International Finance 4832
Lecture 9: Exchange Rate Pegs and Currency Crises

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Spring 2025

Outline

Before:

Part I: Exchange Rates

1. Short-run: UIP, CIP, Arbitrage $\longrightarrow$ Spot ER determination
2. Long-run: PPP, RIP $\longrightarrow$ Expected (future) ER determination

Part II: Balance of Payments and External Wealth

1. Flows: trade of goods, services and assets; income flows; other (transfers)
2. Stock: Net Foreign Assets and the Long Run Budget Constraint (LRBC)
3. IS-LM-FX

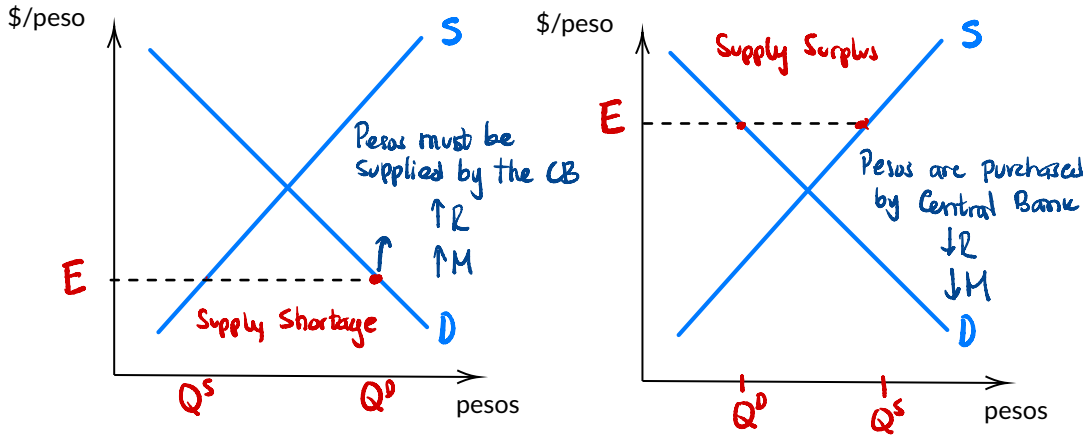
Now: Part III $\longrightarrow$ Policy applications

ER Regimes in detail: Fixed vs. Floating

The Gold Standard, Bretton Woods, ERM (pre-Euro)

Exchange Rate crises and models

Market for pesos: excess demand and supply



Excess demand: shortage of pesos $\longrightarrow$ CB supplies pesos pushing $E_{\$/\text{peso}}$ up (price of peso)

Excess supply: surplus of pesos $\longrightarrow$ CB purchases these with reserve assets

Central Bank

Central Bank controls money supply (M) by buying and selling two assets:

1. Domestic Bonds (B) $\rightarrow$ usually government bonds $\rightarrow$ **Denominated in pesos**
   public bonds: asset bonds are issued by government; liability bonds: issued by the central bank
2. Foreign Reserves (R): Dollars or assets easily convertible to USD $\rightarrow$ **Dollar denom. assets**

Fixed ER Regime:

Central Bank intervenes FX market to maintain the peg

This is done by buying or selling reserves in exchange for pesos

Money supply

Central Bank prints pesos and uses them to buy bonds or reserves

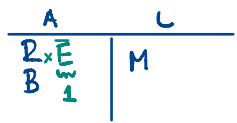
Each peso in circulation is the result of an asset purchase by the Central Bank:

Assets can be home (B) or foreign (R)

CB prints money but that's only paper ... part of the supply only when used to buy assets from people

This means that the value of those assets corresponds exactly to the amount of money supply:

$$M = B + R$$



To simplify, let's assume that all reserves are purchased at a rate $\bar{E}_{peso/\$} = 1$

That is, home currency value of reserves is: $E_{peso/\$}R = \bar{E}_{peso/\$}R = R$

Useful for intuition: set the equation in changes: $\Delta M = \Delta B + \Delta R$

Example: CB buys \$1000 in reserves: $\Delta R = 1000$, then put the money spent in circulation $\Delta M = 1000$

Money supply (cont.)

Balance sheet:

$$M = B + R$$

$\bar{E}_{Peso/\$} = 1$

Central bank's balance sheet example (simplified version)

Assets		Liabilities	
Reserves (R)	500	Money Supply (M)	1000
Domestic Credit (B)	500		

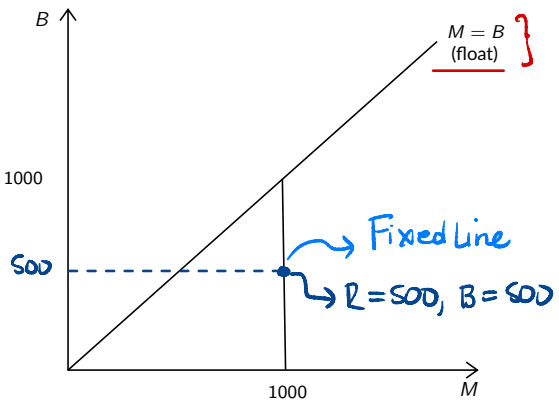
CB balance sheet graph

CB must have reserves ($R > 0$) to trade if it wants to fix the ER (needs resources to defend the peg)

We assume this is the only purpose of holding reserves

Reality: Countries hold FX reserves as savings buffer for emergencies (e.g. Sudden Stops of capital flows)

$M = B + R$



A	L
R = 0	M
B	

CB balance sheet graph (cont.)

Countries may adjust B too, but never try to rely on this (and zero reserves) to maintain peg

Why? $\rightarrow$ FX market changes too often, way faster than it takes for CB to sell/buy large quantity of bonds from government

45 degree line has $R = 0$ (no reserves) and thus float $\longrightarrow$ "Floating line"

Any point on the vertical line generates the same money supply $\longrightarrow$ "Fixed line"

Only way to adjust ΔM is by ΔR

For a given money supply (liabilities) the composition of assets (B, R) may differ

- As you go closer to the Floating Line the economy has fewer reserves
- Currency board: A fixed ER that operates with only reserves (reserves $=$ 100% of M)

Summing up: if balance sheet lies on 45° line $\rightarrow$ ER floats, if it's below in vertical line: Fixed ER

Reserves

How is the equilibrium level of reserves determined?

- Solve for reserves and replace money supply for demand using that *Supply* = *Demand* in equilibrium
- In peg: replace $i = i^*$

$$R = \bar{P}L(i^*)Y - B$$

All variables on RHS are exogenous and known $\longrightarrow$ $\bar{P}$ is fixed, i^* is determined abroad, Y is given, B not used for FX management

Trilemma here: CB only acts (changes reserves) to maintain peg $\longrightarrow$ sets $i = i^*$ at all times

This equation tells us how reserves are adjusted to defend peg after shocks:

- shocks to money demand $(\bar{P}L(i)Y)$
- shocks to domestic credit (B)

Response to money demand shocks

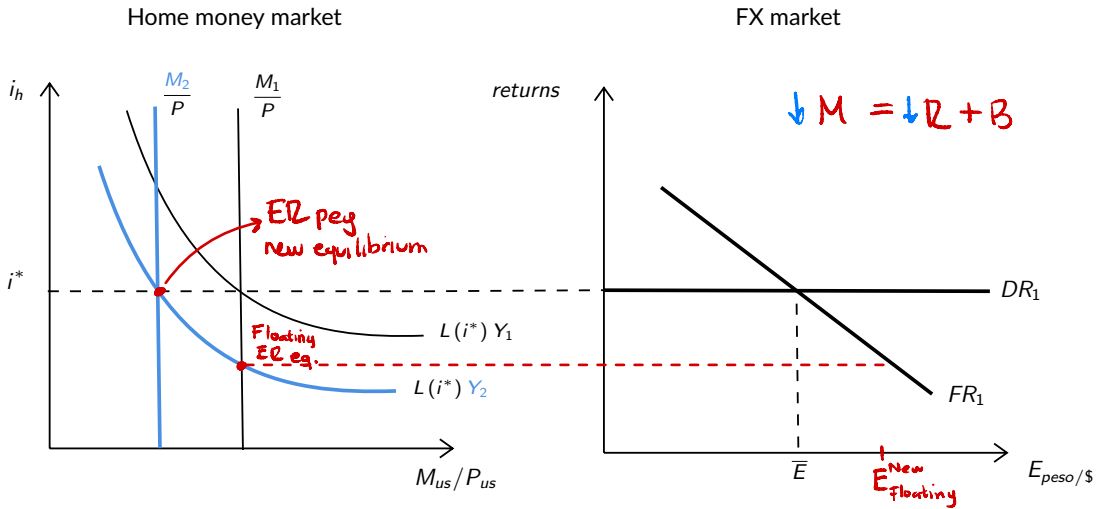
Shocks to money demand: Changes in i^*, Y, or $L(\cdot)$

B is constant (not used for day-to-day FX interventions)

$$R = \bar{P}L(i^*)Y - B$$

Shocks: Y falls $\longrightarrow$ Money demand falls (e.g., by 10%)

- Floating ER: ER depreciates $\longrightarrow$ Money Demand $\downarrow \Rightarrow i \downarrow \Rightarrow E_{peso/\$} \uparrow$
- Fixed ER: CB must use reserves (loses R to defend peg)


Home money market
FX market
i_h
$\frac{M_2}{P}$
$\frac{M_1}{P}$
returns
↓M = ↓R + B
ER peg
new equilibrium
i^*
$L(i^*)\,Y_1$
Floating
ER eq.
$L(i^*)\,Y_2$
DR_1
FR_1
M_{us}/P_{us}
$\overline{E}$
$E^{New}_{Floating}$
$E_{peso/\$}$

Response to money demand shocks (cont.)

Changes in money demand: due to change in i^*, Y, or $L(\cdot)$

Given B is constant, R lowers:

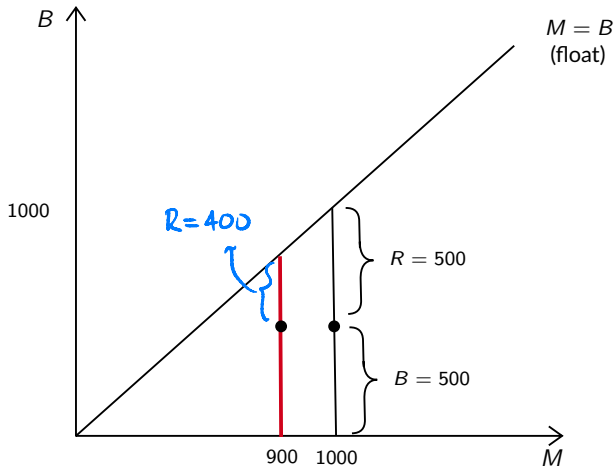
$$R = \bar{P}L(i^*)Y - B$$

Begin with balance sheet as in the plot (M supply is 1000) $\Rightarrow$ Money Demand falls (e.g., by 10%)

- Floating ER: CB does nothing, ER depreciates
- Fixed ER: To prevent depreciation CB has to lower money supply by 10% (to 900)
  - This is done using the Reserves: Buy 100 pesos for 100 dollars of reserves
  - With $R > 0$ reserves absorb the shock and i remains the same $\rightarrow$ peg is defended $i = i^*$

Holding domestic credit constant, a change in money demand leads to an equal change in reserves

Money supply lowers so the "Fixed line" moves to the left:



The backing ratio

The composition of the CB assets changed: fewer reserves relative to money supply

Backing ratio: $\frac{R}{M} \longrightarrow$ Fraction of money supply backed by reserves

The backing ratio lowered:

First: $\frac{R}{M} = \frac{500}{1000} = 0.5$

After the shock: $\frac{R}{M} = \frac{400}{900} = 0.44$

$\frac{R}{M}$ states the size of the maximum demand shock the peg can withstand before breaking

(i.e., before running out of reserves with B fixed)

That is, the peg breaks when backing ratio $= 0$ or $R = 0$

The higher the backing ratio $\longrightarrow$ the more resilient the Fixed ER regime is

Currency boards

Definition: Fixed ER regime with maximum backing ratio of 100%

i.e., Fixed ER with $R = M$ → 100% backing ratio

Motivation: if backingn ratio is low then it's difficult to respond to shocks

- Peg is more likely to fail (with low $\frac{R}{M}$)
- Low R/M invites speculation on peg failing $\longrightarrow$ higher likelihood of "speculative attacks"

Then, Increase R/M to minimize speculation

Famous examples:

Hong Kong: 7.8 HKD $=$ 1 USD [link]

Argentina: (1991-2002) 1 ARS $=$ 1 USD [link]

Money demand shocks: Risk premia

A peg may not be credible and UIP fails to hold $\longrightarrow$ Emerging economies case

Spread between i and i^* can be a source to shocks $\longrightarrow$ **shocks to UIP**

Or shocks to money demand come through i ($= i^* +$ exp. depreciation $+$ deviations to UIP)

Risk adjusted foreign return formula: extends UIP model to account for risk and default premia

$$i = i^* + \frac{E^e}{E} - 1 + \gamma_{fx} + \gamma_{def}$$

Exchange rate risk premium: $\gamma_{fx} \rightarrow$ Investors worry about peg stability $\Rightarrow$ demand higher returns from home as compensation for buying their assets

Total currency premium $= \frac{E^e}{E} - 1 + \gamma_{fx}$ (notice it should be zero if peg is credible)

Default risk premium: $\gamma_{def} \longrightarrow$ also called "country premium"

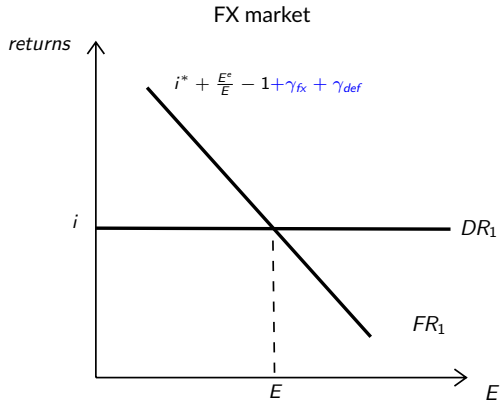
Compensation (extra return) if investors fear about ability of repayment of country issuing asset

The premia add to interest spread. Without these: Spread is only the expected return differential (0 if peg is credible)

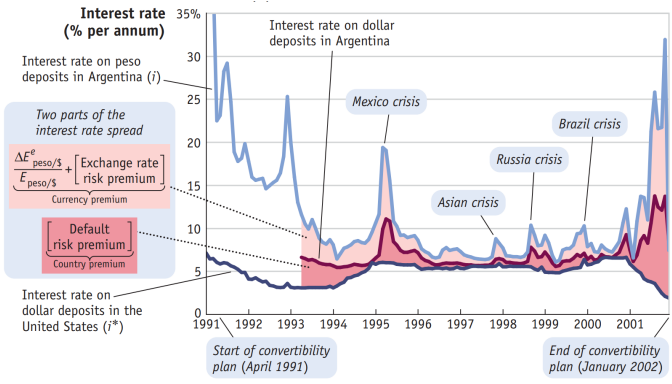
Money demand shocks: Risk premia and the FX market

Now the equilibrium interest rate changes not only because of changes in i^* but also due to the currency premium (exp. deprec $+\gamma_{fx}$) and country premium (γ_{def})

Example of a shock: higher country premium ($\gamma_{def} \uparrow$) $\longrightarrow$ shifts FR up



The premia in the data



Source: econstats.com, ft.com, and Danish Bankers Association

Volatility of Argentina's rate did stem from premia (default and currency risk)

Takeaway: Pegs in emerging markets are subject to stronger shocks (due to credibility problems)

Makes them more likely to fail at defending peg

Response to domestic credit shocks

Shock: B changes $\longrightarrow \Delta B = 100$ (all else equal)

We assumed B was constant and given but in reality it may change

Change in balance sheet:

Assets		Liabilities	
Reserves (R)	500	Money Supply (M)	1000
			+ 100
			1100
Domestic Credit (B)	500		
	+ 100		
	1100		

"All else equal" $\Rightarrow$ money demand ($i,\ Y,\ L(\cdot)$) is unchanged $\Rightarrow$ higher money supply leads to $i \downarrow$, DR shifts down, and $E \uparrow$ (depreciation)

Something has to be done by the CB or the peg breaks $\longrightarrow$ Sterilization is the answer

Sterilization

Definition: Offsetting operation to undo the effects of FX interventions on money supply

How it works: CB sells reserves to buy home currency (pesos), taking money out of circulation

Why it's done? $\longrightarrow$ To nullify to the effect on M from an increase in B

(in a peg this is critical: CB efforts usually go in the direction of not changing M or interest rates (i))

Assets		Liabilities	
Reserves (R)	500	Money Supply (M)	1000
	-100		+ 100
			- 100
Domestic Credit (B)	500		1000
	+ 100		
	1000		

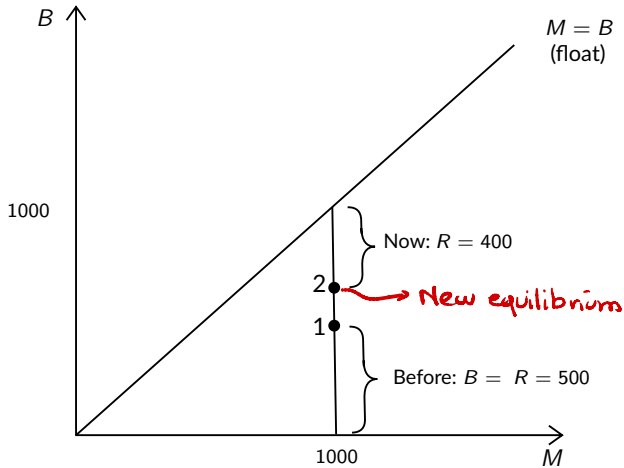
- With this, money supply (and the ER) won't change - Backing ratio falls from 0.5 to 0.4

We call this a **sterilized intervention** because the money supply is unchanged

(i.e., there was a FX intervention whose effects on money supply are "sterilized")

CB balance sheet plot: Sterilization

The sterilization above consists on moving from point 1 to 2 in the plot:



Domestic Credit Changes: ΔB

Central bank oversees the private banking sector: tries to ensure "Financial Stability"

- It regulates how much money private banks must have as reserves (relative to deposits)
- Lends money to private banks when they need liquidity
- Recently, have also provided bailouts to insolvent banks (Global Financial Crisis of 2008)

All this flow of resources from CB to banks lead to chances in B

Balance sheet of a private bank:

Assets		Liabilities	
Cash	10	Checkable deposits	20
Securities	50	Savings deposits	150
Loans	140	Capital	30

Banks can become insolvent or illiquid and request help from CB via ΔB

Insolvent Banks

A bank is insolvent if its liabilities exceed its assets $\longrightarrow L > A$

A solvent bank can become insolvent when the value of its assets falls

Sometimes a bank fails $\longrightarrow$ liquidates its assets to pay back debtors (depositors)

Other times, the bank is deemed to important to fail and CB bails it out (saves it)

- It does so by lending it cash so it can improve its balance sheet slowly
- Money demand does not change here. Then these loans to private banks ($B \uparrow$) are sterilized with reserves

Insolvent Banks (cont.)

To bail out insolvent banks and sterilize:

$B \uparrow$ (domestic lending/credit), Reserves $\downarrow$, and M remains the same

Central Bank balance sheet after a 100M bailout:

Assets		Liabilities	
Reserves (R)	500	Money Supply (M)	1000
	-100		
Domestic Credit (B)	500		
Domestic bonds			
Loans to private banks	+100		

Offsetting Operation →

Shock →

Note how this policy response (bailing out the bank) lowers the backing ratio $\frac{R}{M}$

Illiquid banks

A bank may be solvent ($A > L$) but not have enough cash to cover withdrawals

Consider: Increase in money demand of $ 100

- People try to withdraw $100 from banks
- Banks may not have enough liquid assets to meet this request at once
- Although the bank is solvent, customer can't withdraw their deposits $\longrightarrow$ this creates Financial Instability
- Probability of a bank run increases
  Bank run: massive withdrawal by public (usually speculative)

Central bank can help and lend the $100 to the banks $\longrightarrow$ it does so by $B \uparrow$

What happened here?

1. Liquidity shock $\longrightarrow$ 2. Domestic lending as response ($B \uparrow$)

Illiquid banks (cont.)

Notice that here money demand does increase: People want to withdraw more money

- It's different than the bail out to insolvent banks

Then: CB does not need to sterilize the increase in domestic credit (lending)

- That is: M (supply) can and would grow:

$$R = \underbrace{PL(i)Y}_{\text{grows}} - \underbrace{B}_{\text{grows}}$$

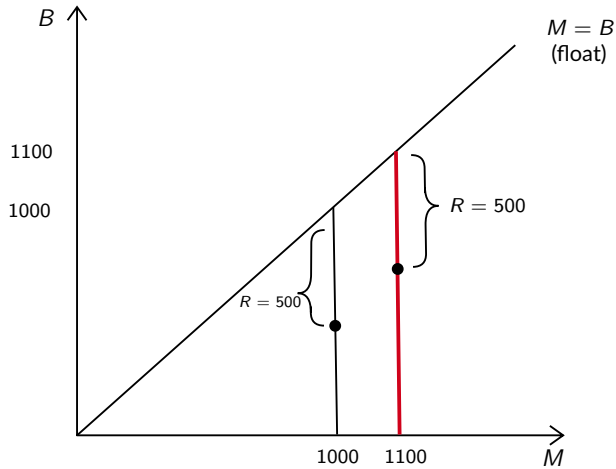
Therefore: No need to deplete reserves (R does not change)

Backing ratio still falls: $\frac{R}{M} \downarrow$

CB's capacity of defending peg falls

CB balance sheet plot: $M^D \uparrow$ and illiquid attack

The "fixed line" shifts to a point with higher money supply



Links between markets and crises

CB lending depletes reserves

- This lowers the backing ratio and may put the ER peg at risk
- This is how a severe banking crisis may lead to a currency crisis

In practice we see ER crises coexisting with banking and default crises

Banking, ER, Default crises feed and make more likely each other (Kaminsky & Reinhart, AER, 1999)

ER crisis feeds banking and default crises $\longrightarrow$ valuation effect (higher foreign debt), erosion of wealth

Banking and Default make more likely an ER crisis $\longrightarrow$ pressure on CB to bail out banks or fund government with monetary emission

A more general Central Bank balance sheet

Central banks can borrow too and in both currencies:

Assets		Liabilities	
Foreign assets	950	**Foreign liabilities**	50
Foreign reserves	950	Foreign Currency Debt issued by CB	50
Gold	0		
Domestic assets	**500**	**Domestic liabilities**	**400**
Domestic bonds	300	Debt issued by CB (sterilization bonds)	400
Loans to private banks	200		
		Money supply	**1000**
		Currency in circulation	900
		Commercial bank reserves	100

The same equations still hold (we only added more detail)

$$R + B = M$$
$$(R_A - R_L) + (B_A - B_L) = M$$

Sterilization bonds

Sterilization: Issue bonds (get indebted) to undo effects of FX interventions on money supply

The balance sheet equation still applies, but in net terms (net: assets - liabilities)

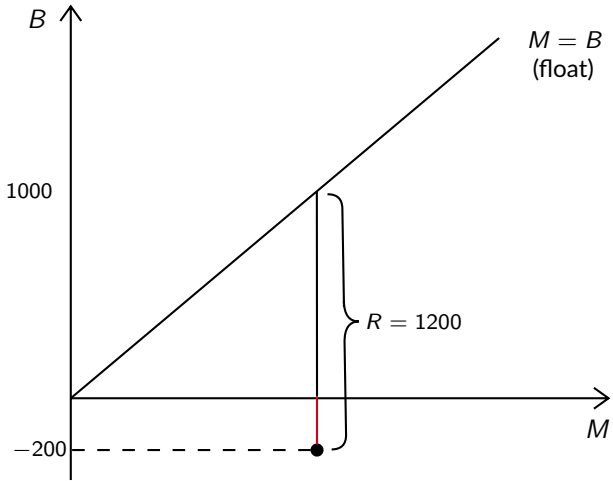
$$\begin{aligned} R \quad + \quad B \quad &= M \\ (R_A - R_L) + (B_A - B_L) &= M \end{aligned}$$

If you have more local currency liabilities (than assets): $B < 0$

Borrowing, i.e., $B < 0$ allows to accomodate $R > M$ if needed $\longrightarrow$ backing ratio > 1

Some central banks have done this before

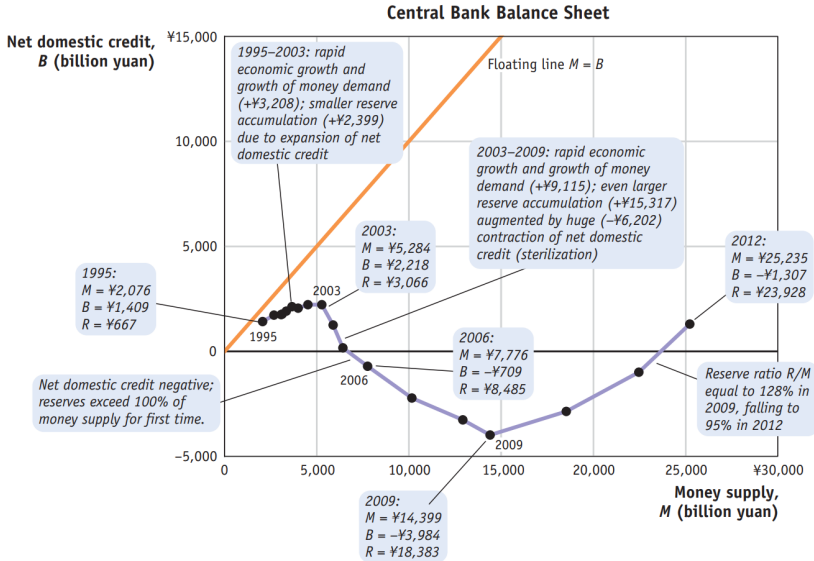
CB balance sheet plot: Sterilization bonds



$$1000 = 1200 - 200$$

$$M = R + B$$

Example: People's bank of China - balance sheet



Source: IMF - IFS

The Argentinian case: 1991-2001

R grew with M in a fixed ER peg

But there was a positive interest rate shock (UIP wedges) due to higher country and risk premium

M lowered due to lower Y (GDP) $\longrightarrow$ lower money demand ($PL(i)Y$)

[Consistent with peg] to defend peg: reserves fall ($M = R + B$)

- The CB sold FX reserves

CB had to sterilize the FX intervention by buying assets ($B \uparrow \ldots \bar{M} = R \downarrow + B \uparrow$) with home cash

- putting more money in circulation

CB reverted later this and went back to 100% baking ratio ($R = M$)

But confidence in the Peso (and peg) lowered and led to eventual termination of currency board

Let's see this story in more detail …

The Argentinian case (cont.)

1991: Argentina fixed the peso to the dollar at 1 to 1

Done to provide a nominal anchor [link]

1993-1994: Steady output growth, money demand increases

CB responds to growth in money demand ($M \uparrow$, fixed line shifts right)

Dec 1994: Crisis in Mexico spills over to Argentina and spreads rise

CB responds to decrease in money demand ($M \downarrow$)

1995: High interest rates decrease output and investment

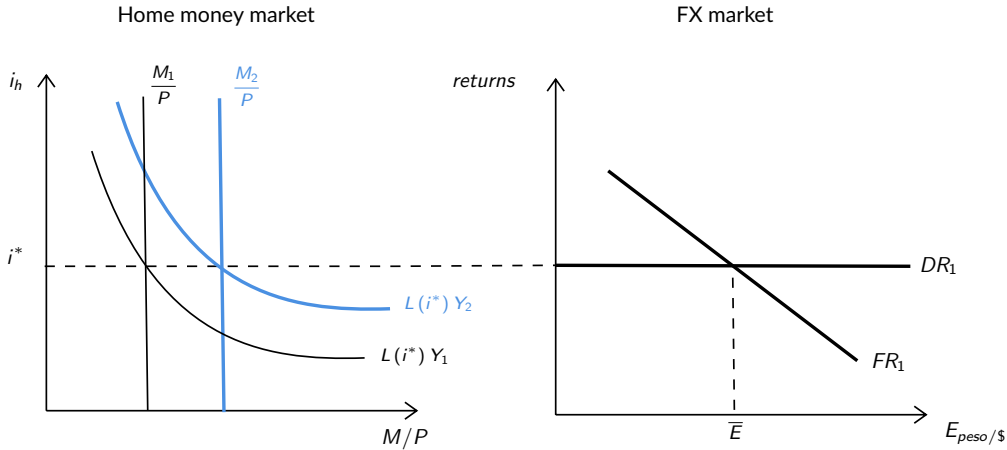
CB responds to increase in domestic credit (M stabilized) (Remember: ΔB does not shift fixed line)

1995: IMF extends credit to Argentina, the peg is deemed credible and the economy recovers

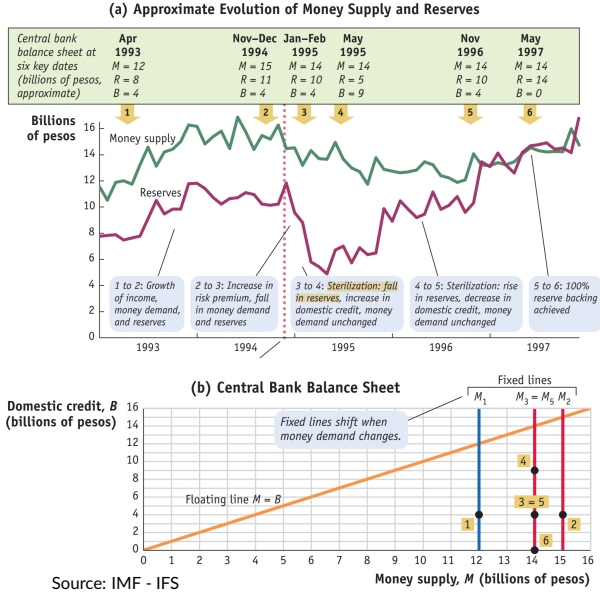
1993-1994: Money demand grows

"Convertibility plan" $\longrightarrow$ aimed to end hyperinflation and boost economic recovery

Output grows $\longrightarrow$ money demand grows $\longrightarrow$ (to maintain ER peg) money supply grows



Argentine Central Banks' balance sheet



Source: IMF - IFS

Movement from (1) to (2):

M: $12 \rightarrow 15$

R: $8 \rightarrow 11$

B: Unchanged

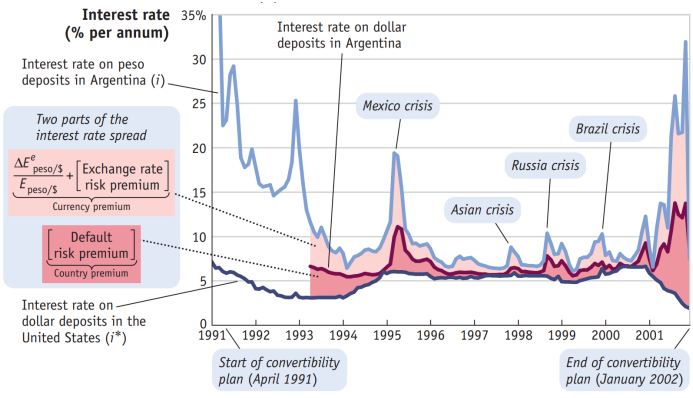
Dec 1994 - early 1995: Mexican Crisis spills over to Argentina

With Mexican debt/ER crisis concerns about other emerging countries arises

Increase in Argentina's risk premium (county and currency premia ↑)

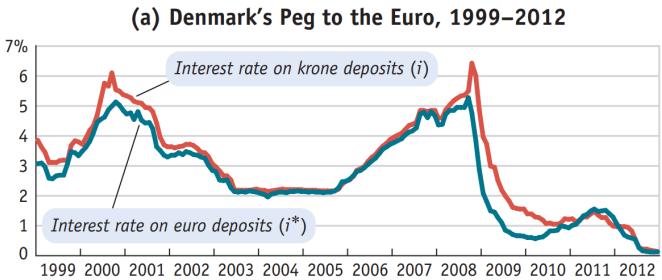
Interest rate jumps: $i^{arg} \uparrow = i^* + (\gamma_{fx} + \gamma_{def}) \uparrow$

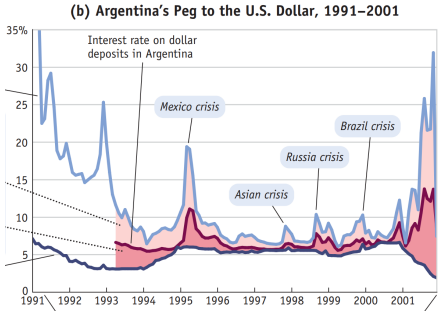
Plug i^{arg} in money demand $\Rightarrow$ money demand lowers: $R + B = PL(i^* + (\gamma_{fx} + \gamma_{def}))Y$



Comparison with other countries' peg

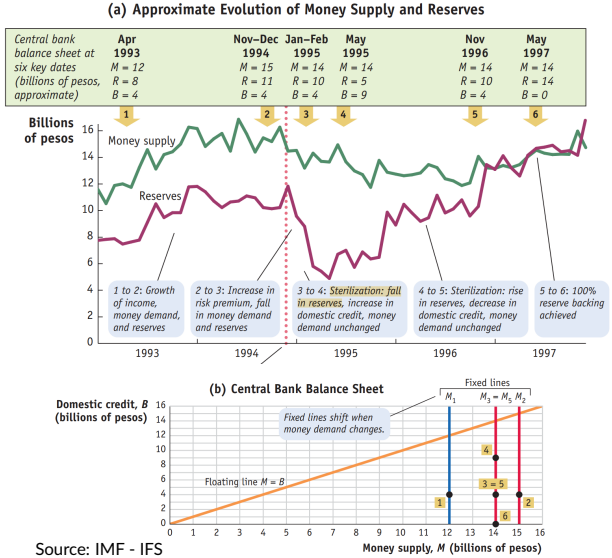
We can see how the premia terms in the UIP make a big difference for countries with less credible ER regime





$$i^{dry} = i^{*} + (\gamma_{fx} + \gamma_{def})$$

Argentine Central Banks' balance sheet: Tequila crisis management



Source: IMF - IFS

Movement from (2) to (3):

M lowers: $15 \rightarrow 14$

R lowers: $11 \rightarrow 10$

B: Unchanged

1995: Domestic credit increases

$i \uparrow$ lowered output and investment

This disrupts banking sector: loans fall, solvency and liquidity problems surged

CB comes in and helps banks by lending to them: $B \uparrow$

$$R\downarrow + B\uparrow = PL(i^* + \gamma_{fx} + \gamma_{def})Y$$

Money demand is about the same $\longrightarrow$ then $R \downarrow$ sterilizes effect of $B \uparrow$

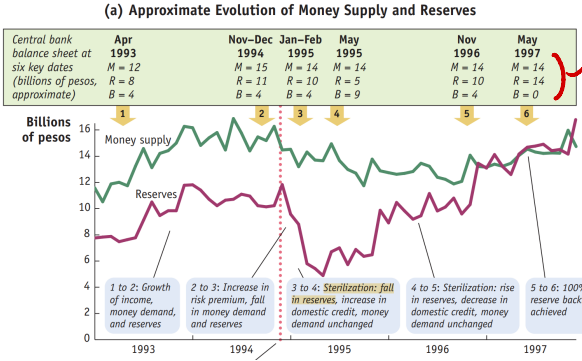
If CB has reserves then ΔB doesn't increase money in circulation, only shocks to monetary demand does

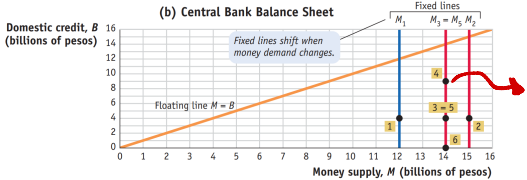
ΔB instead changes composition of balance sheet and banking ratio

Banking ratio falls: $\frac{10}{14} = 0.7$ to $\frac{5}{14} = 0.36$

Concerns about peg sustainability $\uparrow$: people convert pesos to dollars $\rightarrow$ downward pressure on reserves ($R \downarrow$)

Argentine Central Banks' balance sheet: Sterilization and fall in reserves





Backing ratio: 100%.

Movement from (3) to (4):

M: Unchanged R lowers: $10 \rightarrow 5$

B increases: $4 \longrightarrow 9$

Remember: ΔB does not change money supply but puts pressure on peg: lowers backing ratio

Closer to Floating

Source: IMF - IFS

1995: Borrowing Reserves from the IMF

Fear of banking and ER crisis grows and starts affecting th economy in general

The IMF "saves the day" by extending a line of credit to Argentina ($R \uparrow$)

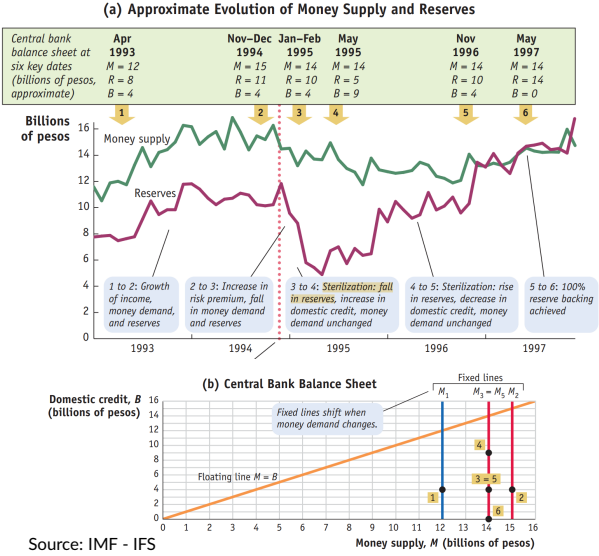
With the loan:

- Agentina gets liquidity to pay sovereign debt
- Banks are recapitalized (bailouts)
  CB sells commercial bank loans to government for reserves
- Reserves are replenished $\longrightarrow$ **backing ratio returns to 1**

Exchange rate is seen as credible again. Peso deposits flow back into banks (risk of bank run lowers)

The economy is stable again and starts growing

Argentine Central Banks' balance sheet: Sterilization with rise in reserves



Source: IMF - IFS

Movement from (4) to (5) and (6):

M: Unchanged $\quad R \uparrow$: $5 \rightarrow 10 \rightarrow 14$

B decreases: $9 \longrightarrow 4 \longrightarrow 0$

Toward currency board $\longrightarrow$ backing ratio of 100% (10/14 to 1)

Argentina's convertibility plan

The convertibility plan survives its first real test

Following years are good and stable

But the economy starts to fade in late 1990s …and **Fiscal Dominance** issues start taking its toll

Fiscal inconsistent policies with peg eventually break it in 2001

Fiscal Dominance: Government wants to run larger deficits with CB financing

- Government issues bonds and "force-sells" them to CB for cash $\longrightarrow$ Monetization of fiscal debt
- Making the CB print more and increase money supply
- This makes peg unsustainable ($B \uparrow$ too much, making $R \downarrow$ until $R = 0$ and then $M \uparrow$)

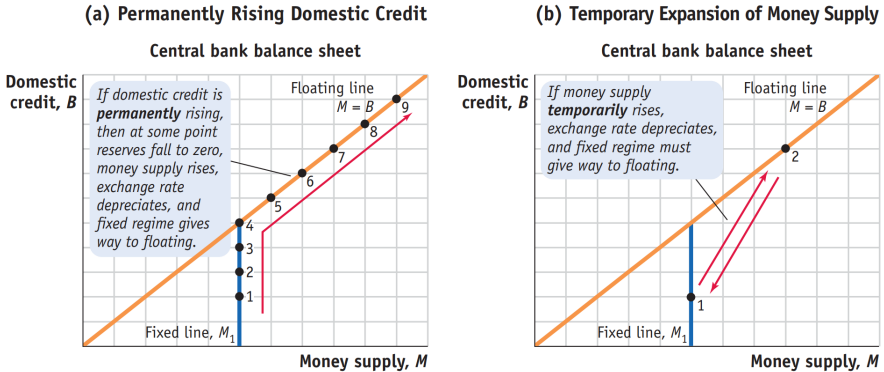
↳ ⇒ Go back to Floating

Two types of reserve crisis

The Argentinian case shows **one type of "peg breaking:"** Unsustainable & frequent increases in B

Eventually reserves become zero & money supply increases depreciating the ER (breaking the peg)

Another type of ER crisis: When increase in M is temporary but strong enough to prompt a strong ER depreciation



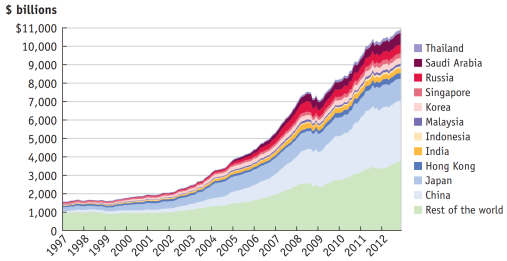
FX Reserve accumulation

By now we can rationalize the EMEs large FX reserves accumulation:

1. higher backing rations permit to absorb larger money demand shocks
2. with Reserves the bank can cover shortfall of foreign capital during Sudden Stops
   (this justifies ratios of less than 100% of M0)
3. Financial stability concerns may justify a higher reserve buildup to cover shortfalls in M2
   (M2 is way larger than M0, thus, this justifies ratios way larger than 100% of M0)

For EMEs like Argentina, this is critical $\longrightarrow$ they could not defend their peg with a 70% backing ratio!

Figure: Reserve Accumulation 1997-2012 (source: IMF)



Wrap-up

- We saw that is not trivial for a CB to manage an ER peg regime

- Requires ample Reserves and capacity to keep money supply stable to prevent depreciations

- Fiscal Policy needs to be consistent
(i.e., running growing deficits funded with CB cash is not compatible with peg)

- Harder task for countries with high perceptions of currency and default risk $\longrightarrow$ Argentina!

$\Rightarrow$ as much as it can be beneficial to stabilize the ER, the task is far from trivial and carries costs

This is what is behind the whole course:

Countries choose ER regimes depending on what's going on (with other policy goals too) and tend to jump from one regime to the other...

Yet, managing regimes is better than full autarky ... you want to be integrated to enjoy the benefits of globalization

How pegs break: ER crises models

Exchange Rate Crises

An FX crisis is a **big** depreciation (what is "big" can be subjective)

- Advanced economies (AE): 10-15%
- Emerging economies (EME): 20-25%

Crises tend to come in waves

- Because of fundamentals (common shocks)
- Because of contagion (external conditions)

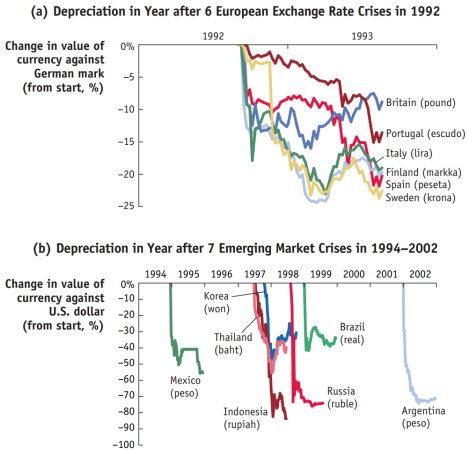
They are often accompanied by banking and default crises

- We've mentioned how these can lead to ER departures from their expected values

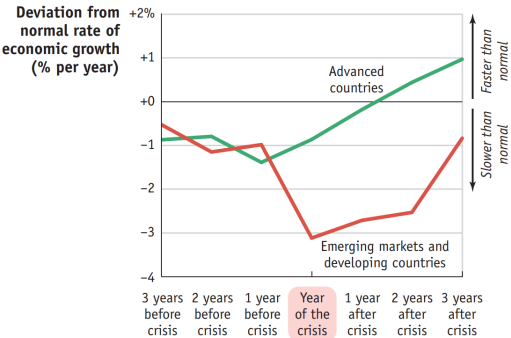
$$i - i^* = \frac{E^e}{E} - 1 + \gamma_{fx} + \gamma_{df}$$

Exchange Rate Crises - examples and cost

These crises have important economic growth costs



Source: OANDA.com



Source: Obstfeld and Taylor (2004)

Two types of FX crises

1. Inconsistent Fiscal Policy (1st generation) - Fiscal Dominance
   - Fundamental problem: Central Bank is NOT independent.

2. Contingent Monetary Policy (2nd generation)
   - Fundamental problem: Central Bank lacks commitment.

Inconsistent Fiscal Policy

- Classic Emerging Market crisis
- Fiscal authority runs government budget deficit $(T - G) < 0$
- Deficit is funded with debt, but eventually public will not buy more debt
- Central bank is **not independent**: Fiscal authorities pressures CB into printing more money to buy debt: monetization
- Monetization: Increase in B, which leads to decrease in R.
  - Reserves fall
  - Peg breaks