Currency crises

“If necessary, we shall defend the currency by the force of arms”

(attributed to Chilean president Carlos Ibáñez)
• Currency crises are episodes of large nominal depreciation
  • ‘large’ defined by some given percentage (e.g., 25%), or relative to some benchmark (e.g., > 2 sd).

• Exchange rate collapses are often intertwined with other types of crises.
  • They may come along with current account reversals (or sudden stops)
  • They may lead to inflation surges
  • They may generate large balance sheet effects and thus a banking crisis (‘twin crises’, as in Kaminsky and Reinhart)
  • …and the cleanup of the banking crisis then may lead to a sovereign debt crisis too.
Great exchange rate collapses:

• 1970s: collapse of Bretton Woods system
• 1980s: Mexico, Argentina, Chile
• 1992-93: the EMS
• 1994: Mexico II (Tequila)
• 1997: Asia
• 1999: Brazil
• 2000-2001: Argentina, Turkey
• 2008: Iceland
• 201x: Grexit / Eurozone?
…but there is a much longer history


…and currency crashes are often accompanied by inflationary explosions.

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Figure 1. The Tight Connection between Currency Crashes and Inflation Crises: Emerging Markets, 1865–2009

Notes: An inflation crisis is defined as a year when inflation exceeds 20 percent, while a currency crash is an annual depreciation (devaluation) greater than or equal to 15 percent per annum. The correlations of inflation and exchange rate crises are contemporaneous.

Sources: Reinhart and Rogoff (2008, 2009a), sources cited therein, and authors’ calculations.
In emerging markets, exchange rate crashes are much more frequently associated with *sudden stops* (i.e., capital flow reversals) than in advanced countries.

**Currency crashes and sudden stops**

<table>
<thead>
<tr>
<th></th>
<th>Emerging Markets</th>
<th>Developed Economies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Devaluations associated with Sudden Stop</td>
<td>63</td>
<td>17</td>
</tr>
<tr>
<td>Of which: First Sudden Stop, then devaluation</td>
<td>42</td>
<td>9</td>
</tr>
<tr>
<td>First devaluation, then Sudden Stop</td>
<td>21</td>
<td>9</td>
</tr>
<tr>
<td>Devaluations not associated with Sudden Stop</td>
<td>37</td>
<td>83</td>
</tr>
</tbody>
</table>

Note: The total number of large devaluations is 19 in emerging markets and 23 in developed economies.

Source: Calvo, Izquierdo and Mejia (2004)
Distribution of EM exchange rate regimes

More “managed floats” – but pegs have not gone away away


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Argentina: Real misalignment of the peso
Selected Eurozone countries
Real effective exchange rate (2000 = 100)

Source: IMF
Spread-betting measures of Euro breakup probability
Exhibit 2

GGB Yields Put Probability of Exit Close to 17%

Source: Morgan Stanley Research, Bloomberg
Exchange rates react strongly to news…

**Real exchange rates against the U.S. dollar**
(up = depreciation)

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**Source:** Haver Analytics monthly data and World Bank staff estimates.

Understanding currency crises

A country that chooses to peg its exchange rate, in a regime of capital mobility, loses its monetary policy independence.

The central bank commits to a monetary policy consistent with maintaining the peg.

But pressures can induce the central bank to abandon the commitment – e.g.,

- The pressure to monetize government deficits
- The pressure to respond to a recession
Three classic approaches to the collapse of currency pegs – in chronological order too ("generations"): 

*First generation*: crises driven by bad fundamentals – unsustainable fiscal-monetary imbalances.

- Motivated by the emerging market crises of 70s-early 80s.
- Attempt to stabilize inflation by pegging the exchange rate – but without supportive fiscal and/or monetary policies
- Policy imbalances build up over time – but the peg collapses abruptly, as if due to ‘shifts in sentiment’
- Limited attention to real effects of abandonment
- Krugman (1979)
Second generation: crises arising from the authorities’ limited commitment to the peg (“escape clauses”)

- Result from the authorities’ intent to stabilize output / employment
- Multiple equilibria with self-fulfilling crises
- Fundamentals still matter -- but not the only factor.
- There are real effects from abandonment – usually favorable
- Possible examples: the EMS ’92; Brazil ’99…
- Obstfeld (1994)
Third generation: focus on sudden stops and balance sheet effects. Currency crash driven by multiple equilibria under financial fragilities.

- Major adverse real effects
- East Asia 97, Iceland 2008…
- Krugman (1999)

Closest to the current view: shift focus to financial crises

- Exchange rate crashes mainly a result (or one aspect) of financial crises.
- In the 2000s, global shift to more flexible (but still managed) exchange rate regimes
- The main exception: the Eurozone – but after Greece, new doubts on its durability…
First generation model: economic policy is inconsistent with the exchange rate rule.

Log-linear version of Krugman 1979:

\[ m - p = -\alpha i \] (money market)

\[ m = d + r \] (loglinear approximation to money supply)

\[ p = p^* + s \] (PPP)

\[ i = i^* + s \] (uncovered interest parity)

Under a fixed exchange rate, \( s = s_0, \ i = i^* \).

Inflationary government finance: \( d = \mu \)
Under the fixed exchange rate,
\[ d + r - s_0 - p^* = -\alpha i^* \]

Since \( s_0, p^*, i^* \) are given, \( r \) must be falling at rate \( \mu \)

- Monetary policy is inconsistent with the fixed exchange rate: in the long run, the country runs out of reserves to defend it.

- Assume that when reserves run out the exchange rate floats freely. Under floating, equilibrium in the money market requires:

\[
d - \tilde{s} = -\alpha \left( i^* + \dot{\tilde{s}} \right); \quad \text{solving,}
\]

\[
\tilde{s} = \int_{t}^{\infty} e^{-\frac{(\tau-t)}{\alpha}} \left[ \frac{d_0 + \mu \tau}{\alpha} + i^* \right] d\tau = d_0 + \mu t + \alpha (\mu + i^*) = d + \alpha (\mu + i^*)
\]
\( \tilde{s} \) is the “shadow” exchange rate – the one that would prevail if reserves had run out. From the previous equation,

\[
\tilde{s} = \mu
\]

The peg collapses in a sudden speculative attack in which investors acquire the entire stock of Central Bank reserves and the exchange rate is floated.

The timing of the attack can be found comparing the fixed and the shadow exchange rates:

\( \tilde{s} < s_0 \)  
After the attack the exchange rate appreciates and speculators incur anticipated capital losses. So the attack can’t happen then

\( \tilde{s} > s_0 \)  
After the attack, the exchange rate depreciates and speculators realize capital gains. Anticipating them, the attack will happen a bit earlier, and earlier…
The attack must happen when $\tilde{s} = s_0$
This defines a threshold credit value $d^A$:

Figure 1: Attack time in a Certainty Model
What is the time of the attack $t^A$?

- Right before the attack, the interest rate rises from $i^*$ to $i^* + \mu$.
- Hence money demand must fall by $\alpha \mu$.
- In money market equilibrium, this must be also the fall in money supply = the fall in reserves to 0.
- Since reserves follow the process $r(t) = r(0) - \mu t$, the attack must happen exactly when the stock of reserves is

$$r(t) = \alpha \mu$$

Hence $r(t^A) = r(0) - \mu t^A = \alpha \mu \implies t^A = \frac{r(0)}{\mu} - \alpha$

$\implies$ The attack happens earlier the lower the reserve stock, the higher the rate of credit growth, and the larger the elasticity of money demand to the interest rate (‘asset substitutability’).
• Here the timing of the attack can be predicted exactly.
• But not anymore if there is some uncertainty about policy:
\[ d_t = d_{t-1} + \mu_t, \text{ where } E[\mu_t] = \mu. \]

Now the instant of the collapse is uncertain, but the logic is the same.

Economic (monetary) policy remains state independent. But as reserves get depleted prior to the attack, the interest rate must rise, because the probability of crisis increases.

• Broner (2006) / Rochon (2006): Krugman-type models in which imperfect information / lack of transparency (e.g., unobservable or hard-to-monitor reserves) extends the life of an unsustainable peg.
An important feature of these models is that the peg collapses in a sudden run on the central bank’s reserves.

Seemingly ‘stable’ policies lead to exchange rate instability.

This behavior is consistent with full rationality of investors, even though policy (or anything else) does not change over time.

Hence the steady (possibly moderate) loss of reserves suddenly accelerates – so central bank defenses that seemed adequate to sustain the peg for a long time are abruptly exhausted.
What if the government tries to “defend” the currency raising the interest rate on domestic bonds [traditional IMF advice]?

[e.g., Lahiri and Vegh (2003): Krugman-like model with money and “liquid bonds”]

Raising the interest rate has two opposing effects:

1. It increases demand for domestic assets – which helps postpone the attack.

2. It raises the public debt service and the fiscal deficit – hence the need for future inflationary finance – which tends to hasten the attack.

Thus *some* defense may be good, but *too much* defense will actually do harm (e.g., Sweden in 1992).
In the Krugman model, the government abandons the peg only when it runs out of reserves.

In reality, abandonment typically occurs when there are ample reserves left.

**Figure 1**

Histogram of reserve losses (R)
What drives the optimal timing of abandonment? (Rebelo and Vegh 2008)

Two ingredients working in opposite directions:

(1) After the exit, the inflation rate must be higher, more so the longer the exit takes – hence delaying exit makes the welfare cost higher. (the cost)

(2) There is an exit cost. Delaying the exit pushes it further into the future and reduces its present value. (the benefit)

Hence, for large misalignment (i.e., a large excess public spending, so debt is piling up quickly) the cost of delaying dominates – exit immediately.

If the exit cost is zero, exit immediately too – there is no benefit from delaying.
It only pays to delay the exit if the fiscal imbalance is small and exit costs are high – but not too much (beyond a certain threshold, it is best to exit immediately anyway).

Extended version: if the peg holds (only!), a (stochastic) fiscal reform may happen and solve the fiscal imbalance.

Now there is an additional reason to delay: an option value of holding on to the peg. The exit cost amounts to giving up the option (this tries to capture the ‘discipline’ the peg is supposed to impose on the fiscal authorities).

As time goes by without abandonment, the probability of reform rises – but the welfare cost of exiting if no reform happens also rises.
Still, it is optimal to exit immediately if the fiscal imbalance is large enough.

For a small fiscal imbalance, it is optimal to delay exit for some time.

But the more likely the arrival of reform, the longer it is optimal to defend the peg.
Can a peg collapse because of *prospective* (rather than actual) policy imbalances?

Some have argued that the East-Asian crisis was driven by the perceived fragility of the banking system – and the anticipation that it would require a government bailout (Burnside et al 2001)

This is seem by many as a big issue in the Eurozone crisis too.

The expectation that a banking crisis is coming leads to an exchange collapse due to the anticipated fiscal implications of the bank rescue – a “prospective” public deficit.

This is like the old Krugman model with a future, rather than a current, fundamentals problem.
Prior to the crash, the fiscal accounts were in fairly good shape

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<td>1.0</td>
<td>-0.9</td>
<td>-4.0</td>
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<td>2.1</td>
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<td>-0.4</td>
<td>-0.8</td>
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</tr>
<tr>
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<td>-0.6</td>
<td>0.9</td>
</tr>
<tr>
<td>Japan</td>
<td>-2.3</td>
<td>-3.6</td>
<td>-4.2</td>
<td>-3.4</td>
<td>-4.3</td>
</tr>
<tr>
<td>United States</td>
<td>-3.8</td>
<td>-3.3</td>
<td>-2.4</td>
<td>-1.2</td>
<td>-0.1</td>
</tr>
</tbody>
</table>

Source: See App. B.
For this argument to hold, bank insolvency should have been common knowledge *before* the crash.
And the (anticipated) fiscal cost of the bank recapitalization would have been seen as very large – so that its financing would require at least partial recourse to seigniorage.

**TABLE 6**

**COSTS OF RESTRUCTURING AND RECAPITALIZING THE BANKING SYSTEM**

<table>
<thead>
<tr>
<th></th>
<th>Percentage of GDP</th>
<th>Date of Estimate*</th>
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<tbody>
<tr>
<td>Indonesia</td>
<td>65</td>
<td>November 1999</td>
</tr>
<tr>
<td>Korea</td>
<td>24</td>
<td>December 1999</td>
</tr>
<tr>
<td>Malaysia</td>
<td>22</td>
<td>December 1999</td>
</tr>
<tr>
<td>Thailand</td>
<td>35</td>
<td>June 1999</td>
</tr>
</tbody>
</table>

* Date of issue of the source country report.
Then anticipations by forward-looking consumers / money holders that the government will resort to inflationary finance *in the future* bring down the exchange regime even *before* any expansion takes place.

So the peg is at risk from the moment agents revise their anticipations about future policy (even if those expectations were unfounded!).

In numerical simulations, the peg collapses (in slow motion) 1-2 years before the actual expansionary policies were put in place.

Still, the trigger of the whole process is the banking system collapse -- which is taken as exogenous. In reality, it would itself depend also on the fiscal stance and aggregate demand…
Second generation: the focus is on the government’s optimal decision about when to abandon the peg.

Now (monetary) policy becomes state dependent.

The basic intuition is that the cost of defending the peg depends on the public’s perceptions about the government’s willingness to defend it.

- If devaluation is expected, it will be factored into prices and/or interest rates, making it more costly (in output terms) not to devalue

More precisely, the option of abandonment yields nonlinear behavioral rules that can generate multiple equilibria

- there may be speculative attacks on exchange rate rules that ex-ante are NOT necessarily bound to collapse.
Fundamentals still matter: if they are solid enough, an attack is not possible. If they are weaker, the crisis is possible, but not assured to occur.

Speculative attacks may be self-fulfilling prophecies: if speculators anticipate an attack, it will happen; if they do not anticipate it, it will not happen.

Like in bank runs, any disturbance that makes speculators coordinate their expectations on the attack equilibrium in effect triggers it off. Sunspot equilibria may arise.
The simplest example: change in monetary rule after the crisis.

Assume that if the peg is abandoned the Central Bank will adopt a more expansionary monetary policy: the rate of credit growth rises from \( \mu_0 \) to \( \mu_1 \).

Assume further that \( \mu_0 = 0 \), so that the exchange rate would be sustainable in a first-generation model.

This yields two values for the shadow exchange rate – one for each value of \( \mu \)

And two threshold values of domestic credit

\[ d^A > d^B \]
• If $d < d^B$, an attack makes the exchange rate equal the shadow value associated with $\mu_1$ (which would be the new rate of credit growth).

But for that volume of credit, the new exchange rate is more appreciated than $s_0$ – there is no incentive for an attack. The fixed rate can survive indefinitely.

• If $d > d^A$, the attack occurs immediately.

• If $d$ lies between $d^B$ and $d^A$ there are multiple equilibria:

At $d = d^B$, an attack leaves the exchange rate exactly at the level $s_0$. Speculators are indifferent between attacking and not. Either of the two outcomes is possible.
Figure 2: Multiple equilibria
Between $d^B$ and $d^A$ the outcome depends on the expectations of individual speculators.

Their actions become *strategic complements*:

- If an individual speculator expects the others to attack the exchange rate, the optimal decision is to attack too, because it yields capital gains as the exchange rate depreciates.

Hence the critical ingredient is the (unspecified) coordination mechanism of individual investors.
More generally, the informational setting plays a key role for the existence of multiple equilibria.

Depending on the extent of private and public information, single or multiple equilibria may arise.

If fundamentals (e.g., reserves) are not common knowledge, but instead individuals receive (private) noisy signals about them, multiplicity goes away (Morris and Shin 1998).

Even if the noise in the private signals is small, each state of fundamentals leads to a unique outcome.
What is the intuition?

• Multiplicity requires a high degree of coordination: all agents adopt the same strategy
• But if agents are uncertain about other agents’ beliefs on the fundamentals, they will take it into account when choosing their strategy.
  • Other agents may get a sufficiently positive signal that they will decide to not attack the currency irrespective of the behavior of others,
  • Or they may get a sufficiently negative signal that they will decide to attack irrespective of the behavior of others.
  • Or other agents may think that other agents may get…etc
• This gives rise to a monotonic relation between the strength of the fundamental and the mass of attacking agents – i.e., uniqueness.
Hence uniqueness is restored in the Morris-Shin setting due to the particular information structure.

- If fundamentals are common knowledge, we get multiple equilibria.

- With only private information, agents cannot coordinate.

- If agents could observe others’ signals, the state of fundamentals could be inferred, and multiplicity would be restored.
• In reality, agents do observe common signals – e.g., reserve stocks, asset prices, government policy -- that aggregate disperse private information and facilitate coordination, by helping infer others’ actions. This tends to restore multiplicity.

• When there is endogenous public information (through policy actions), even if not fully revealing, multiplicity also tends to be restored.

For example, sharply raising interest rates may signal determination to defend the peg, and contain the attack, or also desperation, and accelerate the attack (Sweden 1992). Each of the two interpretations yields a different equilibrium
• Also, if actions are sequential, multiplicity may arise from “herd behavior”
  
  [e.g., after seeing what the preceding $n$ investors do, investor $n+1$ may simply imitate them and ignore her own information].

• Investor size may also matter for information aggregation:

If there is a sufficiently big trader then the attack occurs with certainty – the large trader alone can push the economy over to the crisis equilibrium (it acts like a coordination mechanism).

Also: the influence of the large trader is higher when her trading decision is revealed to the other traders prior to making their own decisions.

  The reason is the signaling potential of the larger trader’s move.
Optimal policy. So far we have taken as given the policy shift following a crisis. What if policy is chosen optimally?

This was first analyzed by Obstfeld (1996) [Lorenzoni (2014) has a Neo-Keynesian version]

The key ingredients are:

(i) Nominal rigidities – wages are set in advance

(ii) An activist government that cares about inflation but also wants to raise output above its ‘natural’ level (i.e., has a ‘credibility distortion’)

(iii) A fixed cost of abandoning the peg (can be asymmetric)

(iv) A random output shock
Each period the government faces the temptation to undertake ‘surprise’ inflation. As the private sector anticipates it, the resulting inflation is socially suboptimal (Barro-Gordon dynamic inconsistency).

The government chooses the rate of devaluation $\varepsilon$ (= inflation rate) after having observed the disturbance $u$ (where $E_{t-1}(u_t) = 0$).

It will optimally devalue (revalue) if the real shock $u$ is sufficiently adverse (favorable).

Rational agents set their wages / prices in anticipation of this.
• If $u > u_{\text{max}}$, there is a devaluation. If $u < u_{\text{min}}$, a revaluation. If $u$ is in between, the government holds the peg.

• But both critical values depend on the rate of anticipated devaluation $\varepsilon^e$ embedded in wage setting.

• The higher it is, the smaller $u_{\text{min}}$ (hence a revaluation is more unlikely) and the smaller $u_{\text{max}}$ too (hence devaluation becomes more likely).

• With rational expectations, anticipated devaluation $\varepsilon^e$ has to equal a weighted average of the devaluation rates expected under the two regimes, with weight equal to the respective probabilities that the regimes will hold. $E[\varepsilon]$. 
This may yield one or *three* equilibria, depending on parameter values.

The equilibrium with highest anticipated devaluation is just the discretionary (floating) equilibrium – as if the fixed cost of exiting the peg did not exist.
If the credibility distortion is large, the discretionary equilibrium may become the only one in the model (the curve shifts up).
This approach illustrates the consequences of an ‘optimal commitment’ to defend the exchange rate rule.

The multiplicity of equilibria arises from the anticipation that large shocks will lead to exiting the rule (“escape clauses”). This gets built into price setting decisions.

This is a relevant concern even for hard pegs – e.g., Argentina, the Eurozone…

Here the critical factor is output (or unemployment). But there may be other factors that make holding the peg too costly – e.g., excessive (nominal) public debt.
This type of framework helps explain crises not preceded by an obvious deterioration of fundamentals, or credibility (as measured by interest rates).

In other words: the relevant fundamentals now include the determinants of the authorities’ willingness to defend the exchange rate rule.

In these models, exiting the peg with a depreciation is usually expansionary.

The indeterminacy of equilibrium makes these currency crises hard to predict.

Empirical work has focused on identifying variables correlated with the occurrence of crises, to develop early warning indicators.

…but with limited (or excessive??) empirical success
Third generation

Models inspired by the Asian crisis (1997), where “optimal abandonment” was definitely not the question.

Focus on balance sheet effects on firms and/or the government.

Balance sheet fragility leads to multiple equilibria.

The adjustment of the exchange rate has perverse effects – it weakens balance sheets and raises the real cost of the crisis.
Financial fragility may arise from various sources:

(1) Time mismatches in firms’ and or banks’ balance sheets: they hold long-term assets and short-term liabilities. This leaves room for classic creditor runs (a la Diamond-Dybvig).

(2) Currency mismatches – foreign-currency borrowing by agents without foreign currency assets (or future incomes) (Krugman 1999; Aghion et al 2004).

(3) Over-indebtedness due to unproductive investment in a context of moral hazard (crony capitalism).

These factors create amplification mechanisms that magnify the real effects of “sudden stops” in capital flows.

Focus on currency mismatches.
Banks’ currency mismatches may arise from their own balance sheets, or those of their borrowers – as in Argentina.
Figure 5.3. Firm's Balance Sheet Dollarization
(Average share of U.S. dollar debt across firms)

<table>
<thead>
<tr>
<th>Year</th>
<th>Tradable sector</th>
<th>Non-tradable sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998</td>
<td>60%</td>
<td>83%</td>
</tr>
<tr>
<td>1999</td>
<td>67%</td>
<td>79%</td>
</tr>
</tbody>
</table>
Krugman 1999: sketch of a model with financial frictions

Investors’ access to financing depends on their net worth. They are indebted in foreign currency.

Consumption and investment have an import content $\mu$

$$y = G(K, L) = \left(e^{-\mu I_{t-1}}\right)^{\alpha} L^{1-\alpha}$$

capital depreciates fully in 1 period

Its price in terms of domestic goods is $e^{-\mu}$.

Investors / capitalists save all their income $\alpha Y$.

$$y = (1 - \mu)I + (1 - \mu)C + eX = (1 - \mu)I + (1 - \alpha)(1 - \mu)y + eX$$

$$\Rightarrow e = \frac{y(1 - (1 - \alpha)(1 - \mu)) - (1 - \mu)I}{X}$$

An increase in investment $I$ leads to a real appreciation.

$X$ is exogenously given.
Investors only want to invest as long as

\[(1+r) \geq \frac{e_{t+1}}{e_t} (1+r^*)\]  where  \((1+r) = G_k(I_{t-1}e^{-\mu},L)\)

Differentiating

\[d \left[ G_k(I_{t-1}e^{-\mu},L) - \frac{e_{t+1}}{e_t} (1+r^*) \right] = \]

\[dI \]

\[\left[ -\mu e^{-(\mu+1)} G_{kk} + \frac{e_{t+1}}{e_t^2} (1+r^*) \right] \frac{de}{dI} - \frac{(1+r^*)}{e_t} \frac{de_{t+1}}{dI} < 0 \]

given that \(\frac{de}{dI} < 0, \frac{de_{t+1}}{dI} > 0, G_{kk} < 0.\)

Hence the expression is declining in \(I.\)
The equality

\[ G_k(I_{t-1}e^{-\mu}, L) - \frac{e_{t+1}}{e_t} (1 + r^*) = 0 \]

defines the maximum value of investment \( I_{\text{max}} \)

- Investment cannot be negative (or fall below a threshold value \( I_{\text{min}} \))
- Lenders set a credit ceiling \( I^f \), proportional to investors’ net worth (i.e., a collateral constraint).

The key ingredient is the effect of \( I \) itself on financeable investment \( I^f \).

\( I \leq (1 + \lambda)W = I^f \) Financeable investment, where
\( W = \alpha y - D - eF \) denotes net worth
\[
\frac{dI^f}{dI} = (1 + \lambda) \frac{dW}{dI} = -F(1 + \lambda) \frac{de}{dI} = (1 + \lambda)(1 - \mu) \frac{F}{X}
\]

If \( \frac{dI^f}{dI} < 1 \), there is a unique equilibrium.

But if \( \frac{dI^f}{dI} > 1 \) there are multiple equilibria.

With \( \frac{dI^f}{dI} > 1 \), an increase in anticipated investment creates expectations of real appreciation and increasing net worth. This relaxes the financial constraint and validates the expansion.

The opposite happens with a decline in anticipated investment.
Multiple equilibria are more likely to arise under:
- high indebtedness
- a high foreign-currency debt / export ratio
- a low marginal propensity to import
The same idea in the IS-LM framework in \((e,Y)\) plane:

The IS schedule has a downward-sloping segment
- if the real exchange rate is very appreciated, balance sheet effects are small and outweighed by traditional competitiveness effects – a depreciation raises demand.

- if the real exchange rate is very depreciated, firms indebted in dollars are already bankrupt, and only the competitiveness effects remain.

- in an intermediate zone, balance sheet effects outweigh competitiveness effects: an increased in \(e\) reduces investment and aggregate demand.

- this leads to multiple equilibria. Two are stable: a “normal” equilibrium and a “crisis” equilibrium with a much more depreciated real exchange rate.
Multiple equilibria in IS-LM setting
Which policies help avoid the crisis (the top equilibrium) ?
- Fiscal austerity does not help: it removes the “good” equilibrium (shifts the IS to the left). If anything, an expansion might help !
- A monetary expansion might pose the same problem – in fact, a contraction might help, but likely with major side effects...
- ‘Structural reforms’ are not the issue here.

The true remedy is to address the financial fragilities – firm / bank balance sheet mismatches.

This requires appropriate (macro-)prudential policies so that risks are taken only by those who can bear them and are duly internalized (more on this later)
Note the self-fulfilling aspect of sudden stops: a loss of confidence [the suspicion that borrowers will not have enough collateral] forces a depreciation and makes firms bankrupt – depreciating assets, destroying collateral, and causing a sharp output drop.

The critical mechanisms are

(1) the effect of credit on the real exchange rate [a decline in capital flows forces a large depreciation, the transfer problem]

And (2) the effect of the real exchange rate on the solvency of firms via currency mismatches.
This was not lost on emerging markets: to reduce vulnerability, since the early 2000s currency mismatches declined a lot in most countries…(perhaps with the exception of emerging Europe)
EM borrowers shifted to local currency-debt

Local currency external debt as % of total (Mean of 14 sample countries)

Wenxin Du & Jesse Schreger, Harvard U., Sept. 2014,
“Sovereign Risk, Currency Risk, & Corporate Balance Sheets,” Fig.2, p.19.
But in some EMs the currency composition of corporate debt is reverting towards foreign currency

Most new external borrowing in foreign currency is being done by nonfinancial corporations – as the borrowing by banks is closely monitored in most countries.

This is typically through bond issuance, and in many cases through foreign subsidiaries and special purpose vehicles. These entities then on-lend the proceeds to the parent firm.

• This implies that much of the borrowing does not show up as debt in BoP statistics – because they are based on the residence of the borrower.

• Instead, it will show up as FDI – which many observers view as a less risky type of liability, even though in this case it so just in appearance.
US dollar credit to selected non-bank borrowers

In billions of US dollars

Graph 1

1 US dollar loans to non-bank residents of the country listed in the panel title. 2 Outstanding US dollar international bonds issued by non-bank residents of the country listed in the panel title. 3 Outstanding US dollar international bonds issued by offshore affiliates of non-banks with a parent entity headquartered in the country listed in the panel title. 4 US dollar loans booked by banks located in the country in the panel title to non-bank borrowers in that country. For China and the Philippines, figures are estimates based on national data.

Sources: National data; BIS international debt securities statistics; BIS locational banking statistics by residence; authors' calculations.
US dollar credit to selected non-bank borrowers

In billions of US dollars

Graph 2

Brazil

Chile

Mexico

Russia

Turkey

South Africa

1 US dollar loans to non-bank residents of the country listed in the panel title.
2 Outstanding US dollar international bonds issued by non-bank residents of the country listed in the panel title.
3 Outstanding US dollar international bonds issued by offshore affiliates of non-banks with a parent entity headquartered in the country listed in the panel title.
4 US dollar loans booked by banks located in the country in the panel title to non-bank borrowers in that country. For Russia, figures are estimates based on national data.

Sources: National data; BIS international debt securities statistics; BIS locational banking statistics by residence; authors’ calculations.
### Emerging market economies’ dollar debt outstanding

**At end-Q2 2015; debt of non-bank borrowers**

<table>
<thead>
<tr>
<th>Country</th>
<th>US dollar debt (USD billions)</th>
<th>External debt</th>
<th>Non-financial corporate debt</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Of which: of residents</td>
<td>Total</td>
</tr>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>Brazil</td>
<td>322</td>
<td>219</td>
<td>193</td>
</tr>
<tr>
<td>Chile</td>
<td>88</td>
<td>86</td>
<td>62</td>
</tr>
<tr>
<td>China</td>
<td>1,178</td>
<td>935</td>
<td>198</td>
</tr>
<tr>
<td>India</td>
<td>118</td>
<td>98</td>
<td>81</td>
</tr>
<tr>
<td>Indonesia</td>
<td>160</td>
<td>149</td>
<td>104</td>
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<tr>
<td>Korea</td>
<td>128</td>
<td>123</td>
<td>69</td>
</tr>
<tr>
<td>Malaysia</td>
<td>41</td>
<td>36</td>
<td>36</td>
</tr>
<tr>
<td>Mexico</td>
<td>237</td>
<td>222</td>
<td>193</td>
</tr>
<tr>
<td>Philippines</td>
<td>59</td>
<td>57</td>
<td>47</td>
</tr>
<tr>
<td>Russia</td>
<td>297</td>
<td>247</td>
<td>99</td>
</tr>
<tr>
<td>South Africa</td>
<td>34</td>
<td>27</td>
<td>24</td>
</tr>
<tr>
<td>Turkey</td>
<td>183</td>
<td>182</td>
<td>89</td>
</tr>
<tr>
<td>Total</td>
<td>2,846</td>
<td>2,381</td>
<td>1,195</td>
</tr>
</tbody>
</table>

**Memo:**

| All EMEs | 3,824 | 3,267 | 2,053 | 6,902 | 30 | 23,485 | 10 |

Figure 2: Currency Composition of Outstanding Emerging Market Bonds

Note: Billions of U.S. dollars on vertical axis.
Source: World Bank database
Figure 5: Bond Liabilities as a Percentage of Foreign Debt Liabilities: Emerging Market Economies

Note: Percent of foreign debt liabilities on vertical axis.
Source: Updated version of dataset reported in Lane and Milesi-Ferretti (2007).
<table>
<thead>
<tr>
<th>Company Name</th>
<th>Parent Company</th>
<th>Incorporated</th>
<th>Country of Risk</th>
<th>Amount (US$ Bn)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petrobras Global Finance BV</td>
<td>PETROBRAS - PETROLEO BRAS-PR</td>
<td>Netherlands</td>
<td>Brazil</td>
<td>3.5</td>
</tr>
<tr>
<td>Lukoil International Finance BV</td>
<td>LUKOIL OAO</td>
<td>Netherlands</td>
<td>Russia</td>
<td>1.5</td>
</tr>
<tr>
<td>Gazprom Neft OAO Via GPN Capital SA</td>
<td>GAZPROM NEFT OAO-CLS</td>
<td>Luxembourg</td>
<td>Russia</td>
<td>1.5</td>
</tr>
<tr>
<td>Russian Railways via RZD Capital PLC</td>
<td>RUSSIAN RAILWAYS JSC</td>
<td>Ireland</td>
<td>Russia</td>
<td>1.3</td>
</tr>
<tr>
<td>AngloGold Ashanti Holdings PLC</td>
<td>ANGLOGOLD ASHANTI LTD</td>
<td>Isle of Man</td>
<td>South Africa</td>
<td>1.3</td>
</tr>
<tr>
<td>Metalloinvest Finance Ltd</td>
<td>METALLOINVEST HOLDING CO OAO</td>
<td>Ireland</td>
<td>Russia</td>
<td>1</td>
</tr>
<tr>
<td>SABIC Capital II BV</td>
<td>SAUDI BASIC INDUSTRIES CORP</td>
<td>Netherlands</td>
<td>Saudi Arabia</td>
<td>1</td>
</tr>
</tbody>
</table>

Source: Adapted from Fuertes and Serena (2014).
Figure 25: Domestic- and Foreign-currency Bond Issuances in LAC

Note: Billions of U.S. dollars on vertical axis.
Source: Own elaboration based on Dealogic data.
Figure 8: Sectoral Composition of Foreign Currency Bonds for Emerging Asia

Note: Billions of U.S. dollars on vertical axis. Source: Data from Asian Development Bank.
Foreign-currency liabilities are not a concern if the debtors have foreign currency assets or revenues (e.g., oil exporting companies) to hedge the currency risk.

- But at present the authorities have no tools to ensure that borrowers are hedged – i.e., the risk has shifted to unregulated borrowers
- The evidence shows that in a number of countries even firms in the utility and construction sectors are engaging in foreign-currency borrowing. They are very likely to be unhedged.
- There is also strong evidence that some of these firms are borrowing just to engage in the carry trade

The risk is that a sudden stop and abrupt real depreciation could badly damage their balance sheets and/or those of their banks.
Annex 1

The Morris and Shin (1998) model
(as in Angeletos and Werning 2005)
Sketch of Morris-Shin model (as in Angeletos-Werning 2005):

-- continuum of agents, indexed by $i \in [0,1]$
-- each agent can choose action $a_i \in \{0,1\}$, where 1 is “attack” and 0 is “not attack”.
-- the government chooses regime outcome $R \in \{0,1\}$, where 1 is “collapse” and 0 is “statu quo”.
-- payoff to individual $i$ is $u_i=a_i(R - t)$ where $t < 1$
-- government chooses collapse ($R = 1$) iff $A \geq \theta$ where $A = \int a_i \, di \in [0,1]$ is the mass of agents attacking and $\theta$ is the strength of the fundamentals.
Agents’ actions are *strategic complements* -- it pays for individual $i$ to attack if everybody else attacks, and not to attack if everybody else does not:

$$u_i = U(a_i, A, \theta) = \begin{cases} a_i (1-t) & \text{if } A \geq \theta \\ -a_i t & \text{if } A < \theta \end{cases}$$

For known $\theta$, the optimal strategy is

$$g(A, \theta) = \arg\max_{a \in [0,1]} U(a_i, A, \theta) = \begin{cases} 1 & \text{if } A \geq \theta \\ 0 & \text{if } A < \theta \end{cases}$$

Both $U$ and $g$ are increasing in $A$, so there is both a positive externality and a strategic complementarity.

Assume that $\theta$ is common knowledge. Let $\underline{\theta} \equiv 0$ and $\bar{\theta} \equiv 1$.

- for $\theta \leq \underline{\theta}$ the regime collapses with certainty.
- for $\theta > \bar{\theta}$ the regime survives with certainty.
- for $\underline{\theta} < \theta \leq \bar{\theta}$ the regime is vulnerable to a large-enough attack: there are multiple equilibria with self-fulfilling expectations.
Assume now that the fundamentals are not common knowledge, but individuals have **private** noisy information about them. Agent $i$ observes $x_i = \theta + \sigma \xi_i; \quad \xi_i \sim iid$ with zero mean and symmetric density $dF(.)$

Here $1/\sigma$ is the precision of the private information (note $\sigma=0$ does not amount to public information: even with $\sigma=0$ agent $i$ does not know what the others know).

Agents also have a uniform (improper) prior about $\theta$.

An equilibrium here is:

(i) a strategy $a(x) \mid a = \arg \max_{a \in \{0,1\}} E[U(a, A(\theta), \theta) \mid x]$

(ii) an aggregate attack $A(\theta) = \int a(x) dF\left(\frac{x-\theta}{\sigma}\right)$

A **monotone** equilibrium is one where $a(x)$ is monotonic in $x$ (i.e., an agent attacks iff $x \leq x^*$ for some critical $x^*$).
Monotone equilibria are the only equilibria in this model. They are characterized by

- a critical $x^*$ such that agents attack if $x \leq x^*$
- a critical $\theta^*$ such that the regime collapses if $\theta \leq \theta^*$

How do we find the equilibrium?

**Step 1.** For given $\theta$, the aggregate size of the attack equals the mass of agents receiving signals $x \leq x^*$. This is the same as the probability of getting $x \leq x^*$:

$$A(\theta) = F \left( \frac{x^* - \theta}{\sigma} \right)$$

Regime change occurs if $\theta \leq \theta^*$, where $\theta^*$ is given by $A(\theta^*) = \theta^*$, or

$$F \left( \frac{x^* - \theta^*}{\sigma} \right) = \theta^* \quad \text{i.e., attack strength equals fundamental strength}$$
Step 2. The expected payoff of an individual agent observing signal $x$ is:

$$E[U(a, A(\theta), \theta) \mid x] = a(\Pr[\theta \leq \theta^* \mid x] - t).$$

[i.e., prob of attack success]

But $\Pr[\theta \leq \theta^* \mid x] = \Pr[\xi \geq \frac{x - \theta^*}{\sigma}] = 1 - F\left(\frac{x - \theta^*}{\sigma}\right)$

Hence the agent attacks iff $1 - F\left(\frac{x - \theta^*}{\sigma}\right) > t$.

Indifference of the marginal agent defines the critical value of the signal:

$$F\left(\frac{x^* - \theta^*}{\sigma}\right) = 1 - t$$

Step 3. Combining steps 1 and 2, the **unique** equilibrium is given by

$$\theta^* = 1 - t$$

$$x^* = \theta^* + \sigma F^{-1}(1 - t) = 1 - t - \sigma F^{-1}(t)$$
Hence the regime always collapses for $\theta < 1 - t$

and traders attack whenever they get $x < 1 - t - \sigma F^{-1}(t)$

Further, as $\sigma \to 0$, $x^* \to \theta^*$
Annex 2

The Obstfeld (1996) model
Basic structure

\[ y_t = \bar{y} + \alpha(s_t - w_t) - u_t \]  \text{aggregate supply}

\[ w_t = E_{t-1}[s_t] \]  \text{wage rule}

\[ \varepsilon_t = s_t - s_{t-1} \]  \text{inflation rate}

\[ L_t = (y_t - y^*)^2 + \beta \varepsilon_t^2 + C(\varepsilon) \]  \text{loss function}

where \( y^* > \bar{y} \Rightarrow \text{dynamic inconsistency} \)
Substituting, \( L_t = (\bar{y} - y^* + \alpha (\varepsilon_t - \varepsilon^e_t) - u)^2 + \beta \varepsilon_t^2 + C(\varepsilon) \)

This is a classic Barro-Gordon loss function, with three components:

(1) output: each period there is a temptation to inflate (= devalue) to raise output. As the private sector anticipates it, the result is socially suboptimal.

(2) inflation. The government chooses it after having observed the disturbance \( u \) (where \( E_{t-1}(u_t) = 0 \)).

(3) Fixed cost (reputational ?) of exiting the peg. Could be asymmetric.

To solve the model, first ignore the fixed cost.
• Under discretion: the government chooses inflation \( \varepsilon \).

\[
\frac{\partial L}{\partial \varepsilon} = 2\alpha (\bar{y} - y^* + \alpha (\varepsilon - \varepsilon^e) - u) + 2\beta \varepsilon = 0
\]

\( \Rightarrow \varepsilon = \frac{\alpha}{\alpha^2 + \beta} [y^* - \bar{y} + u + \alpha \varepsilon^e] \)

\( \Rightarrow y = \bar{y} + \frac{\alpha^2}{\alpha^2 + \beta} (y^* - \bar{y}) - \frac{\beta}{\alpha^2 + \beta} (u + \alpha \varepsilon^e) \)

The value of the objective function is

\[
L^{Flex} = \frac{\beta}{\alpha^2 + \beta} [y^* - \bar{y} + u + \alpha \varepsilon^e]^2
\]

• For finite \( \beta \), the government will try to partially offset the disturbance \( u \) through inflation
• Under the exchange rate rule, \( \varepsilon = 0 \).

Replacing, \( L^{Fix} = (\bar{y} - y^* - \alpha \varepsilon^e - u)^2 \)

• Reintroduce now the fixed cost \( C \). The government sticks to the exchange rate rule iff \( L^{fix} < L^{flex} + C \):

\[
(\bar{y} - y^* - \alpha \varepsilon^e - u)^2 < \frac{\beta}{\alpha^2 + \beta} \left[ y^* - \bar{y} + u + \alpha \varepsilon^e \right]^2 + C
\]

or \( \frac{\alpha^2}{\alpha^2 + \beta} \left[ y^* - \bar{y} + u + \alpha \varepsilon^e \right]^2 < C \)

In the opposite case, there is a realignment. This defines \( u_{max}, u_{min} \):

\[
\begin{align*}
    u_{max} &= \frac{\left[ C(\alpha^2 + \beta) \right]^{1/2}}{\alpha} - \left[ y^* - \bar{y} + \alpha \varepsilon^e \right] \\
    u_{min} &= -\frac{\left[ C(\alpha^2 + \beta) \right]^{1/2}}{\alpha} - \left[ y^* - \bar{y} + \alpha \varepsilon^e \right]
\end{align*}
\]
• If \( u > u_{\text{max}} \), there is a devaluation. If \( u < u_{\text{min}} \), a revaluation. If \( u \) is in between, the government holds the peg.

• Both critical values depend on anticipated devaluation. The higher it is, the smaller \( u_{\text{min}} \) (hence a revaluation is more unlikely) and the smaller \( u_{\text{max}} \) too (hence devaluation becomes more likely).

• With rational expectations, anticipated devaluation has to be a weighted average of the devaluation rates expected under the two regimes. The weights have to be the probabilities that the respective regimes hold:
\[ E[\varepsilon] = \Pr[u > u_{\text{max}}] \cdot E[\varepsilon|u > u_{\text{max}}] + \Pr[u < u_{\text{min}}] \cdot E[\varepsilon|u < u_{\text{min}}] \]

\[ \Rightarrow E[\varepsilon] = \frac{\alpha}{\alpha^2 + \beta} \left[ (\Pr[u > u_{\text{max}}] + \Pr[u < u_{\text{min}}]) \left( y^* - \bar{y} + \alpha \varepsilon^e \right) \right] \]

\[ + \frac{\alpha^2}{\alpha^2 + \beta} \left[ \Pr[u > u_{\text{max}}] \cdot E[u|u > u_{\text{max}}] + \Pr[u < u_{\text{min}}] \cdot E[u|u < u_{\text{min}}] \right] \]

If \( u \) is uniform over \([-\mu, \mu]\)

\[ \Pr[u > u_{\text{max}}] = \frac{\mu - u_{\text{max}}}{2\mu} \quad \text{;} \quad \Pr[u < u_{\text{min}}] = \frac{u_{\text{min}} + \mu}{2\mu} \]

\[ E[u|u > u_{\text{max}}] = \frac{\mu + u_{\text{max}}}{2} \quad \text{;} \quad E[u|u < u_{\text{min}}] = \frac{\mu^2 + u_{\text{min}}}{2(\mu + u_{\text{min}})^2} \]

Replacing,

\[ \Rightarrow E[\varepsilon] = \frac{\alpha}{\alpha^2 + \beta} \left[ \left(1 - \frac{u_{\text{max}} - u_{\text{min}}}{2\mu}\right) \left( y^* - \bar{y} + \alpha \varepsilon^e \right) - \frac{u_{\text{max}}^2 - u_{\text{min}}^2}{4\mu} \right] \]
But the shock thresholds $u_{\text{max}}$ and $u_{\text{min}}$ (for devaluation and revaluation) depend themselves on anticipated devaluation.

Combing the expression for $E[\varepsilon]$ and those for $u_{\text{max}}$ and $u_{\text{min}}$ yields may yield one or three equilibria, depending on parameter values.

The equilibrium with highest anticipated devaluation is just the discretionary (floating) equilibrium – as if the fixed cost did not exist:

$$\varepsilon = \frac{\alpha}{\beta} [y^* - \bar{y}]$$
If the credibility distortion $y^* - y$ is large, the discretionary equilibrium may become the only one in the model (the curve shifts up).