Alessandro Missale

FINANCIAL INTEGRATION AND CRISES

2021

Lecture 9

Lecture 9

Currency Crises – First Generation Model

- Fixed exchange rate regimes
  - Implications for monetary policy
- First Generation Model of Currency Crises
  - The Flood and Garber (1984) model
  - Timing of a speculative attack
  - The run on reserves

References: Krugman (JMCB 1979); Flood and Garber (JIE 1984)

Fixed exchange rate

- Under a fixed exchange-rate regime **the Central Bank formally commits to an exchange rate target**, e.g. a fixed parity or a band, and must use monetary policy to achieve it.

Note that Flexible exchange rates can be heavily managed and practically similar to fixed regimes except for the absence of a formal commitment.

Fixed exchange rate regimes

- Such regimes are also called **pegs** since the currency is pegged to a foreign one or to a basket of currencies. **Crawling pegs** are so called because the exchange rate follows a predetermined depreciation path that depends on inflation rate differentials. In other regimes the exchange rate can move within a narrow **bands around a central parity** as under the ERM of the European Monetary System (EMS 1979-93-98): $\pm 2.25\%$

Monetary policy independence is lost

- With free capital mobility, to peg the exchange rate at $S_t = \bar{S}$, the CB must set the interest rate so that the modified *UIP* holds at $S_t = \bar{S}$

$$i_t = i_t^* + \frac{E_t S_{t+1} - \boldsymbol{S_t}}{\boldsymbol{S_t}} + pr_t \rightarrow i_t = i_t^* + \frac{E_t S_{t+1} - \boldsymbol{\bar{S}}}{\boldsymbol{\bar{S}}} + pr_t \qquad (1)$$

- The interest rate must react to changes in i_t^*, $E_t S_{t+1}$ and premium pr_t while such changes are adjusted by S_t in a flexible regime.
- **The CB cannot freely set the interest rate to pursue other goals**
- **With perfect capital mobility monetary policy independence is lost**; it cannot be used for output stabilization, price stability, balanced trade because of intervention required to maintain the exchange rate fixed.

Impossible Trinity (or the Trilemma): it is impossible to have at same time

- Free capital mobility (no capital controls)
- A fixed (stable) exchange rate
- An independent monetary policy

Money supply is endogenous with fixed rate

- As the Central Bank (CB) must set the interest rate to satisfy
- $i_t = i_t^* + \frac{E_t S_{t+1} - \bar{S}}{\bar{S}} + pr$

  the money supply becomes endogenous.

- **How does the CB change the interest rate?**
- **Why not to use foreign reserves to avoid the depreciation?**

The money supply

The CB sets the interest rate by changing the Monetary Base

- **Monetary Base** $M = CU + R$
  - CU = Currency = coins and banknotes held by the nonbank public
  - R = commercial banks' reserves ($R \neq R^F$ = foreign reserve assets)

In an open economy the CB can create (supply) monetary base, $\boldsymbol{M}$, by buying domestic bonds, $\boldsymbol{D}$, in the open market (domestic source) or by buying foreign reserve assets, $\boldsymbol{R^F}$, in the forex market (foreign source):

Central Bank Balance Sheet

ASSETS	LIABILITIES
$\boldsymbol{R^F}$	$\boldsymbol{M}$
$\boldsymbol{D}$	$\boldsymbol{capital}$

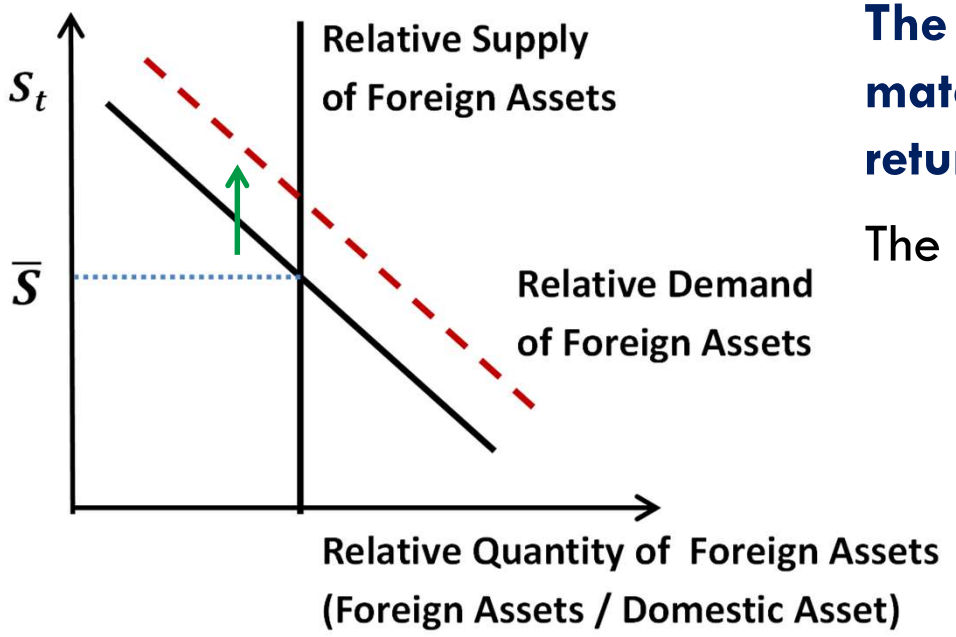
$\boldsymbol{D}$ = CB Domestic Credit
eg Government bonds

$\boldsymbol{R^F}$ = Foreign reserve assets
e.g. Foreign bonds

An increase in the demand of foreign assets

An increase in the relative demand of foreign assets due, for example, to higher foreign interest rates, or an increase in the premium, or expected depreciation (if, $\bar{S}$ not fully credible) put pressure on the exchange rate.

Equilibrium exchange rate



The CB must defend the exchange rate.

The CB must raise the interest rate to match the higher expected rate of return on foreign assets.

The money supply must decrease.

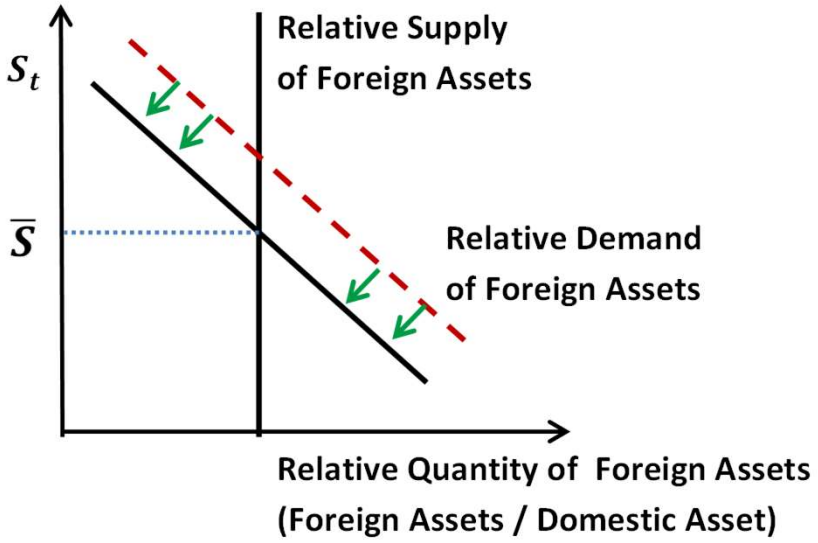
Money destruction in domestic bond market

The CB can sell domestic bonds in the open market in exchange for monetary base (ie for commercial bank reserves)

ASSETS	LIABILITIES
R^F	$M \downarrow$
$D \downarrow$	

- $D \downarrow + R^F = M \downarrow$
- $M \downarrow \rightarrow i \uparrow$

the overnight interest rate on the interbank market increases



A high enough interest rate is targeted to bring back the relative demand for foreign assets and keep the exchange rate fixed.

Money destruction in the Forex market

The CB can intervene in the foreign exchange market

- The CB sells its foreign reserve assets, in the forex market in exchange for monetary base (ie domestic currency or reseves).
- **The interest rate rises and the monetary base decreases:**
  - $D + R^F \downarrow = M \downarrow$
  - $M \downarrow \rightarrow i \uparrow$

ASSETS	LIABILITIES
$R^F \downarrow$	$M \downarrow$
D	

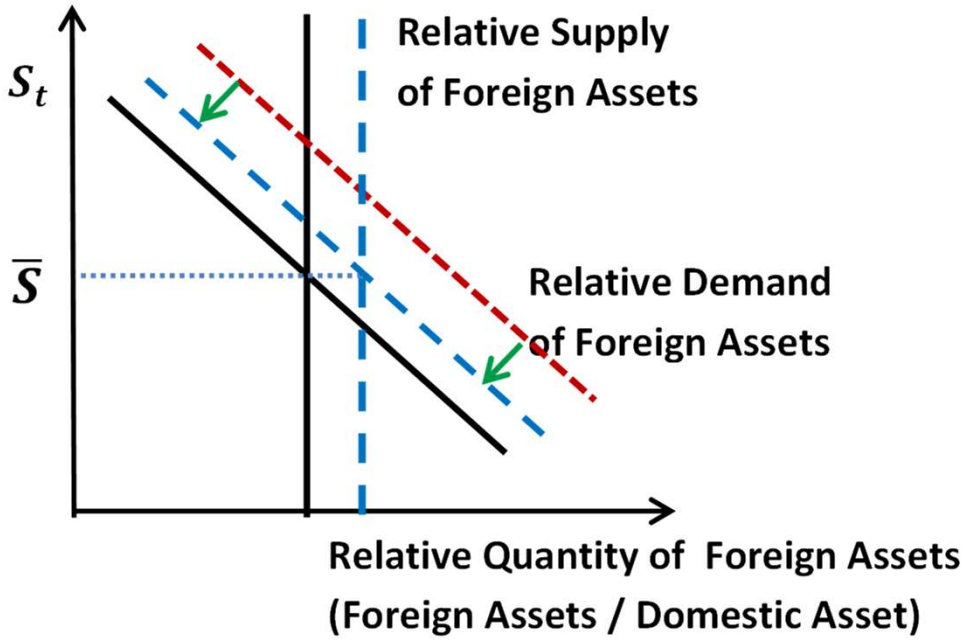
- The higher interest rate reduces the demand for foreign assets;
- The relative supply of foreign assets (on the market) also increases.
- Both help to keep the exchange rate fixed.

The traditional story in textbooks is that, under a fixed rate regime, the CB is commited to provide the foreign currency in exchange for the domestic currency at the fixed exchange rate – price $\bar{S}$. The CB draws down its foreign reserves to satisfy the demand for the foreign currency.

Forex market sale of reserve assets

Foreign reserve assets are sold in exchange for monetary base

- The relative demand of foreign assets shifts back as i rises
- The relative supply of foreign assets increases



Sterilization (and crisis)

- To avoid the cost of a high interest rate needed to defend the exchange rate **the CB can sterilize the effect of the reduction of foreign reserves on the monetary base by buying domestic bonds, D**:

- $\Delta D = -\Delta R^F$ so that $\Delta D + \Delta R^F = \Delta M = 0$ Note $\Delta R^F < 0$

ASSETS	LIABILITIES
$R^F \downarrow$	$M \leftrightarrow$
$D \uparrow$	

- $i \leftrightarrow$

- Sterilization may work temporarily (for temporary shocks) but if the demand for foreign assets persists, the CB keeps losing reserves.
- With perfect capital mobility sterilization is short lived.
- **As the CB runs out of reserves a currency crisis unfolds** and the CB is eventually forced to devalue.

Currency crises - Exchange rate crises

A currency crisis may break up because of:

1. **Fundamental imbalances**: i) monetization of government budget deficits and domestic credit creation; ii) a severe recession; iii) an overvalued exchange rate that leads to current account deficits; iv) too high inflation leading to a real appreciation; etc.
2. **Loss of confidence** in the CB ability or willingness to maintain the exchange rate fixed. Investors' expectations that the CB is about to devalue and/or move to a flexible exchange rate can be self-fulfilling as they lead to a higher interest rate.

- **First generation models emphasize fundamental imbalances**
- **Second generation models emphasize expectations / loss of confidence**

First models of currency crises or Balance-of-Payment Crises

In the classical model of Flood-Garber (1984)

- The Central Bank pegs the exchange rate at $S_t = \bar{S}$ but cannot control a growing domestic credit, D_t, because it is forced to finance the government deficit by buying government bonds. The growing domestic credit must be sterilized by selling foreign reserve assets, R_t^F, in order to keep a constant monetary base, M_t, and interest rate.

When Foreign reserves finish, the CB devalues (leave the peg for floating).

- In **Krugman (1979)** depletion of foreign reserves is caused by current account deficits financed with sales of reserve assets $\Delta R^F < 0$.

Flood and Garber (1984) model

Model - Flood-Garber (1984)

- $i_t = i^* + \frac{E_t S_{t+1} - S_t}{S_t}$ (1) UIP (free capital mobility – no premium)
- $P_t = S_t$ (2) Absolute PPP with $P^* = 1$
- $M_t^d = P_t(Y - \alpha i_t)$ (3) Demand for monetary base
- $M_t = R_t^F + D_t$ (4) Supply of monetary base

The Central Bank pegs the exchange rate at $S_t = \bar{S}$ but it cannot control a growing domestic credit:

- $D_{t+1} - D_t = \mu_{t+1}$ (5) with $E_t \mu_{t+1} = \mu$ $\mu_{t+1} \geq 0$

either because the CB has to finance the government deficit or, say, provide liquidity to the banking sector.

Modelling the speculative attack

Distinguish 3 periods

i. The period the exchange rate is held fixed - until time T-1
ii. The moment of the attack and devaluation - period T
iii. The period, after devaluation - the exchange rate floats from T+1 on

Then, find the time T the speculative attack takes place and its characteristcs: exchange rate dynamics, depletion of reserves. etc.

Main features of First Generation Model of Currency Crisis

a. Behavior of monetary authorities is passive;
b. Rational optimizing investors/speculators;
c. The crisis is inevitable because of bad fundamentals;
d. The crisis is predictable

Before the crisis the Exchange rate is fixed

The CB buys government bonds to finance the deficit and sterilizes this increase in domestic credit by selling reserves to keep the monetary base constant:

- $\Delta R^F = -\Delta D$ so that $\Delta D + \Delta R^F = \Delta M = 0$ (6)

ASSETS	LIABILITIES
R^F	$M \uparrow$
$D \uparrow$	

ASSETS	LIABILITIES
$R^F \downarrow$	$M \leftrightarrow$
$D \uparrow$	

- Initially, reserves are high enough so that the exchange rate is held fixed at $S_t = \bar{S}$, and expected to remain fixed next period: $E_t S_{t+1} = \bar{S}$
- From UIP $E_t S_{t+1} = S_t = \bar{S} \rightarrow i_t = i^*$
- From PPP $P_t = \bar{S}$

Equilibrium: Money supply = Money demand which is constant

- $R_t^F + D_t = \bar{S}(Y - \alpha i^*)$ ← constant (7)

The CB is losing foreign reserves

To keep $i_t = i^*$ the money supply must be constant.

Then, foreign reserves

- $R_t^F = \bar{S}(Y - \alpha i^*) - D_t$ (8)

decrease at the rate μ_t at which domestic credit increases:

- $R_t^F - R_{t-1}^F = -(D_t - D_{t-1}) = -\mu_t$ (9)

- **Over time, Reserves are depleted**

Note that CB behavior is passive: **The Currency Crisis is inevitable**

After the crisis the Exchange Rate Floats

- Once foreign reserves are depleted*, the fixed exchange regime collapses and **the CB moves to a floating exchange-rate regime**.
- The CB keeps monetizing the gov't deficit and, since reserves are exhausted, the monetary base increases at the same '*rate*' of CB credit to the government
  - $D_{T+1} - D_T = M_{T+1} - M_T = \mu_{T+1}$ (10)
- The exchange-rate also depreciates at a '*rate*' proportional to μ_{T+1}
  From money market equilibrium and the *UIP*
  - $\Delta D_{T+1} = \mu_{T+1} = \Delta S_{T+1}(Y - \alpha i^*) - \alpha\Delta[E_T \Delta S_{T+2}] = \Delta S_{T+1}(Y - \alpha i^*)$ (11)

  The increase (depreciation) of the exchange rate is proportional to the increase in domestic credit (money supply) (See slide 24 for the proof).

  *Note that we could assume a minimum negative level of reserves, $\bar{R} < 0$, instead of $\bar{R} = 0$).

A wrong speculative attack

What happens at time T when the fixed exchange regime collapses?

- Assume certainty (to gain intuition) and ***mistakenly*** suppose that foreign reserves declines gradually to zero so that the attack takes place when $R^F = 0$.

One moment before the attack, at T- , the equilibrium on the money market is

- $D_{T-} = \bar{S}(Y - \alpha i^*)$ (12)

At the time of the attack i goes up, money demand shrinks and the equilibrium is

- $D_T = S_T(Y - \alpha i^*) - \alpha(E_T S_{T+1} - S_T)$ (13)

By equating $D_{T-} = D_T$ we have

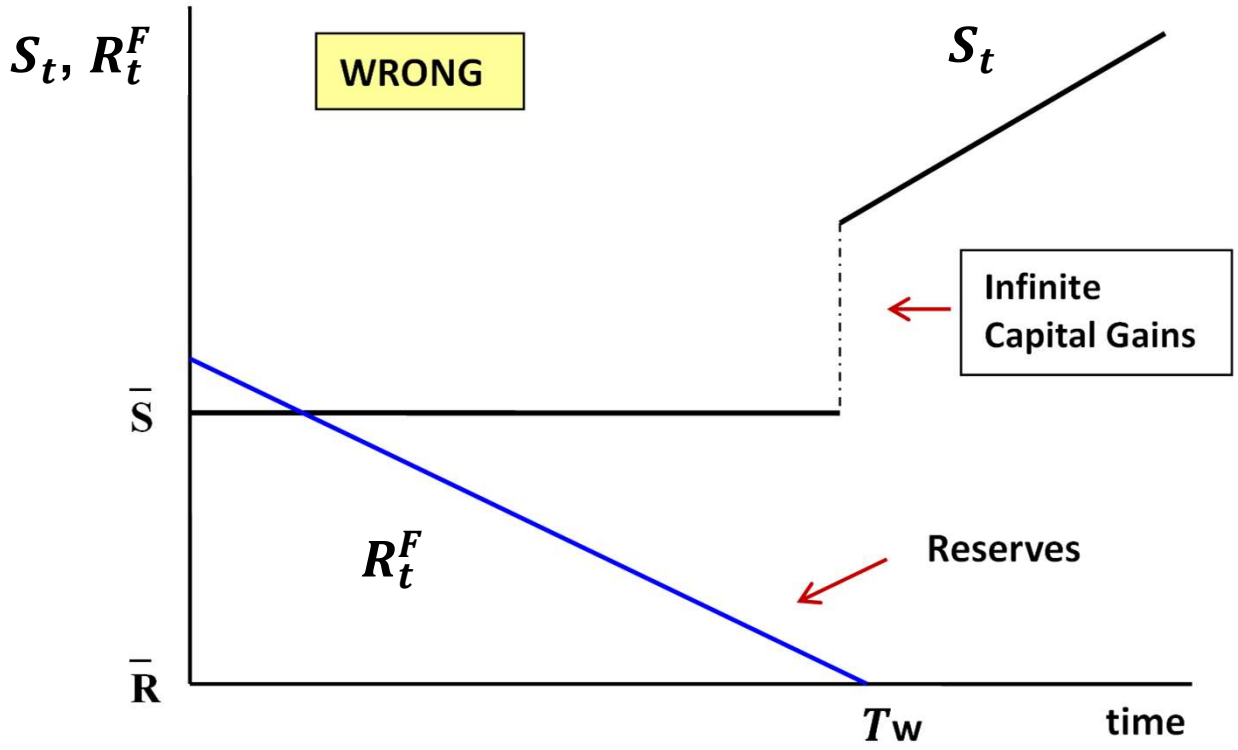
- $\bar{S}(Y - \alpha i^*) = S_T(Y - \alpha i^*) - \alpha(E_T S_{T+1} - S_T)$ (14)

that is satisfied only if $S_T \gg \bar{S}$. **As money demand falls, the Price level must rise**

- BUT rational investors would never let the exchange rate jump, as this would imply **huge capital gains**! They would launch the attack earlier.

The wrong run on reserves

If foreign reserves declined gradually to 0, the exchange rate would be expected to jump above the parity $\bar{S}$, and there would be an opportunity for a large capital gain. Hence, investors launch the attack earlier.



Smart investors launch the attack before Tw

The right speculative attack

The Shadow Floating Exchange Rate

- Define the shadow exchange rate as the exchange rate, $\hat{S}_t$, that would realize if the peg were abandoned for a floating exchange-rate regime.
- Then, with certainty, **the speculative attack takes place as soon as the shadow floating exchange rate is equal to the fixed rate, ie $\hat{S}_T = \bar{S}$.**
- When μ_T is uncertain, the attack arrives as soon as $\hat{S}_T > \bar{S}$.
  Intuitively, there is a realization of D_T large enough that $\hat{S}_T > \bar{S}$ and the peg is abandoned.

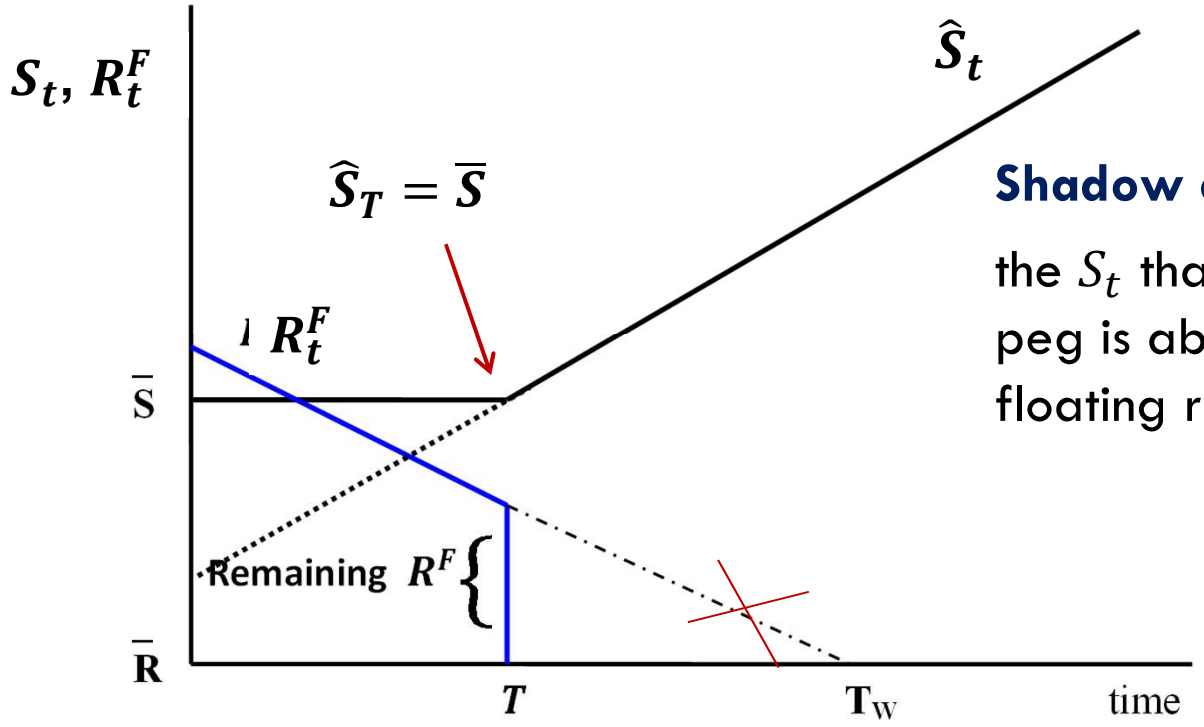
Note: that if $\hat{S}_T < \bar{S}$ investors have no reason to attack as foreign reserves would be acquired at price $\hat{S}_T$ and thus at the loss $\bar{S} - \hat{S}_T > 0$.

Right timing of the attack (certainty case)

The attack is launched when the shadow floating exchange rate is equal to the fixed rate, ie $S_T = \bar{S}$.

Remaining reserves are acquired all at once at time T

There is **a run on reserves**!



Shadow exchange rate

the S_t that prevails if the peg is abandoned for a floating regime

The shadow floating exchange rate

To find the shadow rate, $\hat{S}_t$, ie the equilibrium exchange rate under floating when all reserves are lost, consider the **money market equilibrium**:

- $D_t = \hat{S}_t(Y - \alpha i^*) - \alpha(E_t\hat{S}_{t+1} - \hat{S}_t)$ (15)
- $D_t = \beta\hat{S}_t - \alpha E_t\hat{S}_{t+1} + \alpha\hat{S}_t$ (16) where $\beta \equiv Y - \alpha i^*$
- $\hat{S}_t = \frac{1}{\alpha+\beta} D_t + \frac{\alpha}{\alpha+\beta} E_t\hat{S}_{t+1}$ (17) First-order difference equation

Guess the solution $\hat{S}_t = \lambda_0 + \lambda_1 D_t$ [that rules out Bubbles; see slide 28]

- $\lambda_0 + \lambda_1 D_t = \frac{1}{\alpha+\beta} D_t + \frac{\alpha}{\alpha+\beta} [\lambda_0 + \lambda_1(D_t + \mu)]$ (18)
- $\lambda_1 D_t = \frac{1}{\alpha+\beta} D_t + \frac{\alpha}{\alpha+\beta} \lambda_1 D_t \rightarrow \lambda_1 = {}^1\!/_\beta$ (19)
- $\lambda_0 = \frac{\alpha}{\alpha+\beta} \lambda_0 + \frac{\alpha}{\alpha+\beta}\frac{1}{\beta}\mu \rightarrow \lambda_0 = \frac{\alpha}{\beta^2}\mu$ (20)

Shadow Exchange Rate $\hat{S}_t = \frac{\alpha}{\beta^2}\mu + \frac{1}{\beta} D_t$ (21)

The time T of the attack

Note from (21) that depreciation depends on money growth

- $\Delta\hat{S}_{t+1} = \frac{1}{\beta}\Delta D_{t+1} = \frac{\mu_{t+1}}{\beta}$ (22) with $\beta \equiv Y - \alpha i^*$

Under certainty, **the attack is launched at time T when the shadow exchange rate is equal to the fixed parity**:

- $\bar{S} = \hat{S}_T = \frac{\alpha}{\beta^2}\mu + \frac{1}{\beta}D_T$ (23)
- **Noting that $D_T = D_0 + \mu T$** (24)
- $\bar{S} = \frac{\alpha}{\beta^2}\mu + \frac{1}{\beta}(D_0 + \mu T)$ (25)

At time 0 we have from demand = supply: $\bar{S}\beta = R_0 + D_0$ so that

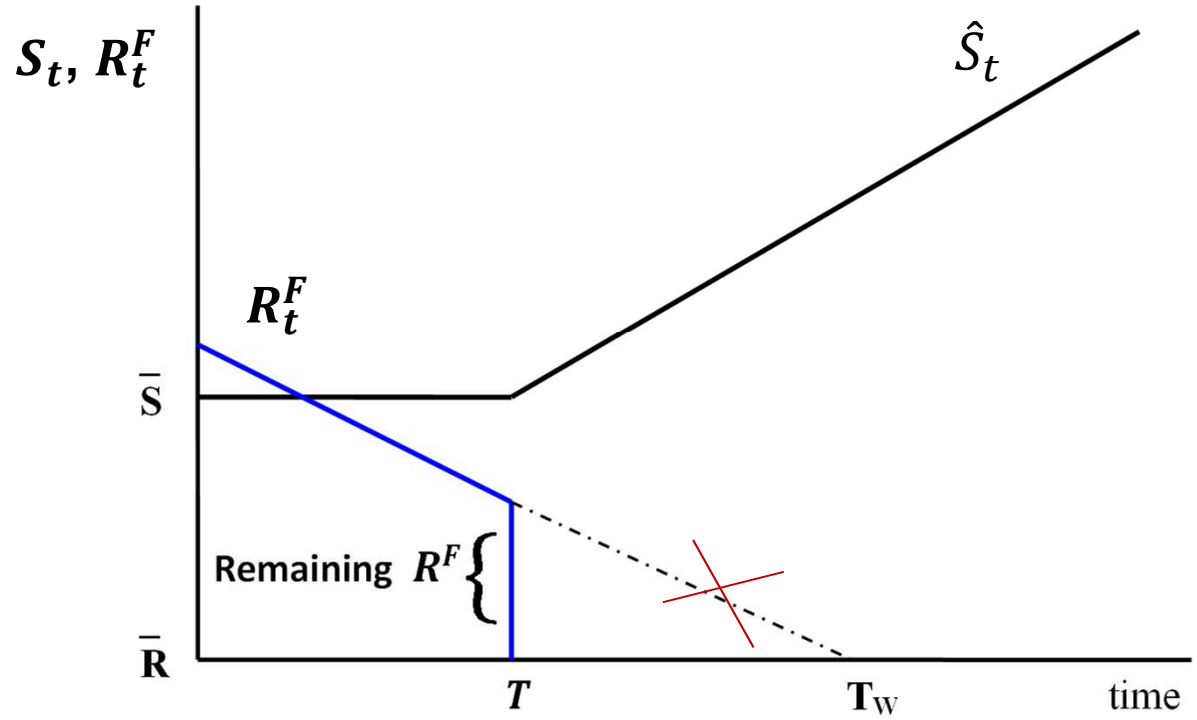
- $T = \frac{1}{\mu}R_0 - \frac{\alpha}{\beta} = \frac{1}{\mu}R_0 - \frac{\alpha}{Y - \alpha i^*}$ (26)

Survival time T increases with the initial amount of reserves and decreases with μ and the sensitivity of money demand to interest rate.

The right run on reserves (certainty case)

Remaining reserves, R_T^F, are acquired all at once at the time T of the crisis (Reserves do not decrease gradually to zero).

The speculative attack has the characteristics of a run on reserves



The run on reserves - Intuition

At time T the interest rate increases because of the expected depreciation

- $i_T \uparrow = i^* + \frac{E_T S_{T+1} - S_T}{S_T} \uparrow$

the demand for domestic money falls: it is exchanged for reserves.

- Just before the attack, at T-, the equilibrium on the money market is
  $R^F_{T-} + D_{T-} = \bar{S}(Y - \alpha i^*)$ (1)
- At the time of the attack, T, the demand for money falls and the eqm is
- $D_T = \bar{S}(Y - \alpha i^*) - \alpha(E_T S_{T+1} - \bar{S})$ (2)
- $D_T = D_{T-} + R^F_{T-} - \alpha(E_T S_{T+1} - \bar{S})$ (3) = (1) + (2)

Remaining reserves, $R^F_T = \alpha(E_T S_{T+1} - \bar{S})$ are taken away all at once

Domestic money is given back to the Central Bank in exchange for foreign reserve R^F_T. A **'run' on reserves** takes place.

- $R^F_T = \alpha(E_T S_{T+1} - \bar{S}) = \alpha\mu/\beta$ (3)

Conclusions

Merits of the Model:

- **The model is a good description of a currency crises.**
  It captures the main features of a speculative attack and the collapse of a fixed exchange-rate regime: the loss of a vast amount of reserves all at once; the transition to a flexible exchange rate, optimizing speculators, dynamics, timing of devaluation.
- **The model shows the role of fundamentals.**

BUT

- The CB is totally passive, it has no choice than devalue.
- There is no role for expectations, with a caveat: the possibility of Bubbles for the exchange rate that can precipitate an 'early' crisis.

The Bubble

- Note that if the previosly derived Shadow exchange rate (see slide 23)
  - $\hat{S}_t^* = \frac{\alpha}{\beta^2}\mu + \frac{1}{\beta}D_t$ (21) **is a particular solution** of
  - $\hat{S}_t = \frac{1}{\alpha+\beta}D_t + \frac{\alpha}{\alpha+\beta}E_t\hat{S}_{t+1}$ (17)
- Then
  - $\hat{S}_t^+ = \hat{S}_t^* + A_t$ where $A_t = A\left(1+\frac{\beta}{\alpha}\right)^{t-T}$
- **is also a solution**, ie another possible shadow exchange rate.
- A_t is a bubble growing at the rate β/α that affects the shadow rate

Arbitrary speculative behavior can precipitate the speculative attack earlier, at $T^+ = \frac{1}{\mu}R_0 - \frac{\alpha}{\beta} - \frac{\beta}{\mu}A$ with a greater amount of reserves taken away in the run $R_T^{F+} = \alpha\mu/\beta + \beta A$

There are multiple equilibria with bad ones driven by self-fulfilling expectations

Thank You!