Alessandro Missale

FINANCIAL INTEGRATION AND CRISES 2021

Lecture 10

Lecture 10

Currency Crises – Second Generation Models

- Second Generation Models of Currency Crises
  - The interaction between investors' expectations and CB decisions

- **Self-fulfilling Confidence Crises**
  - Krugman (1996) model – Obstfeld (1996) model
  - The relative importance of expectations and fundamentals

References: Krugman (NBER MA 1996); Obstfeld (1996)

Second Generation Models of Currency Crises

Main difference with first generation models:

- **Authorities decide;** they choose whether to devalue or maintain the exchange rate fixed

  → **Crises are not inevitable**

Authorities face a trade-off

- **Resist the crisis and pay the cost of, say, high interest rates**: lower investment; output contraction; weakened banking sector; credit market disruption; higher interest payments on government debt.
- **Give up and pay the cost of devaluation**: reputational and political costs; loss of credibility; impaired fixed exchange regime; higher inflation; failures of firms/banks with debt in foreign currencies, etc.

Expectations and strategic interaction

Investors' expectations affect the trade-off that the authority faces between "Resist the crisis" and "Give up and devalue".

- For example, expected depreciation implies that the interest rate must increase to defend the exchange rate:

- $i_t = i_t^* + \frac{E_t S_{t+1} - \bar{S}}{\bar{S}} + pr_t \rightarrow E_t S_{t+1} \uparrow \rightarrow i_t \uparrow$

- Higher interest rates imply greater costs of resisting the crisis and may turn the authority's decision in favor of devaluation.

Investors' expectations that the country is about to devalue and/or move to a flexible exchange rate **can be self-fulfilling**.

The interest rate hike - An example

The increase in the interest rate i_t needed to defend the exchange rate parity can be substantial

- For example, suppose investors assign a 25% probability of a 16% currency devaluation next month. Then, expected depreciation is 4%

- $$i_t = i_t^* + \frac{E_t S_{t+1} - \bar{S}}{\bar{S}} + pr_t$$

  +4 +4

- To counter a 4% expected depreciation in one month, the monthly interest rate must rise by 4 percentage points (as the UIP must hold over 1-month period).
- Hence, **the yearly rate must increase by 48%** (=4x12) to convince investors to hold domestic bonds.

Confidence Crises

The strategic interaction between investors' expectations and authority's decisions makes self-fulfilling crises and multiple equilibria possible.

In second generation models, currency crises may break up because of:

1. **Fundamental imbalances;**
2. **Loss of confidence** by financial investors in the authority's ability or, more precisely, willingness to maintain the exchange rate fixed.

→ Investors' expectations can be self-fulfilling
…even though fundamentals are 'not too bad'

Pessimistic expectations can be motivated by weak fundamentals:
i) Trade deficits and debt accumulation; ii) a severe recession that calls for lower interest rates and depreciation; iii) a fragile banking sector that needs liquidity and low interest rates; iv) a high government debt.

The narrative of a confidence crisis

Suppose investors expect a devaluation

- The authorities will try to convince markets of their willingness to maintain the exchange rate fixed and start increasing the interest rate.

Authorities may soon face a trade-off:

- Keep short-term interest rates high enough to satisfy the UIP at the cost of causing a recession; weakening the banking system; paying high interests on debt.
- Give up, devalue and bear the costs of devaluation.

- If the costs of defending the exchange rate exceed the costs of devaluation, **the Authorities decide to devalue the exchange rate**.

Bad expectations have a self-fulfilling nature since they alter the trade off faced by the authorities, making the defense of the currency a too costly option.

A simple model

Krugman (1996) Model

- In period t, the CB can either
  - maintain the exchange rate fixed: $S_t = \bar{S}$
  - or devalue and set $S_t = S^* > \bar{S}$

where S^* is the optimal equilibrium exchange rate.

The CB Loss function is

- $L = \alpha(S^* - S_t)^2 + \beta(E_t \Delta S_{t+1})^2 + R_{\Delta S}$ (1)
- $\alpha(S^* - S_t)^2$ captures the cost of misalignment;
- $E_t \Delta S_{t+1}$ is the expected rate of devaluation set by investors;
- $\beta(E_t \Delta S_{t+1})^2$ is the cost of expected devaluation, eg through higher i_t
- $R_{\Delta S}$ is the fixed cost of devaluation:

  If the CB devalues $R_{\Delta S} = C$, if it maintains the peg $R_{\Delta S} = 0$

Rational Expectations Equilibria

Note that investors may either expect that:

- the exchange rate is maintained, so that $E_t \Delta S_{t+1} = 0$, or
- the exchange rate is devalued and set equal to S^*, so that the expected devaluation is $E_t \Delta S_{t+1} = S^* - \bar{S}$

Look for **rational expectations equilibria** where:

- Given investors' expectations the CB finds it optimal to act as expected;
- Given CB's actions expectations are correct.

Two equilibria

- Given expectations that the peg is maintained, the CB finds it optimal to keep the exchange rate fixed: $S_t = \bar{S}$.
- Given devaluation expectations, the CB finds it optimal to devalue.
- In both cases Expectations are correct.

Fixed Exchange Rate Equilibrium

Suppose investors expect that the peg is maintained: $\boldsymbol{E_t \Delta S_{t+1} = 0}$

(The expected devaluation = 0)

If the CB maintains the peg, its Loss is:

- $L_{F|F} = \alpha(S^* - \bar{S})^2$ (2)

If the CB devalues:

- $L_{D|F} = C$ (3)

- Note that, after the devaluation, expectations are not revised; investors do not expect further devaluations (interest rates go down) since the exchange rate is set at its optimal value S^*.

Maintaining the exchange rate fixed is an equilibrium if:

- $L_{F|F} < L_{D|F} \rightarrow \alpha(S^* - \bar{S})^2 < C$ (4)

Note: this may not be the only equilibrium

Devaluation Equilibrium

Suppose investors expect a devaluation: $\boldsymbol{E_t \Delta S_{t+1} = S^* - \overline{S}}$

If the CB maintains the peg, its Loss is:

- $L_{F|D} = \alpha(S^* - \bar{S})^2 + \beta(S^* - \bar{S})^2$ (5)

If the CB devalues the expected devaluation goes to zero* because the exchange rate is set at its optimal value S^*; ie interest rates fall since investors do not expect any further devaluation.

- $L_{D|D} = C$

Devaluation is an equilibrium if:

- $L_{D|D} < L_{F|D} \rightarrow C < (\alpha + \beta)(S^* - \bar{S})^2$ (6)

*Note that expectations are revised in this case

Multiple equilibria – the relative role of Expectations and Fundamentals

Consider the two equilibrium conditions:

- Fixed exchange rate: $\alpha(S^* - \bar{S})^2 < C$ (4)
- Devaluation: $C < (\alpha + \beta)(S^* - \bar{S})^2$ (6)

- For good fundamentals, ie low misalignment $(S^* - \bar{S}) \to 0$, maintaining the peg is the only possible equilibrium.
- For bad fundamentals, ie large misalignment $(S^* - \bar{S}) \to \infty$ devaluation is the only possible equilibrium.

For intermediate values of fundamentals there are multiple equilibria:

- $\alpha(S^* - \bar{S})^2 < C < (\alpha + \beta)(S^* - \bar{S})^2$ (7)

- Whether the good equilibrium or the crisis equilibrium realizes depends on investors' expectations: **Expectations that the CB will devalue are self-fulfilling** since the expected devaluation raises interest rates, thus making a defense of the exchange rate a too costly option.

The role of fundamentals in Alesina et al.

Note that fundamentals had the same role in the **debt crisis model** by Alesina-Prati-Tabellini (1990). (See Lecture 8, Slides 9,10)

Given the cost of default $\bar{A}$

- For good fundamentals, ie low d_t, honoring the debt is the only equilibrium.
- For bad fundamentals, ie high d_t, default is the only equilibrium.
- **For intermediate values of fundamentals there are multiple equilibria**:
  - $\frac{1}{1-\beta} f([1-\beta]d_t) < \bar{A} < f(d_t)$ (8)

- A confidence/liquidity crisis may break up because **expectations that the government will default are self-fulfilling:** Since investors refuse to roll over the debt, debt service becomes too costly (it requires a tax hike to repay all maturing debt) and the government defaults.

Alternative mechanisms

In the previous model, there is an external imbalance due to an overvalued exchange rate. The expected devaluation can drive a self-fulfilling crisis through an increase in interest rates.

- Most mechanisms in the literature for self-fulfilling expectations hinge on the effects of interest rates on:
  - Economic activity
  - Public debt accumulation (if short-term or at floating rates);
  - Banking sector's vulnerability and interest-rate exposure;
  - Income distribution (eg with variable-rate mortgages).
- Other mechanisms exist, as in Obstfeld (EER 1996).
  - Expected depreciation may lead to higher expected inflation and an output contraction (a worsening of the output-inflation trade-off) like a bad aggregate supply shock.

A model with uncertainty

Obstfeld (1996) Model

- The CB has committed to a fixed exchange rate.

In period t, the CB can either maintain the exchange rate fixed or devalue in which case **the CB decides the rate of devaluation $\boldsymbol{\epsilon_t}$** depending on the realization of an **output shock, $\boldsymbol{u_t}$**. For very favorable shocks the CB can even revalue.

The CB Loss function

- $L \;= (y^* - y_t)^2 + \beta {\epsilon_t}^2 + R_\in$ (1)

y^* is the CB's output target; $y^* > \bar{y}$ = natural level of output.

$(y^* - y_t)^2$ captures the cost of lower than optimal (aimed) output;

$\beta {\epsilon_t}^2$ is the cost of inflation = realized rate of depreciation, $\boldsymbol{\epsilon_t}$ (PPP holds)

$R_\in$ is a fixed cost of abandoning the parity:

Devaluation costs $R_\in = \bar{C}$; Re-valuation costs $R_\in = c$

The CB's problem

Surprise devaluation increases output but expected deval has negative effects

- $y_t = \bar{y} + \alpha(\epsilon_t - E\epsilon_t) - u_t$ (2) **Phillips curve**
- where u_t is a bad output shock

The CB has a temptation to devalue/inflate so as to increase output above its natural level $\bar{y}$ because $\bar{y} < y^*$.

- Commitment to a fixed exchange rate helps to avoid the inflation bias.
- Expected devaluation=inflation leads to faster price-wage dynamics and to a AS contraction; a shift in the expectations-augmented Phillips curve. Then, **maintaining zero inflation is costly; it requires an output contraction.**
- By devaluing the currency the CB can avoid such output loss.

The CB chooses ϵ_t to minimize the Loss function

- $L = (y^* - y_t)^2 + \beta{\epsilon_t}^2 + R_{\in}$ (1)

  s.t. $y_t = \bar{y} + \alpha(\epsilon_t - E\epsilon_t) - u_t$ (2)

taking investors' expectations as given

The certainty case

Suppose there are no shocks to output, $u_t = 0$, so that

- $y_t = \bar{y} + \alpha(\epsilon_t - E\epsilon_t)$ (2b)

Fixed exchange rate equilibrium

- Investors expect the peg is maintained $E\epsilon_t = 0$

If the CB maintains the fixed parity, $\epsilon_t = 0$, then $y_t = \bar{y}$ and the

- Loss from maintaining the peg
- $L_{F|F} = (y^* - \bar{y})^2$ (3)

If the CB devalues, it chooses ϵ_t to minimize the Loss function

- $L = (y^* - y_t)^2 + \beta{\epsilon_t}^2 + R_\in$ (1)

  s.t. $y_t = \bar{y} + \alpha(\epsilon_t - 0)$ (2c)

The rate of devaluation, ϵ_t, satisfies the FOC

- $\epsilon_t = \frac{\alpha}{\alpha^2+\beta}[y^* - \bar{y}]$ (4)

Fixed exchange rate equilibrium

If the CB devalues, it chooses $\epsilon_t = \frac{\alpha}{\alpha^2+\beta}[y^* - \bar{y}]$ and

Output is equal to

- $y_t = \bar{y} + \frac{\alpha^2}{\alpha^2+\beta}[y^* - \bar{y}]$ (5)

- The loss from devaluation is

- $L_{D|F} = \frac{\beta}{\alpha^2+\beta}(y^* - \bar{y})^2 + \bar{C}$ (6)

Maintaining the exchange rate fixed is an equilibrium if $L_{F|F} < L_{D|F}$

- $(y^* - \bar{y})^2 < \frac{\beta}{\alpha^2+\beta}(y^* - \bar{y})^2 + \bar{C}$ (7a)
- $\frac{\alpha^2}{\alpha^2+\beta}(y^* - \bar{y})^2 < \bar{C}$ (7b)

Devaluation expectations

Devaluation equilibrium

- Investors expect the CB to devalue. They base their expectations of devaluation on CB's optimal choice.

If the CB devalues, it chooses ϵ_t to minimize the Loss function given investors' expectations

- $L = (y^* - y_t)^2 + \beta {\epsilon_t}^2 + R_\in$ (1)

  s.t. $y_t = \bar{y} + \alpha(\epsilon_t - \boldsymbol{E\epsilon_t})$ (2b)

FOC

- $\epsilon_t = \frac{\alpha}{\alpha^2+\beta}[y^* - \bar{y} + \alpha \boldsymbol{E\epsilon_t}]$ (8)

- ϵ_t increases with expected devaluation
- Investors take expectations based on the FOC (8)

- $E\epsilon_t = \frac{\alpha}{\alpha^2+\beta}[y^* - \bar{y} + \alpha E\epsilon_t] \rightarrow E\epsilon_t = \frac{\alpha}{\beta}(y^* - \bar{y})$ (9)

Devaluation equilibrium

If the CB devalues, $\epsilon_t = E\epsilon_t = \frac{\alpha}{\beta}(y^* - \bar{y})$ (9)

which implies that outuput is equal to $y_t = \bar{y}$ (10)

- Loss from devaluation
  - $L_{D|D} = \frac{\alpha^2+\beta}{\beta}(y^* - \bar{y})^2 + \bar{C}$ (11)

If the CB maintains the peg, output falls

- $y_t = \bar{y} - \boldsymbol{\alpha E\epsilon_t} \rightarrow y_t = \bar{y} - \frac{\alpha^2}{\beta}(y^* - \bar{y})$ (12)
- Loss from maintainig the peg
  - $L_{F|D} = \left(\frac{\alpha^2+\beta}{\beta}\right)^2 (y^* - \bar{y})^2$ (13)

Note the output contraction from expected devaluation if the peg is maintained

Devaluation is an equilibrium if $\boldsymbol{L_{D|D} < L_{F|D}}$

- $\frac{\alpha^2+\beta}{\beta}(y^* - \bar{y})^2 + \bar{C} < \left(\frac{\alpha^2+\beta}{\beta}\right)^2 (y^* - \bar{y})^2$ (14)

Condition for multiple equilibria

Multiple equilibria are possible if both conditions holds

- $\bar{C} < \frac{\alpha^2}{\beta}\left(\frac{\alpha^2+\beta}{\beta}\right)(y^* - \bar{y})^2$ (14b) for devaluation
- $\frac{\alpha^2}{\alpha^2+\beta}(y^* - \bar{y})^2 < \bar{C}$ (7b) for fixed exchange rate
- $\frac{\alpha^2}{\alpha^2+\beta}(y^* - \bar{y})^2 < \bar{C} < \frac{\alpha^2}{\alpha^2+\beta}\left(\frac{\alpha^2+\beta}{\beta}\right)^2(y^* - \bar{y})^2$ (15)*

- which is possible for an intermediate level of output distortions $y^* - \bar{y}$ relative to the cost of devaluation, $\bar{C}$, and high α relative to β.

Whether the economy ends up in the good or bad equilibrium depends on expectations.

*Note the condition for devaluation $\frac{\alpha^2+\beta}{\beta}(y^* - \bar{y}) > \sqrt{\bar{C}\frac{(\alpha^2+\beta)}{\alpha^2}}$

Appendix - Uncertainty case: Output shocks

Suppose output is uncertain

- Consider a bad output shock, u_t, that is unknown to investors (or price setters) when they form their expectations at time t-1; i.e. $Eu_t = 0$
- $y_t = \bar{y} + \alpha(\epsilon_t - E\epsilon_t) - \boldsymbol{u_t}$

The CB observes $\boldsymbol{u_t}$ and chooses $\boldsymbol{\epsilon_t}$ to minimize the Loss function

- $L = (y^* - y_t)^2 + \beta\epsilon_t{}^2 + R_\in$ (1)

  s.t. $y_t = \bar{y} + \alpha(\epsilon_t - E\epsilon_t) - u_t$ (2)

taking investors' expectations as given.

Note that the CB maintains the peg for low-intermediate realizations of u_t, while it devalues for high realizations of u_t, and this is reflected in $E\epsilon_t > 0$.

In the present case, **expected devaluation** is not just 0 or a given value but it is the average of different values that **depend on the distribution of $\boldsymbol{u_t}$**.

The CB's decision

If the CB devalues (revalues), the rate of devaluation, ϵ_t, satisfies the FOC

- $\epsilon_t = \frac{\alpha}{\alpha^2+\beta}[y^* - \bar{y} + u_t + \alpha E\epsilon_t]$ (3)

ϵ_t increases with expected devaluation and the output shock.

Output is equal to

- $y_t = \bar{y} + \frac{1}{\alpha^2+\beta}[\alpha^2(y^* - \bar{y}) - \alpha\beta E\epsilon_t - \beta u_t]$ (4)

The Loss is equal to

- $L_D = \frac{\beta}{\alpha^2+\beta}[y^* - \bar{y} + u_t + \alpha E\epsilon_t]^2 + \bar{C}$ (with c if revaluation)

If instead the peg is maintained, $\epsilon_t = 0$

- $L_F = [y^* - \bar{y} + u_t + \alpha E\epsilon_t]^2$

Note the higher cost of expected devaluation when the peg is maintained

Devaluation depends on shocks and expectations

The CB devalues if bad shocks to output are so large that $L_D < L_F$

- $L_D = \frac{\beta}{\alpha^2+\beta}\,[y^* - \bar{y} + u_t + \alpha E\epsilon_t]^2 + \bar{C}$ **<** $[y^* - \bar{y} + u_t + \alpha E\epsilon_t]^2 = L_F$
- $u_t > \bar{u} \equiv \frac{1}{\alpha}\sqrt{\bar{C}(\alpha^2+\beta)} - (y^* - \bar{y} + \alpha E\epsilon_t)$

The CB re-values if shocks are so favorable ($u_t \ll 0$) that $L_R < L_F$

- $L_R = \frac{\beta}{\alpha^2+\beta}\,[y^* - \bar{y} + u_t + \alpha E\epsilon_t]^2 + c$ **<** $[y^* - \bar{y} + u_t + \alpha E\epsilon_t]^2 = L_F$
- $u_t < u_L \equiv -\frac{1}{\alpha}\sqrt{c(\alpha^2+\beta)} - (y^* - \bar{y} + \alpha E\epsilon_t)$

Note that, in the present case, **expected devaluation** is not just 0 or a given value but it is the average of different values that **depend on the distribution of u_t**; ie on the probability that u_t falls in the different intervals.
In turn, the intervals are affected by expectations; as $E\epsilon_t$ rises, $\bar{u}$ falls.

Rational expected rate of devaluation

- The rational expectations, E^*, of the rate of devaluation can be computed, by assuming that u_t is uniformly distributed over $[-\mu\ ;\ \mu]$, as:
- $E^*\epsilon_t = E^*(\epsilon_t|u_t < u_L)\,Pr(u_t < u_L) + E^*(\epsilon_t|u_t > \bar{u})\,Pr(u_t > \bar{u})$

and using equation (3) of the optimal CB's choice of $\boldsymbol{\epsilon_t}$

- $E^*\epsilon_t = \frac{\alpha}{\alpha^2+\beta}\left[\left(1-\frac{\bar{u}-u_L}{2\mu}\right)(y^* - \bar{y} + \alpha E\epsilon_t) - \frac{\bar{u}^2-u_L^2}{4\mu}\right]$ (5)

In a rational expectations equilibrium, investors' $\boldsymbol{E\epsilon_t = E^*\epsilon_t}$

- To find the fixed points of eq. (5), we can plot the right-hand-side of (5) and look for intersections with the 45 degree line.
- Note that **both $\bar{u}$ and u_L decrease with $E\epsilon_t$** . As $E\epsilon_t$ increases, the range of shocks for which the CB devalues increases, while the range of shocks for which it revalues shrinks.

To plot the RHS of (5) we look at the derivative of (5) with respect to $E\epsilon_t$

Rational expected devaluation

Note that $\bar{u}$ and u_L are function of $E\epsilon_t$ (see slide 24). Then,….

the derivative of eq. (5) with respect to $E\epsilon_t$ is equal to (assuming low $\bar{C}, c$)

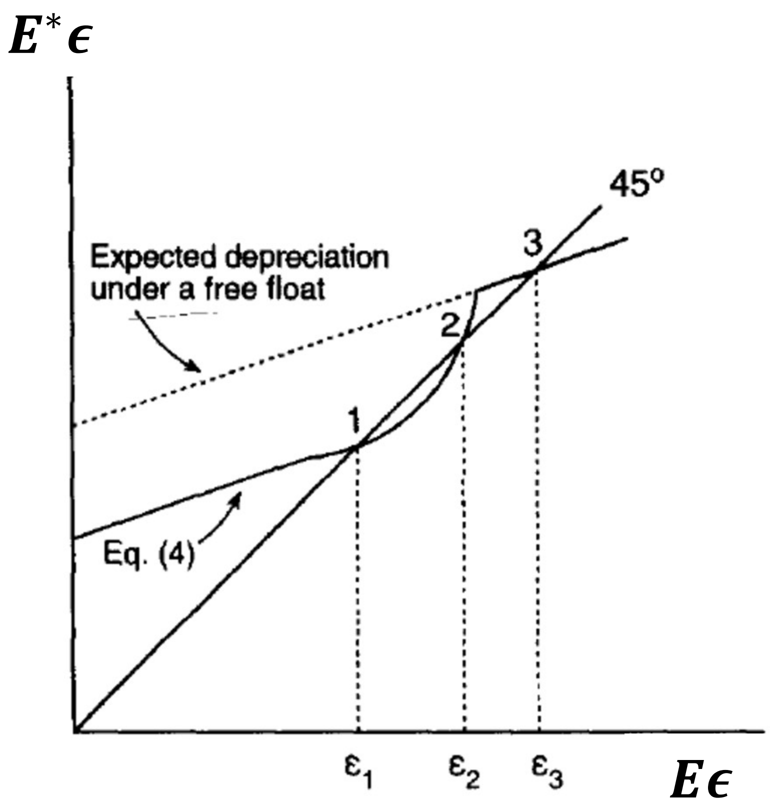
- $\frac{\alpha^2}{\alpha^2+\beta}$ for low $E\epsilon_t$ so that $-\mu < u_L$ ie revaluation is possible
- $\frac{\alpha^2}{\alpha^2+\beta}\left[\frac{1}{2} + \frac{1}{2\mu}(y^* - \bar{y} + \alpha E\epsilon_t)\right]$ for $u_L \leq -\mu < \bar{u}$ no revaluation
- $\frac{\alpha^2}{\alpha^2+\beta}$ for high $E\epsilon_t$ so that $\bar{u} \leq -\mu$ only devaluation*

*Note: Once $E\epsilon_t$ is high enough so that $\bar{u} = -\mu$ the CB devalues with probability 1 and expected depreciation is the same as with a flexible exchange rate: $E^*\epsilon_t = \frac{\alpha}{\beta}(y^* - \bar{y})$ See eq. (3)

Multiple equilibria

There may be three equilibrium expected devaluation rates

In Equilibrium 3, the CB is expected to devalue for any output shock and the CB finds it optimal to do so. Devaluation materializes despite $\bar{C}$.



The intercept increases with $y^* - \bar{y}$, ie with worsening of fundamentals.

The existence of equilibrium 3 is necessary (but not sufficient) **to have multiple equilibria.**

Note: if equilibrium 3 does not exist, it means that equation (4) has a lower intercept, eg at $E^* \leq 0$, and only equilibrium 1 exists.

Necessary condition for multiple equilibria

- **Equilibrium 3**, in which expected depreciation is the same as under floating, so that the CB devalues for any shock to output, **is necessary (though not sufficient) for multiple equilibria.**

This necessary condition for Multilple Equilibria is

- $\bar{u} \leq -\mu$ which is satisfied for (CB devalues with Prob =1)
- $\frac{\alpha^2+\beta}{\beta}\ (y^* - \bar{y}) - \mu \geq \sqrt{\bar{C}\frac{(\alpha^2+\beta)}{\alpha^2}}$ Same as in certainty case (See slide 21)

- A relatively high output distortion, $y^* - \bar{y}$, a low devaluation cost, $\bar{C}$, a low inflation aversion, β, and a strong impact, α, of expected devaluation make the existence of the "all-time devaluation" equilibrium more likey and thus the emergence of multiple equilibria.
- The expectation that the CB will devalue for any shock drives output so low that the CB is forced to devalue; **expectations are self-fulfilling**.