

Exchange Rate Crises and Fiscal Solvency

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1 Generation One Exchange Rate Crisis Models

- Crisis Fundamental: Fiscal Solvency
 - government deficit financed by limited reserves
- successful explanation of crises in 1980's
- failed after 1990 even in crises with obvious fiscal component (Argentina 2001)
 - Argentine currency board
 - No government deficits in Mexico (1994-95) and Southeast Asian countries (1997)
 - Mexican sterilization

1.1 Research Response to Failure

- Modify generation one model to handle specifics of each crisis
- New generations of currency crisis models with different fundamentals
 - Macro Stabilization
 - Sudden Stops

1.2 New Generation-One Type Model

- Crisis Fundamental: Fiscal Solvency
- Combine insights from
 - Original generation one model with fiscal solvency as a centerpiece
 - Fiscal Theory of the Price Level (FTPL)
- More general model which can explain a wider variety of crises for which fiscal solvency is a fundamental

1.3 Both Models are Policy Switching Models

- Generation One
 - Initial policy mix is unsustainable with probability one
 - Monetary policy maintains fixed exchange rates until infeasible
 - When infeasible – crisis
 - Monetary policy switches to flexible exchange rates
 - Fiscal policy retains original stance

- New Model

- Active monetary policy fixes exchange rate (equivalently price)

- Passive fiscal policy

- * government surplus adjusts to past debt to assure intertemporal budget balance for any initial debt

- * taxes are distortionary

- * transitory stochastic surplus shocks imply increase in debt as in Barro's (1976) optimal tax model

- * upper bound on present value of future surpluses

- **Stochastic shocks** and **upper bound** imply that initial passive fiscal policy is at **risk** of being unsustainable

- Crisis
 - shocks
 - * current fiscal shocks
 - * current expectations of future fiscal shocks
 - * changes in expectations about upper bound
 - * changes in fiscal policy rule
 - could send government to a surplus-debt position from which government cannot raise the present-value of the surplus enough to service debt, conditional on initial policy
 - sudden stop of capital - agents will not lend into position in which cannot expect to receive market rate of return

- Policy Switching

- monetary policy switches to passive with price level target (zero expected inflation but positive and negative price surprises)
- fiscal policy switches to active
- new fiscal rule raises expected present-value of surplus
- if not sufficient to restore government IBC, then exchange rate depreciation reduces real value of government debt
- in the new flexible exchange rate equilibrium, price and exchange rate surprises offset fiscal shocks
- agents know post-crisis policy and use this to form expectations

- Alternative post-crisis policy
 - devalue and repeg at lower rate with no other policy change
 - use debt default to reduce real value of debt with or without fiscal reform

- Use model to explain crises related to fiscal solvency
 - Argentina (2001)
 - Mexico (1994-95)
 - Thailand and South Korea (1997)

2 Simple Model

Four key assumptions

1. International creditors lend only if they expect to receive market rate of return
2. Domestic government issues debt denominated in its own currency
3. There is an upper bound on the present value of future surpluses
4. Initial policy mix entails sustainability risk and risk to government debt

2.1 Goods and Asset Markets

- Small open economy
 - Fixed world interest rate
 - Fixed world price level
- Single good - law of one price $P_t = S_t$
- **Key Assumption 1:** Interest rate parity

$$\frac{1}{1 + i_t} = \left(\frac{1}{1 + i} \right) E_t \left[\frac{S_t}{S_{t+1}} \right] \quad (1)$$

- **Key Assumption 2:** Government debt is nominal with potential for capital loss

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

- Debt equation (government flow budget constraint)

$$b_t = (1 + i) b_{t-1} - (\gamma_t - E_{t-1}\gamma_t) - s_t \quad (2)$$

- Intertemporal government budget constraint

$$\begin{aligned} & \lim_{T \rightarrow \infty} E_t b_{t+T} \left(\frac{1}{1+i} \right)^T & (3) \\ &= (1+i) b_{t-1} - (\gamma_t - E_{t-1}\gamma_t) - E_t \sum_{h=0}^{\infty} s_{t+h} \left(\frac{1}{1+i} \right)^h \\ &= 0. \end{aligned}$$

- Exchange rate surprises create revenue – anticipated exchange rate changes do not

- **Key assumption 3:** Upper bound on the present value of future surpluses

$$\sum_{h=0}^{\infty} s_{t+h} \left(\frac{1}{1+i} \right)^h$$

- implies upper bound on debt

$$b_t \leq \bar{b} = \sum_{h=0}^{\infty} \frac{s_{t+h}}{i} \left(\frac{1}{1+i} \right)^h$$

- and on long-run equilibrium surplus

$$\bar{s} = i\bar{b}$$

- **Key assumption 4:** Fiscal policy has sustainability risk and risk to government debt

$$s_t = (1 - \alpha) s_{t-1} + \alpha [(1 - \lambda) \hat{s} + \lambda i b_{t-1}] + \nu_t, \quad (4)$$

$$\frac{i}{1 + i} < \alpha < 1, \quad 0 \leq \lambda, \quad 0 < \hat{s} \leq \bar{s} - \bar{\nu},$$

s_t	real primary surplus	\bar{s}	upper bound on the long run surplus
\hat{s}	long run target surplus	$1 - \alpha$	persistence in the surplus.
b_t	real value of debt	λ and \hat{s}	are policy parameters
ν_t	bounded fiscal shock		

2.2 Initial Policy Mix (Regime 1) with No Upper Bounds

- Monetary policy sets $\gamma_t = E_t \gamma_{t+1} = 0$ when there is no possibility of a crisis next period
- Fiscal policy sets $\lambda = 1$
- One unit root and one stable root $0 < (1 - \alpha)(1 + i) < 1$
- Barro's optimal tax model (1976) with debt absorbing transitory fiscal shocks
- Permanent increase in government spending does not affect the surplus (does not nest original generation one unless abandon optimal tax interpretation)

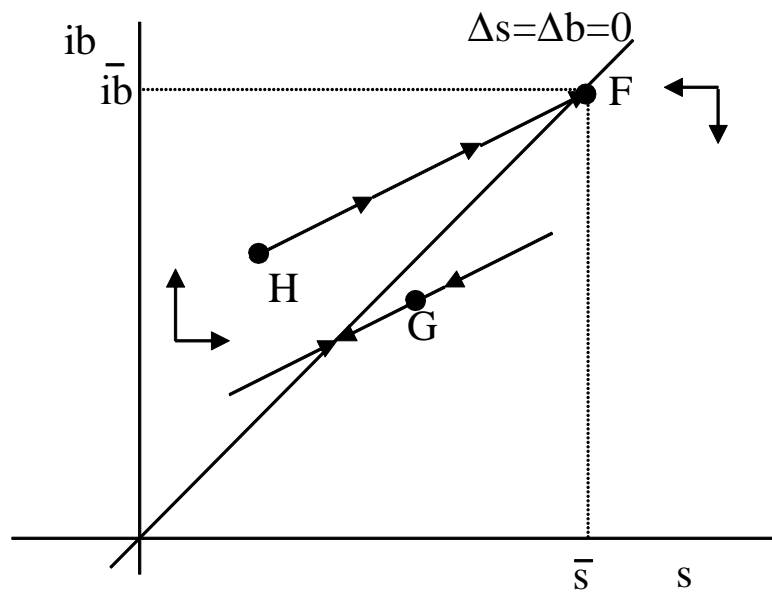


Figure 1: Passive Fiscal Policy

- In absence of upper bounds, system always expected to travel to a stochastic long-run equilibrium

2.3 Initial Policy Mix (Regime 1) with Upper Bounds

- Long-run positions are along 45 degree line
- Long-run positions along 45 degree line above point F
 - violate the upper bound
- Short-run positions above HF
 - lead to expected long run position above F
 - imply expected present-value surpluses are larger than feasible under initial policy and upper bounds
- Shocks which would send the system to infeasible positions require a policy response

2.4 Post-Crisis Policy Mix (Regime 2)

- Monetary policy sets $E_t \gamma_{t+1} = 0$
- Fiscal policy sets $\lambda = 0$ and $\hat{s} \leq \bar{s} - \bar{v}$
- One stable root $(1 - \alpha)$ and one unstable root $(1 + i)$: saddlepath stable
- \hat{s} not \bar{s} determines the position of SP

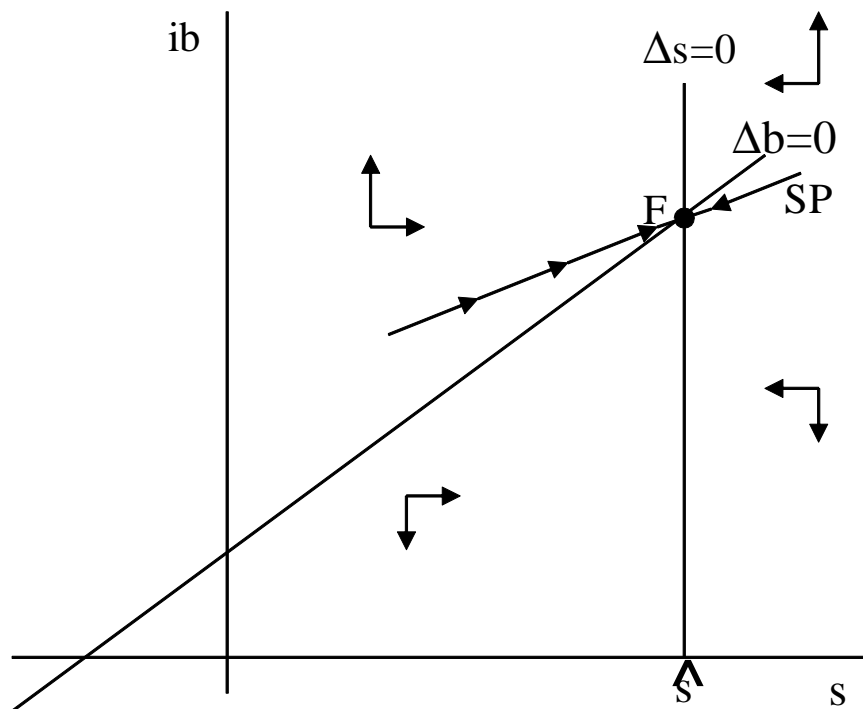


Figure 2: Active Fiscal Policy

2.4.1 Equilibrium in Regime 2

- $\gamma_t - E_{t-1}\gamma_t$ offsets fiscal shocks, keeping system on saddlepath
- Chari, Christiano and Kehoe's (1991) optimal tax model with price surprises creating debt devaluation and revaluation to absorb fiscal shocks
- Stochastic FTPL model in which price surprises offset fiscal shocks assuring government IBC holds

3 Exchange Rate Crisis with Policy Switching

3.1 Assumptions

- Initial position: $s_{t-1} < ib_{t-1} < \hat{s}$
- Government maintains initial policy mix as long as possible.
- Once a crisis next period becomes possible, monetary authority allows the interest rate to rise to maintain the fixed exchange rate in current period

- When cannot borrow to continue passive fiscal policy rule under fixed exchange rates, policy switches
 - active fiscal policy with $\hat{s} \leq \bar{s} - \bar{\nu}$
 - monetary authority sets $E_t \gamma_{t+1} = 0$, but flexible rates allow γ_t to deviate from zero

3.2 Equilibrium with Policy Switching

Definition 1 *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 the surplus rule from equation (4) 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 (2) and (3), hold, expectations are rational, debt does not exceed its upper bound, and world agents expect to receive the return on assets determined by interest rate parity, equation (1).*

3.2.1 Equilibrium Post-Crisis Position

- On SP leading to \hat{s}
- If above, debt rises faster than interest rate violating government intertemporal budget constraint and upper bound
- **Upper bound locus** in region $s_t \leq \hat{s}$ is the saddlepath leading to target surplus (\hat{s})

3.3 Shocks Creating a Crisis

- Current fiscal shocks
- Expected future fiscal shocks
- Policy rule changes

3.4 Crisis Dynamics with Current Fiscal Shocks

- State variable determining distance between saddlepath to target surplus (\hat{s}) and current value of debt is δ_{t-1}
 - Excludes expectations and current fiscal shock
- Shadow value of depreciation ($\tilde{\gamma}_t$)
 - value of γ_t that would place system on saddlepath to \hat{s}
 - depends on expected depreciation, distance variable, current fiscal shock

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

- Actual depreciation

$$\gamma_t = \max \{ \tilde{\gamma}_t, 0 \}. \quad (5)$$

3.4.1 Expectations of Depreciation

- Assume agents believe the fiscal borrowing constraint will bind, creating depreciation if $\tilde{\gamma}_t > 0$
- If $\delta_{t-1} = 0$, then expectations of depreciation are so high $\left(\frac{1+i}{\alpha+i}\bar{\nu}\right)$ that depreciation fails to occur only for $v_t = \bar{\nu}$
 - expectations must be correct on average
 - only depreciation, never appreciation
 - expectations must be high enough such that actual depreciation can have positive and negative deviations about expectations

- If $\delta_{t-1} < 0$, no solution for expected depreciation exists
 - solve for critical value of shock (ν_t^*) which sets $\tilde{\gamma}_t = 0$
 - there is no solution when $\delta_{t-1} < 0$ because $\tilde{\gamma}_t > 0$ for all ν_t implying that the probability of a crisis with depreciation is unity
 - taking expectations with a unitary probability of depreciation

$$E_{t-1}\gamma_t = E_{t-1}\tilde{\gamma}_t = E_{t-1}\gamma_t - \frac{1+i}{\alpha+i}(\delta_{t-1})$$

cannot hold with $\delta_{t-1} < 0$

- If $\delta_{t-1} > 0$, well-defined solution for expected depreciation and interest rate adjusts for expectations through interest rate parity

- Let economy be in period $t = T$

Proposition 2 *When $\delta_T \geq 0$, the equilibrium interest rate in period T adjusts for rational expectations of depreciation ($E_T \gamma_{T+1} \geq 0$), 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.*

3.4.2 Crisis Due to Current Fiscal Shock

- Let $\delta_{T-1} > 0$ and small enough that $E_{T-1}\gamma_T > 0$

- Draw a shock (ν_T) for which $\tilde{\gamma}_T > 0$

- implies $\delta_T < 0$ under initial passive fiscal policy

$$\delta_T = -(\alpha + i)\tilde{\gamma}_T - \alpha(\hat{s} - ib_T)$$

- agents refuse to lend into this position

- fiscal policy switches and $\gamma_T = \tilde{\gamma}_T$

- validates agents's beliefs that $\gamma_T = \max\{\tilde{\gamma}_T, 0\}$

- Alternatively, draw a shock (ν_T) for which $\tilde{\gamma}_T < 0$, but $\delta_T < 0$ because $(\hat{s} - ib_T) > 0$
 - agents refuse to lend into this position
 - fiscal policy switches and $\gamma_T = 0$
 - adopt lower surplus target to make current position on a saddlepath to long-run surplus less than \hat{s}
 - validates agents's beliefs that $\gamma_T = \max\{\tilde{\gamma}_T, 0\}$

3.4.3 Illustrate Crisis with Phase Diagram

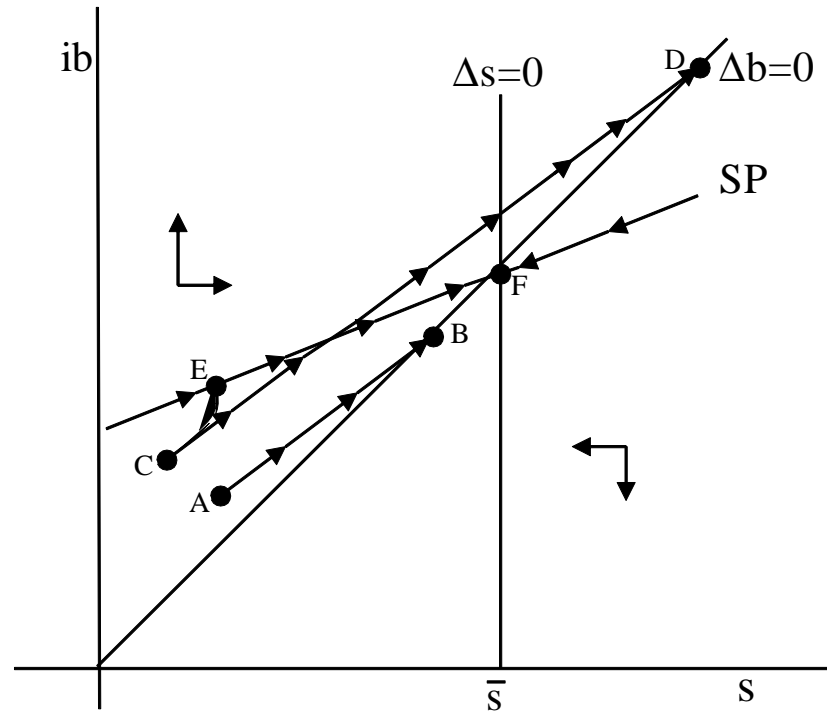


Figure 3: Switching Regime

- Upper bound locus is SP

- **Point A** Under initial policy, expect to converge to feasible long-run position at point B
- **Point C** Under initial policy, expect to converge to infeasible position D
 - expectation of policy switch raises expected present value of future surpluses, making point C feasible
 - interest rate rises, reflecting expectations of depreciation, implying that debt adjusts more quickly than along CD path
- **Point above SP** Under initial policy, even with the possibility of future switching, this cannot be an equilibrium
 - an anticipated price level jump does not change the value of debt

- When shock, together with expectations moves system above SP, sudden stop in lending and crisis
 - Equilibrium restored with policy switching and depreciation to return to SP
- When evolution of debt would send system above SP next period, sudden stop in lending and crisis
 - Equilibrium restored with policy switching to lower target than \hat{s}

3.5 Crisis Dynamics under Alternative Shocks

- Increase in expected future government spending
- Change in fiscal surplus rule
 - Persistence (α)
 - Long-run target surplus (\hat{s})

4 **Alternative Policy Responses to a Crisis**

- Devalue and repeg at lower rate
- Default

5 Model Applied to Recent Currency Crises

5.1 Argentina (2001)

- Upon implementation, policy appears relatively safe
- Recession created negative surplus shocks and increased persistence of deficits (changed parameters of fiscal rule)
- Increased persistence increased slope of the saddlepath, and negative shocks sent debt over
- Interpret the sudden stop in capital flows as agents refusing to lend into a position of government insolvency

- Eventually resolved with both currency depreciation and default as both reduce real government debt
- Argentina did not succumb earlier because there was positive probability that it could avoid a crisis
- Note that having sufficient reserves to back the money supply had no effect on the crisis

5.2 Mexico (1994-95)

- Fiscal surpluses and low debt, yielding a point like G in Figure 1
- Crisis trigger was 15% surprise devaluation in December 1994
- Trivial effect on outstanding real value of government debt
- Signaled government's willingness to use devaluation (but not revaluation) to reach and maintain a particular adjustment path in the face of shocks
- Since on desired adjustment path, and would only use devaluation, expectations of devaluation high

- Markets remained turbulent with high interest rates and high devaluations
- Perhaps US loans helped restore confidence that government would not use devaluation to achieve fiscal goals

5.3 Southeast Asia (1997)

- Strong fiscal positions
- Financial crisis implied expected future government expenditures to solve the crisis (BER)
- Expected future expenditures reduced the upper bound locus
- If the upper bound locus falls below current debt, immediate crisis
- If debt was below but close, higher expectations of devaluation raised interest rates, increasing the probability that future fiscal shocks would send the system over

6 Conclusions

- Generation-one type model with fiscal solvency as key fundamental
 - Replace initial inconsistent policy mix with policy mix which fails with probability less than one
 - Replace role of seigniorage in generating government revenue with debt devaluation
 - Model with policy switching is an FTPL model of exchange rate crises

- Wide variety of shocks can create a crisis or increase the probability of a crisis
 - Anything which reduces the expected present value of surpluses relative to initial debt
 - Current fiscal shocks
 - Expected future fiscal shocks
 - Changes in the parameters of the fiscal rule due to either explicit policy change or loss of confidence in current policy

- Agents will not lend into a position of insolvency - sudden stop
 - Restore lending only after restore expectations of fiscal solvency
 - Depreciation and default both reduce real debt (solve same problem) and so can occur together
 - Importance of fiscal reform in conjunction with debt devaluation
- Fiscal solvency explains a wider variety of currency crises than traditional generation one model would imply