Global Financial Systems
Chapter 12
Currency Crisis Models

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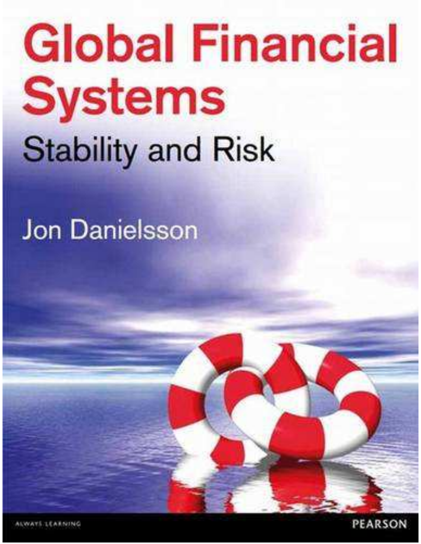
Book and slides



- The tables and graphs are the same as in the book
- See the book for references to original data sources
- Updated versions of the slides can be downloaded from the book web page

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1st Generation (1G) Currency Crisis Model

1G models

- Collapse of Bretton Woods in 1971 leads to an increase in the number of currency crises
- 1G models developed to explain crises of the late 70s and 80s. Continuing relevance
- The basic assumption is that a currency crisis stems from monetary or fiscal policy that is incompatible with a fixed exchange rate regime
- We study a simplified version of Flood and Garber (1984) who drew upon Krugman (1979)
- Specifically follow the implementation in Obstfeld and Rogoff (1996)

Money market equilibrium

There is a small open economy which employs a fixed exchange rate.

- m_t log domestic money supply
- p_t log price level in domestic country
- i_t domestic interest rate

The real demand for money is a negative function of the domestic interest rate.

$$m_t - p_t = -\alpha i_t \tag{1}$$

This gives the equilibrium condition in the money market

Central bank balance sheet

Assets	Liabilities
Net domestic currency bonds	Currency
Net foreign currency bonds	Required reserves
Net foreign currency reserves	Net worth
Gold	

Simplified:
$$m_t = d_t + r_t \tag{2}$$

Where

- d_t log domestic credit
- r_t log foreign exchange reserves

Money creation

- The government runs *persistent deficits*
- Which are financed by *money creation*

$$\dot{d} = \mu \tag{3}$$

- Domestic credit is changing at a rate of μ
- μ is assumed to be *constant and strictly positive*

PPP and UIP

These are the no arbitrage conditions

$$p_t = p_t^* + \log e_t \tag{4}$$

$$i_t = i_t^* + \mathrm{E}_{t-1}\,\Delta \log e_t = \log e_t - \log e_{t-1} \tag{5}$$

$\log e_t$ log spot exchange rate (domestic/foreign)

Currency peg

- The exchange rate is fixed and equal to $\log \bar{e}$
- Substituting (2), (4), (5) into (1) leads to:

$$r_t + d_t - p_t^* - \log \bar{e} = -\alpha(i_t^* + \mathrm{E}_{t-1} \Delta \log e_t) \qquad (6)$$

- By assumption, $\log \bar{e}$ is constant, p_t^* and i_t^* normalized to zero:

$$\dot{r} + \dot{d} = 0 \qquad (7)$$

- From (3), we can write:

$$d_t = d_0 + \mu t \qquad (8)$$

- We assume that the government will support the fixed rate as long as its net reserves remain positive

Shadow exchange rate

- The *shadow exchange rate* is the rate that would prevail if the currency were allowed to *float*, denoted $\log \tilde{e}$
- Note:

$$\log \dot{e} = \mu = \mathrm{E}_{t-1} \Delta \log e_t \tag{9}$$

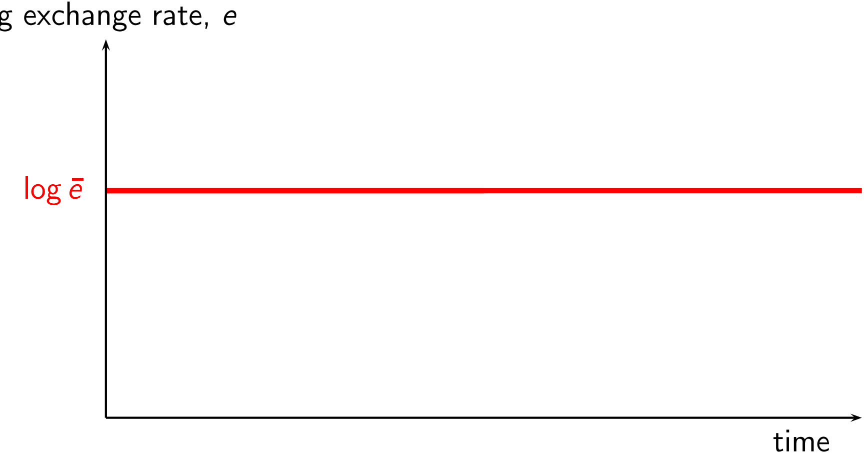
- And, given $r = 0$, (1) becomes:

$$d_t - \log \tilde{e}_t = -\alpha(\mathrm{E}_{t-1} \Delta \log e_t) \tag{10}$$

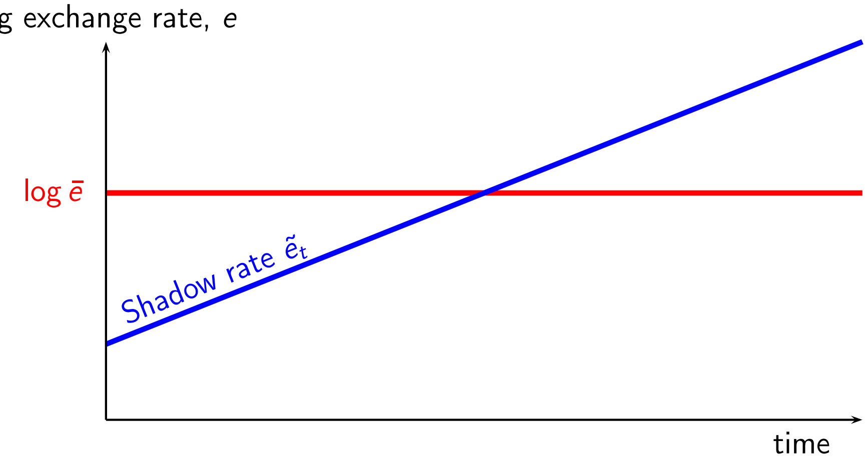
- Solving for the shadow exchange rate $\log \tilde{e}$:

$$\log \tilde{e}_t = \alpha\mu + d_t \tag{11}$$

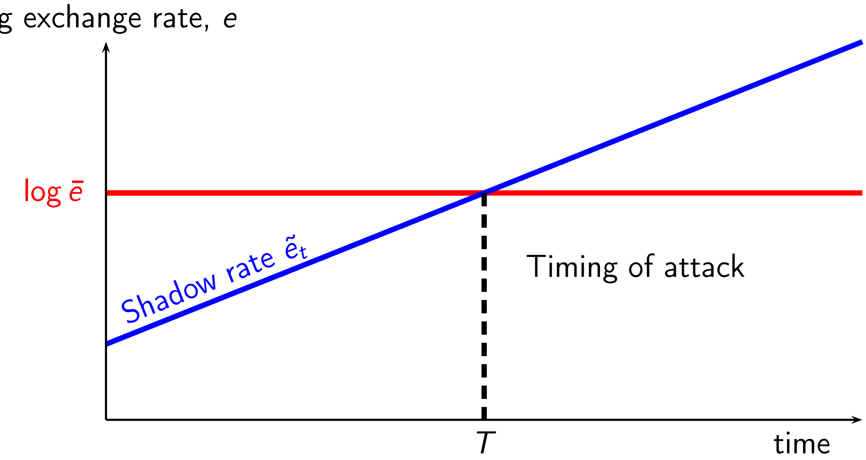
Exchange rate



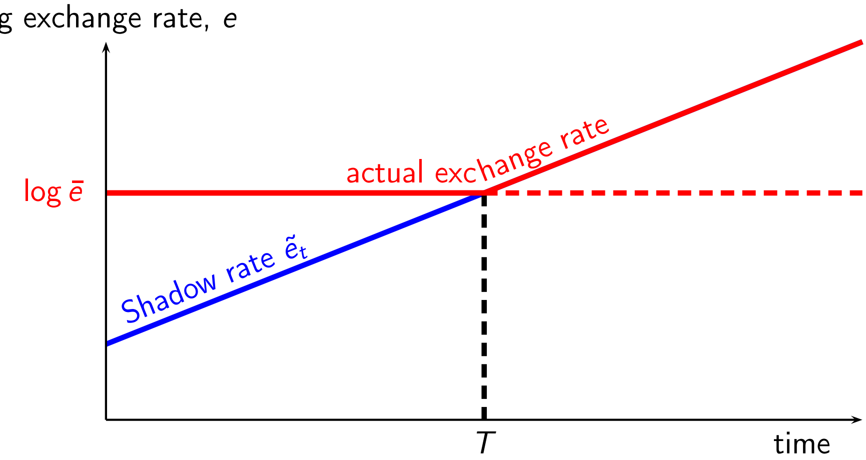
Exchange rate



Exchange rate



Exchange rate



Timing of attack

- A speculative attack happens *before* the CB exhausts its reserves
- Otherwise, there would be a perfectly anticipated rise in the exchange rate, implying an infinite rate of capital gain, and therefore an *arbitrage* opportunity
- Therefore, speculators will buy all the reserves *before*

- The attack takes place when

$$\log \tilde{e}_T = \log \bar{e}$$

- Speculators do not attack after, because at any such point there would be a discrete jump in the exchange rates implying *infinite profits*
- Speculators do not attack before because if they did, the currency would *appreciate* to the shadow rate resulting in a negative return.

Solving for time of attack

- Recall (8):

$$d_t = d_0 + \mu t$$

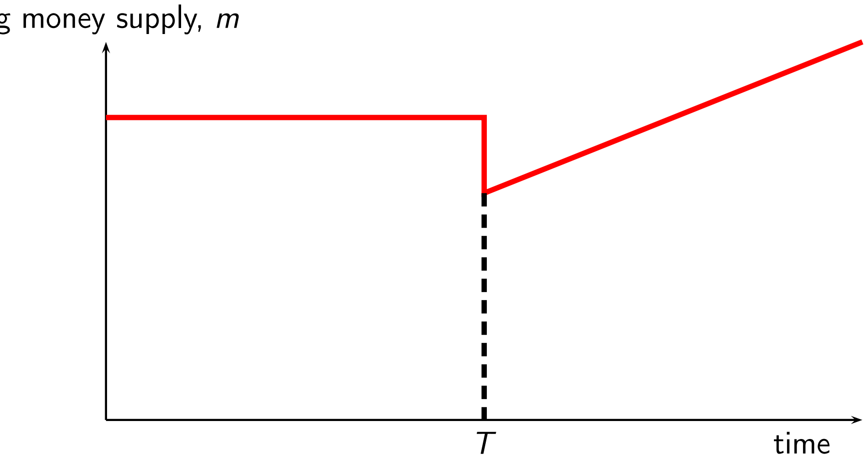
- Substitute for d_t in (11), and noting that at T, $\log \tilde{e} = \log \bar{e}$:

$$\log \bar{e} = \alpha\mu + d_0 + \mu T \tag{12}$$

- Solving for T:

$$T = \frac{\log \bar{e} - d_0 - \alpha\mu}{\mu} \tag{13}$$

Money supply



Summary

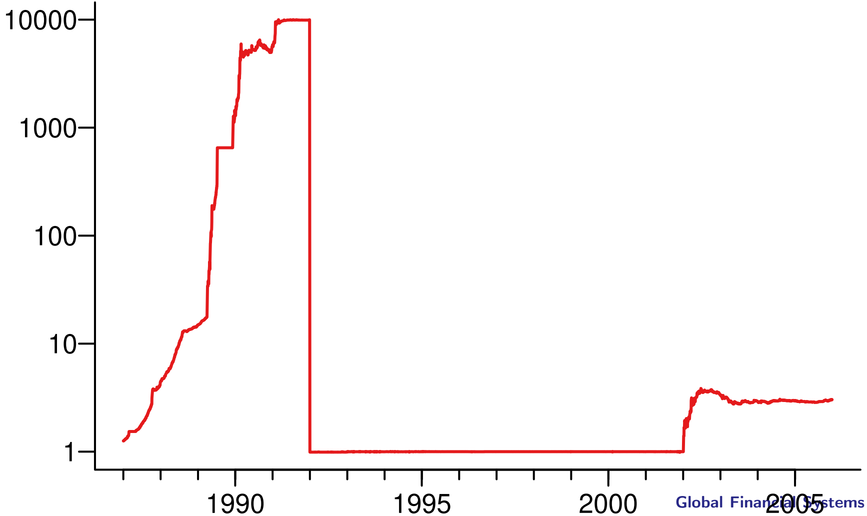
- Currency crises originate from domestic policies that are incompatible with a fixed exchange rate regime
- Not caused by speculators' irrationality
- Timing of speculative attack is predictable
- There will be inflation after the peg is abandoned
- Model is reliant on strong assumptions, e.g. UIP, PPP and perfect foresight

Argentina

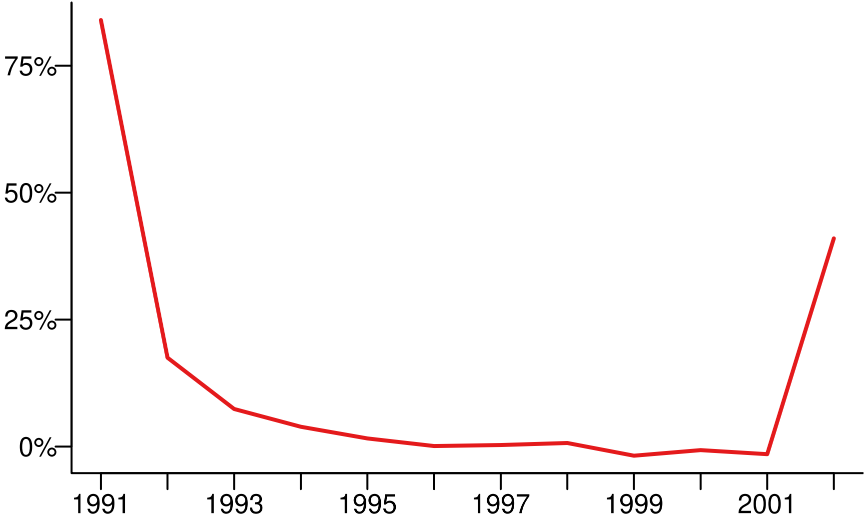
Argentina — Background

- Argentina was one of the riches countries until the middle of the last century, now on par with or below poorest countries in EU
- Experienced currency crises, hyperinflation, sovereign default in the second half of last century
- *High inflation rate* persisted until the early 90s
- In 1991 the government adopted a *currency board* at *parity* to the dollar
- Prices *stabilize* quickly and inflation is brought down rapidly

The peso depreciation



Inflation



The 90s

- With low inflation, Argentina saw *strong growth* in the 90s
- Persistent *budget deficits* and *fiscal problems* continued but were masked by the strong growth performance
- In the late 90s, Asia, Russia and Brazil were all hit by a crisis and reacted with a *devaluation* of their currencies
- At the same time the dollar *appreciated* strongly
- Making the Argentinean peso look *overvalued*

The crisis

- Debt as a ratio of GDP increased even in boom times
- *Growth* unsustainable
- Argentina plunges into recession in 1999 driven by *loss of export competitiveness* due to the overvalued peso
- The government facing an election responds by *increasing fiscal spending* (*AKA fiscal stimulus*)
- *Fiscal federalism* — regions borrow, center does now know or can't control
- Recent echoes in e.g. Spain and China

- As growth stalls, the government resorts to *expansionary fiscal policy* causing the debt ratio to surge
- Investors get nervous and start *pulling out capital*
- As capital outflows increase, the government finds it difficult to service its debt
- *Devaluation* not an option due to the currency board
- Large part of the debt is denominated in *dollars*
- Government continues with expansionary fiscal policy, heading for disaster (*Does this ring a bell?*)

- In late 2000 Argentina is unable to pay back its maturing debt and needs to ask the IMF for a *loan*
- IMF lends *$17 billion* but the situation does not improve
- The government is unwilling to reign in fiscal spending
- The IMF *withholds* a further loan in 2001 causing the government to *default* on $65 billion of its debt
- The currency board is *abandoned* a few weeks later
- The peso depreciates from parity to the dollar to a rate of *3.4:1*

Reasons

- Vulnerable to external shocks because fiscal policy *incompatible* with a fixed exchange rate regime
- The dollar peg *eliminated* monetary policy as an option and put strong *restrictions* on fiscal policy to keep debt sufficiently low to avoid an overvaluation of the peso
- Prudent fiscal policy was also important to maintain the *credibility* of the currency board (stimulus)
- The government never got its finances under control and when faced with a crisis, responded with an expansionary fiscal policy
- The fiscal policy of expansion was the result of political institutions pushing to commit more fiscal resources than they had

Classical 1G story

- Everybody knew it was unsustainable
- Government used up all reserves
- Markets anticipated drop
- Capital controls
- ADR market classic example of how agents bypass restrictions

Can the 1G model be applied to the current crisis?

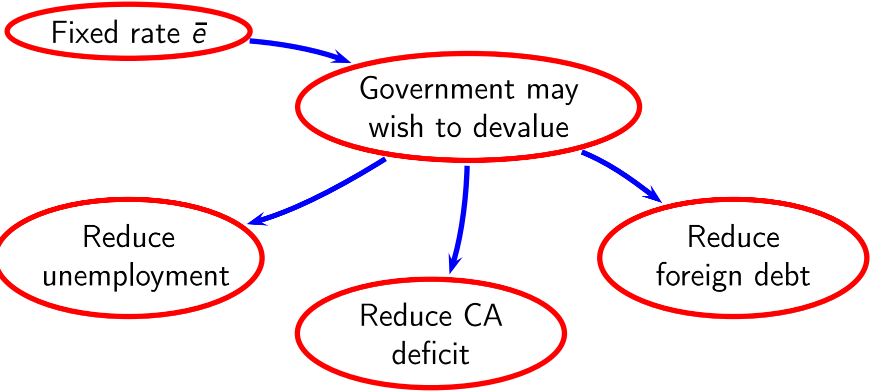
- Original model was about gold, and basic intuition applies to many situations
- While the 1G currency model does not apply to most currency crisis
    - it has parallels with what is going on in Europe
    - for example Greece
- How can the model be applied here?

Copeland 2G Model

Multiple equilibria

- An attack can be *self–fulfilling* and independent of monetary policies
- What determines whether a currency will be attacked is *market sentiment*
- The success of attacks then becomes a *self–fulfilling* event
- We now look at a model by Copeland (2000)

Desired exchange rate



These policies are summed up in $\hat{e}$, the desired exchange rate, which the government would choose were it not committed to the peg

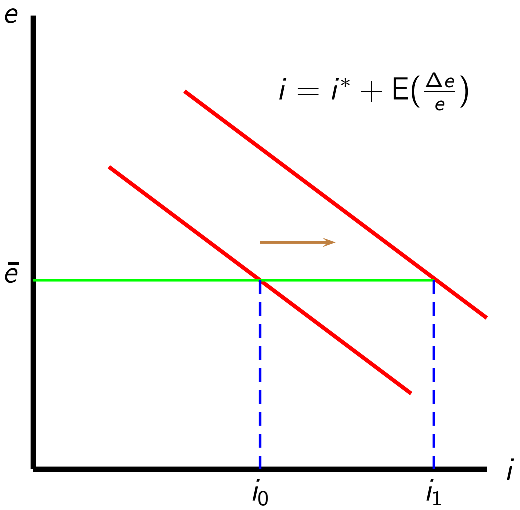
Cost of devaluation — high cost if peg is abandoned

- Political pain
- Loss of *credibility* of monetary authority
- International investors may demand *higher yields* in future
- This cost is summed up in the indicator function $\text{Cost}(\Delta e)$
- The function $\text{Cost}(\Delta e)$ takes *two values*

$$\text{Cost}(\Delta e) = \begin{cases} 0 & \text{for } \Delta e = 0 \\ Q & \text{for } \Delta e > 0 \end{cases}$$

- A high level of Q makes it more costly and therefore less likely for the government to devalue

Cost of defense (UIP)



- Peg more costly to defend when a devaluation is expected
- Expectation leads to a rise in domestic interest rate
- Adverse impact on economy

Government loss function

- The government aims to *minimize* the following loss function

$$\mathcal{L} = \{\psi(\hat{e} - \bar{e}) + \eta \text{E}(\Delta e)\}^2 + \text{Cost}(\Delta e) \quad \psi, \eta > 0$$

- $\psi(\hat{e} - \bar{e})$ is the loss associated with *overvaluation*
- Focus on $\hat{e} > \bar{e}$, government is only concerned with an overvaluation
- $\eta \text{E}(\Delta e)$ is the loss associated with *defending* the peg with increasing interest rates

Two cases with two choices

Government is *expected to defend*

- $\mathrm{E}(\Delta e) = 0$ the cost of defending is:

$$\mathcal{L}_1 = \{\psi(\hat{e} - \bar{e})\}^2$$

- In a rational expectations equilibrium, the government defends if:

$$\mathcal{L}_1 < Q$$

Two cases with two choices

Government is *expected to abandon peg*

- Government expected allow depreciation to $\hat{e}$, the cost of defending becomes:

$$\mathcal{L}_2 = \{(\psi + \eta)(\hat{e} - \bar{e})\}^2$$

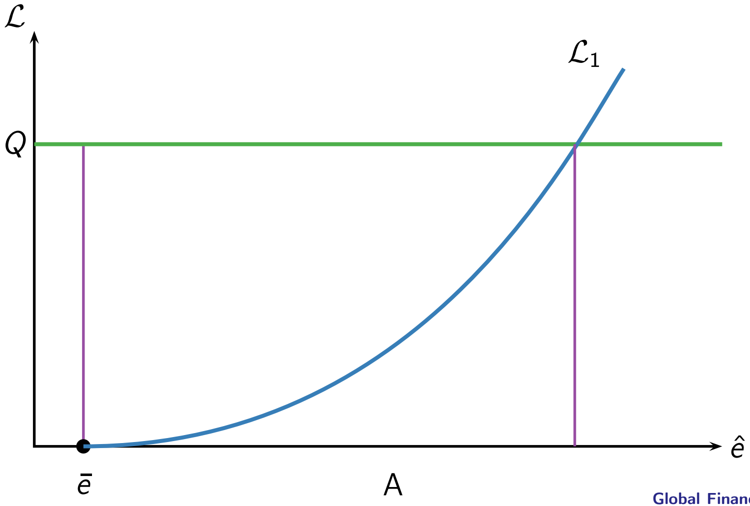
- Now the government chooses to devalue if:

$$\mathcal{L}_2 > Q$$

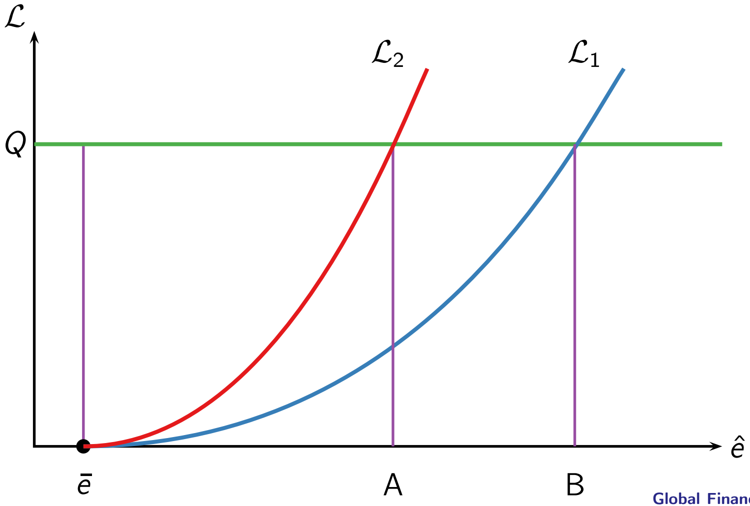
Multiple equilibria

Multiple equilibria

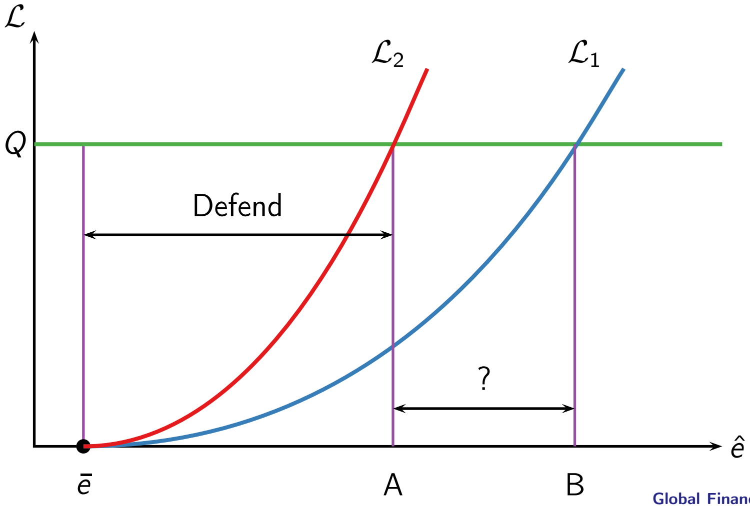
Multiple equilibria



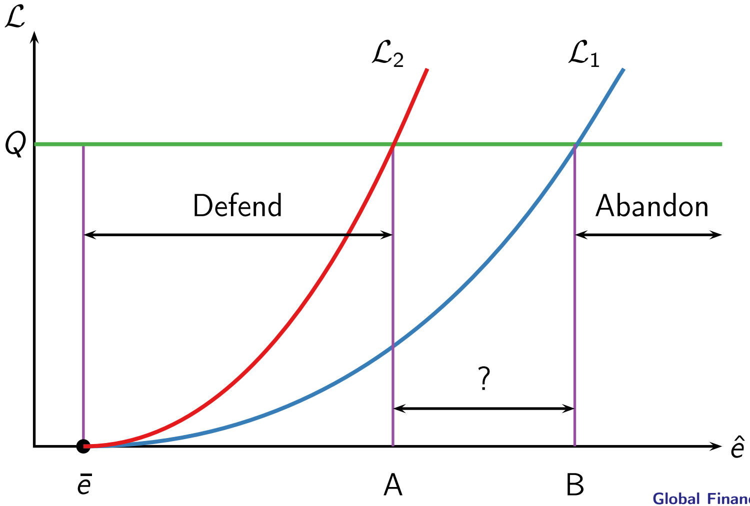
Multiple equilibria



Multiple equilibria



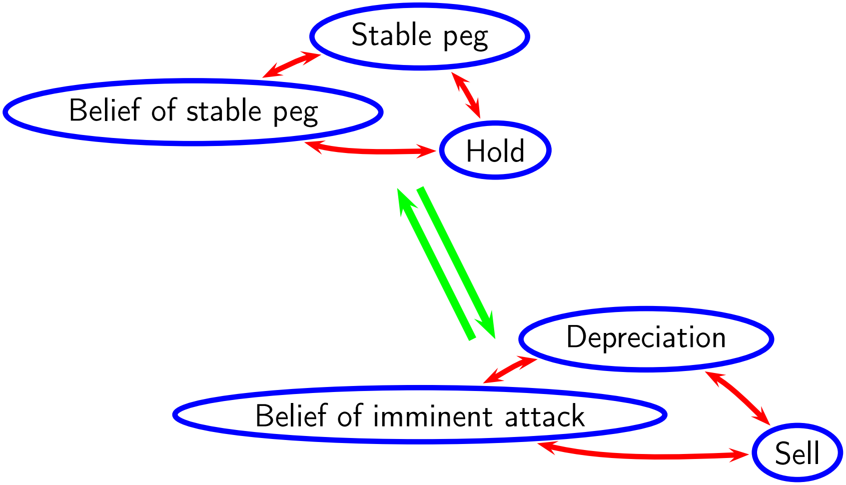
Multiple equilibria



Intermediate fundamentals

- If $\hat{e}$ lies between A and B, that is if $\mathcal{L}_1 < Q < \mathcal{L}_2$, there are *multiple equilibria*, the government finds it:
  - optimal to defend if the market expects the peg to be defended
  - optimal to abandon if the market expects the peg to be abandoned
- A speculative attack in these regions would be *self–fulfilling*
- Attack can succeed without any reference to the fundamentals

Self–fulfilling attack



Fundamentals

- However, fundamentals are not completely irrelevant
- They determine the *gap* between $\hat{e}$ and $\bar{e}$, which determines how easy the government finds it to defend
- The difference between $\hat{e}$ and $\bar{e}$ determines also the *slope* of the loss function
- Fundamentals also affect the abandonment cost Q
- The higher Q, the *costlier* it is for the government to devalue and the less likely that it will do so

The relevance of 2G models

- Existence of multiple equilibria has been questioned
- Consequence of common knowledge of fundamentals
- And common knowledge of actions in equilibrium
- Moreover, no convincing theory of shifts between equilibria
- Empirically, attacks occur mostly when fundamentals have already deteriorated

ERM Crisis 1992–1993

ERM System

- Part of the European Monetary System, precursor of the euro
- Essentially a target zone exchange rate regime
- The European Currency Unit (*ECU*), an artificial unit of account, was created
- Exchange rates for each currency against the ECU were established
- The system allowed a *fluctuation band* of $\pm 2.25\%$ around this central rate
- Member countries had to *intervene* to ensure their currencies stayed within *the band*

Dominant role of Germany

- Effectively, the bands were maintained against the *most stable currency*, the Deutschmark (*DM*), which became the unofficial *reserve currency*
- The Bundesbank was *supposed* to lend DM to countries whose currencies came under depreciatory pressure
- Therefore, Germany was the only country with *discretion* over its own monetary policy

Reunification of Germany

- Amalgamation of a large rich economy with a smaller poorer economy
- Germany embarked on a massive *fiscal expansion* to transfer resources to the east
- East German marks were converted to DM at a rate of *1.8:1*
- The government deficit rose from 5% to 13.2%
- Bundesbank concerned about high inflation pursued a *contractionary* monetary policy, by raising interest rates

Adverse impacts

- High interest rates and *appreciation* of DM hurt other countries
- *UK* was in a recession, with unemployment levels over 10%
- Same was true of *Italy, Spain, Sweden*
- Those countries *couldn't* use expansionary monetary policy or a weaker currency to stimulate their economy
- Speculators figured the system was not *sustainable*

Speculative attacks

- September 16, 1992 is nicknamed "Black Wednesday"
- In the morning, *BoE* raised rates from 10% to 12%, a few hours later, to 15% but could not stop the massive selling of pounds
- Eventual loss for the UK of £3.3 billion
- Sterling left the ERM that evening, followed by the Italian lira
- Eventually, on August 3, 1993, the size of the bands were widened from $\pm$2.25% to $\pm$15%
- Basically a free float

2G explanation

- Market sentiment gradually turned and was casting doubt whether governments would stay firmly committed to the ERM
- Governments were *weighting* the costs involved in staying in the ERM (loss of monetary independence) against the benefits (monetary union)
- Investors started to believe that the costs for some governments in the ERM had become too high and they were no longer committed to the peg
- Countries with the *weakest fundamentals* were the first to be attacked and the first to abandon the ERM

Parallels with today

1. Devalue
   - The countries that devalued/left were in a recession
   - Devaluation helped them to recover
   - Is that needed today?
2. Be stable
   - Currency crises and devaluations and inflation costly
   - Stability valuable
   - Hence common currency

Global Games

Global games models

- Speculators have an uncertain signal about the fundamentals
- This delivers unique equilibria

Setup

net benefit to government of holding peg

$$B(\overset{+}{\theta}, \overset{-}{\ell})$$

- θ is underlying strength of economy
- ℓ is proportion of speculators who attack
- For concreteness,

$$B(\theta, \ell) = \theta - \ell$$

- So, peg abandoned if and only if

$$\theta < \ell$$

Survival of regime

- When $\theta < 0$, peg *fails irrespective* of speculators' actions
- When $\theta \geq 1$, peg *survives irrespective* ofspeculators' actions
- When $0 < \theta \leq 1$, the peg is "*ripe for attack*"
- Peg is abandoned if and only if

$$\theta < \ell$$

- i.e. a *sufficiently large* speculative attack is launched

Speculators' choices

- Speculators, indexed by $[0, 1]$
- Two actions: *attack, refrain*
- Payoff to refrain is zero
- Cost of attack is t, but profit from collapse of peg is 1
- So, payoff to attack depends on
  - state θ
  - proportion ℓ of creditors who attack

$$v(\theta, \ell) = \begin{cases} 1 - t & \text{if} \quad \ell > \theta \\ -t & \text{if} \quad \ell \leq \theta \end{cases}$$

- Coordination problem when $\theta \in (0, 1)$

Fundamental signal

- θ uniformly distributed
- Noisy signal

$$x_i = \theta + s_i$$

  s_i uniformly distributed over $[-\varepsilon, \varepsilon]$
- Posterior distribution over θ conditional on x_i is uniform over

$$[x_i - \varepsilon, x_i + \varepsilon]$$

- Strategies

$$x_i \longmapsto \{\text{Attack}, \quad \text{Refrain}\}$$

Solution

- Solving for unique equilibrium in switching strategies around x^*
  - Failure point θ^* depends on switching point x^*
  - Switching point x^* depends on failure point θ^*

- Failure point θ^* solves $\theta = \ell$.
- If all follow x^*-switching, ℓ is the proportion whose signal is below x^* when the true state is θ^*

$$\ell = \frac{x^* - (\theta^* - \varepsilon)}{2\varepsilon}$$

- So, $\theta^* = \ell$ if and only if

$$\theta^* = \frac{x^* - (\theta^* - \varepsilon)}{2\varepsilon} \qquad \text{(Eq 1)}$$

- At switching point x^*, a speculator is indifferent between attack and refrain

$$
\begin{aligned}
& \Pr(\text{peg fails}|x^*)(1-t) + \Pr(\text{peg stays}|x^*)(-t) \\
= \; & \Pr(\text{peg fails}|x^*) - t \\
= \; & 0
\end{aligned}
$$

- Peg fails iff $\theta < \theta^*$. So

$$\Pr\left(\theta < \theta^* | x^*\right) = t$$

$$\frac{\theta^* - (x^* - \varepsilon)}{2\varepsilon} = t \qquad \text{(Eq 2)}$$

- Two equations in two unknowns - θ^*, x^*. Solving,

$$\begin{aligned} \theta^* &= 1 - t \\ x^* &= 1 - t - \varepsilon\left(2t - 1\right) \end{aligned}$$

- As $\varepsilon \to 0$, $x^* \to \theta^*$

Verification of solution

- When $x_i < x^*$, speculator wants to attack.
- When $x_i > x^*$, speculator wants to refrain.
- Say $x_i < x^*$.

$$\begin{aligned} \Pr(\text{peg fails}|x_i) &= \frac{\theta^* - (x_i - \varepsilon)}{2\varepsilon} \\ &> \frac{\theta^* - (x^* - \varepsilon)}{2\varepsilon} \\ &= \Pr(\text{peg fails}|x^*) \end{aligned}$$

- And conversely for when $x_i > x^*$
- Switching strategy around x^* is equilibrium.
- In fact, it's the unique equilibrium.

Dimensions of debate

- Multiple equilibria
- Externalities, inefficiencies
- Sudden, precipitous changes
- Outcome correlated with fundamentals

Strategic/fundamental uncertainty

- Distinction between *fundamental uncertainty* and *strategic uncertainty*
- In equilibrium of currency attack model,

$$\theta^* = 1 - t$$
$$x^* = 1 - t - \varepsilon(2t - 1)$$

- As $\varepsilon \to 0$, $x^* \to \theta^*$.
- Fundamental uncertainty disappears as $\varepsilon \to 0$. However, there is still uniqueness of equilibrium (difference between $\varepsilon = 0$ and limit as $\varepsilon \to 0$)
- Why?

What happens to strategic uncertainty as $\varepsilon \to 0$?

- Consider the following question
- **Question.** My signal is exactly x^*. What is the probability that proportion ℓ or less of the speculators are attacking the currency?
- The answer to this question is important, since the fact that I am indifferent between attacking and not attacking is due to uncertainty about the incidence of attack
- My reasoning must take account of:
  - My uncertainty over true state θ
  - My uncertainty over incidence of attack

Two steps to answer the question

- Step 1. If the true state θ is higher than some benchmark level $\hat{\theta}$, then the proportion of speculators receiving signal lower than x^* is ℓ or less. This benchmark state $\hat{\theta}$ satisfies:

$$\frac{x^* - \left(\hat{\theta} - \varepsilon\right)}{2\varepsilon} = \ell$$

Or

$$\hat{\theta} = x^* + \varepsilon - 2\varepsilon\ell$$

- Step 2. So, the answer to the question is given by the probability that the true state is higher than $\hat{\theta}$, conditional on signal x^*. This is,

$$
\begin{aligned}
& \frac{(x^* + \varepsilon) - \hat{\theta}}{2\varepsilon} \\
= & \frac{(x^* + \varepsilon) - (x^* + \varepsilon - 2\varepsilon\ell)}{2\varepsilon} \\
= & \ \ell
\end{aligned}
$$

Incidence of attack

the proportion of speculators who attack

- The cumulative distribution function over the incidence of attack is the identity function
- $\Rightarrow$ density function over the incidence of attack is *uniform* over $[0, 1]$
- How is this answer affected by the size of the noise ε?
- Not at all!!
- $\Rightarrow$ As $\varepsilon \to 0$, the uncertainty concerning θ dissipates, but the strategic uncertainty is as severe as ever

Transparency and disclosure

- What are the effects of more precise public information concerning θ?
- Debate on transparency and disclosures hinges on this
- No universal answers
- When fundamentals are weak, greater public disclosure of θ increases probability of attack
  - strategic uncertainty dissipates - makes coordinated attack easier
  - fundamental uncertainty also dissipates - increases incentive for attack

Examples

"Constructive ambiguity"

- Thailand 1997
- Rescue of LTCM, 1998
- Lehman's 2008
- Liquidity support in 2008
- LTRO
- Greece 2012

Disclosure strategies

- When fundamentals are strong, greater public disclosure of θ decreases probability of attack
  - strategic uncertainty dissipates - coordinated pull back from attack
  - fundamental uncertainty also dissipates - increases incentive to refrain from attack

Note: difference between ex ante decisions on disclosures and opportunistic disclosures