Financial Integration and Crises

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Lecture 2

Outline

Exchange Rate Economics
Currency Crises

Definition: Exchange Rates

Definitions:

- *Nominal Exchange Rate*: price of one currency in terms of another.

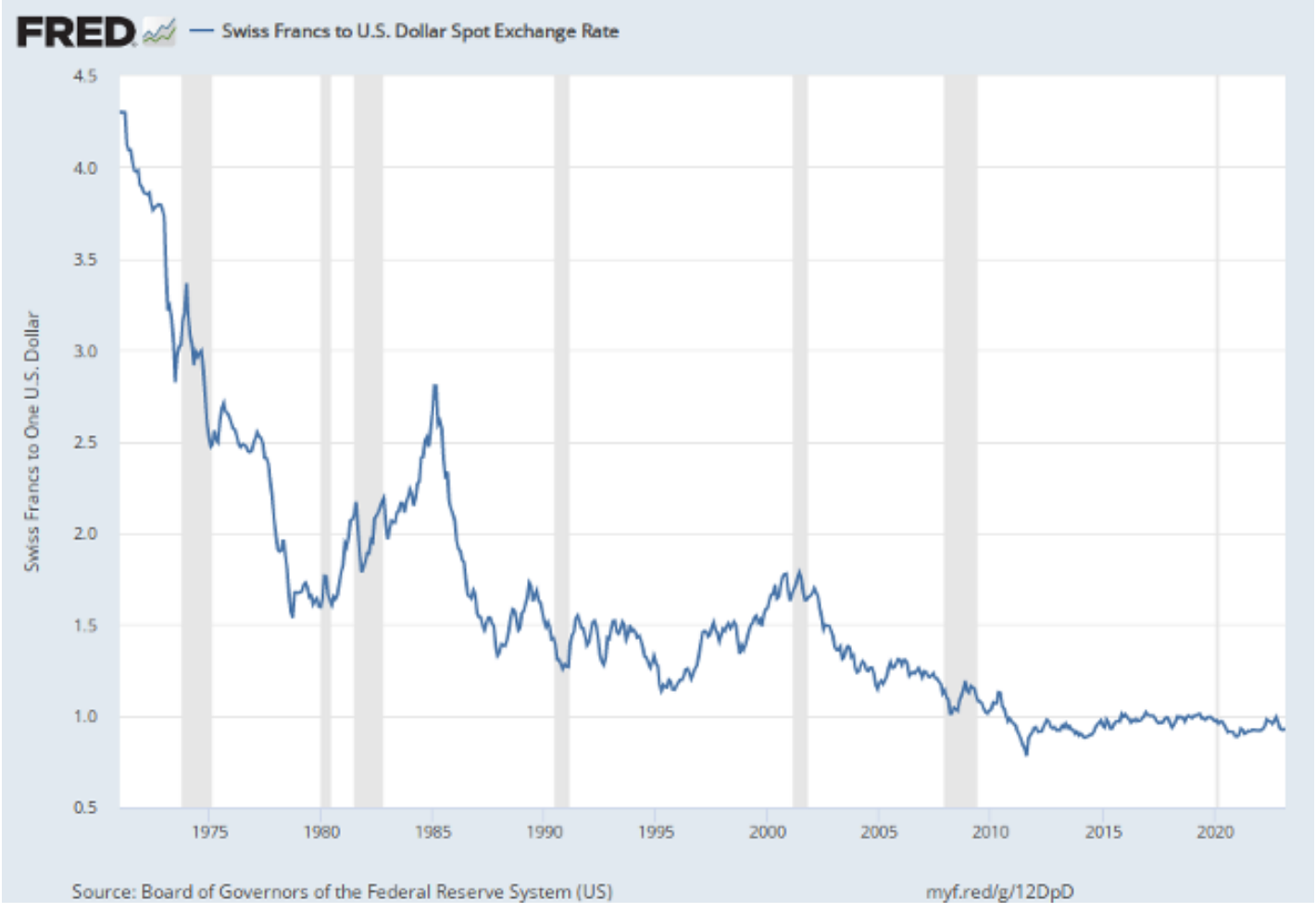
  Two ways of expressing the nominal exchange rates:
  -# of units of domestic currency for one unit of foreign currency; $S_{CHF/\$} \longrightarrow$ 0.8984 $CHF/\$$
  -# of units of foreign currency for one unit of domestic currency; $S_{\$/CHF} \longrightarrow$ 1.1145 $\$/CHF$
  Spot market: where currencies are traded for current delivery

- *Depreciation:* the value of one currency falls with respect to the other:

  e.g.: $\uparrow S_{CHF/\$}$ - increase the amount of Swiss Franc necessary to buy a USdollar - CHF depreciates versus the dollar

- *Appreciation:* the value of one currency rises with respect to the other:
  $\downarrow S_{CHF/\$}$

Exchange Rate: Long run Perspective



Exchange Rate: CHF/EUR

Swiss franc (CHF)

24 February 2023
EUR 1 = CHF 0.9898 0.0006(0.1%)

Change from 17 January 2000 to 24 February 2023

Min (28 September 2022)	Max (12 October 2007)	Average
0.9437	1.6903	1.5197

Exchange Rates: background

Definitions:

- Movements in exchange rates under different exchange rate regimes:

  -Floating Exchange Rate regime (no Central Bank interventions) $\rightarrow$ appreciations and depreciations
  -Fixed Exchange Rate regime (Central Bank interventions) $\rightarrow$ revaluations and devaluations

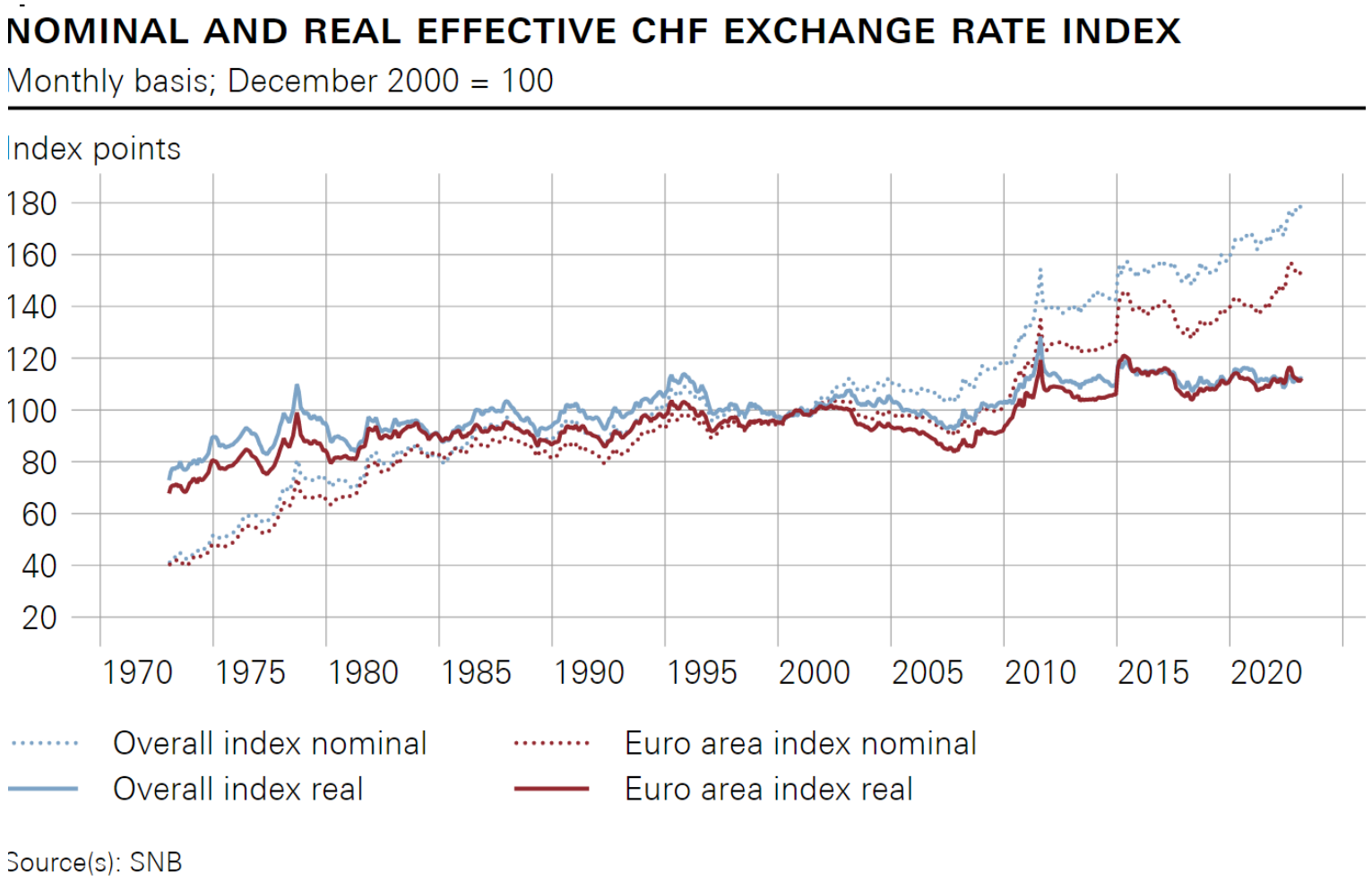
- Effective Exchange Rate for CHF:

$$EER_{CHF} = \sum_{j=1}^{n} \omega_j S_{CHF/j}$$

  where ω_j is a weight that in general depends on the trade share of Switzerland with country j out of total Switzerland's trade.

- The real effective exchange rate index measures the real external value of the Swiss franc, and is the nominal index adjusted for price developments in Switzerland and abroad; it is frequently used as an indicator for assessing the price competitiveness of an economy. A rise in the index value indicates a real appreciation in the Swiss franc.(next graph)

Exchange Rates



Exchange Rates

Definitions

- *Forward Exchange Market: where currencies may be bought and sold for delivery in a future period.*

  $F^{1month}_{CHF/\$}$ = $CHF/\$$ 1 month forward rate

- E.g.: if investors agree on an exchange of $5,500$ Swiss Franc for $10,000$ dollars in a months time: $F^{1month}_{CHF/\$} = 0.55$
  - if $F^{1month}_{CHF/\$} > S_{CHF/\$} \rightarrow$ forward premium;
  - if $F^{1month}_{CHF/\$} < S_{CHF/\$} \rightarrow$ forward discount.
- Forward Exchange Market - used to avoid the risk of exchange rate changes

  E.G.: I need to pay my supplier of US-cars in dollar ($\$10,000$) in 1 month:
  $S_{CHF/\$} = 0.50$, $F^{1month}_{CHF/\$} = 0.55$ but it could be that $S^{1month}_{CHF/\$} = 0.6$
  If I sign the forward contract I would need $CHF5,500$ (against the possibility of having to pay $CHF6,000$).

Exchange Rate: Arbitrage

Arbitrage conditions in open economy

- Consider small open economy that trades two currency bonds:
  - B^F_{t+1} denotes the stock of foreign currency ($) denominated bonds at the end of period t;
  - B^H_{t+1} denotes the stock of domestic currency (CHF) denominated bonds at the end of period t.
- Consumers' preferences:

$$U = u(C_1) + \beta E_t u(C_2) \tag{1}$$

where $\beta \in [0, 1]$ is the discount factor. C is consumption good and u is the period utility function with $u' > 0$ and $u'' < 0$.

- E_t is the rational expectation conditional on information at time t.

Exchange Rate

Budget Constraints:

- Let P_t denotes the price level at time t; $1+i$ $(1+i^*)$ denotes the domestic (foreign) nominal interest rate and S_t the nominal exchange rate at time t.
- The individual budget constraints in period 1 and 2 are:

$$S_1 B_2^F + B_2^H = P_1 Y_1 + (1+i) B_1^H + \\ + (1+i^*) S_1 B_1^F - P_1 C_1 \tag{2}$$

$$S_2 B_3^F + B_3^H = P_2 Y_2 + (1+i) B_2^H + \\ + (1+i^*) S_2 B_2^F - P_2 C_2 \tag{3}$$

- Simplify $S_2 B_3^F = B_3^H = 0$ since the economy ends at the end of period 2. Starting condition $B_1^H = B_1^F = 0$.

Exchange Rate

Arbitrage Condition in Open Economy

- Solving the maximization problem:

$$\frac{U^{'}(C_1)}{P_1} = \beta(1+i)E_t\frac{U^{'}(C_2)}{P_2}$$

$$S_1\frac{U^{'}(C_1)}{P_1} = \beta(1+i^*)E_t\frac{S_2U^{'}(C_2)}{P_2}$$

- Combining the previous two first order conditions:

$$(1+i)E_t\frac{U^{'}(C_2)}{P_2} = (1+i^*)E_t\frac{S_2U^{'}(C_2)}{S_1P_2}$$

Exchange Rate: arbitrage

Arbitrage conditions in Open Economy

- From first order approximation of previous condition you get the uncovered interest rate parity condition. First order approximation abstracts from second moments (no risk premium).
- Uncovered interest parity condition (UIP): the domestic interest rate must be higher (lower) than the foreign interest rate by an amount equal to the expected depreciation (appreciation) of the domestic currency

$$\frac{E_t S_{t+1} - S_t}{S_t} \simeq i_t - i_t^*$$

  Face the risk that the depreciation rate might be different than expected - *uncovered* position
- Covered interest parity condition (CIP): the domestic interest rate must be higher (lower) than the foreign interest rate by an amount equal to the to the forward discount (premium) on the domestic currency

$$\frac{F_{t+1} - S_t}{S_t} = i_t - i_t^*$$

  Face no risk of movements in exchange rate movements - *covered* position. Covered interest rate parity is also known as FX swap rate.

Forward Discount Puzzle

- Forward contract: at time t, specifies how many units of domestic currency are needed in order to buy one unit of foreign currency for delivery at time $T \geq t$.
- If we denote with S_t the spot rate, we have the following arbitrage condition: (covered interest rate parity)

$$\frac{F_t}{S_t}(1 + i_t^*) = (1 + i_t)$$

- Is there a prediction bias in the forward rate? Does $F_t = \mathrm{E}_t S_{t+1}$?

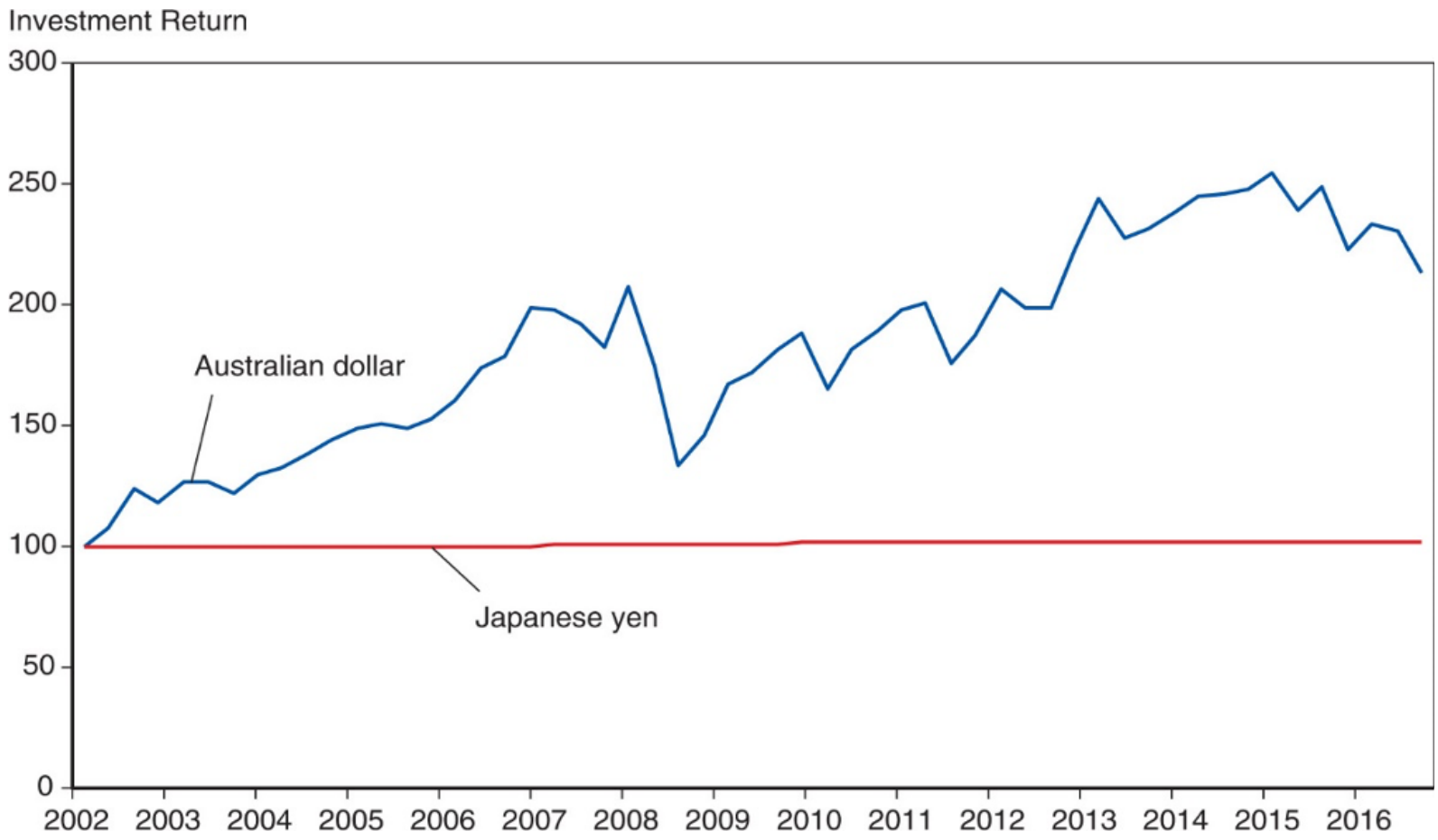
Forward Discount Puzzle

- Empirical test for the prediction bias in the forward rate:

$$s_{t+1} - s_t = a_0 + a_1(f_t - s_t) + \varepsilon_t$$

- Forward market efficiency test asks if $a_0 = 0$ and $a_1 = 1$.
- Empirical finding: the forward rates are biased predictors: $a_1 \simeq -0.9$.
- Note that we are testing both RE and uncovered interest rate parity (absence of risk premium)

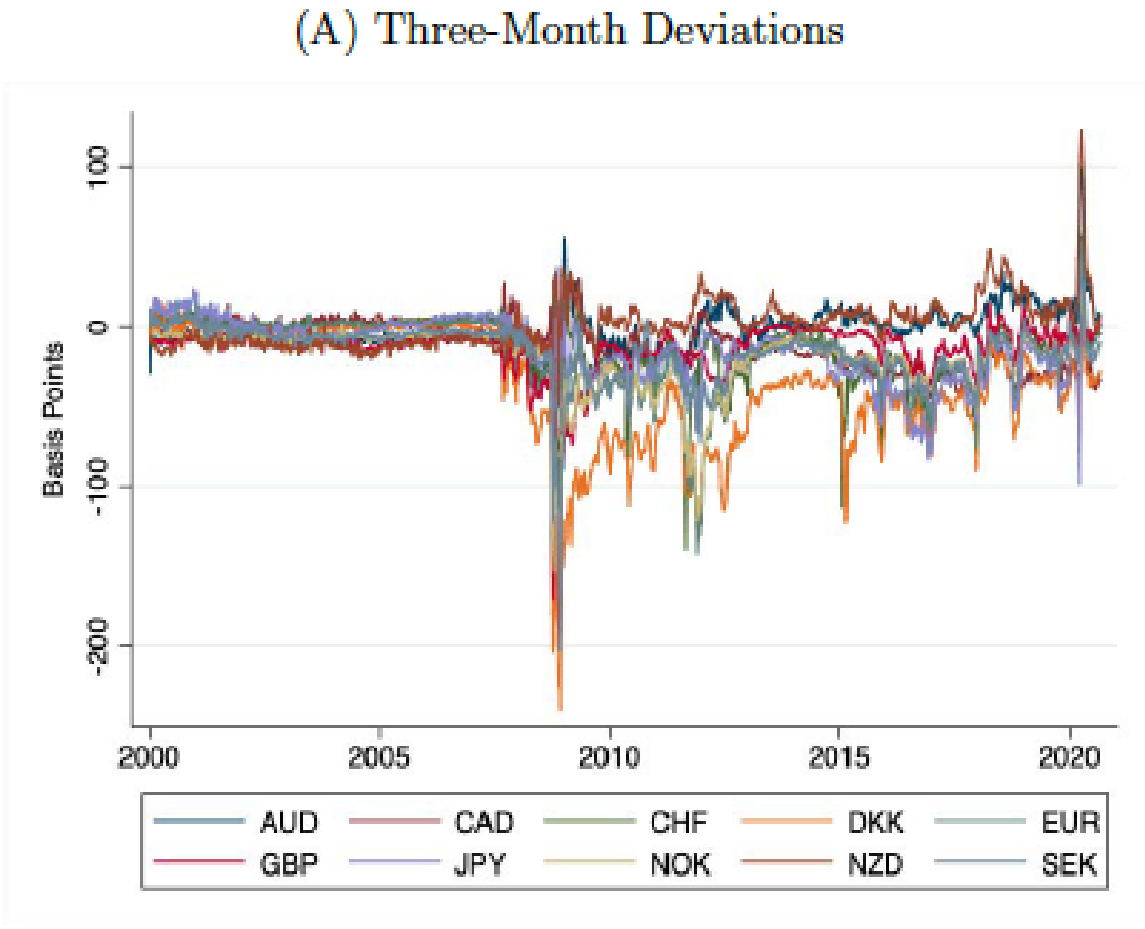
Carry Trade


Investment Return
300
250
200
150
100
50
0
Australian dollar
Japanese yen
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016

Exchange Rate Arbitrage: Basis

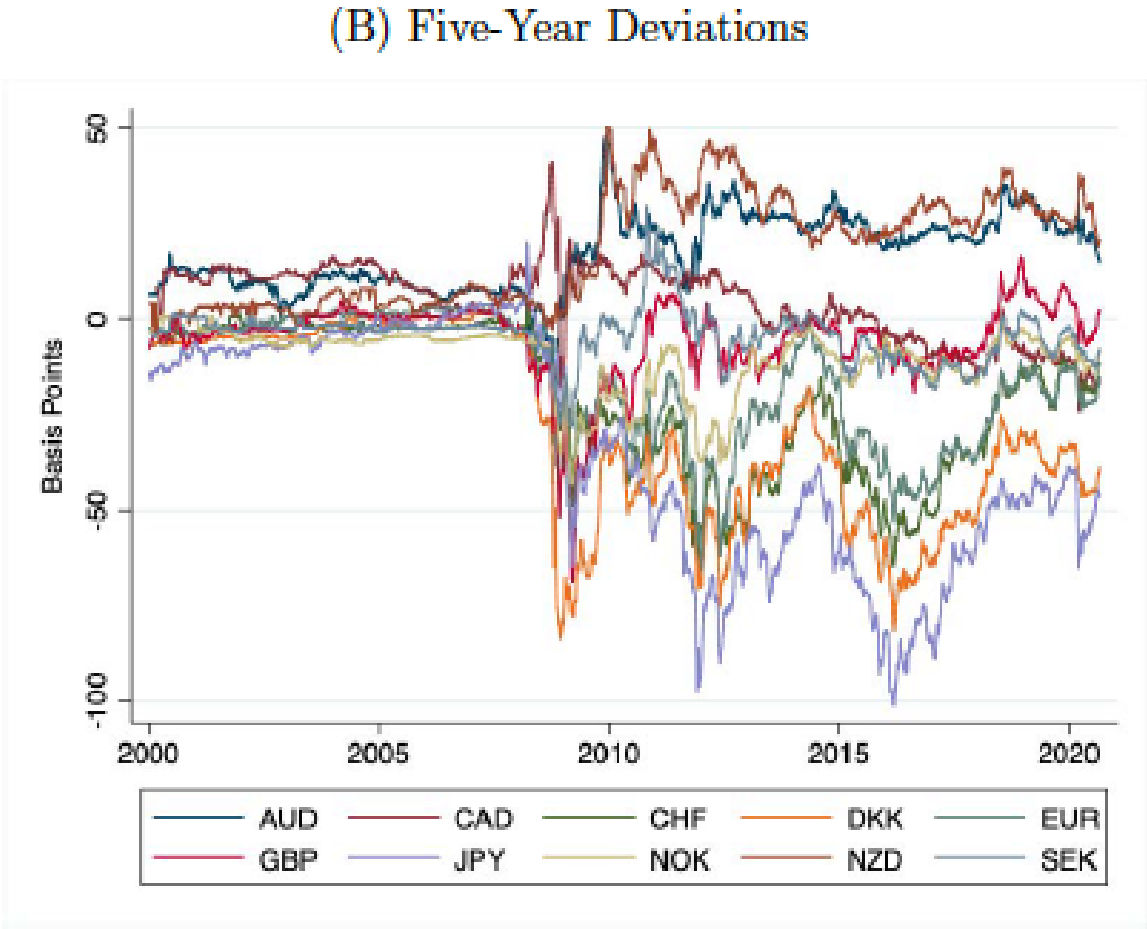
- What is basis? It is when assets that are substitutes, or near substitutes, trade at different prices.
- In the case CIP, basis is a deviation from CIP and could, in theory, be arbitraged.
- Example: Suppose a dealer quotes an FX swap price in which the implied dollar interest rate is 5 percent. At the same time, dollar LIBOR for the same maturity is at 4 percent. This means that there is a 1 percent basis of dollar premium.
- The FX swap rate is not trading at a level consistent with the theoretical FX swap rate which could be derived from the euro and dollar LIBOR cash interest rate differentials. In other words, an investor can earn a higher return by lending dollar through a FX swap than in the inter-bank LIBOR market. Conversely, it is more expensive to borrow dollar through the FX swap market than in the inter- bank LIBOR market, though both should, in theory, be near substitutes.

CIP Deviations (Du and Shreger, 2022)



Based on IBOR: interbank offering rate.

CIP Deviations (Du and Shreger, 2022)



Based on IBOR: interbank offering rate.

Exchange Rate Arbitrage: Example

- Consider the pricing of a forward FX rate

$$F = S * \left(\frac{1 + i\left(\frac{days}{total}\right)}{1 + i^{*}\left(\frac{days}{total}\right)} \right)$$

- Example:
  - Spot euro-dollar is 1.56
  - 3-month dollar LIBOR rate fixes at 2.872%
  - 3-month euro LIBOR rate fixes at 4.855 %
  - the 3-month settlement date is 94 days from now and there are 360 days in a year.
  - the implied theoretical forward would be 1.5520.

Exchange Rate Arbitrage: Example

- Assume the same spot and LIBOR fix rates are observed as above.
- In addition, assume the 3-month euro-dollar FX forward (and FX Swap) is trading at -67.45.
  - Note: FX Forward (or Swap) Points is just the interest rate differential between the two currencies over the time period, as calculated by using the CIRP formula. The market convention is to quote the price as 'grossed up' for trading purposes, but is effectively in basis points (technically called forward or FX swap points).
- As outlined above
  - Spot rate: \$1.5600 + Forward points (-0.00674) = Traded Forward Rate: \$1.55326

Exchange Rate Arbitrage: Example

- In this example the actual FX forward rate ($1.55326) observed trading in the market is greater than the theoretical forward rate ($1.5520) we can calculate using the LIBOR fix rates.
- How can this occur?
- By studying the CIRP condition, there are only 2 ways that this can happen:
  - The implied euro cash rate is lower than that suggested by the LIBOR fix rate
  - The implied dollar cash rate is higher than that suggested by the LIBOR fix rate

Exchange Rate Arbitrage: Example

- We can compute the implied dollar cash rate.

$$i = \frac{360}{days} * \left(\left(\frac{F}{S} \right) * \left(1 + i^* * \left(\frac{days}{360} \right) \right) - 1 \right)$$

- So if we insert the values from the example we have that

$$i = \frac{360}{94} * \left(\left(\frac{1.55326}{1.56} \right) * \left(1 + 0.0485 * \left(\frac{94}{360} \right) \right) - 1 \right) = 3.18\%$$

- Therefore, market convention is to say that the basis spread measure of the implied dollar cash rate from a 3-month FX Swap over the 3-month dollar LIBOR fix rate is 31 basis points .
- In effect, this implies that FX forward (and Swap) market is not trading in-line with the theoretical prices (LIBOR fix rates) a development which could (should) be arbitraged.

Exchange Rate Determination: Long-run perspective

- What determines exchange rate in the long-run?
- Long run theory: exchange rate is based on actual buying power over a basket of goods, and so changes in the nominal exchange rate should reflect changes in the price of goods.
- Short-run: financial market perspective
- Long-run: goods market perspective

Exchange Rate Channel

Prices Levels and Exchange Rate

- Law of one price (LOP): in competitive markets, free of transportation costs and official barrier to trade, identical goods sold in different countries must sell for the same price once converted in the same currency.

$$p_i = Sp_i^*$$

where p_i $\left(p_i^*\right)$ is the domestic (foreign) price of good i and S is the nominal exchange rate.

- Absolute Purchasing Power Parity (PPP): the exchange rate between two currencies should be equal to the ratio of the countries' price levels.

$$P = SP^*$$

where P $\left(P^*\right)$ denotes the domestic (foreign) price level computed as the price of a representative consumption basket. *If PPP holds, a CHF10 note should buy the same amount in all countries. Thus the exchange rate should move to equalize the prices of an identical basket of goods and services in different countries.* LOP always implies PPP if the composition of the basket of goods is the same across the two countries (while the reverse is not necessarily true).

Introduction to Exchange Rate Economics

Arbitrage conditions in Open Economy

- Empirical Evidence on PPP and the law of one price:
  - Changes in national price levels do not tell us much about changes in the nominal exchange rate;
  - Law of one price (LOP) also does not do very well;
  - Relative PPP does better but still not a good indicator of exchange rate changes.
  - Departures from PPP can be higher in the short-run than in the long-run.

Exchange Rate Channel

Arbitrage conditions in Open Economy

- Relative PPP:

$$\underbrace{\frac{\Delta S}{S}}_{\text{\% change nominal exchange rate}} = \underbrace{\frac{\Delta P}{P}}_{\text{\% change in domestic price level}} - \underbrace{\frac{\Delta P^*}{P^*}}_{\text{\% change in foreign prices}}$$

$$\frac{\Delta S}{S} = \pi - \pi^*$$

- If the Switzerland's price level rises by 5% over a year while U.S's by only 2%, relative PPP predicts a 3% depreciation of the Swiss franc against the dollar, leaving the relative domestic and foreign purchasing powers of both currencies unchanged.
- Relative PPP is about growth rates of prices, whereas absolute PPP is about levels.
- Relative PPP can hold even when absolute PPP does not.

Exchange Rate Channel

Arbitrage conditions in Open Economy

- *Prices Levels and Exchange Rate in the Long-Run*
  - LOP is based on the absence of **transportation costs and barrier to trade**. But these costs can be high enough to prevent goods and service to be traded across countries. *Strategy of buying a good in a country and selling in another is not costless - so prices may differ*
  - The existence of **nontradables** goods and services whose prices are not linked internationally allows systematic deviations from PPP. Shift in domestic and supply curve that determines the price of nontradables might cause differences in price levels across countries.

Exchange Rate Channel

Arbitrage conditions in Open Economy

- *Prices Levels and Exchange Rate in the Long-Run:*
  - Markets can be non competitive so that prices of similar goods might differ across countries because of **different market structures**. It might happen that a single firm sell the same good at a different price depending on the market. *(But would there be an arbitrage opportunity? - not if you have trade barriers as well)*
  - Data are based on **different commodity baskets** so that there is no reason for exchange rate changes to reflect changes in price levels across countries. *One reason for this difference is that people living in different countries spend their income in different ways.*
  - **Price stickiness** might prevent convergence of prices in the short run.

Exchange Rate Channel: Consumer Perspective

Consumption in Open Economy

- Closed Economy: we generally assume homogenous goods. Sectoral Differentiation: durables, non-durables.
- Open Economy:
  - non-traded goods (typically services);
  - traded goods (imported and domestically produced that are also exported).

$$C = C_T^{\alpha} C_N^{1-\alpha}$$

with C_T is the consumption of traded goods and C_N denoting the consumption of non-traded goods. α is the expenditure share in traded goods.

  - Also traded goods can be imported

$$C_T = C_H^{\gamma} C_F^{1-\gamma}$$

with C_H is the consumption of home produced goods and C_F denoting the consumption of imported (foreign produced) goods. γ is the expenditure share in home produced goods.

- Exchange Rate influences price of imported goods.

Exchange Rate Channel

Arbitrage conditions in Open Economy

- Non-tradeable goods and the Real Exchange Rate.
  - Definition of the Real Exchange Rate:

$$Q = \frac{SP^*}{P}$$

Domestic currency price of the foreign basket relative to domestic basket. Note that Q=1 when PPP holds.

  - Consider a situation in which there are tradable and non-tradable goods. We assume that domestic (foreign) consumers spend a share α (α^*) of their income on tradable goods (T) and a share $1-\alpha$ $(1-\alpha^*)$ on non-tradable.(N). Price indexes (using a Cobb-Douglas utility function) are

$$P = P_T^{\alpha} P_N^{1-\alpha} \qquad P^* = P_T^{*\alpha^*} P_N^{*1-\alpha^*}$$

that can be rewritten as

$$P = P_T \left(\frac{P_N}{P_T}\right)^{1-\alpha} \qquad P^* = P_T^* \left(\frac{P_N^*}{P_T^*}\right)^{1-\alpha^*}$$

Exchange Rate Channel

Arbitrage conditions in Open Economy

- Non-tradeable goods and the Real Exchange Rate.
  - Using the definition of the real exchange rate we obtain:

$$Q = \frac{SP^*}{P} = \frac{SP_T^*}{P_T} \times \frac{\left(P_N^*/P_T^*\right)^{1-\alpha^*}}{\left(P_N/P_T\right)^{1-\alpha}}$$

So the RER depends on:

1. $\frac{SP_T^*}{P_T}$: real exchange rate for tradable goods (law of one price);
2. P_N/P_T : relative price of non-tradable to tradable in the Home country;
3. P_N^*/P_T^* : relative price of non-tradable to tradable in the Foreign country;

From this we can see that even if the LOP holds absolute PPP can fail if the relative prices for tradable and non-tradable are different across countries (local factors determine demand and supply of non-tradeable goods).

Exchange Rate Channel

Arbitrage conditions in Open Economy

- Focus now on the traded goods component and consider differentiated goods.
- Price indexes (using a Cobb-Douglas utility function) are

$$P_T = P_H^{\gamma} P_F^{1-\gamma} \qquad P_T^* = P_H^{*\gamma^*} P_F^{*1-\gamma^*}$$

with P_F price of foreign produced goods (imported goods) in domestic currency (CHF) and P_F^* price of foreign produced goods in local currency (USD).

  - Using the definition of the real exchange rate we obtain:

$$RER_T = \frac{SP_T^*}{P_T} = \frac{S\left(P_H^{*\gamma^*} P_F^{*1-\gamma^*}\right)}{P_H^{\gamma} P_F^{1-\gamma}}$$

$$= \underbrace{\left(\frac{SP_H^*}{P_H}\right)^{\gamma^*}}_{LOP} \underbrace{\left(\frac{SP_F^*}{P_F}\right)^{1-\gamma^*}}_{LOP} \underbrace{\left(\frac{P_H}{P_F}\right)^{\gamma^*-\gamma}}_{ToT}$$

Exchange Rate Channel

Arbitrage conditions in Open Economy

- Using the definition of the real exchange rate we obtain:

$$RER_T = \underbrace{\left(\frac{SP_H^*}{P_H}\right)^{\gamma^*}}_{LOP} \underbrace{\left(\frac{SP_F^*}{P_F}\right)^{1-\gamma^*}}_{LOP} \underbrace{\left(\frac{P_H}{P_F}\right)^{\gamma^*-\gamma}}_{ToT}$$

So the RER for traded goods depends on:

1. $\frac{SP_H}{P_H^*}, \frac{SP_F}{P_F^*}$: deviations from the law of one price.
2. $\frac{P_F}{P_H}$: terms of trade price of import over price of export. Rewrite it as

$$ToT = \frac{SP_F^*}{P_H}$$

When ToT↑ worsening of terms of trade, when ToT↓ we have improvement of terms of trade.

Exchange Rate Channel: Consumption

Traditional approach (behind IS-LM and Mundell-Fleming)

- Price fixed (nominal rigidities) and producer currency pricing. No differentiation in terms of goods that are traded.
- Early "Consensus View":Fleming (1962), Mundell(1963), Dornbusch (1976), Svensson and van Wijnbergen (1989), Obstfeld and Rogoff (1995):

$$P_M = S_{h/f} P_F^*$$

- Prices rigid in the producer's currency (PCP): $\bar{P}_F^*$ so that depreciations (appreciations) are inflationary (deflationary) $\Rightarrow S \uparrow \Rightarrow P_M \uparrow$ (full pass-through of exchange rate changes)
- Depreciations (appreciations) deteriorate (improve) terms of trade.

$$ToT = \frac{P_M}{P_X} = \frac{S_{h/f} \bar{P}_F^*}{\bar{P}_H}$$

with P_H denoting the price of home exports ($\bar{P}_H$ denotes prices that are fixed) so that $S \uparrow \Rightarrow ToT \uparrow$

- Impact on trade balance and relative competitiveness.

Alternative pricing assumption

- Local Currency Pricing with Fixed price: Betts and Devereux (2000), Devereux and Engel (2003).
- Prices rigid in the local (destination) currency (LCP) and as such depreciations have no impact on inflation

$$P_M = \bar{P}_F$$

  so that $S \uparrow \Rightarrow P_M \leftrightarrow$

- Depreciations (appreciations) improve (deteriorate) terms of trade and there is no expenditure switching effect.

$$ToT = \frac{P_M}{P_X} = \frac{\bar{P}_F}{S_{h/f}\bar{P}^*_H}$$

  with $\bar{P}^*_H$ denoting the price of home exports fixed in foreign currency so that $S \uparrow \Rightarrow ToT \downarrow$

- Underlying assumptions: symmetry of pricing.

Alternative pricing assumption: vehicle currency

- Vehicle currency paradigm: Corsetti and Pesenti (2005), Goldberg and Tille(2008, 2009): Neither PCP, nor LCP, but pricing in very few currencies.
- Dominant role for dollar (Dominant currency paradigm, Gopinath)
- Dollar invoicing share: 4.7 times its share in world imports, 3.1 times its share in world exports.
- Euro invoicing share: 1.2 times for imports and exports.
- Prices are rigid in their currency of invoicing. Conditional on a price change, prices not very sensitive to exchange rates.

Alternative pricing assumption: evidence (from Cas et. al. 2020)

	Dollar Share	Euro Share	Own Currency Share	US Export Share	Euro Export Share
Argentina	0.97	0.02	0.00	0.08	0.14
Australia	0.77	0.01	0.20	0.06	0.05
Brazil	0.94	0.04	0.01	0.17	0.20
Canada	0.70	·	0.23	0.80	0.04
China	·	·	0.05	0.19	0.13
Denmark	0.23	0.31	0.19	0.05	0.37
France	0.40	0.50	0.50	0.14	0.49
Germany	0.24	0.62	0.62	0.15	0.42
Japan	0.50	0.08	0.39	0.22	0.10
South Africa	0.52	0.17	0.25	0.10	0.21
South Korea	0.85	0.06	0.01	0.15	0.10
Switzerland	0.19	0.35	0.35	0.11	0.48
Thailand	0.82	0.02	0.07	0.15	0.09
Turkey	0.46	0.41	0.02	0.06	0.37
United Kingdom	0.29	0.13	0.51	0.14	0.49
United States	0.97	·	0.97	–	0.15

EM share in world imports: 38%, exports: 33%

Exchange Rate Channel: Global Value Chain

Production side:

- Final good producing sector $i = \{T, N\}$ has the Global Value Chain (GVC) production function:

$$Y^i = (A_t^i L_t^i)^{\gamma_p} \left(M_t^i\right)^{1-\gamma_p}$$

where L_t^i is the labor allocation to sector i such that $\sum_i L_t^i = L_t$, and M_t^i is the intermediate goods bundle for sector i and is defined as:

$$M_t^i = \left[{\nu_{pN}^i}^{\frac{1}{\rho_m}} \left(M_{Nt}^i\right)^{\frac{\rho_m - 1}{\rho_m}} + {\nu_{pH}^i}^{\frac{1}{\rho_m}} \left(M_{Ht}^i\right)^{\frac{\rho_m - 1}{\rho_m}} + {\nu_{pF}^i}^{\frac{1}{\rho_m}} \left(M_{Ft}^i\right)^{\frac{\rho_m - 1}{\rho_m}} \right]^{\frac{\rho_m}{\rho_m - 1}}$$

with the associated price:

$$P_{Mt}^i = \left[\nu_{pN}^i \left(P_t^N\right)^{1-\rho_m} + \nu_{pH}^i \left(P_{Ht}\right)^{1-\rho_m} + \nu_{pF}^i \left(P_{Ft}\right)^{1-\rho_m} \right]^{\frac{1}{1-\rho_m}}$$

where for $k = \{N, H, F, \}$, ν_{pk}^i is the weight given to intermediate good k in sector i.

Exchange Rate Channel: summary

Real Side Perspective: summary

- Pricing: pricing to market;
- Invoicing: in which currency to price goods;
- Exposure: consumption (importing) and production (global value chain)

Exchange Rate Determination

Monetary Model of Exchange Rate Determination
Floating Regime
Fixed Exchange Rate Regime

Lecture 2: Exchange Rate Determination and Currency Crises

Exchange rate determination in a simple monetary model (long run model)

Why the monetary model?

- earliest approach to exchange rate determination;
- good benchmark for comparing other approach of exchange rate determination;
- useful insight for capturing long-run trends

Model assumptions:

- PPP holds

  Vertical aggregate supply - prices are flexible and do not affect output (though technology, growth in labour force, capital accumulation can affect output).

Lecture 2: Exchange Rate Determination and Currency Crises

Review model
Preferences:

$$U = u(C_1) + u\left(\frac{M_1}{P_1}\right) + \beta u(C_2) + \beta u\left(\frac{M_2}{P_2}\right) \tag{4}$$

The individual budget constraints in period 1 and 2 are:

$$\begin{aligned} e_1 B_{f,2} + B_{h,2} + M_1 = P_1 (Y_1 - T_1) + (1+i) B_{h,1} + \\ + (1+i^*) e_1 B_{f,1} - P_1 C_1 + M_0 \end{aligned} \tag{5}$$

$$\begin{aligned} e_2 B_{f,3} + B_{h,3} + M_2 = P_2 (Y_2 - T_2) + (1+i) B_{h,2} + \\ + (1+i^*) e_2 B_{f,2} - P_2 C_2 + M_1 \end{aligned} \tag{6}$$

Lecture 2: Monetary Model of Exchange Rate Determination

First order conditions

Maximization problem gave us following first order conditions:

-Intertemporal path of consumption (Euler equation):

$$u'(C_1) = \beta u'(C_2)\frac{P_1(1+i)}{P_2} \tag{7}$$

-Arbitrage relationship among domestic and foreign assets:

$$\left[1 - \frac{1+i}{1+i^*}\frac{e_1}{e_2}\right] = 0 \tag{8}$$

-Money demand in the first period:

$$u'\left(\frac{M_1}{P_1}\right) = u'(C_1)\frac{i}{1+i} \tag{9}$$

-Money demand in the second period:

$$u'\left(\frac{M_2}{P_2}\right) = u'(C_2) \tag{10}$$

Lecture 2: Monetary Model of Exchange Rate Determination

Supply side and consumption
Aggregate supply is vertical

- Endowment economy in which we have Y_1, Y_2;
- it does not mean that output is constant: it can change because of technological progress or growth in the labor force or accumulation of capital;
- it implies that prices are perfectly flexible.
  We note also that in (7)

$$\frac{P_1}{P_2}\frac{e_2(1+i^*)}{e_1} = \frac{P_1}{P_2}(1+i) = (1+r)$$

because of arbitrage condition and the fisher parity equation.

- We make the assumption that $\beta(1+r) = 1$ so that $C_1 = C_2 = C$.

Lecture 2: Monetary Model of Exchange Rate Determination

External condition

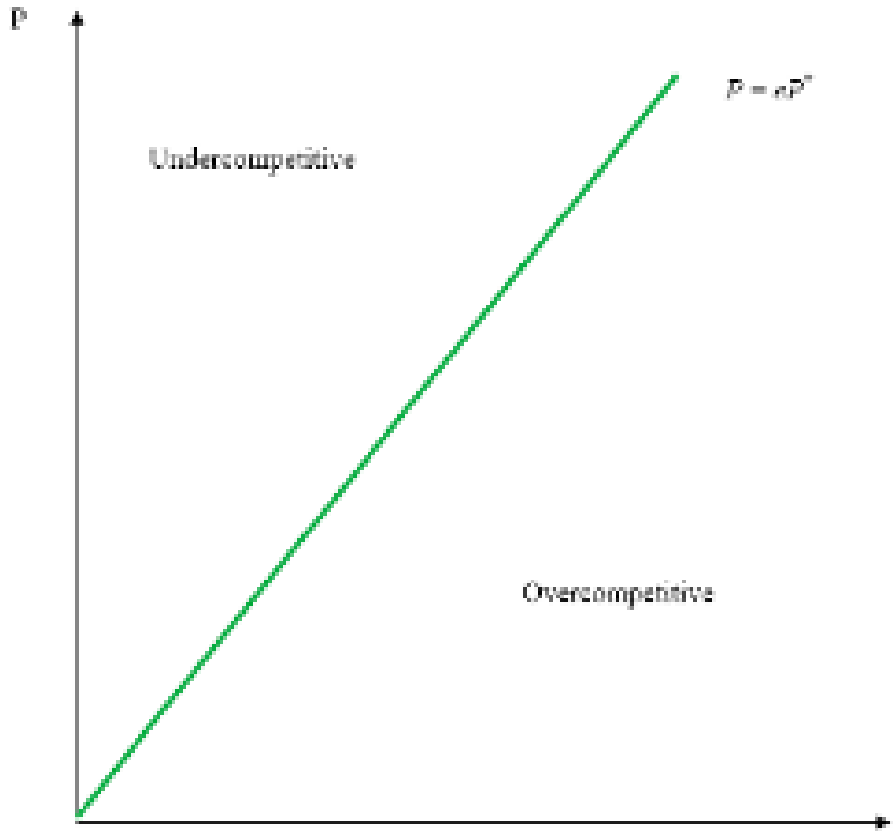
- the exchange rate between two currencies should be equal to the ratio of the countries' price levels in every period:

$$P = eP^*$$

where P (P^*) denotes the domestic (foreign) price level computed as the price of a representative consumption basket.

Lecture 2: Monetary Model of Exchange Rate Determination

Purchasing Power Parity:



Lecture 2: Monetary Model of Exchange Rate Determination

Aggregate demand

- Money market equilibrium: money supply is equal to money demand $\left(M^d = M^s\right)$

$$\frac{M_1^d}{P_1} = L\left(\underset{+}{C_1}, \underset{-}{i}\right) \tag{11}$$

$$\frac{M_2^d}{P_2} = L\left(\underset{+}{C_2}\right) \tag{12}$$

- In equilibrium money demand is equal to money supply:

$$M^d = M^s$$

- Note that money market equilibrium depend on time t and time $t+1$ endowment (real income)

Lecture 2: Monetary Model of Exchange Rate Determination

Equilibrium:

- Balance budget rule by government in every period:

$$-P_1 T_1 = M_1 - M_0 \tag{13}$$

$$-P_2 T_2 = M_2 - M_1 \tag{14}$$

- Combining (13), (14) with (**??**) and since $\beta(1+r) = 1$:

$$C = \frac{(1+r)\, Y_1 + Y_2}{2+r}$$

Lecture 2: Monetary Model of Exchange Rate Determination

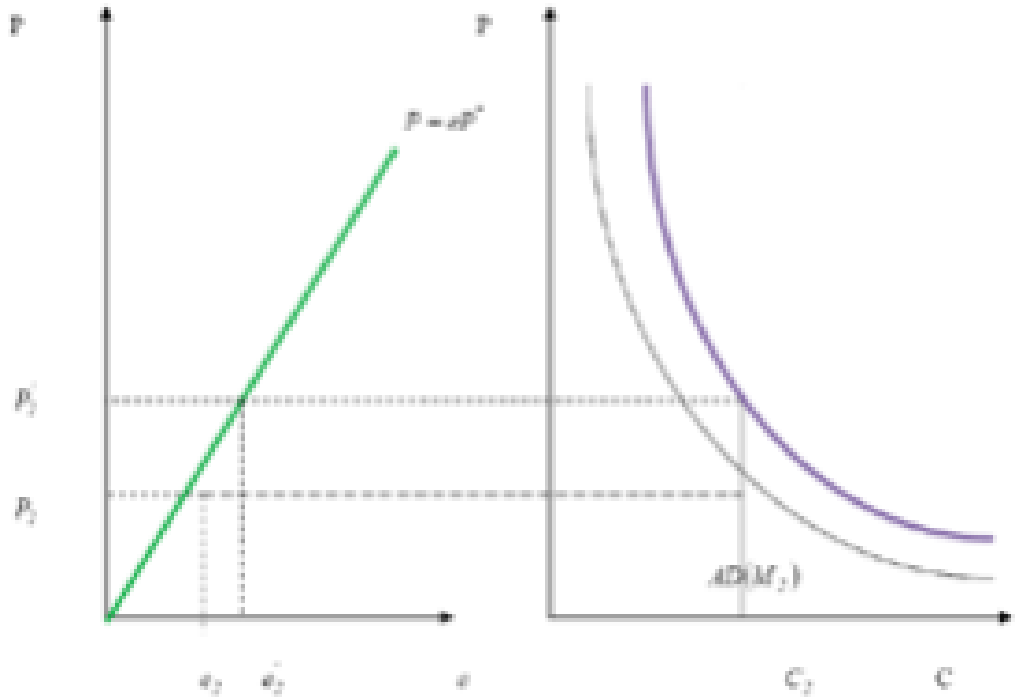
- Intersection between aggregate demand and supply determines the domestic equilibrium price level.
- We start from period 2:

$$P_2 = \frac{M_2^s}{L(C_2)}$$

- Exchange rate determination in this economy is obtained once we use the PPP relationship:

$$e_2 P_2^* = P_2 = \frac{M_2^s}{L(C_2)} \Rightarrow e_2 = \frac{M_2^s}{P_2^* L(C_2)}$$

Lecture 2: Monetary Model of Exchange Rate Determination



Lecture 2: Monetary Model of Exchange Rate Determination

- In period 1:

$$P_1 = \frac{M_1^s}{L\left(C_1, i\right)}$$

Exchange rate determination in this economy is obtained once we use the PPP relationship:

$$e_1 P_1^* = P_1 = \frac{M_1^s}{L\left(C_1, i\right)} \Rightarrow e_1 = \frac{M_1^s}{P_1^* L\left(C_1, i\right)}$$

Lecture 2: Monetary Model of Exchange Rate Determination

- Note that there are two intertemporal linkages that are important in understanding the determinants of spot exchange rates:

1. Supply consideration (Y_2) matters through consumption choice.
2. Demand consideration (M_2^s) matters through arbitrage condition, $1+i = \frac{e_2}{e_1}(1+i^*)$ so that:

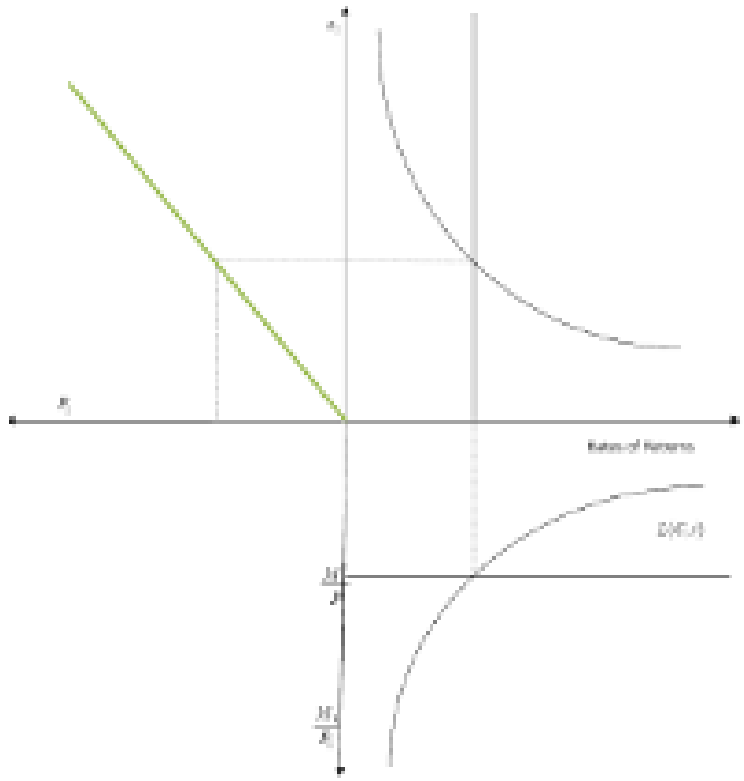
$$e_1 = \frac{M_1^s}{P_1^* L\left(C_1, \frac{e_2}{e_1}(1+i^*) - 1\right)}$$

So from the previous equations we know everything we need to know about how the prediction of the monetary model on exchange rate in a floating exchange rate regime.

- if $\uparrow M_1^s \Rightarrow \uparrow e_1$;
- if $\uparrow P_1^* \Rightarrow \downarrow e_1$;
- if $\uparrow Y_1 \Rightarrow \downarrow e_1$;

Lecture 2: Monetary Model of Exchange Rate Determination

- Period 1 Equilibrium



Lecture 2: Monetary Model of Exchange Rate Determination

- Current account/Balance of payment:

$$CA_1 = e_1\left(B_{f,2} - B_{f,1}\right) + \left(B_{h,2} - B_{h,1}\right) =$$
$$P_1Y_1 - P_1C_1 + iB_{h,1} + i^*e_1B_{f,1}$$

$$BOP_1 = CA_1 + KA_1 + FX_1$$

Lecture 2: Monetary Model of Exchange Rate Determination

Consider a money supply increase in the domestic economy in the first period: we assume that the other exogenous variables do not change;

- At the old price level there is an excess of supply of money;
- The excess of supply of money will induce agents to demand more goods and services;
- Given our assumption of fixed output, this will induce an increase in prices and a decrease in the interest rate;
- As domestic prices increases competitiveness will be restored if the nominal exchange rate depreciates.
- As the domestic interest rate decreases, arbitrage equilibrium is restored if the nominal exchange rate depreciates.

Lecture 2: Monetary Model of Exchange Rate Determination

Fixed Exchange Rate Regime

- Consider now the monetary model under fixed exchange rate regime;

  We need to properly specify the mechanism through which money is supplied in this case. Under a fixed exchange rate regime, the monetary authority buys and sells the domestic currency in order to keep the exchange rate at the fixed level.

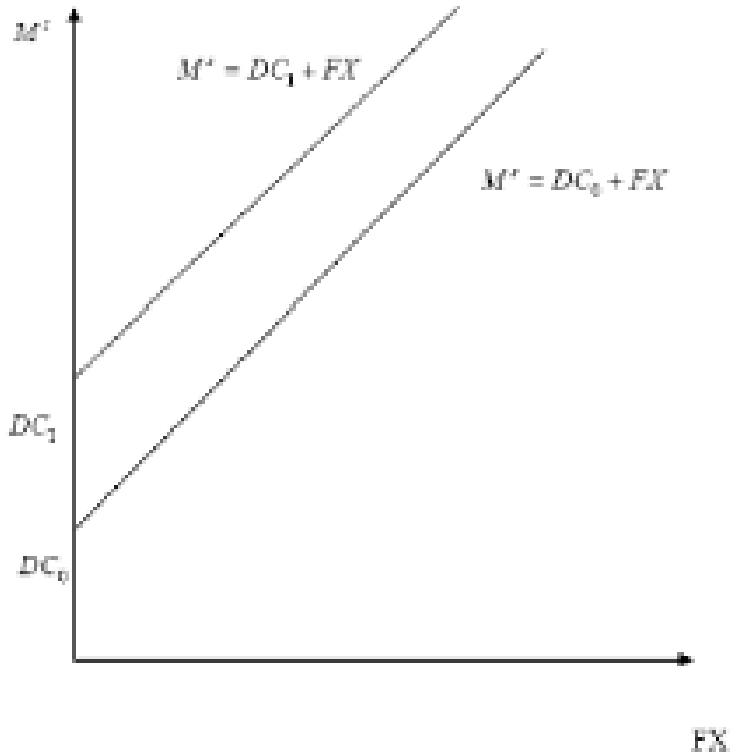
$$M^s = FX + DC$$

  where DC denotes domestic credit and is the component of the money supply that is controlled by the monetary authority; FX is the stock of foreign exchange rate reserve held by the Home Central Bank and is used in order to meet the demand and supply of domestic currency at a given fixed exchange rate.

Lecture 2: Monetary Model of Exchange Rate Determination

Fixed Exchange Rate Regime

Money Supply under a Fixed Exchange Rate Regime:



Lecture 2: Monetary Model of Exchange Rate Determination

Fixed Exchange Rate Regime

- Example: if there is a fall in the demand of home currency, a depreciation of the exchange rate can be prevented only by buying domestic currency through official foreign exchange intervention by reducing the level of foreign reserves. In short: a balance of payment surplus implies an increase in FX; a balance of payment deficit implies a decrease in FX.
- In a floating exchange rate regime the balance of payment is identically zero, because the monetary authority does not use foreign currency reserves to intervene in the currency markets. ($\Delta FX = 0$ and $\Delta M^s = \Delta DC$).
- In a fixed exchange rate regime, the balance of payment is not zero: the surplus or deficit are covered by the use of foreign currency reserves to intervene in the currency markets. ($\Delta FX \neq 0$ and $\Delta M^s = \Delta DC + \Delta FX$).

Lecture 2: Monetary Model of Exchange Rate Determination

Fixed Exchange Rate Regime

- Equilibrium: ($e_1 = e_2$ fixed at $\bar{e}$)
- First note that from arbitrage condition $e_1 = e_2 \Rightarrow 1 + i = 1 + i^*$.
- Money market equilibrium in period 1 and 2:

$$M_1^s = P_1 L\left(C_1, i\right) = \bar{e} P_1^* L\left(C_1, i\right)$$

$$M_2^s = P_2 L\left(C_2\right) = \bar{e} P_2^* L\left(C_2\right)$$

Note that the previous expression is telling us that nothing that the monetary authority does, will affect money demand as the terms on the right hand side are exogenous from the policy authority's perspective

Lecture 2: Monetary Model of Exchange Rate Determination

Fixed Exchange Rate Regime

- Money supply is then equal to:

$$M_1^s = FX_1 + DC_1 = \bar{e}P_1^* L\left(C_1, i\right)$$

$$M_2^s = FX_2 + DC_2 = \bar{e}P_2^* L\left(C_2\right)$$

From which we determine the level of foreign reserves:

$$FX_1 = \bar{e}P_1^* L\left(C_1, i\right) - DC_1$$

$$FX_2 = \bar{e}P_2^* L\left(C_2\right) - DC_2$$

Note that in this case there no intertemporal channel working through arbitrage condition but only through future output. Foreign reserves are equal to the gap between given demand for domestic money and the supply of domestic credit.

- if $\uparrow DC_1 \Rightarrow \downarrow FX_1$;
- if $\uparrow P_1^* \Rightarrow \uparrow FX_1$;
- if $\uparrow Y_1 \Rightarrow \uparrow FX_1$;

Lecture 2: Monetary Model of Exchange Rate Determination

Fixed Exchange Rate Regime

Consider an increase in the foreign price level in period 1; we assume that the other exogenous variables do not change;

- For given domestic prices, the country is becoming more competitive;
- the excess of demand for domestically produced goods generate a balance of payment surplus;
- foreign exchange reserves will increase and money supply will also increase as a consequence;
- the increase in the money supply will generate an increase in the domestic price level that will restore the same level of competitiveness as before;
  Important implication: if the domestic economy is a small economy, then it cannot follow an independent monetary policy under a fixed exchange rate regime, i.e. it does not change the price level or inflation rate different from the one in the rest of the world.

Lecture 2: Monetary Model of Exchange Rate Determination

Fixed Exchange Rate Regime

- Announced Devaluation once for all.
- for a given foreign price level, the home country is now overcompetitive;
- there is going to be an excess of demand of domestically produced goods and a balance of payment surplus;
- this will induce an accumulation of foreign exchange reserve;
- domestic money supply will increase and since output is given this will induce an increase in the domestic price level;

note: devaluation effect on the balance of payment might be delayed depending on short run elasticities of demand for exports and imports. (J-curve)

Lecture 2: Currency Crises

First generation currency crisis:

- Model developed by Krugman (1979). (motivation behind this model was the Bretton Woods collapse in 1971)
- Basic structure: monetary model of exchange rate determination (+ Investor's behavior in dynamic setting)
- Underlying key assumption: no uncertainty (i.e. we have perfect foresight).
- Message: traders speculate against fixed exchange rate in order to profit from an anticipated action. Their behavior is "justified" because of an inconsistency between internal and external objectives.
- Outcome: balance of payment crises in which traders acquire a large portion of the central's bank foreign reserve as the bank attempts in vain to support its currency. Speculative attacks in this framework are inevitable and represent an entirely rational market response to persistently confliction internal and external macroeconomic targets.

Lecture 2: Currency Crises

The model

- Money demand equation:

$$\frac{M_t^d}{P_t} = \alpha - \beta i_t$$

and money supply follows from Central Bank balance sheet:

$$M_t^s = FX_t + DC_t$$

Investor's behavior is capture by uncovered interest parity condition:

$$\frac{e_{t+1}^e - e_t}{e_t} = i_t - i_t^*$$

Lecture 2: Currency Crises

Other assumptions:

a) We assume that purchasing power parity holds and we normalize the foreign price level to 1.

$$\frac{e_t P_t^*}{P_t} = 1 \text{ with } P_t^* = 1 \Rightarrow e_t = P_t$$

b) We assume that there is perfect foresight and we normalize the foreign interest rate to 0.

$$e_{t+1}^e = e_{t+1} \text{ with } i_t^* = 0 \Rightarrow \frac{e_{t+1} - e_t}{e_t} = i_t$$

c) There is a lower bound on the level of foreign reserves that the central bank owns.

$$FX_t \geq 0$$

Lecture 2: Currency Crises

Solution of the model:

- Money market equilibrium

$$M_t^d = M_t^s \Rightarrow \frac{FX_t + DC_t}{P_t} = \alpha - \beta i_t$$

- + UIP

$$\frac{FX_t + DC_t}{e_t} = \alpha - \beta \left(\frac{e_{t+1} - e_t}{e_t} \right)$$

Lecture 2: Currency Crises

- **Fixed Exchange Rate Regime:**

$$e_t = \bar{e} \; \forall t$$

- And money demand is given by

$$M_t^d = \alpha \bar{e}$$

- The money market equilibrium implies

$$\frac{FX_t + DC_t}{\bar{e}} = \alpha \tag{15}$$

Lecture 2: Currency Crises

Sustainability of the regime

- If

$$FX_t > \alpha\bar{e} - DC_t$$

the peg is unsustainable because at the given exchange rate $\bar{e}$, money demand is larger than money supply (a devaluation could resume equilibrium by increasing money demand).

- Example:. Suppose the sterling is pegged to the dollar at a given rate $\bar{e}$ and the Bank of England ran out of dollar reserves. If at this rate there is still demand for dollars, the only way the equilibrium can be resumed is if the dollar becomes more expensive, i.e. if there is a devaluation of the exchange rate ($\bar{e}$ increases).
- Moreover, equation (15) implies that, in a fixed exchange rate regime, changes in domestic credit have to be accompanied by changes in reserve levels:

$$-\Delta FX_t = \Delta DC_t$$

Lecture 2: Currency Crises

- Let's define the shadow exchange rate as the exchange rate that would prevail in the market if there were no intervention in the foreign exchange market. That is, the exchange rate that would prevail if there was a **Floating Exchange Rate Regime and reserves are at the lower bound**

$$FX + DC_t = \alpha e_t^s - \beta \left(e_{t+1}^s - e_t^s \right) \tag{16}$$

- Note that the value of the current exchange rate depends on its value one period ahead.

Lecture 2: Currency Crises

An unsustainable peg

- Consider the situation in which the Central Bank expands the domestic component of money supply at a constant rate indefinitely:

$$DC_t = DC_{t-1} + \mu$$

where μ is the change in domestic credit.

- Given that in a fixed exchange rate regime (see equation (15)) changes in domestic credit have to be accompanied by changes in reserve levels, we have that:

$$-\Delta FX_t = \Delta DC_t = \mu$$

- In order to defend the peg, the central bank will intervene in the foreign market by selling foreign reserves at the same rate of increase of the domestic credit component of the money supply. The monetary authority will eventually run out of foreign reserves and will be forced to abandon the peg.

Lecture 2: Currency Crises

The timing of the crisis:

- Since we are in a framework in which everything is known in advance, traders in the foreign market will anticipate the abandonment of the peg and at a certain point will start selling the domestic currency so that reserves will be driven to zero abruptly.
- Coming back to our example: The Bank of England is pegging the pound to the dollar and we know that at some point the peg will be abandoned and the pound will devalue versus the dollar. If speculators know that in advance, they will buy dollars and sell pounds even before the central bank run out of reserves.

Lecture 2: Currency Crises

When do the speculators sell the currency?

- Recall the definition of shadow exchange rate:

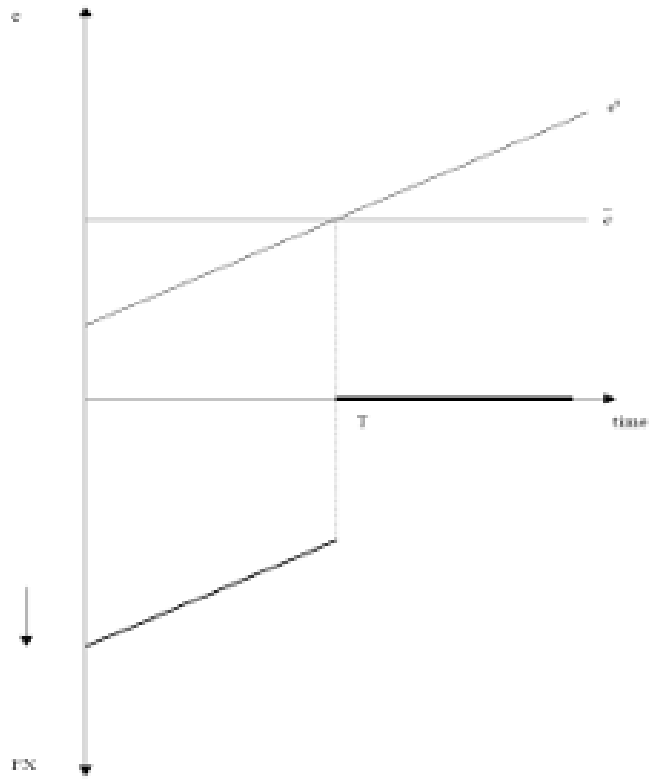
$$\Delta DC_t = \alpha \Delta e_t^s - \beta \left(\Delta e_{t+1}^s - \Delta e_t^s \right) \tag{17}$$

and maintain the assumption about the growth in domestic credit:

$$\Delta e_t^s = \mu / \alpha \tag{18}$$

- Since domestic credit is growing at a constant rate μ, and since the shadow exchange rate depends on the path of money supply, we have that the shadow exchange rate will depreciate also at a constant rate proportional to μ.
- The attack on the domestic currency will occur at time T at which the shadow exchange rate is equal to the fixed rate.

Lecture 2: Currency Crises



Lecture 2: Currency Crises

- Any individual trader has the incentive to exchange domestic currency for foreign currency before reserves run out.
- Suppose that the attack will occur at time $T_2 < T$ then the exchange rate will appreciate discretely but this cannot be an equilibrium since people do not want to sell a currency that will appreciate.
- Suppose the attack occurs at time $T_1 > T$ then the exchange rate would jump from the fixed value and it would depreciate discretely. Traders that hold the currency will incur in a capital loss and since they know everything in advance they will sell the currency before T_1.
- The attack occurs at time T.

Lecture 2: Currency Crises

Money market after the attack

- At the moment of the attack the money supply will fall (given the loss in reserves).
- Money demand will contained by higher interest rates.

$$i_t = i_t^* + \Delta e_{t+1} = i_t^* + \mu/\alpha$$

That is, after the attack the nominal exchange rate is given by the shadow exchange rate and it depreciates at a rate proportional to μ, which implies that the domestic interest rate is higher than the foreign one in order to preserve the UIP condition.

Lecture 2: Currency Crises

Things to note about this model of currency crisis:

1. The root cause of the crisis is poor government policy. The source of the upward trend in the shadow exchange rate is given by the increase in domestic credit (the need for this might arise for example because of fiscal deficits to be financed by seigniorage) $\Rightarrow$ solve fiscal problem and there is no crisis. Speculative target is provided by government's pursuit of inconsistent policies: e.g. persistent deficits together with an exchange rate peg.
2. The crisis, though sudden, is a deterministic event: the crisis is inevitable given the policies and the timing is in principle predictable
3. First generation currency crisis model seem to do no harm - no effect on output
4. Note that what matters in determining the crisis are future policies that investors foresee, not the one observed in the past.

Lecture 2: Exchange Rate Mechanism Crisis

Is this a good model for describing ERM crisis in 1992 ?

- ERM: system of fixed exchange rate regime among major European economies (system of target zones around a center parity)
- Background fact: German reunification which overheated German economy forced Bundesbank to increase interest rates to fight inflationary pressures.
- While German economy was booming, the rest of continental Europe was facing high unemployment.

Lecture 2: Exchange Rate Mechanism Crisis

- UK economy entered the ERM with a parity (£1=DM2.95) well below the level at which the sterling was in the previous year.
- During September 1992, speculators started attacking weak economies in the ERM. UK authorities were forced to increase interest rate twice (by 2% and 3%) in a matter of days and then finally reducing them by 3%.
- Speculators (like George Soros) made profits as sterling depreciated by 10% in the space of few days.
- Critical aspect of the crisis: market perception about different commitment of policy authorities (German versus UK authorities). German commitment to fight inflation dominated German commitment to intervene in the currency market to support attacked currencies. UK commitment to belong to ERM was perceived as weaker as high interest rates needed to defend the sterling were costly from political and economic reasons.

Lecture 2: Exchange Rate Mechanism Crisis

- There was no evidence of irresponsible policies in any of the country involved.
- There was no obvious trend in long-run equilibrium exchange rate (shadow rate was not depreciating)
- There was no mechanical link between capital flight and abandonment of the peg.

Lecture 2: Currency Crises

- Quitting the fixed exchange rate regime may be a policy *choice* (and might not be inevitable)
- Example: British officials chose not to pay the price for defending the pound with higher interest rates, while French officials made the opposite decisions.

Lecture 2: Currency Crises

Second generation currency crisis model

- This class of model is characterized by multiple equilibria: if agents expect a crisis to happen it might be too costly to maintain the peg, if agents are confident the crisis might be avoided.
- Defending a currency peg can have costs and benefits:
  - If the currency is pegged at an uncomfortable level (overvalued), the government is forced to accept a lower level employment in the short-run than it would otherwise have wanted.
  - This cost may be higher if the peg is not credible. In this case, investors will demand higher interest rates in order to hold assets denominated in the country's currency. If the government defends the peg by providing those higher interest rates, it will worsen employment.
  - The benefits from pegging the exchange rate may be: maintaining a nominal anchor (i.e., credible monetary policy), political, or other economic goals.

Lecture 2: Currency Crises

- Suppose that, as long as the peg is credible, the cost of abandoning the peg is higher than the benefits. But if the peg is no longer credible, this cost outweighs the benefits. So even a government that would be willing to pay the price of sustaining the peg in absence of speculative attack, it might be unwilling to stand up in such situation. Speculators who believe that other speculators are about to attack are themselves encouraged to do so. (self-fulfilling crises of confidence).

Lecture 2: Currency Crises

Policy trade-offs

- Define the desired exchange rate e^* as the exchange rate that the government would choose if it had not made a commitment to the fixed rate.
- Assume that the exchange rate peg will be more costly to defend when devaluation is expected.
- Assume that there is a cost that arises once the government decides to abandon the fixed exchange rate regime.

Lecture 2: Currency Crises

- These 3 elements are embedded in the following loss function for the government:

$$L = \underbrace{\left[\psi\left(e^{*}-e\right)+\eta\Delta e^{e}\right]^{2}}_{\text{loss from defending}} + \underbrace{I\left(\Delta e\right)}_{\text{loss from abandoning}},$$

with $\psi, \eta > 0$. And we assume that the loss from abandoning is given by the following function

$$I\left(\Delta e\right) = \begin{array}{c} 0 \text{ for } \Delta e = 0 \\ Q \text{ for } \Delta e > 0 \end{array}$$

Lecture 2: Currency Crises

- Suppose now that we start from a situation in which the exchange rate is pegged at $\bar{e}$. Different equilibria depend on expectations.

  Case 1) The government is *expected* to resist the pressure to devalue, that is $\Delta e^e = 0$. The loss from defending is given by

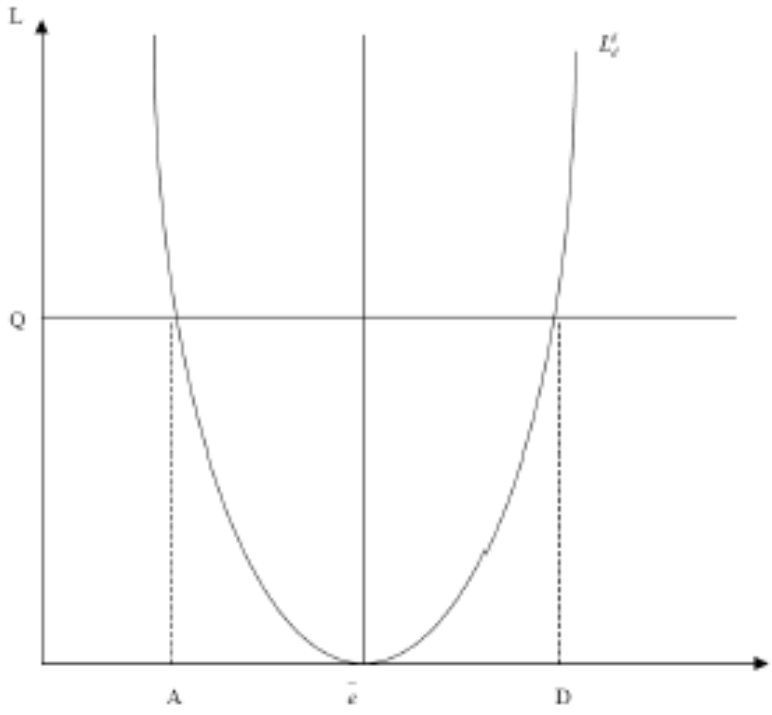
  $$L_d^d = \underbrace{\left[\psi\left(e^* - \bar{e}\right)\right]^2}_{\textit{loss from defending}}$$

  When this is an equilibrium?

  - when, conditional on market expectations, the government finds optimal to defend, that is when $L_d^d < Q$

Lecture 2: Currency Crises

CASE 1



-As long as the desired level of the nominal exchange rate, e^*, is in between the segment AD then the condition for an equilibrium in which the government is not devaluing is satisfied.

Lecture 2: Currency Crises

Case 2) The government is *expected* to abandon and to depreciate the exchange rate at the desired level e^*, that is $\Delta e^e = e^* - \bar{e}$. The loss from defending is given by

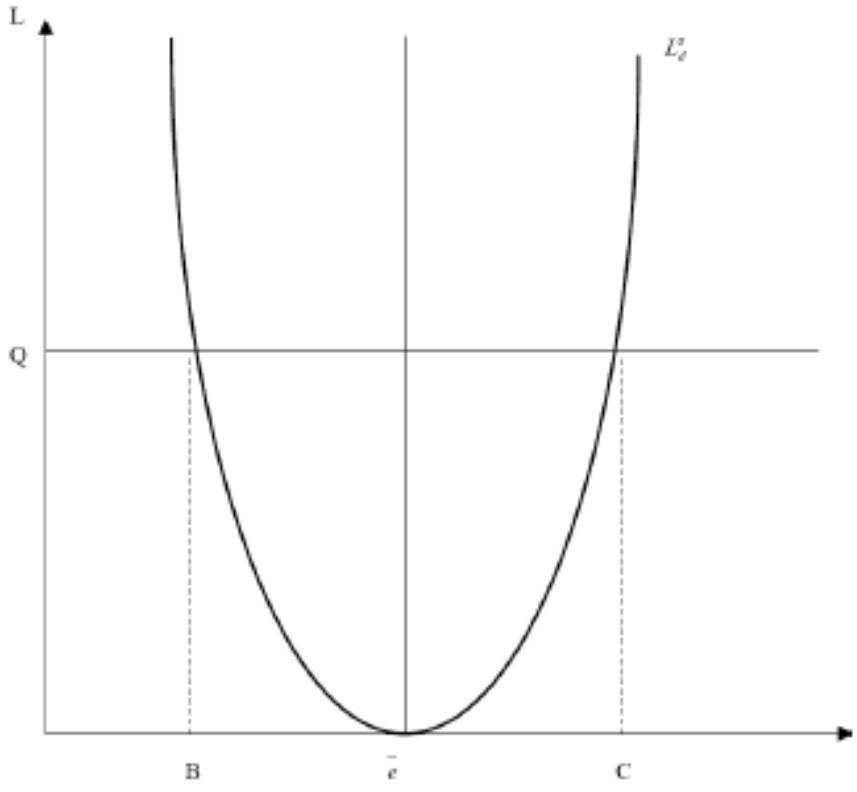
$$\underset{\textit{loss from defending}}{L_d^a} = \left[\psi\left(e^* - \bar{e}\right) + \eta\left(e^* - \bar{e}\right)\right]^2$$

When this is an equilibrium?

- when, conditional on market expectations, the government finds optimal to defend, that is when $L_d^a > Q$.

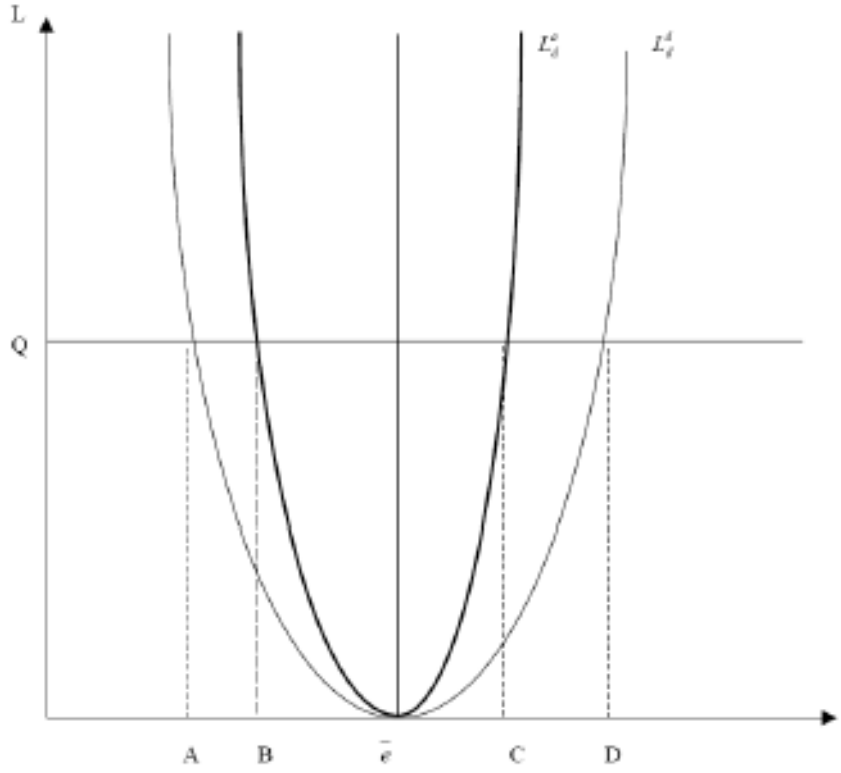
Lecture 2: Currency Crises

CASE 2



-As long as the desired level of the nominal exchange rate, e^*, is outside the segment BC then the condition for an equilibrium in which the government is devaluing is satisfied.

Lecture 2: Currency Crises



-Here we combine the two cases and examine the possible solutions.
-When e^* is in between the segment BC then the condition for an equilibrium in which the government is not devaluing is satisfied.
-When e^* is outside the AD region then the condition for an equilibrium in which the government abandons, is satisfied.
-When e^* is in the AB region or in the CD region, then the government validates market expectations: multiple equilibria regions.

Lecture 2: Currency Crises

- Equilibrium is a situation in which the government choice is compatible with market expectations. There is a region in which both market expectations are validated

$$L_d^d < Q < L_d^a$$

In this region we have multiple equilibria.

Lecture 2: Currency Crises

- The implications of this model are that for a given shape of the loss function, and for a given desired exchange rate e^*, it might become impossible for a country to defend an exchange rate regime since the outcome depends entirely on whether the market expects the government to devalue of not. A speculative attack is self-fulfilling: it succeeds simply because it was expected to occur without any reference to fundamentals.

Lecture 2: Currency Crises

Analysis of the model:

1. the smaller the gap between e^* and $\bar{e}$ the easier is to defend;
2. the higher is Q, the cost of abandoning the peg, the easier will be to defend other things being equal.
3. results depend on the fact that the government locked in an exchange rate peg which is not optimal (i.e. it does not correspond to the desired one).

Lecture 2: Currency Crises

Difference with first generation models:

1. no irresponsible policy; (but still not full commitment to the peg)
2. no predictability of the time of crisis.
3. if the country leaves the peg, there is no negative impact on employment and output. The monetary policy constraint is removed and the result is positive in terms of short-run macroeconomics benefits (think about Britain after 1992 and Brazil very recent experience).