Exchange Rate Systems

Free Float, Fixed and Mixed

Exchange Rate Systems

• **Pure FX Rate Systems**
- Free Float or Flexible
- Fixed

• **CB: Brief Review**

A CB is a "bank." It holds:

◊ Assets: Foreign (FC Reserves FC bonds)) + Gold + Domestic (mainly loans to domestic institutions and government securities)

◊ Liabilities: DC outstanding (backed by assets the CB owns) + Deposits of banks.

Note: Change in assets = change in liabilities => A purchase of an asset, say FC (or the unusual assets bought during the financial crisis), results in an increase in the liabilities, through an increase in the MS.

Table II.1
U.S. Federal Reserve Balance Sheet (December 2017)

Consolidated U.S. Fed Balance Sheet (in USD billions)			
Liabilities		***Assets***	
Federal Reserve Notes	1,569.1	U.S. Treasuries	2,454.2
Reverse Repurchase Agreements	386.8	Mortgage Backed Securities	1,764.9
Deposits	2,445.1	Gold	11.0
Other liabilities	6.3	SDR	5.2
Total	***4,407.3***	FC Denominated Assets	21.2
		Central Bank Liquidity Swaps	12.0
Capital Account	***41.4***	Other assets	180.2
Capital paid in	31.4	***Total***	***4,448.7***
Surplus	10.0		

• **Capital Account**

Capital Account = Total Assets – Total Liabilities (USD 41.4 billion)

Surplus: Retained earnings not paid to the US Treasury (USD 10 billion).

• **CB: Brief Review - Roles**

• Historical roles of a CB:

- Lender of last resort ("*Bank of banks*")
- Supervisor of financial institutions.

This is the banking side of a CB.

• But, a CB is also the Monetary Authority: It controls the domestic money supply (MS), with the responsibility over

- Inflation (I_d low)
- Economic GDP (Y_d close to full employment).

This is the economic policy side of a modern CB (today, the main role).

• Targets are conflicting: CBs set i_d, balancing I_d and Y_d.

• CB: Brief Review – Monetary Policy

• Textbook (Monetary Economics) example:

Fed lowers the Fed rate ⇒ other interest rates in the economy fall ($i_d \downarrow$)

⇒ Lower i_d stimulate spending (aggregate demand, AG, ↑).

⇒ Businesses respond, increasing production (aggregate supply ↑)

⇒ Economic growth up (Y ↑)

Now, if the increase in AG is big enough it can push up P_d (& I_d↑).

• In general, all the above effects take time: 1-3 years.

Some estimates point that a 1% decrease in a CB rate, increases Y_d by .5% - .75% over 2 years & I_d by .25% over 2-3 years.

Aside Note: What is the effect on S_t? On average, a 1% surprise increase in i_d increases S_t by 1.5% almost immediately.

• CB: Brief Review – Policy Rules

• CBs balance I_d and Y_d; following a *policy rule*:

$$i_d = f(I_d, Y_d - Y_{\text{Full Employment}})$$

In practice, CBs tend to follow a *Taylor rule*:

$$i_d = \omega + \lambda I_d + \theta Y\_gap$$

$\omega = r^* + \gamma (-I_d^*) = 2\% + .5 * (-2\%) = 1\%$

$\lambda = 1 + \gamma = 1.5$

$\theta = 0.5$

r^* = real interest rate = 2%

I_d^* = CB's target I_d = 2%

$Y\_gap = Y_d - Y_{\text{Full Employment}}$

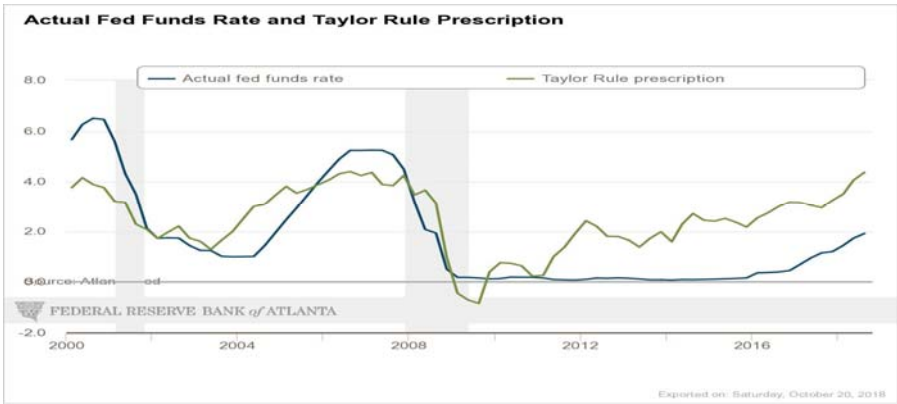
Note: According to the Taylor rule, U.S. interest rates are low (2018 Q3): It should be 4.20%, but it is 2% (& also low 2002-2005, pre-financial crisis).

• CB: Brief Review – Policy Rules

• Taylor rule variations: Gradual adjustments, reflecting the practice of gradual, small adjustments in interest rates. This *modified Taylor rule* is:

$$i_{d,t} = \rho\, i_{d,t-1} + (1 - \rho)\,[r_t^* + I_{d,t} + \gamma\,(I_{d,t} - I_{d,t}^*) + \theta\, y\_gap_t]$$

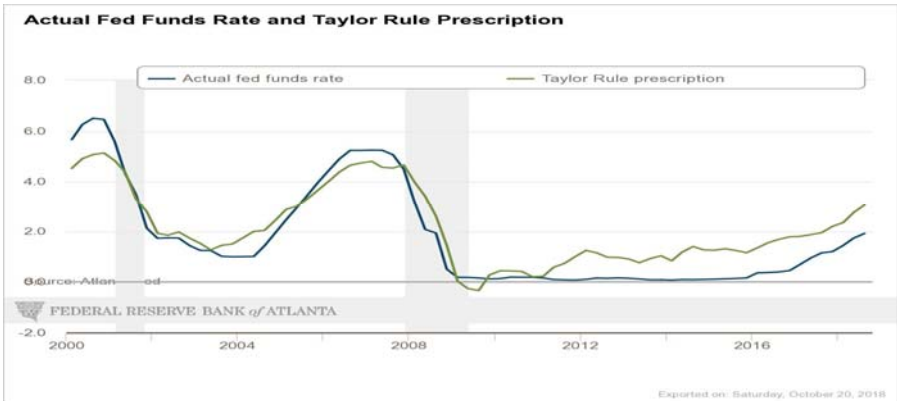
where ρ is the smoothing parameter (ρ=0, original Taylor rule).



• CB: Brief Review – Policy Rules

• If we use the *modified Taylor rule*, with ρ = 0.5, we have a better fit.

Now, the prescribed interest rate should be 3%, closer to the observed 2%.



• CB: Brief Review - Names

Around the world, CBs have different names: U.S. Federal Reserve System ("The Fed"), European Central Bank (ECB), Central Bank of UAE, Central Reserve Bank of Peru, Bank of Mexico, Swiss National Bank, Monetary Authority of Singapore, etc.

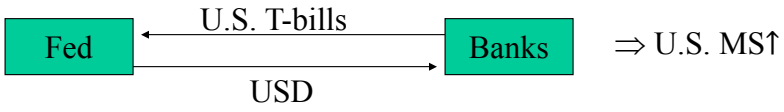
• CB: Brief Review - Open Market Operations

CBs have several monetary policy instruments. The most important:

- ◊ Open market operation (OMO)
- ◊ Bank reserve requirement
- ◊ Interest rate policy

OMOs are the main policy tool. Through an OMO, a CB puts money in and takes money out of the banking system, by buying/selling government securities (say, U.S. Treasury bills):

- MS Increase: CB buys securities from banks, paying with DC.

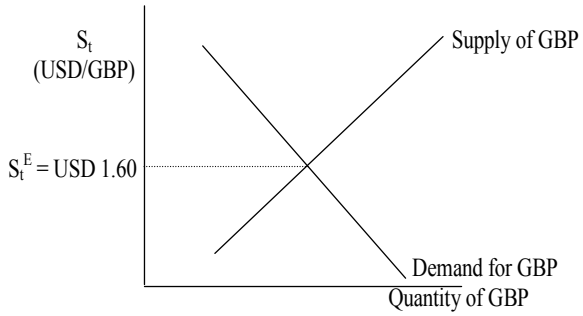


⇒ U.S. MS↑

- MS Decrease: CB sells securities to banks, receiving DC.

1. Flexible Exchange Rate System (Free Float)

In a *flexible exchange rate system* the CB allows the exchange rate to adjust to equate the supply and demand for foreign currency.



All the variables mentioned before (i_d - if ; I_d - I_f , etc.) will affect S_t. In particular, international capital flows will change S_t.

Whatever S_t is, the CB is fine with it.

Features of a Free Float

- S_t reflects economic activity, through S & D for FC.
- S_t is subject to volatility (there is FX risk!).
- Money supply is exogenous. Thus, the CB has an independent monetary policy.
- Under certain assumptions (IS-LM model, perfect capital mobility), fiscal policy does not work.
- External shocks (say, oil shocks or sudden outflows of capital) can be quickly be absorbed by changes in S_t^E.

Milton Friedman, Nobel Prize Winner, (1953) argued that under a free float *"changes in S_t occur rapidly, automatically, and continuously and so tend to produce corrective movements before tensions can accumulate and a crisis develop."*

Terminology

A currency *depreciates* (*appreciates*) when, under a free float, it becomes less (more) expensive in terms of foreign currency.

2. Fixed Exchange Rate System

In a *fixed exchange rate system* the Central Bank is ready to buy and sell *unlimited* amounts of domestic currency at set (*fixed*) price, say S*.

Example: Hong Kong has a fixed exchange rate (a peg) system since October 17, 1983. The exchange rate is S*=7.8052 HKD/USD.

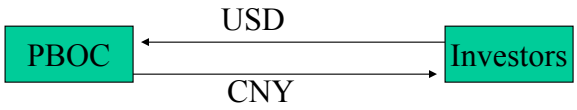
Note: The HKD is not fixed against all currencies, only against the USD.
The USD moves ⇒ the HKD moves.

From 2010 to 2015, the USD moved widely against the EUR, the HKD also moved: From 11.50 HKD/EUR (Apr 24, 2011) to 9.15 HKD/EUR (Jan 8, 2015). ¶

• In order to support the fixed parity S*, a CB needs
- enough DC to buy "unlimited" amounts of FC.
- enough reserves (FC) to buy "unlimited" amounts of DC.

• Every time somebody buys FC from the CB, the money supply (MS) decreases. International capital flows will affect the domestic MS.

Example: International capital inflows to China



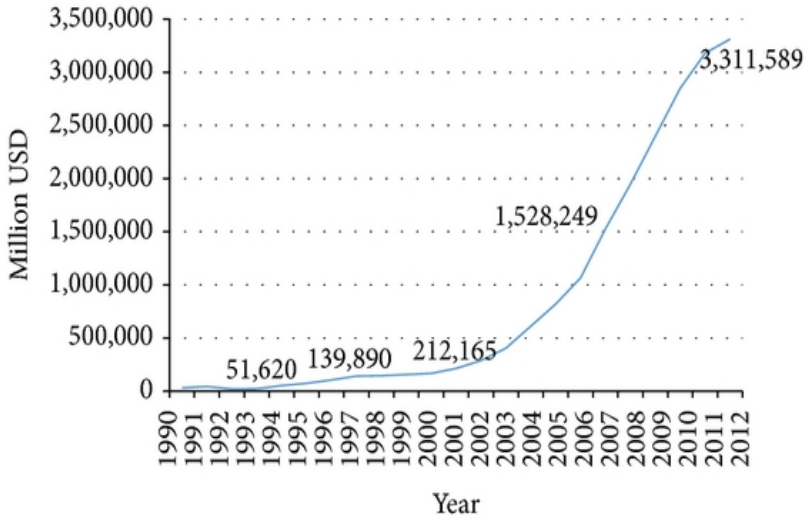
⇒ China's MS↑

Note: The People's Bank of China (PBOC, China's CB) may not like an increase in the MS (along with lower i_{CNY} & inflationary pressures) and take some counteraction to mitigate the increase in MS. ¶

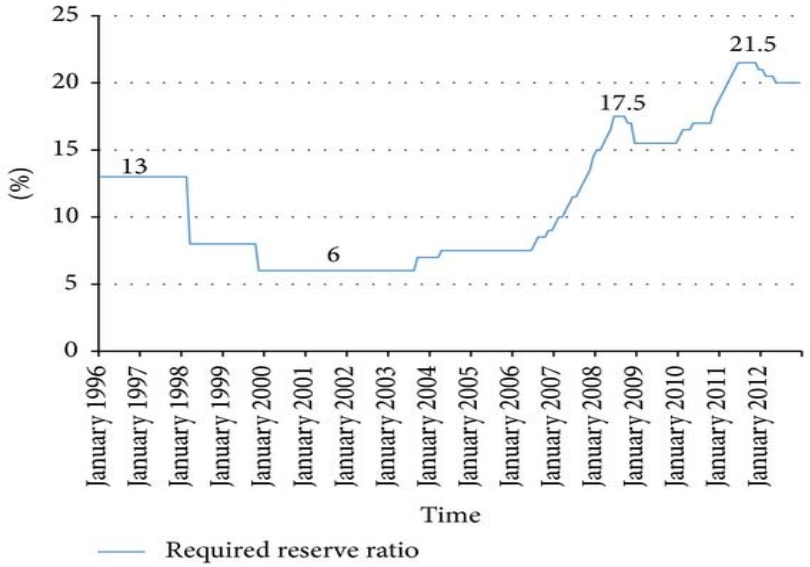
A CB counteraction taken to mitigate the effect of some variable (say, capital inflows) on the domestic MS is called *sterilization.*

Example: For the past 30 years, China has maintained a fixed FX system and received huge capital inflows. To sterilize the PBOC has changed its RRR 42 times since 1998, currently stands at 20% (twice as in U.S.).

Accumulation of foreign exchange reserve in China—2000 to 2012 (taken from Chung, Hwang, & Wang, 2014):



Change of required reserve ratio in China (taken from Chung, Hwang, & Wang, 2014):



Fixed FX System: Variations

Some CBs have a fixed exchange rate system, but S_t is not really fixed:

- "*Target zone system*," where the exchange rate is kept within a band (the *target zone*).
- "*Crawling peg system*," where the fixed exchange rate is regularly adjusted, usually to keep up with domestic inflation.

Example: On July 21, 2005, the People's Bank of China (China's CB) announced that the CNY would be pegged to a basket of foreign currencies, rather than being only tied to the USD.

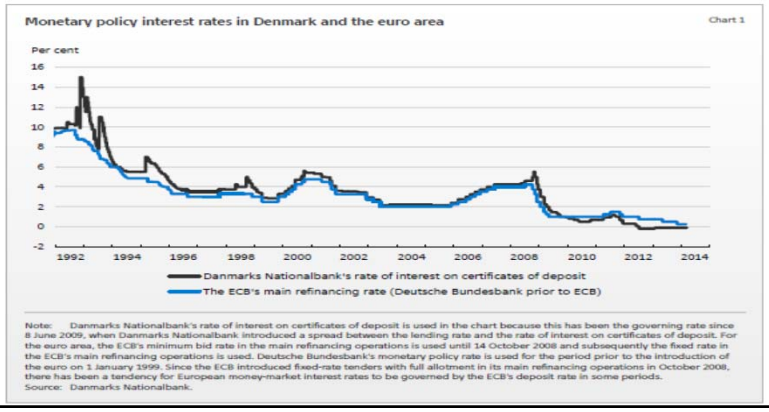
The CNY would trade within a narrow 0.3% band against the basket of currencies. The basket is dominated by the USD, EUR, JPY and KOW.

The Central Bank of Chile, in 1983 (adjusted in 1984), adopted a crawling peg with a fluctuation band of ± 0.5%. The CLP/USD was adjusted according to the previous month's inflation minus an estimate of U.S. inflation (around 2% annually). ¶

Example: Giving up Monetary Policy

Since 1982, Denmark adopted a target zone system, pegging against the DEM and, in 1999, to the EUR. Following the ERM II, S_t is fixed at S*= 7.46038 DEK/EUR, but it may fluctuate by ± 2.25%.

When the ECB changes its monetary policy interest rates, Danmarks Nationalbank typically responds by making similar changes.



Features of Fixed System

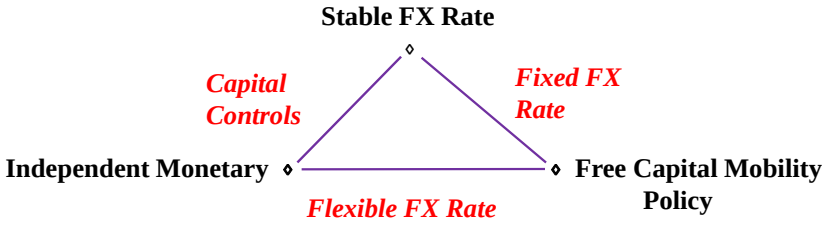
◊ Money supply is endogenous ⇒ No *independent* monetary policy!
◊ Exchange rate has no/low volatility. (Good for trade, investments.)
◊ Under certain assumptions (same as above), fiscal policy works.
◊ If CB does not have enough reserves, *credibility* is crucial.
◊ Since S_t is fixed, external shocks have to be absorbed through prices, which tend to be rigid. (Slower adjustments to shocks/imbalances.)

Trilemma (due to Robert Mundell (1962), Nobel Prize Winner)

It is impossible for a country to have at the same time:

- ◊ A fixed (stable) FX regime.
- ◊ Free international capital mobility –i.e., no capital controls.
- ◊ An autonomous (independent) monetary policy.

A country can have two, but not the three:



⇒ *Inconsistent* monetary policy = Attempt to have the three things.
A "consistent" inconsistent monetary policy leads to currency crisis.

Typical Trilemma problem

• Under a fixed system, the local government substantially increases the domestic money supply (MS_d) to finance deficit spending or to mitigate an external shock:

$MS_d \uparrow \Rightarrow i_d \downarrow \Rightarrow (i_d - i_f) \downarrow \Rightarrow$ International capital outflows

$\Rightarrow$ CB's FC reserves $\downarrow$.

In a free float, $S_t \uparrow$ (>S*). That's the adjustment. But, under a fixed system, S* does not change. This is a problem!

Note: If we think of the free float S_t as the "true equilibrium" ("*shadow*") FX rate, (S_t - S*) signals a potential profit for speculators. Eventually, if inconsistency continues, a *speculative attack* on the FC reserves occurs.

CB Dilemma: To Defend or Not To Defend? A CB considers the costs and benefits of defending the fixed parity, S*.

• Usually, CBs defend S*.

Currency Crisis

A CB cannot support a Fixed FX System anymore, because it is running out of FC reserves. (Currency Run: domestic residents *run* to banks to exchange DC for FC, before banks run out of FC!).

Solution to a currency crisis: Float the currency.

Currency crisis are not uncommon. Often, they come from an *inconsistent* fixed FX system –for example, the CB attempts to have an independent monetary policy. Then, over time, CB credibility weakens.

Predictors of a currency crisis ("*early warning signals*"): Low FX reserves, high government deficits, low real exchange rate (DC overvalued, often due to high domestic inflation), weak financial system, high short-term debt, etc.

Example: Mexico '94 (Tequila), Thailand '97 (Rice), Russia '98 (Vodka), Brazil '99 (Caipirinha), Argentina '01 (Tango), Iceland '08.

Currency Crisis

• Usually, CBs defend S*. They borrow FC, substantially raise i_d, or impose capital controls. These actions may be costly and/or may cause (or make worse) a recession.

Definite solution to a currency crisis: Float the currency.

When a CB abandons S* because it is running out of FC reserves or the costs of defending S* are too high, a devaluation/depreciation occurs.

Speculators ask: Will the CB be able to defend the parity S*? Will the government bear the costs of defending it?

Currency Run: Domestic residents *run* to banks to exchange DC for FC, before the devaluation occurs (or banks run out of FC!).

Examples: Mexico ’94 (Tequila), Thailand ’97 (Rice), Russia ’98 (Vodka), Brazil ’99 (Caipirinha), Argentina ’01 (Tango), Uruguay ’03, Iceland ’08, Nigeria ’16.

Currency Crisis

• On average, a currency crisis is followed by a 30% drop of the value of DC. In many cases there is a temporary higher drop (say, 50%), before reverting to a value closer to the average.

A very serious crisis: 75% or more drop (Indonesia ‘97, Argentina ’01).

Terminology

A *devaluation* (*revaluation*) occurs when the price of foreign currencies under a fixed exchange rate regime is increased (decreased) by the CB.

Note: The possibility of a currency crisis creates a risk under the Fixed FX system: *devaluation risk*. The magnitude of this risk depends on the CB credibility –i.e., very credible CB, devaluation risk is zero.

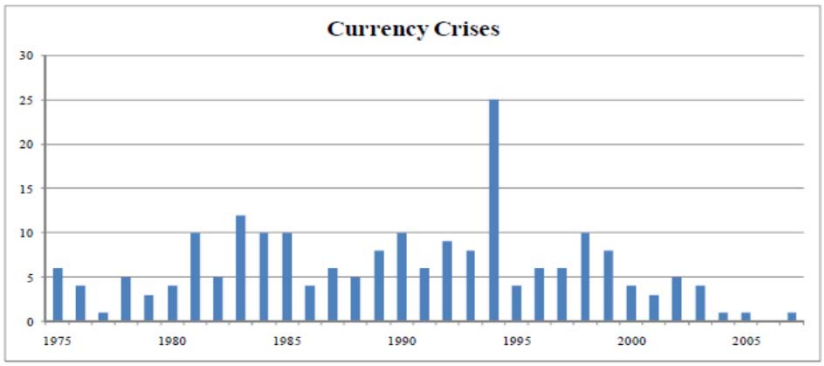
Currency Crisis are not a new phenomenon.
The first well-documented crisis is *The Kipper und Wipperzeit* (1619–1623), when the Holy Roman Empire states in their efforts to finance the Thirty Years' War (1618–48) *debased* its coins.
- *Kipper*: Coin clipping
- *Wipperzeit*: See-saw (an allusion to the counterbalance scales used to weigh species coin).

Two forms of debasement actually fueled the crisis:
(1) Reduce the value of silver coins by clipping shavings from them;
(2) Re-mint coins by melting the old coins and mixing them with inferior metals.

Photograph of a noticeably clipped (shaved) 1622 thaler minted in Prague

Reproduced courtesy of Archives, American Numismatic Society.

Currency Crisis are Common
Currency crisis are common. Figure below shows 208 currency crises – defined as a 30% depreciation of DC that is also, at least, a 10% increase from previous year– during the 1970-2008 period.

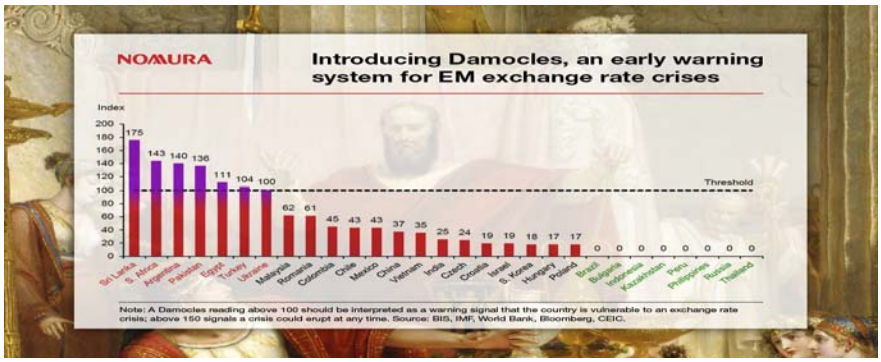


Note: Currency crisis is defined as a nominal depreciation of the currency of at least 30 percent that is also at least a 10 percent increase in the rate of depreciation compared to the year before. Five-year exclusion windows employed. The figure for 1994 is inflated by the devaluation of the 14 African members of the CFA zone against the French franc and the dollar.
Source: Laeven and Valencia (2008).

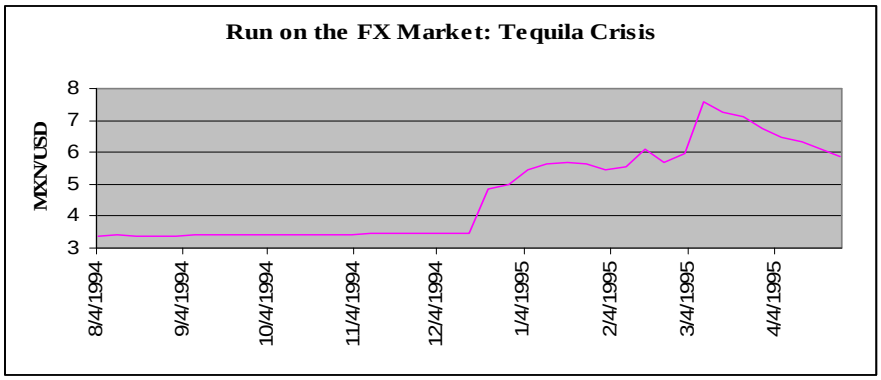
Currency Crisis: Predictors ("***Early warning signals***")

Predictors of a currency crisis: Low FX reserves, high government deficits, low real exchange rate (DC overvalued, often due to high domestic inflation), weak financial system, high short-term debt, etc.

Many traders use an index to predict a currency crisis. A new one is the "Damocles Index," used by *Nomura.* (Nomura claims 67% of past 54 EM currency crisis were predicted 12 months in advanced.)



Example: Mexico Dec '94 –The Tequila crisis



Mexican USD reserves went from USD 18B in October 1994 to USD 5B in December 1994, when the decision to abandon the fixed exchange rate against the USD was made.

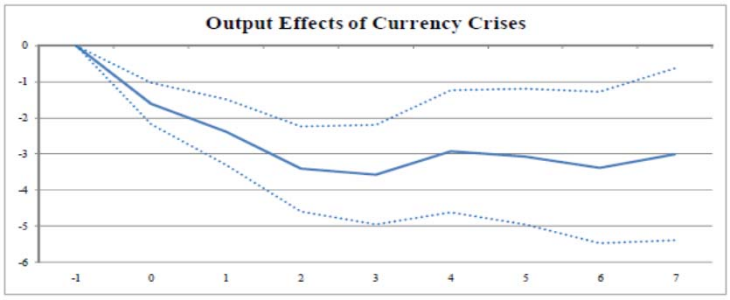
Overall, Mexico spent USD 25B in FC reserves and borrowed USD 25B (from the U.S. Fed) to defend the peso's dollar peg. ¶

Devaluations Are Unpopular

• Economic Reasons:

- Pass-through to import prices (Domestic prices increase) ⇒ Inflation
- Real wages decrease
- Contractionary impact on the economy: 3% loss of GDP after 7 years!

The contraction of the economy is usually associated with balance sheet effects –i.e., a mismatch between currency of denomination of debt (mainly, in FC) and income (mainly, in DC)– in corporate and government sectors.



Devaluations Are Unpopular

• Politicians are run out of office.

- Cooper (1971) finds that heads of state lose their jobs twice as often within 1 year of devaluation:

  30% as compared to 14% in a non-devaluation control group.

- Frankel (2005), updated sample 1971-2003 and measured exit 6 months after devaluation:

  23% (43 cases out of 109) as compared to 12% in the control group.

Twin Ds

• A currency crisis is usually a product of serious macro-economic problems: Sovereign defaults –a government decides not to pay its bonds – and/or banking crisis are not rare during these times.

In general, sovereign defaults are accompanied by large devaluations. These are the "*Twin Ds*": *Default* and *Devaluation*.

• Reinhart (2002), looking at the period 1970-1999:

- Prob[Devaluation|Default] = 84%
- Prob[Devaluation|No Default] = 17%

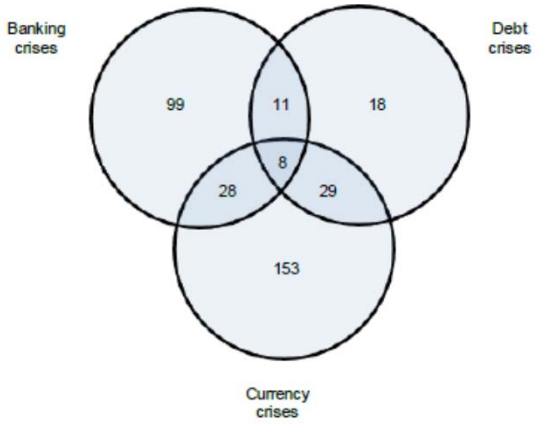
Na et al. (2017) expand sample to 2013: 84% is a high. New prob: 50%.

Laevan and Valencia (2012), using their own definitions of a currency crisis, find a similar probability: 56% (=37/66).

Twin Ds

• Laevan and Valencia (2012), using their definitions, report the following diagram with the *Twin Ds* and the *Twin Crisis* (simultaneous banking and currency crises).

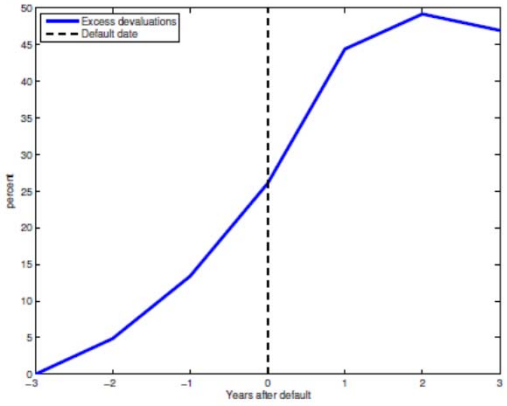
Figure 4. Simultaneous Crises



Twin Ds

• Default is usually followed by a large devaluation: 45% in 6 year window around a default event.

Figure 1: Excess Devaluation Around Default, 1975-2013



Na et al. (2017) suggest that these large devaluations are needed to realign prices (real wages) to avoid unemployment shock. In their model if no devaluation occurs (think Greece), unemployment is up by 20%.

3. Managed Float

In practice, the exchange rate system is a mixture: *managed* floating.
In general, we see a free float, but sometimes the CB *intervenes* to buy and sell FC with the *intent* of changing the market determined S_t.

4. Dual Systems

In some markets, S_t is fixed by the government. But, the government sells FC at the official S_t only for some transactions. For all the other transactions, a *black market* is created.

Example: Until 2002, Iran had three officially recognized exchange rates. In 1999; the rates were:

1) The "official" rate of 1,750 IRR/USD, for oil, gas and essential imports; the "export" rate of 3,000 IRR/USD;

2) The variable Tehran Stock Exchange rate of 7,863 IRR/USD, used by some exporters.

3) For all other transactions, the rate was 8,615 IRR/USD.

Range of Exchange Rate Regimes

Ranked in terms of (decreasing) flexibility for the CB:

- Free Float or Flexible
- Managed "*Dirty*" Float
- Crawling Peg
- Fixed
- Currency Board (Fixed + 100% FC reserves)
- Adopting a foreign currency as legal tender. When the U.S. currency is adopted, it's called "*dollarization*" (Panama, British Virgin Islands, El Salvador, Ecuador, Zimbabwe).

Exchange Rate Regimes: Fixed or Flexible?

Feature	Fixed	Flexible
	Cons	**Pros**
Adjustment to imbalances	Difficult	Easy
External shocks	Vulnerable	Less vulnerable
Support S_t	May need to raise i_d (or cause recession)	No need to do anything
Monetary policy	Ineffective	Effective
	Pros	**Cons**
FX Volatility	Stable S_t (good for trade & investments)	Volatile (P_d also volatile)
I_d: Control/Reduce	Good (with credibility)	Harder
Fiscal policy	Effective	Ineffective

Exchange Rate Regimes: Fixed or Flexible?

• Both regimes have pros and cons: No clear winner.

• Regime choices should reflect individual characteristics of an economy.

• We observe:

– Large economies with sound economic policies, good institutions (say, an independent CB) and high credibility prefer a flexible regime.

– Developed economies with bad economic policies, bad instituions and low credibility rely on a fixed regime.

• Aside: If a CB decides to fix, which currency should be the anchor? Stable trade & investments advantage suggests fixing against the currency of a large trading partner:

– In Latin America, the USD is a good choice.

– In Andorra (between Spain and France), the EUR should be the anchor.

Central Bank FX Intervention

• Definition

FX Intervention occurs when CBs buy and sell FC with the *intent* to change S_t to a different S_t^E.

• CBs have economic models to determine what they believe is an equilibrium S_t. Using these models, CB determines a range for S_t

$\Rightarrow$ S_t should move between $\mathbf{S_t^L}$ and $\mathbf{S_t^U}$.

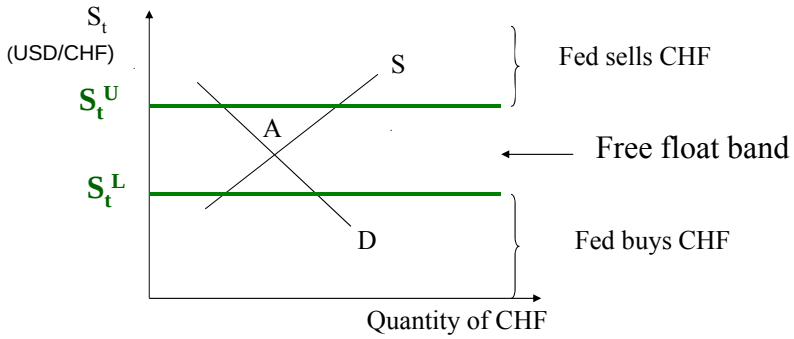
If S_t is within the range ($\mathbf{S_t^L} < S_t < \mathbf{S_t^U}$), CB does nothing (free float!)
If $S_t > \mathbf{S_t^U}$, CB determines FC is overvalued => CB intervention
If $S_t < \mathbf{S_t^L}$, CB determines FC is undervalued => CB intervention

Appreciating FC ($S_t > \mathbf{S_t^L}$) $\Rightarrow$ CB sells FC.
Depreciating FC ($S_t < \mathbf{S_t^U}$) $\Rightarrow$ CB buys FC.

Situation: Suppose the US Fed follows the value of the CHF.

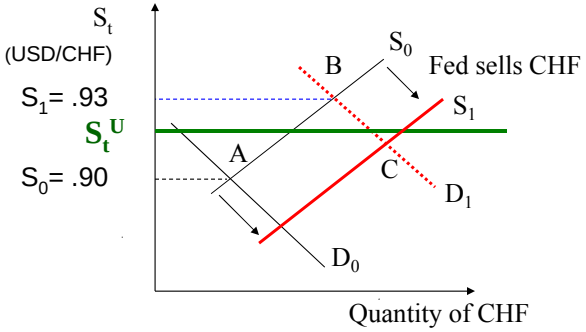
If S_t is within the range ($S_t^L < S_t < S_t^U$), Fed does nothing
If $S_t > S_t^U$, Fed determines FC is overvalued => Fed sells CHF
If $S_t < S_t^L$, Fed determines FC is undervalued => Fed buys CHF

=> The Fed acts like an FX speculator.

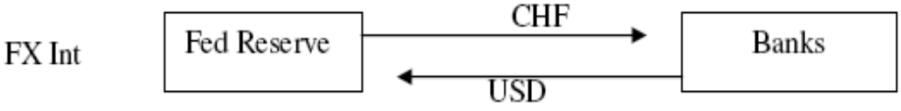


Example: The USD depreciates against the CHF (A to B). At S_t=.93 USD/CHF, the Fed determines CHF too expensive: $S_t > S_t^U$

⇒ Fed *intervenes*



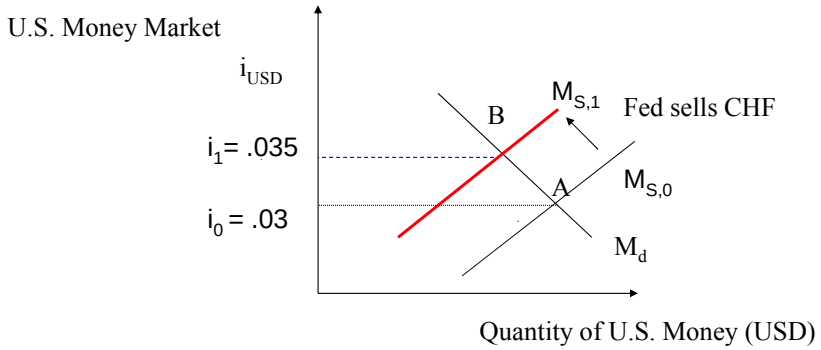
⇒ Fed sells CHF to bring S_t under S_t^U (B to C).



The Fed sells CHF and receives ("buys") USD.

• CB FX intervention affects money supply:
When the CB sells (buys) FC => Money supply decreases (increases) (This is the Fixed Regime characteristic of the managed float).

Example: US Fed intervenes to halt appreciation of CHF.



Process: Fed sells CHF $\Rightarrow M_S \downarrow \Rightarrow$ interest rates (i_{USD}) $\uparrow$

• CB Intervention: Details

• CBs tend to deal with major domestic banks, but will also transact with major foreign banks.

• Size of intervention. The final size depends on the initial FX market reaction. If the initial FX market reaction goes according to the CB direction, then the CB may decide to cut short the intervention.

• How often do CBs intervene? In a 1999 BIS survey of CBs, the percentage of business days on which CBs report intervening from 0.5% to 40% percent, with a 4.5% median.

• Disclosure of intervention? Most CBs intervene secretly, releasing actual intervention data with a lag, if at all. Some authorities, like the Swiss National Bank, always publicize interventions at the time they occur. Why secrecy? Poor credibility, bad fundamentals.

• Other CB Interventions in the FX Market

• CBs can buy foreign assets, instead of FC.

For example, the People's Bank of China and the Bank of Japan have on occasion bought several hundred billions of U.S. Treasuries, in order to stop the decline of the USD against the CNY and the JPY, respectively.

• CBs can use the forward market, instead of the spot market. In a 1999 BIS survey, 52% of CBs admitted to "sometimes using the forward market." CBs can also use other derivatives, for example, FX options.

• Sometimes, CBs do not directly buy and sell FC. Instead, CBs can achieve a change in S_t by affecting demand and supply of FC, through increases in transaction taxes, capital controls, banking regulations, etc.

For example, Spain, Ireland, and Portugal introduced capital controls-including mandatory deposits against the holding of foreign currencies-during the ERM crises of 1992-93.

• Other CB Interventions in the FX Market

• CB intervention can be *concerted*: Several CBs agree a currency is under/over valued and decide to jointly intervene in the FX market. For example, in September 1985, the G7 decided to stop the appreciation of the USD, by buying the other G7 currencies and selling the USD.

• But, the most popular form of intervention is just "talk of under/overvaluation," by government officials, usually referred as *jawboning*. It is simpler and cheaper (if it works) than any other FX intervention. Here, the credibility of CBs plays a big role.

• CB Intervention: Data

Despite these issues and the academic sentiment that FX intervention is not worth it, CB do intervene in FX markets. In a 1999 BIS survey of CBs, the percentage of business days on which CB report intervening from 0.5% to 40% percent, with a 4.5% median.

The largest player by far is Japan. For example, between April 1991 and December 2000, the Bank of Japan bought USD on 168 occasions for a cumulative amount of USD 304 billion and sold USD on 33 occasions for a cumulative amount of USD 38 billion.

Japanese interventions dwarf all other countries' official intervention in the foreign exchange market; for example, it exceeds U.S. intervention over the same period by a factor of more than 30.

• CB General Policy Objective for FX Intervention: Stabilization

Lean against the Wind: CB sells FC when its appreciating and buys FC when its depreciating.

• CB Intervention: Issues

(1) Implicit notion of "overvaluation/undervaluation" in FX market.

⇒ Q: Do CBs have "superior" information?
A: Mixed evidence: Some CBs have big losses; others show profits due to intervention.

(2) CB generates FX stability.

⇒ Uncertainty over CB actions increase FX volatility, and risk. Precisely, what a CB dislikes.

⇒ Q: But, do CBs succeed to reduce FX volatility?
A: In general, negative evidence.

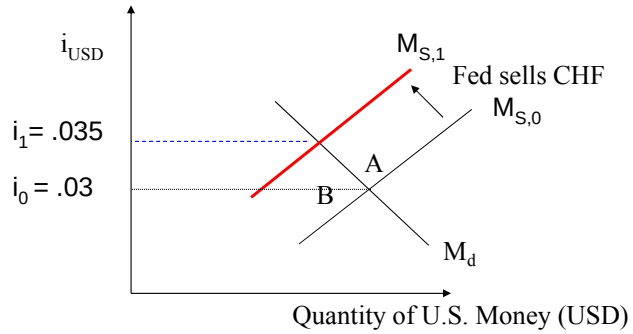
(3) Potential conflict with other countries. When a CB intervenes in the FX market ($S_t \uparrow$) to boost exports, trading partners will be affected.

⇒ *beggar-they-neighbor* devaluation. Popular in the 1930s.

• **Sterilization**

CB actions taken to neutralize the effects of intervention in Money Markets. That is, the change in domestic interest rates.

To leave domestic interest rates unchanged, the CB needs to bring back the domestic money supply (MS) to its original level (point A).

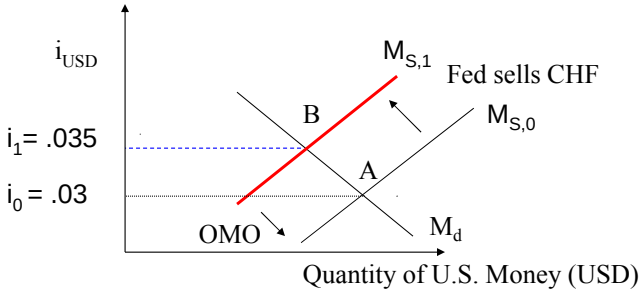


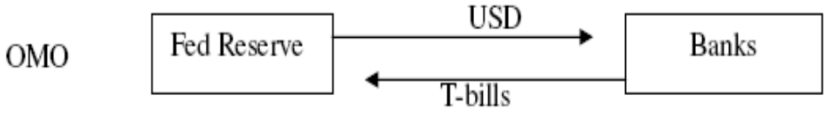
• CB tool to change MS: Open Market Operation (OMO), bank's RRR. Through OMOs, a CB puts money in and takes money out of domestic banks by buying/selling government securities –for example, US T-bills.

• **Sterilization in the US**

- When the Fed buys T-bills, exchanging USD for T-bills => US MS↑
- When the Fed sells T-bills, exchanging USD for T-bills => US MS

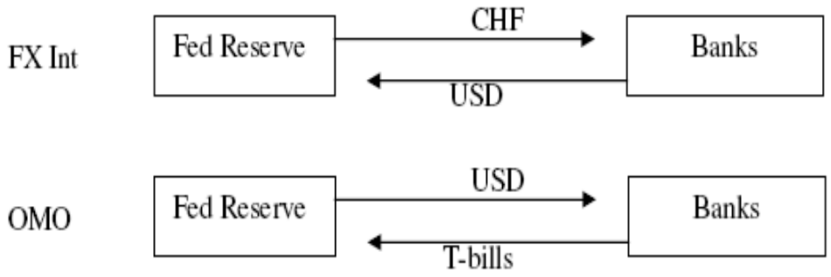
Example (continuation): Back to previous example.
The Fed uses an OMO: Fed buys T-Bills to increase MS.



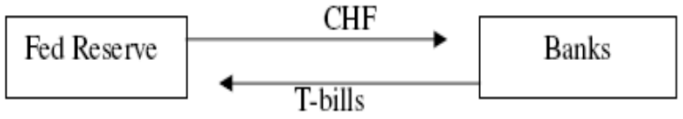


This CB intervention will be classified as *sterilized intervention*.

CB Intervention + Sterilization: Cash flows exchange:



Net effect: OMO + Fed Intervention



• Sterilized Interventions: Side Effects

• Sterilization changes the composition of the Fed's (and, in equilibrium, the public's) mix of domestic and foreign assets. This creates a *balance sheet effect.*

Depending on the rates of return of the assets involved, this effect can be positive or negative for the CB.

• Suppose the CB can keep for a while S_t artificially high/low and money markets out of sync with the FX Market. For example, a CB keeps S_t low (DC overvalued). Then, the CB forces the economy to subsidize the import sector (& domestic consumption) and leaves domestic producers in a tough situation. For a short time, the side effects can be tolerated; for a long time, they can lead to a *resource allocation problem*.

• Banks do not like holding large amounts of government bond and/or having high reserve-requirement ratios => A squeeze in bank's profits.

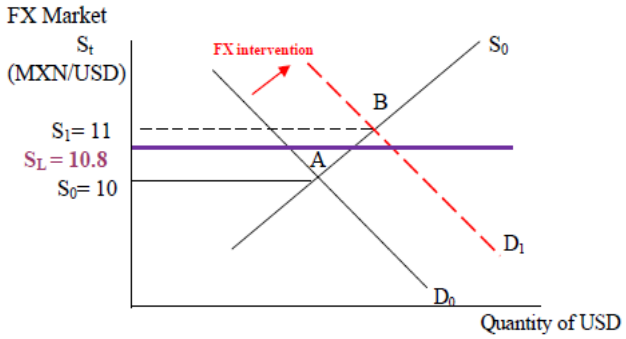
Example: The Banco de Mexico (Banxico, Mexico's CB) considers the USD undervalued ($S_t < \mathbf{S_L}$), with:

S_0= 10 MXN/USD & $\mathbf{S_L}$**= 10.8 MXN/USD**

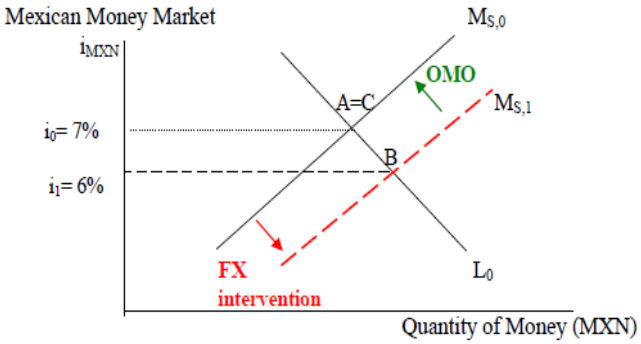
Banxico decides to intervene, but does not want to affect i_{MXN}:

Original Situation: S_0= 10 USD/MXN & i_0=7%

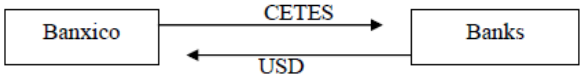
Banxico FX intervention (Buy USD): S_1= 11 USD/MXN & i_1=6%



OMO: Buy MXN-sell CETES: S_1= 11 USD/MXN & i_0=7%



Net effect: OMO + BOM Intervention



Banxico will invest the USD in U.S. T-bills, which have a lower effective yield than the CETES (now, paying 7%!) => negative balance sheet effect (if sterilization works the change in S_t is zero).

• Sterilized Interventions: Do They Work?

In the short-run, sterilizations tend to work, affecting S_t in the direction the CB wanted. But the evidence regarding lasting effects on S_t is mixed and it tends to be on the negative side, especially for major currencies.

Sustaining sterilizations can be costly, due to the balance sheet effects. In Banxico example, CETES yield 7%, while US T-bills have a substantial lower yield. Over time, these costs can be difficult to bear.

Mohanty and Turner (2005) report that, between 2000 and 2004, the CBs of Korea, the Czech Republic, and Israel issued currency-stabilizing bonds of values equivalent to 300%, 200% and, 150% of their respective reserve money for the purpose of sterilization operations. Interest payments, when domestic interest rates go up, render sterilization operations too costly to last.

FX Curiosity: Zimbabwe's $50 Billion Dollar Note (January, 2009)

Because of its huge inflation, Zimbabwe's Central Bank, which is rapidly running our of paper, introduced the ZWD 50 billion dollar note. The new note is equivalent to about USD 1.25.

What will ZWD 50 billion buy you? Two loaves of bread and no change.