the saddlepath to the long-run target value for the primary surplus. There are two cases to consider. When $\tilde{\gamma}_T < 0$, devaluation with $\gamma_T = \tilde{\gamma}_T$, sets $\Omega_T = 0$. When $\delta_T < 0$, but $\tilde{\gamma}_T > 0$, the government does not revalue. Instead, it chooses a target surplus $\hat{s}' < \hat{s}$, such that the system is on the saddlepath to a lower target surplus without an exchange rate change. That is, it replaces $\hat{s}$ with $\hat{s}'$ in equation (22), substitutes this into equation (23) and solves for $\hat{s}'$ which sets the new expression for $\tilde{\gamma}_T = 0$. ■

We can summarize the argument as follows. Agents believe that the government will switch policies and allow the currency to depreciate as necessary when it cannot borrow the amount needed to continue passive fiscal policy. Agents refuse to lend when there is no value for the interest rate, based on the expected value for depreciation, which can compensate then for expectations of capital loss on debt. Policy switching is the response to the inability to borrow, validating agents beliefs that the government will switch policies and allow non-negative depreciation when it cannot borrow.

Definition 5 *Conditional on the expectation that a lending crisis will be resolved with policy switching to keep expected values for future debt from rising above* $\frac{\hat{s}}{i} \leq \frac{\bar{s}}{i}$, *a **boundary path** for debt service* (ib) *is given by the saddlepath leading to* $\hat{s}$.

Note that the boundary path is defined with respect to the government's desired long-run values for the surplus and debt, not by their upper bounds. Equation (21) shows that for $\nu_t = \gamma_t = E_{t-1}\gamma_t = 0$, a positive value for δ_{t-1} implies that the current value of debt, b_t, is below the boundary locus. However, fiscal shocks (ν_t), expectations of default $(E_{t-1}\gamma_t)$, and default (γ_t) can all affect the position of b_t relative to the boundary locus.

Phase diagrams are useful to understand how such a crisis could arise. Figure 3 superimposes the $\Delta s = 0$ curve and the saddlepath for the active-fiscal-policy system on the phase diagram for the passive-fiscal-policy system.

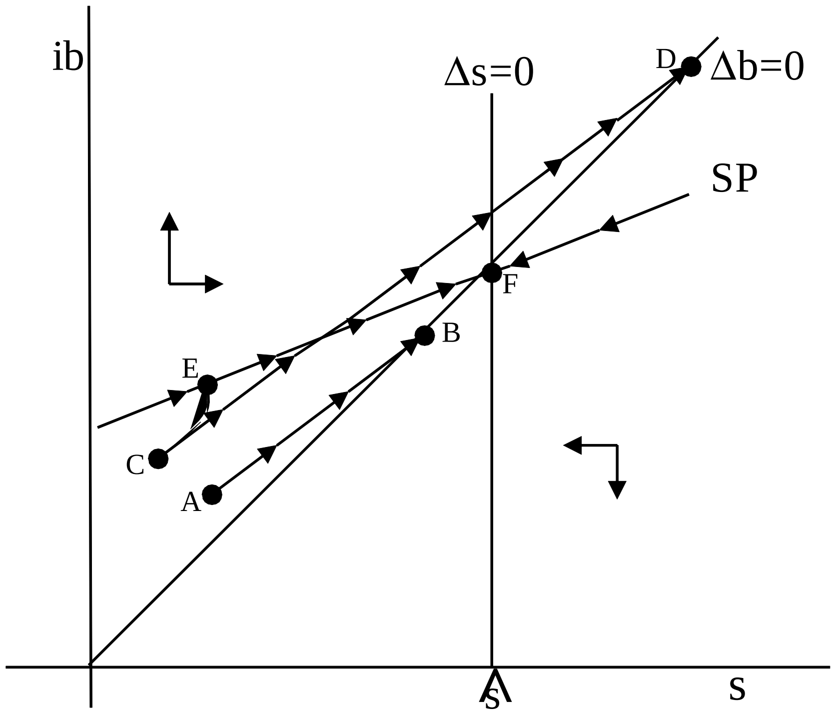

Figure 3: Switching Regime

Consider the dynamics leading up to a crisis, using the phase diagram in Figure 3, when the only shocks are current fiscal surplus shocks. When the system is far below SP, say at point A with $\delta_{t-1} > \bar{v}$, then no shock could send the system above SP, and the arrows of motion for the passive-fiscal-policy system govern. Consider the feasibility of a position like C. Point C is feasible because the expectation of a regime switch in the future raises the expected present-value surplus to equal the value of outstanding debt. As the system approaches the saddlepath so that $\delta_{t-1} < \bar{v}$, the market begins to anticipate depreciation, given by equation (27). This anticipation forces the interest rate to increase to incorporate the increase in expected inflation from equation (1). The monetary authority allows the interest rate to rise to keep the current exchange rate fixed. Therefore, debt is expected to increase more quickly than implied by the locus CD, reaching SP at a point like E.

A crisis occurs when agents refuse to lend, and there are two ways in which this can happen. Conditional on $\delta_{T-1} > 0$, a surplus shock smaller than the cricital value could send the system above the saddlepath in period T such that $\delta_T < 0$ and $\tilde{\gamma}_T < 0$. Such a position cannot represent an equilibrium, and regime switching with depreciation brings the system to the saddlepath.[24] Alternatively, the dynamics of the surplus and debt under passive policy could imply that debt next period in the absence of the regime switch would travel above the saddlepath such that $\delta_T < 0$, but $\tilde{\gamma}_T > 0$. Agents will not lend into this position since no rationally-expected value for the future depreciation could place the system on a stable path. A regime-switch allows debt and the surplus to move along a saddlepath below SP, implying a long-run surplus below $\hat{s}$. When a sudden stop occurs with debt below the saddlepath, there is no depreciation. After the regime switch, capital gains and losses on debt due to exchange rate changes are symmetric, implying that expectations of inflation and exchange rate change are again zero.

Corollary 1 *A government which wants to sustain current fiscal policy as long as possible chooses the largest feasible target value for the long-run surplus.*

Proof. By Lemmas 1, 2, and 3, the probability of a crisis is determined by the boundary locus. The position of the boundary locus is determined by $\hat{s}$, and the boundary locus is higher the larger is $\hat{s}$. ■

[24] Since the probability of devaluation is less than one, when a shock occurs requiring devaluation, its magnitude is greater than expected allowing b to jump downwards.

3.2.1 Shocks Other Than Current Fiscal Shocks

Any shock which changes the position of the post-crisis equilibrium value of debt affects the value of δ_T. Therefore, these shocks can cause a crisis or increase the probability of one. Again assume that the economy in Regime 1 is in the range for which $s_T < ib_T < \hat{s}$.

Expected future fiscal shocks An increase in expected future government spending reduces the post-crisis equilibrium value of debt according to equation (20). This reduces the value of δ_T.

Changes in the parameters of the surplus rule A reduction in the expected long-run target value of the surplus shifts the saddlepath down, reducing δ_T for any given value of debt. A change in the policy parameters in the fiscal rule, for example a reduction in the responsiveness of government spending to debt (reduction in α) increases the slope of the saddlepath without increasing long-run equilibrium values, directly reducing δ_T.

4 Alternative Policy Responses to a Crisis

Policy-switching is only one possible response to a crisis that policy makers might choose. In this section, we briefly consider others.

4.1 Devalue and Repeg at a Lower Rate

The government could also devalue and repeg the exchange rate at a lower value to reach the adjustment path toward its target surplus without any fiscal policy change. In this case monetary policy must allow the interest rate to be determined by expectations of devaluation to satisfy interest rate parity, equation (1), defending the fixed exchange rate. Let δ_{t-1} be redefined as the state variable determining the distance between the target value for debt, given by $\hat{s}/i$, and the current expectation of its long-run value under passive fiscal policy from equation (11).[25] This policy implies the second proposition.

Proposition 3 *A policy in which the government devalues to place the system on the adjustment path toward $\hat{s}$ and repegs at the lower rate without fiscal reform will fail next period with probability one.*

Proof. After devaluation to place the system on the desired adjustment path, $\delta_T = 0$, and the probability of devaluation next period is unity by Lemma 2. Expectations of devaluation $\left(E_T\gamma_{T+1}\right)$ are at least as high as $\frac{\bar{\nu}}{\alpha}$, implying high interest rates.[26] With probability one, the fixed rate fails in the subsequent period with a devaluation and in every period thereafter.

■

Post-crisis equilibrium is characterized by repeated exchange rate depreciation which can be arbitrarily large in magnitude. Expectations of depreciation must be large enough that depreciation occurs for any fiscal shock. This is because the government is assumed never to revalue to reach its target adjustment path. Expectations of depreciation must be correct on average, implying that expectations of depreciation must be the average value of depreciation. Therefore, following the crisis, markets remain turbulent. Agents expect additional depreciation, interest rates are high, and additional depreciation is necessary. Given sustained post-crisis turbulence, it would be difficult to make a case that this policy represents optimal response.

[25] $\delta_{t-1} = (1-\alpha)\, s_{t-1} - \alpha b_{t-1} + \frac{1-(1-\alpha)(1+i)}{i}\bar{s}$ and the distance is given by $\Omega_t = \frac{\delta_{t-1}+\nu_t+\alpha(E_{t-1}\gamma_t - \gamma_t)}{1-(1-\alpha)(1+i)}$. For a derivation, see Daniel (2007).

[26] The shadow rate of devaluation is given by $\tilde{\gamma}_t = E_{t-1}\gamma_t + \frac{1}{\alpha}\left[\delta_{t-1} + v_t\right]$. With $\delta_{t-1} = 0$, $E_{t-1}\gamma_t \leq -\frac{\bar{\nu}}{\alpha}$.

4.2 Default

The government could plan to respond to a crisis by reneging on its no-default commitment. Both default and devaluation reduce the real value of outstanding debt moving the, system toward the $\hat{s}-$saddlepath. The larger the default, the smaller the devaluation and vice versa. However, given that default typically takes time to resolve and given that agents usually do not know the magnitude of default, expectations about the magnitude could be volatile, implying a volatile exchange rate until a value for default is finalized. Since default solves the same fiscal solvency problem as devaluation, default and devaluation can occur together.[27]

4.3 IMF Loan

Assume that the country plans to resolve the crisis by securing an IMF loan to replace the private market source of loans it looses in a crisis. To simplify the presentation and contrast this policy with those preceding it, we assume there is no accompanying debt devaluation either through depreciation or default. An IMF loan with debt devaluation would be analyzed as a combination of the two policy responses.

The IMF is willing to make the loan when the private market is not because the IMF can force fiscal policy change as a condition for receiving the loan. IMF programs for countries with fiscal problems usually require an increase in the value of the government surplus for a specific period of time. We model this as an increase in the mean of ν_t for a specific period

[27] For an analysis of default as a response to the crisis, see Daniel and Shiamptanis (2008). The interest rate parity equation must be modified such that the world interest rate is equated with the expected return on the domestic asset, conditional on the possibility of default.

of time. In Figure 1, this flattens the adjustment path, leading to a lower expected value for the long-run surplus, restoring fiscal solvency. Effectively, the government's intertemporal budget constraint is restored because the present value of future surpluses rises, not because the real value of debt falls. With this policy, expectations of depreciation are always zero.

5 Model Applied to Recent Currency Crises

In this section we illustrate the implications of the fiscal solvency model for several recent currency crises not explained well by the standard generation one model. Fiscal solvency remains essential in the explanation but future seigniorage is not. Crises are caused by current fiscal shocks combined with loss of confidence in the fiscal rule, expected future fiscal shocks, and a policy of devaluation and repegging without policy switching, leading to expectations of further devaluation.

5.1 Argentina 2001: Current Fiscal Shocks and Loss of Confidence

The first crisis we consider is the Argentine crisis in 2001. This crisis cannot be explained by a generation one model since the currency board prevented money-financed government deficits and made a total run on reserves impossible. Yet, government deficits and rising government debt did precede the crisis, and the crisis was characterized by both currency depreciation and sovereign default, highlighting the role of fiscal problems. Simulations of the fiscal solvency model imply that the Argentine crisis was caused by a combination of a negative fiscal shocks stemming from the 1998 recession, a reduced surplus-response to government debt (α), and a crisis of confidence reducing the expectations for the governments long-run target value for the primary surplus $(\hat{s})$.

For the simulations, we assume that the values for the surplus and debt in the model represent ratios to GDP, implying that the interest rate variable is the growth-adjusted real interest rate. We assume that the growth-adjusted real interest rate is .02, based on real interest rates of about 5-6% and reasonable expected growth rates of 3-4%. We let the upper bound on the target surplus be 1.5% of GDP, larger than any surplus achieved in the 1990's, although not larger than the IMF target surpluses for the short run. At this interest rate, the upper bound on the surplus implies an upper bound on debt of 75% of GDP. The stabilization program initiated in 1991 involved not only the currency board but a strong fiscal policy as indicated by small persistence in the surplus. We have too little data to estimate the parameters of the fiscal rule followed at the beginning of the stabilization program with any confidence. Using IMF data (IMF 2003 and Krueger 2002) on the primary surplus and debt for the consolidated public sector, including federal and provincial governments, as a fraction of GDP from 1991-1998, we estimate a value for α of .60[28], and argue that this strong fiscal stance is consistent with initial policy.

In 1991, the value of debt was 38.5% of GDP, while the surplus was $-.5\%$. We use a uniform distribution to generate surplus shocks and let bounds on the distribution be $\pm 2\%$ of GDP since surplus shocks this large were observed. We use 5,000 simulations to calculate the probability of a crisis in twenty years. If we assume that a crisis would be resolved with a switch to active fiscal policy and passive monetary policy, then the initial

[28]We use the regression coefficient of the change in the surplus on the surplus less debt service calculated at $i = .02$ when the constant is forced to be zero.

position of Argentina in 1991 was well below the upper bound path, given by the saddlepath leading to a surplus of 1.5% of GDP. Given these parameter values, simulations show that the stabilization program initiated by Argentina was very safe with the probability of a crisis in twenty years almost zero.

The 1998 recession brought large fiscal deficits, and debt increased to 50.9% of GDP by the end of 2000. However, simulations with the higher debt and the surplus at its 2000 value of -.1% show that the increase in debt alone would not have increased the probability of a crisis, had Argentina maintained its strong fiscal stance. With the same fiscal rule and the same upper bound on the surplus, simulations show that the probability of a crisis in ten years remains close to zero. Therefore, according to the model, the increase in debt due to negative fiscal shocks alone cannot explain the crisis.

It is reasonable to argue that the 1998 recession weakened both the fiscal stance as well as confidence in fiscal policy. Large fiscal deficits are consistent with both a string of negative fiscal shocks and a change in the fiscal rule whereby surpluses become more persistent and less responsive to debt as α falls. Fiscal policy from 1998-2001 is more consistent with a value of $\alpha = .17$.[29] Additionally, a crisis of confidence could have lowered the public's expectation of upper bound on the surplus which the government could sustain, so we assume that the upper bound falls from 1.5% to 1.25% implying a fall in the upper bound on debt to 62.5%. With the weaker fiscal stance and reduced confidence, the probability of a crisis in ten years increases to 77% with the mean time to a crisis being two years. Therefore, the model with a reduction in the surplus-responsiveness of debt and a lower upper bound on

[29] This is the regression estimate for α using four years of data from 1998-2001.

the surplus predicts the crisis which occurred. The crisis did not occur immediately with the 1998 recession because there was still some possibility that it could be avoided.

The simulations imply that reduced responsiveness of fiscal policy to debt was key to generating the crisis. Had the initial 1991 stabilization program been accompanied by the weaker fiscal stance we assumed occurred with the 1998 recession, then simulations show that the program would have been much less safe with crisis probability over the next twenty years rising to 35% with mean time to a crisis being about ten years. This illustrates the importance of the strong fiscal stance, represented by a large response of the surplus to debt, for the viability of the initial stabilization program.

Therefore, the model implies that the initial monetary and fiscal reform in 1991 in Argentina was sound. If Argentina had maintained a fiscal rule like that it initiated in the beginning of the reform, then it would have likely avoided the crisis. The recession brought not only negative surplus shocks, but also a weakened fiscal rule and reduced confidence in fiscal policy, substantially raising the probability of a crisis.

5.2 Mexico 1994-95: Devaluation and Repeg without Policy Switching

The Mexican crisis was not preceded by money-financed government deficits (Calvo and Mendoza 1996, Cole and Kehoe, 1996). Instead, primary surpluses had exceeded 1% of GDP since 1983, and debt as a fraction of GDP was falling. At the end of 1993, debt was 25.3% of GDP.[30] Mexico was at a point like G in Figure 1, moving toward a target surplus well below

[30]Primary surplus data are from Banco de Mexico website: http://www/banxico.org.mx/ under "Public Finances" and other data is from IFS Statistics.

its upper bound. The country was not experiencing fiscal solvency problems in any standard sense and cannot be explained by a generation one model. The fiscal solvency model can explain Mexico's crisis if we assume that the surprise 15% devaluation of the peso relative to the US dollar in December 1994 was a signal that the government planned to respond to shocks, which moved it away from its desired adjustment path, with devaluation, but not with revaluation or fiscal reform.

Under this assumption, the devaluation set $\delta_T = 0$. Since the distance to the desired adjustment path was zero after the devaluation, and only devaluation would be used to offset future fiscal shocks, expected future devaluation could be arbitrarily high from Lemma 2, and the new peg would fail with probability one from Proposition 2. This is indeed what happened. Interest rates shot up, reflecting further expected devaluations. Additional speculative attacks and devaluations followed. If Mexico had explicitly switched to flexible exchange rates, as in the switching model presented above, then post-crisis expectations of future exchange rate change would have been zero. The repegging at a lower rate implied that the government would react to future negative shocks with devaluation but would maintain the exchange rate with future positive shocks. This created large expectations of devaluation, effectively causing devaluation even when there were positive fiscal shocks.

A policy to restore confidence and change the perception that the government would use future debt devaluation to achieve fiscal goals was necessary to end the crisis. It is reasonable to argue that the large US loan illustrated US confidence in the government, restoring private confidence, thereby strengthening expectations about fiscal rule parameters, possibly by raising $\hat{s}$ and/or α, and increasing δ_T.

5.3 Southeast Asia 1997: Expected Future Government Expenditures

Burnside, Eichenbaum, and Rebelo (BER 2001, 2006) have convincingly argued that the currency crises in Southeast Asia were due to expected future increases in government expenditures to finance the banking crisis. However, their model remains couched in terms of the generation one currency crisis model in which an increase in future money growth and seigniorage is a necessary component in restoring fiscal solvency. This leads to a model of the timing of a currency crisis based on an assumption that money will take a discrete upward jump on a particular future date and then grow faster after that date.

The solvency model generates a currency crisis due to an increase in expected future government expenditures, irrespective of any assumptions about future monetary growth. Under the assumption that the government will respond to a crisis with policy switching, the increase in expected future spending lowers the maximum value of current debt consistent with the fixed exchange rate policy mix and the current value for the surplus. Equivalently, we could capitalize the present value of expected future spending into a current value, add this to debt, and compare the sum to the old upper bound path for debt. A crisis occurs as soon as agents refuse to lend because they believe that the government's desire to borrow would place it above the path toward its upper bound.

Consider Thailand, where the crisis first erupted. Primary surpluses and strong GDP growth had reduced total government debt from a peak in 1986 of 36.5% of GDP to only

3.8% by the end of 1996.[31] In Figure 1, Thailand was at a point like G. However, in 1996 the country entered a recession, and reductions in land and stock market values created a financial sector crisis. BER (2001) present estimates of the costs of recapitalizating the banking sector of 30 to 35% of GDP. Capitalizing this into current debt implies that the country's effective debt/GDP was similar to that in 1986. Its surplus/GDP was larger at .9% of GDP in 1996 compared to -3% in 1986. Even though the recession could have implied expected near-term negative surplus shocks, it is difficult to argue that if the government was expected to follow the same fiscal rule it had followed earlier, that agents would have believed that it was near fiscal insolvency in 1996, when it was clearly solvent in 1986.

The difference between the two periods lies in the financial sector crisis and political uncertainty over the fiscal implications of its resolution. The political uncertainty could have caused agents to believe either that the government could not maintain its strong fiscal rule or that its upper-bound surplus was smaller, both reducing the value for debt along the upper-bound path. This reduction could have contributed to the perception that government borrowing would place debt on an unsustainable path. The exchange rate remained volatile in subsequent months, with gains and losses, but with losses dominating, until the government had determined how to handle the banking crisis. Volatile exchange rates are consistent with volatile expectations about the present-value of future surpluses under active fiscal policy.

Korea also faced a banking crisis with estimates of the cost of restructuring the banking system at 24-30% of GDP (BER 2001). Also similar to Thailand, the country had experienced primary government surpluses for four years and debt was only 7.5% of GDP at the end of

[31] Data is from IFS.

1996. However, if future liabilities are capitalized into current debt, then debt/GDP was almost twice as large as its largest value since 1980 (17% of GDP in 1982) and well above its mean value of 12% since 1980.[32] Therefore, it is reasonable to argue that agents believed that Korea faced a fiscal solvency problem. Additionally, concern over the fiscal response to the banking crisis could have led agents to believe that the government would adopt a weaker fiscal stance, further increasing the probability of a crisis.

5.4 Other Crises

These crises are meant to illustrate the major types of shocks which can cause fiscal financial crises, including current fiscal shocks, expected future fiscal shocks, loss of confidence in current fiscal policy which reduces the expected value of future fiscal surpluses, and devaluation to respond to a current shock with implicit promises to use additional devaluation to respond to future shocks. We could use the model to analyze many other actual crises. At the time of this paper's writing, Iceland is experiencing a crisis in which the estimated future government expenditures necessary to recapitalize the banking system are something like 80% of GDP. The country has experienced a sudden stop of capital flows, its currency has depreciated sharply, and it is negotiating for an IMF loan. Equilibrium in the sense of the model has not yet been restored as private capital is not flowing at any interest rate, implying that markets believe the government remains in an insolvent position.

[32] Data are from IFS.

6 Conclusions

This paper provides a dynamic model of currency crises which retains fiscal solvency as the central cause, as in generation one models. However, it replaces the initial inconsistent policy mix of the generation one model with a policy mix which fails with positive probability. And it replaces the role of seigniorage in restoring fiscal solvency with debt devaluation, created by currency depreciation. The model is the product of insights from the original generation one model, which highlights fiscal solvency as a key fundamental in exchange rate crises, and the FTPL, which allows capital gains and losses on debt to maintain fiscal solvency.

When stochastic shocks move the government's desired debt above the path leading to the long-run upper bound, agents refuse to lend, precipitating a crisis. The crisis could be caused by current fiscal shocks, which raise desired debt and reduce the current surplus, by expectations of new future fiscal commitments which raise the expected present-value of future surpluses, or by a change in the current fiscal rule or the expectation of such a change. Agents will not lend and equilibrium cannot be restored until policy responds to restore expectations of fiscal solvency. One possibility is a regime switch, in which the fiscal rule becomes active and monetary policy becomes passive, as in the FTPL. This allows future price level (and exchange rate) surprises to offset stochastic surplus shocks and usually requires exchange rate depreciation in the crisis period to reduce the outstanding value of debt. A policy of devaluation to restore fiscal solvency without a change in the fiscal rule will restore equilibrium, but at the cost of arbitrarily high expected future devaluation and interest rates. Cumulative exchange rate depreciation is lower the sooner fiscal reform is implemented. This result highlights the importance of fiscal reform in restoring orderly markets after a crisis. Since currency depreciation and sovereign default both restore fiscal solvency, they can occur together.

We apply the model to explain crises in Argentina (2001), Mexico (1994), and Southeast Asia (1997), which do not fit the stylized facts of generation one crisis models. The model can be used to attribute the Argentine crisis to negative fiscal shocks and a change in the fiscal rule, perhaps caused by the recession. Both currency depreciation and default on sovereign debt were used to restore fiscal solvency. The Mexican crisis can be explained by the surprise devaluation which signaled the government's willingness to use debt devaluation to keep debt along its desired adjustment path. The crises in Southeast Asia can be attributed to large expected future government expenditures to recapitalize banks, as argued by Burnside, Eichenbaum, and Rebelo (2001, 2006), as well as political uncertainty over the fiscal implications of their resolution in Thailand and possible contagion in South Korea.

The model advances on Daniel (2001b) by providing a dynamic "Fiscal Theory of the Price Level" model of currency crises as well as by considering responses to currency crises other than policy switching. The FTPL model of currency crises advances on policy switching models by Sims (1997) and Davig and Leeper (2006) and Davig, Leeper, and Chung (2007) by allowing policy switching to be the endogenous response to a crisis, which resolves the crisis by restoring fiscal solvency. It highlights the danger of using devaluation without fiscal reform to restore solvency. More generally, the model provides additional support for viewing fiscal policy as a key determinant of exchange rate crises.

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