Exchange Rates

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Outline

- Definitions: Nominal and Real Exchange Rate
- A Theory of Determination of the Real Exchange Rate
- Foreign Exchange Market
- Price Arbitrage: Purchasing Power Parity
- Interest Rate Arbitrage: Uncovered and Covered Interest Rate Parity
- Determination of the Nominal Exchange Rate

Definitions: Nominal Exchange Rate (NER)

- **Nominal Exchange Rate** is the price of a foreign currency in terms of the home currency
  - $E_{\$/€} = 1.3467$=US exchange rate (in US terms, Dollars per Euro)
  - $E_{€/\$} = 0.7425$=Euro exchange rate (in European terms, Euros per Dollar)

- Thus, $E_{\$/€} = 1/E_{€/\$}$
  - An increase in $E_{\$/€}$ means a dollar depreciation.

- If a currency can buy more (less) of another currency, we say it has been appreciated (depreciated)
  - $\uparrow E_{\$/€}$ or $E_{€/\$} \downarrow$: dollar depreciation, euro appreciation

Nominal vs Real Exchange Rates (RER)

- **Real exchange rate** is the Nominal Exchange rate times the inverse of the relative price levels
  - Dollar pound real exchange rate

$$e_{\$/£} = E_{\$/£}\frac{P_{UK}}{P_{US}}$$

    where $E_{\$/£}$:dollar price of 1 pound, P_{UK}: is the price level in UK, P^{US} price level in US
  - $e_{\$/£}$: the relative price of a consumption basket in the UK in terms of consumption in US

US dollar depreciation vs other Currencies

- Makes US residents relatively poorer
- Makes US products cheaper to foreigners

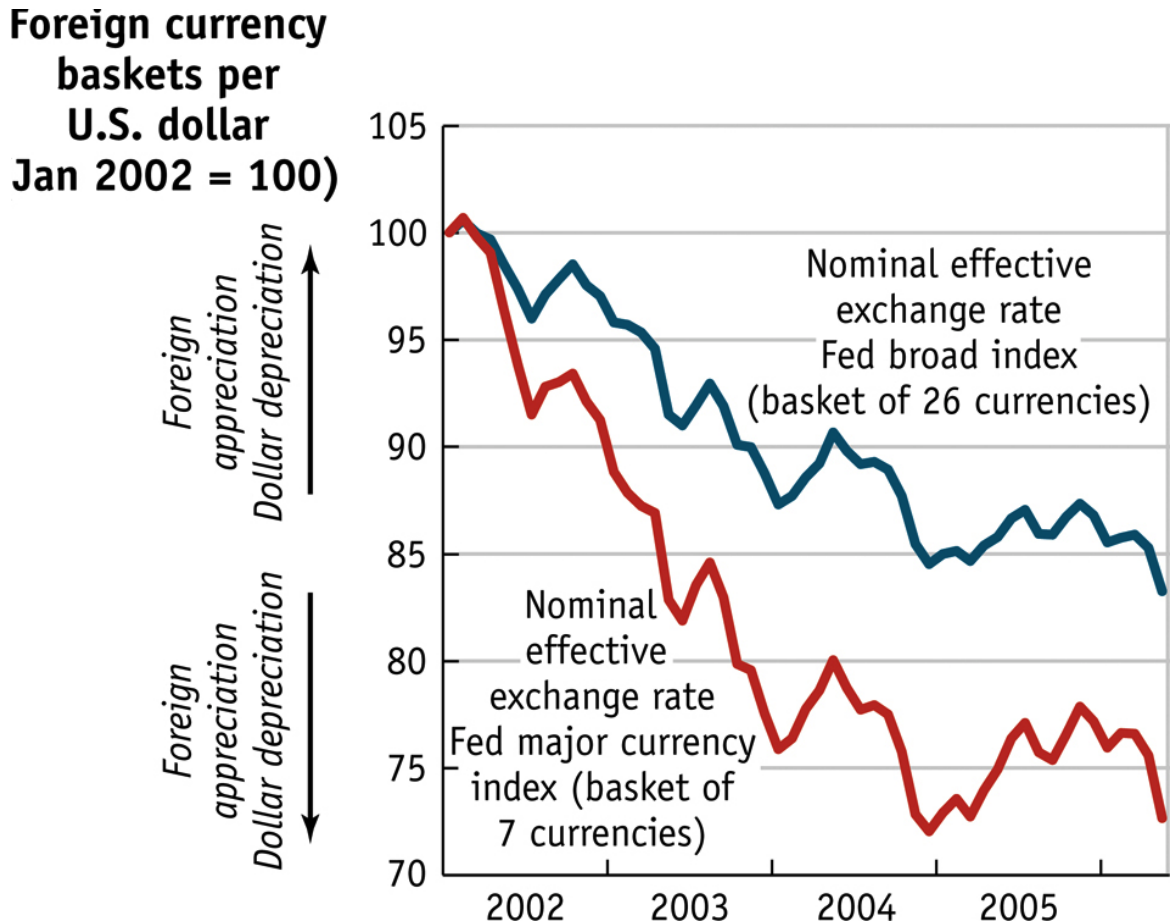

Figure: Source: Feenstra and Taylor 2010

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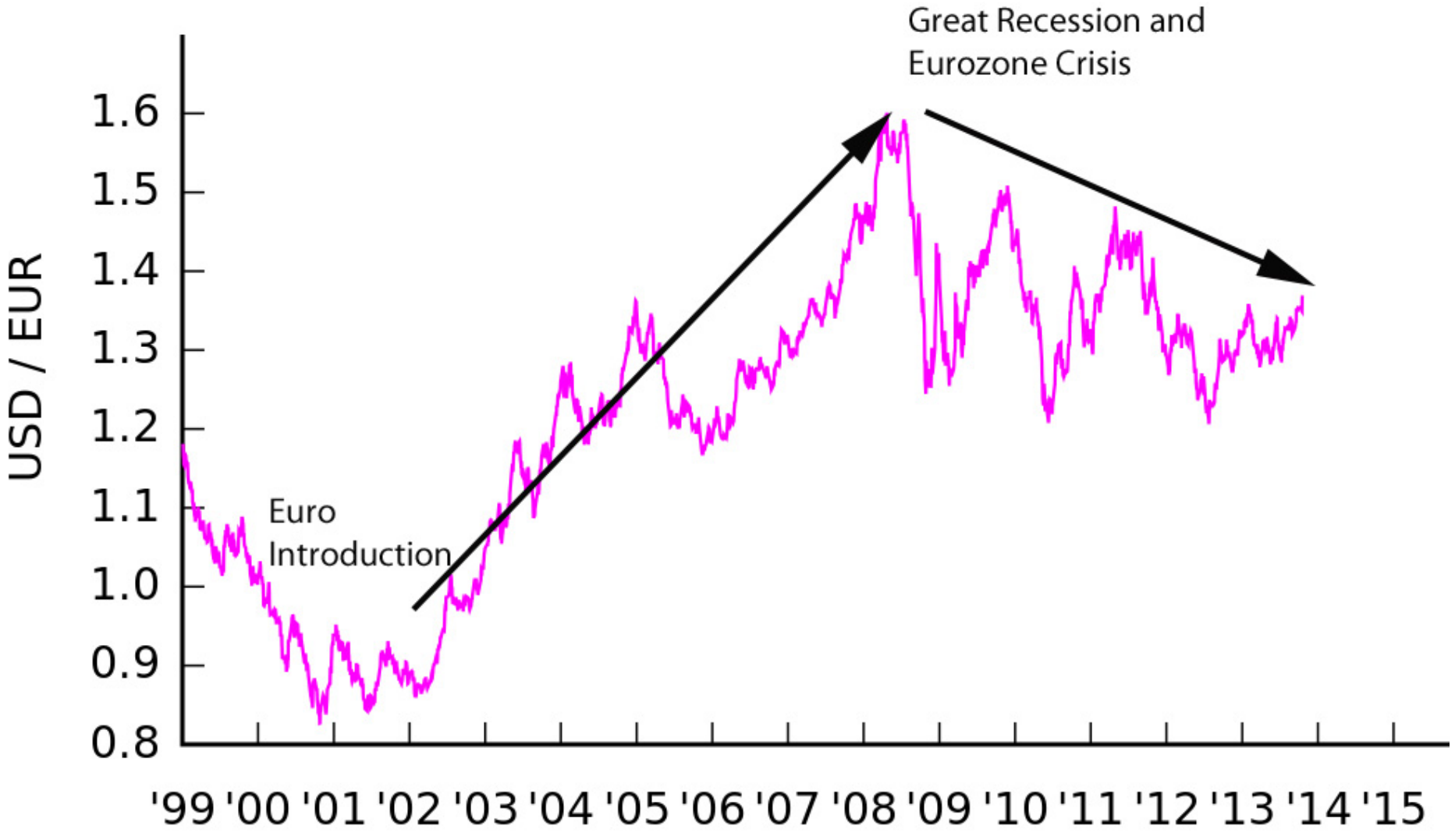
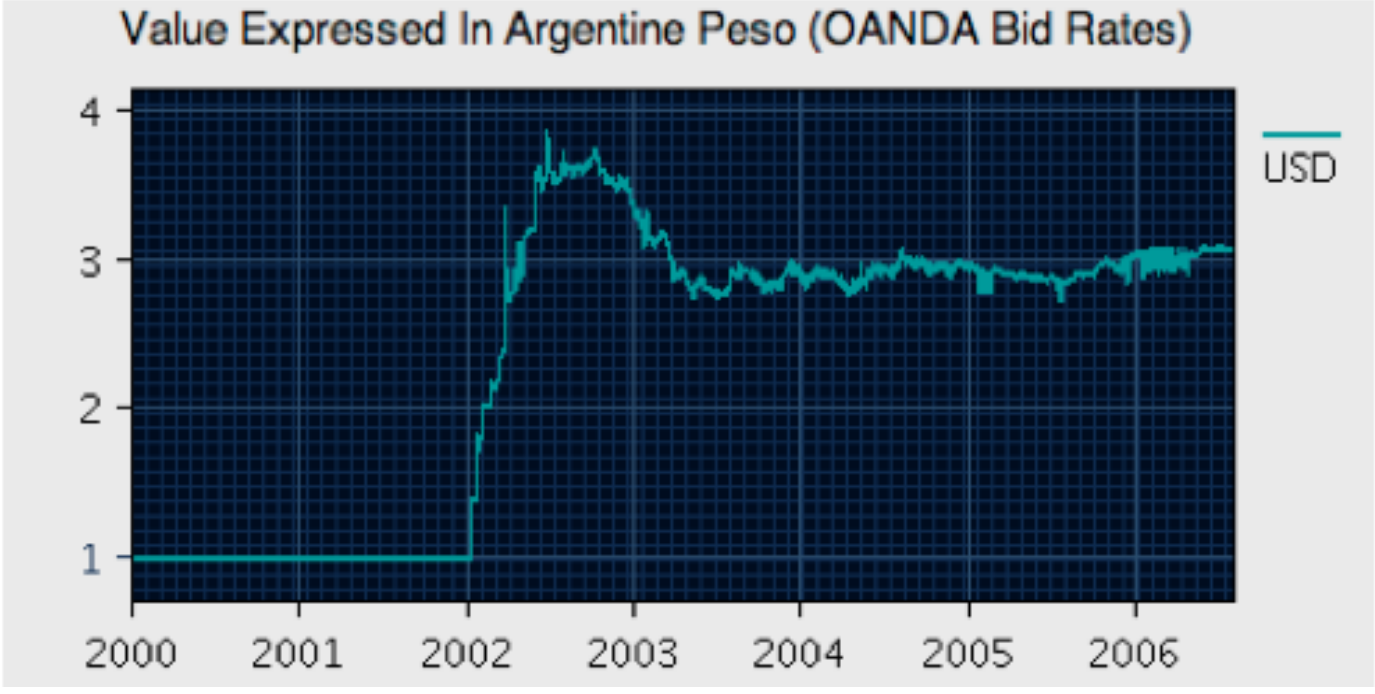
US dollar Depreciation and Appreciation



Currency Crisis: Argentinian Peso depreciation

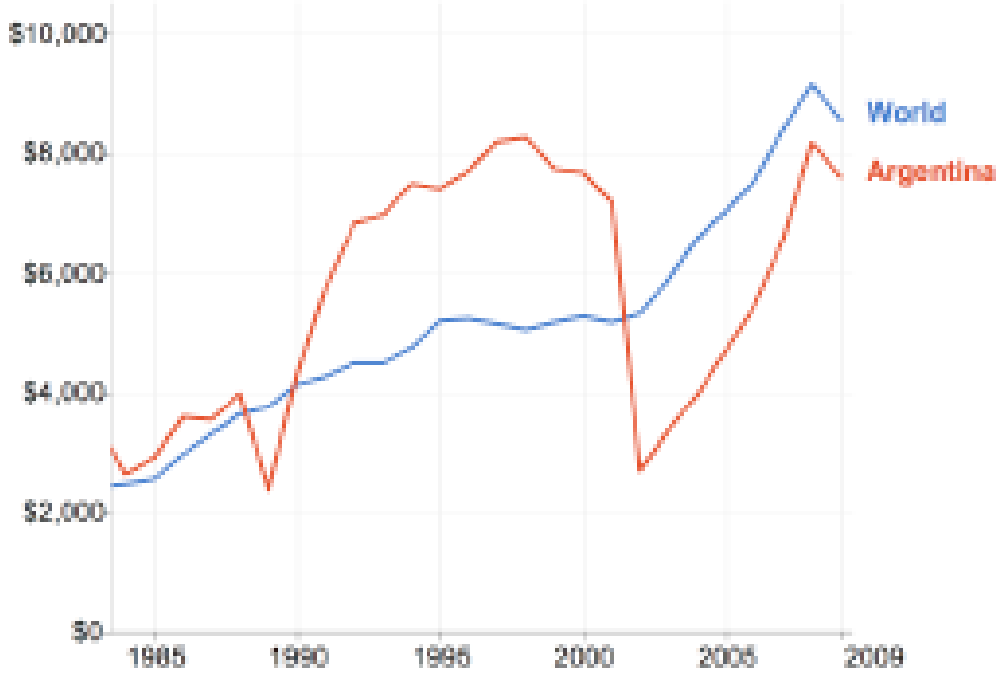
- **Between Jan and Jul '02, Argentine Peso depreciated 70%**
  - What does it mean for Argentinians?



Headline News: Effects on Argentinians

- **Consequences of the Argentinian devaluation episode**
  - Jan 2002, Argentine gov. announced default on $155 billion in debt.
  - Unrest, political upheaval
  - As of 2006, unemployment rate was still 10%.
  - Inflation increased dramatically for 2 years, still remains high.
- **Real GDP in dollars fell dramatically.**

Figure: Argentine and World Real GDP per capita in $ (World Bank)

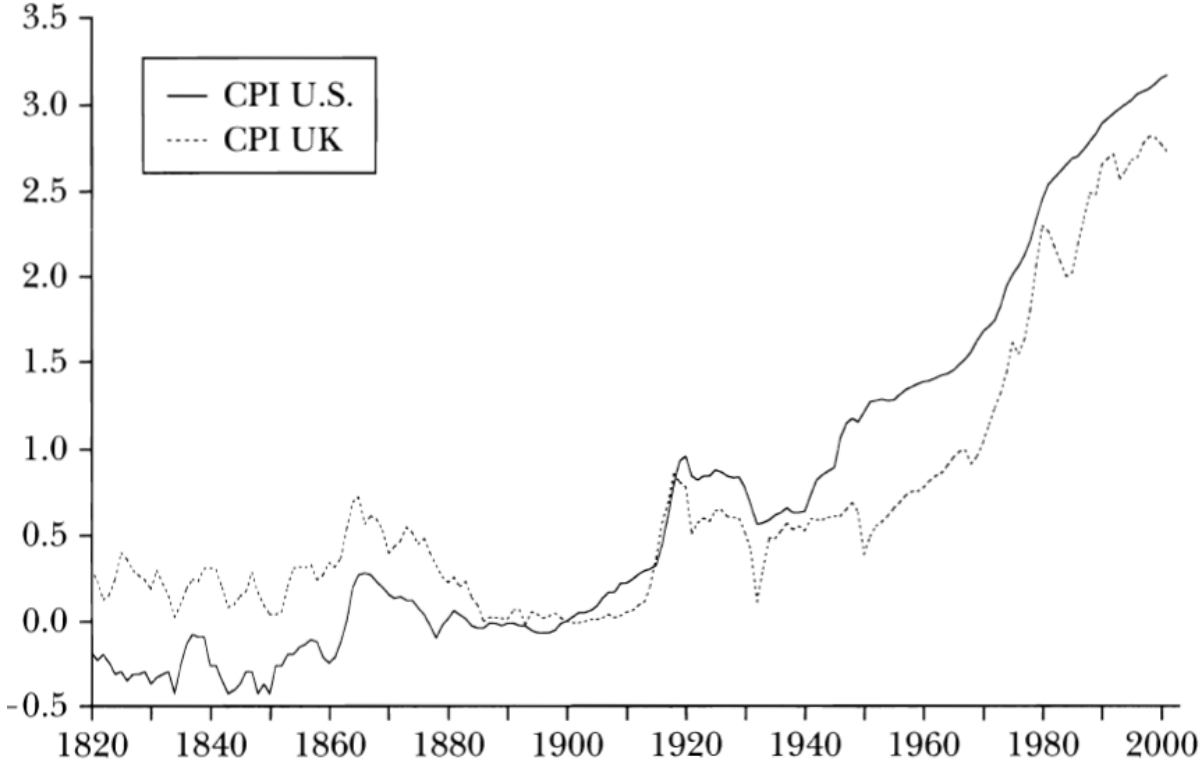


Real Exchange Rate Determination

Real Exchange Rates

- **Real exchange rates are persistent**

Figure: Consumer Price Indices (CPI) for UK and US in US dollar terms (log scale). Taylor and Taylor, Journal of Economic Perspectives, 2004.



A Theory of Determination of the Real Exchange Rate

- **Objective: A Theory of What Determines RER**
  - A Theory of RER is far easier to develop:
    - In general, economic theories work better with real than nominal magnitudes
  - Step 1: Derive a relationship between RER and relative prices
  - Step 2: Derive a relationship between relative prices and economic fundamentals

Step 1: RER and Relative Prices

- Definitions:.
  - P_T : price of tradeables,
  - P_N : price of non-tradeables,
  - P : overall price level
  - '*' indicates foreign variable.

- Assumptions:
  - "Law of one price" holds for traded goods $P_T = EP_T^*$
  - For nontraded goods, in general, $P_N \neq EP_N^*$

Step 1: RER and Relative Prices

- Assume the price level, P, is a function $\phi(.,.)$ of the price of tradables and nontradables, $P = \phi(P_T, P_N)$, where ϕ is homogeneous of degree 1
  - Homogeneous of degree 1: $\phi(x, y) = \lambda\phi(x/\lambda, y/\lambda)$, or $\lambda\phi(x, y) = \phi(\lambda x, \lambda y)$

The Impact of Non-Tradables in the RER

- Assume $P = \phi\left(P_T, P_N\right)$ where ϕ is homogeneous of degree 1

$$\begin{aligned} e &\equiv \frac{EP^*}{P} \\ &= \frac{E\phi\left(P_T^*, P_N^*\right)}{\phi\left(P_T, P_N\right)} \\ &= \frac{EP_T^*\phi\left(1, \frac{P_N^*}{P_T^*}\right)}{P_T\phi\left(1, \frac{P_N}{P_T}\right)} \end{aligned}$$

- Now use Law of one price for tradeables, $P_T = EP_T^*$,

$$e = \phi\left(1, \frac{P_N^*}{P_T^*}\right) \Big/ \phi\left(1, \frac{P_N}{P_T}\right)$$

The Impact of Non-Tradeables in the RER

- Law of one price implies $e = \phi\left(1, \frac{P_N^*}{P_T^*}\right) \Big/ \phi\left(1, \frac{P_N}{P_T}\right)$
  - Therefore, $e > 1$ if $\frac{P_N^*}{P_T^*} > \frac{P_N}{P_T}$., i.e. RER depends on relative prices of tradeables to non-tradeables
  - Is this true in the data?
    - We will study the academic research on this hypothesis in detail later on

- The last piece of the theory is to develop a theory of how $\frac{P_N}{P_T}$ is determined

The Impact of Non-Tradeables in the RER

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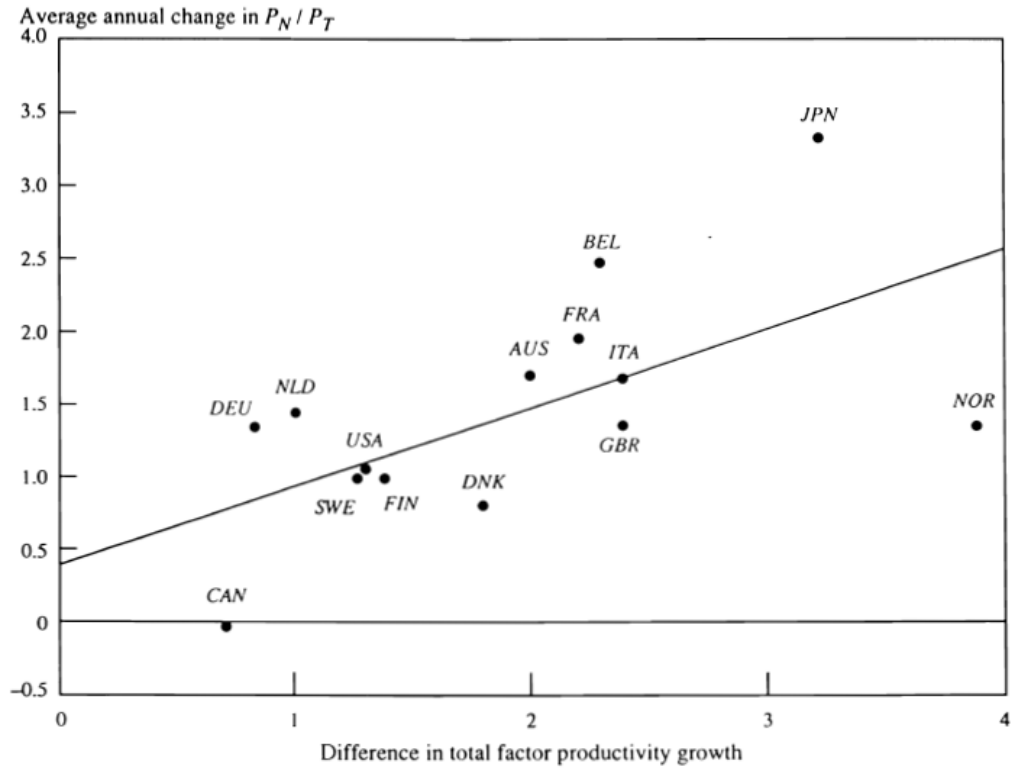
  - The Balassa-Samuelson effect

Step 2: Relative Prices & Economic Fundamentals (Balassa-Samuelson)

- A theory with Nontradeables and Tradeables
  - 2 goods, traded: Q_T, non-traded: Q_N
  - Production functions: $Q_T = a_T L_T$, $Q_N = a_N L_N$
    - a_i :productivity, L_i : labor used, where $i = T, N$
- Profits in each sector $P_i Q_i - wL_i$, where $i = N, T$
  - Zero profit condition: $P_i Q_i = wL_i$, for $i = N, T$
  - Using production functions $P_i a_i L_i = wL_i \implies w = P_i a_i$
- Therefore,

$$\frac{P_N}{P_T} = \frac{a_T}{a_N}$$

The Balassa-Samuelson Effect in the Data



Note: The figure plots the average annual percentage change in the relative price of nontradables in terms of tradables (vertical axis) against the average annual growth in total factor productivity differential between the traded sector and the nontraded sectors (horizontal axis) over the period 1970-1985 for 14 OECD countries. Source: José De Gregorio, Alberto Giovannini, and Holger C. Wolf, "International Evidence on Tradable and Nontradable Inflation," *European Economic Review* 38, June 1994, 1225-1244.

Foreign Exchange Market

The Market for Foreign Exchange

- Exchange rates are set minute by minute in the Foreign Exchange (Forex) market
  - Individuals, corporations, public institutions trade currencies
  - An over-the-counter market since it is not an organized exchange market

- The global currency trade is 3.2 trillion per day, 290% more than in 1992
  - Major exchange centers: UK, US, Japan

Largest Currency Traders

Top 10 currency traders

% of overall volume, May 2011

Rank	Name	Market share
1	Germany Deutsche Bank	15.64%
2	United Kingdom Barclays Capital	10.75%
3	Switzerland UBS AG	10.59%
4	United States Citi	8.88%
5	United States JPMorgan	6.43%
6	United Kingdom HSBC	6.26%
7	United Kingdom Royal Bank of Scotland	6.20%
8	Switzerland Credit Suisse	4.80%
9	United States Goldman Sachs	4.13%
10	United States Morgan Stanley	3.64%

Source: wikipedia

Spot Contracts

- Spot exchange: a contract for immediate exchange of currencies
  - In the rest of the course, we will mostly talk about spot contracts

- How it works
  - Trader 1 calls Trader 2 and asks for a price of a currency, say GBP
  - The bid price is the exchange rate (ER) at which 2 is willing to buy GBP
  - The ask (or offer) price is the ER at which 2 is willing to sell GBP
  - The difference (bid-ask spread) generates profits for Trader 2

Derivatives

- Derivatives: contracts for which their pricing is derived from the spot rate
  - Forwards, swaps, futures and options.
  - These contrants exist to allow investors to trade currency for delivery at different times or with different contigencies
  - **Forwards**: It is a contract where the settlement date for the delivery of the currencies is forward in the future for a set price
    - E.g. the time of the delivery -the maturity- could be 90 days from now, a year from now etc
    - Because the contract has a fixed price it carries no risk.

Price Arbitrage: Purchasing Power Parity

Absolute & Relative Purchasing Power Parity (PPP)

- **Absolute PPP: Real exchange rate is expected to be 1**
  - **Absolute Purchasing Power Parity would imply:**
    $\log\left(E_{\$/£}P_{UK}\right) \approx \log\left(P_{US}\right)$
  - PPP refers to the price index while law of one price to one good at a time
- **Relative PPP implies that there no expected movements in the Real exchange rate**
  - **Relative Purchasing Power Parity would imply:**
    $d\log\left(E_{\$/£}P_{UK}\right) \approx d\log\left(P_{US}\right)$

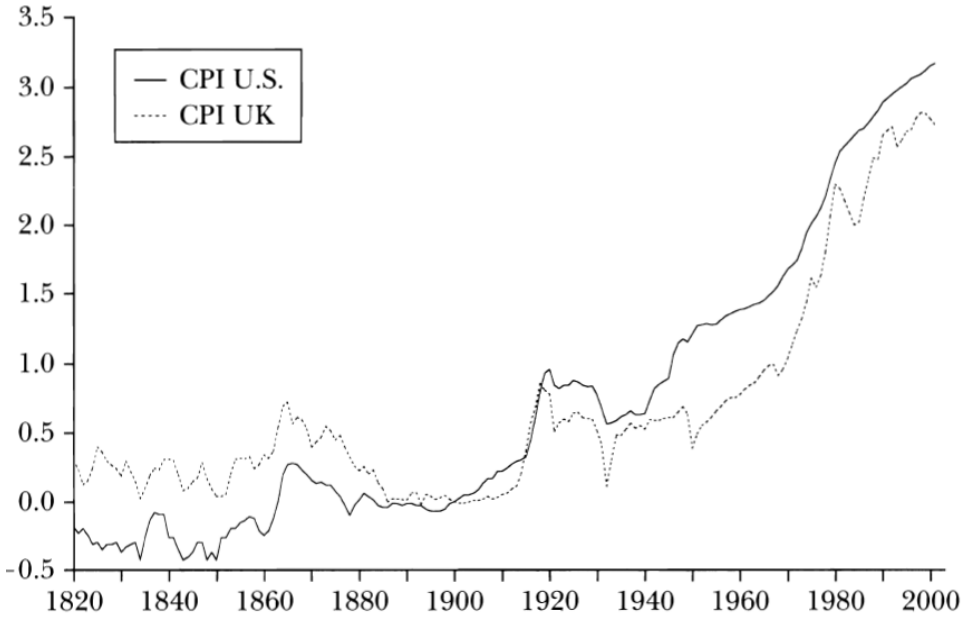
Absolute Purchasing Power Parity

- **Absolute PPP: Real exchange rate is expected to be 1**
  - **Absolute Purchasing Power Parity would imply:**
    $\log\left(E_{\$/£}P_{UK}\right) \approx \log\left(P_{US}\right)$
- PPP is based on the law of one price: in the absense of transaction costs, prices should be the same across markets because of arbitrage
  - In the short run, obviously this is not true.

Absolute PPP in the Data

- **If all the goods were instantly tradeable, PPP theory should be true!**
- **Not true in the short run.** Approximately true in the long-run.

Figure: Consumer Price Indices (CPI) for UK and US in US dollar terms (log scale). Taylor and Taylor, Journal of Economic Perspectives, 2004.



Testing for Relative PPP

- **Postulate that** $\log\left(E^t_{\$/£}P^t_{UK}\right) \approx \log\left(P^t_{US}\right)$ for some time t.
  - We know that for small periods, it may not hold. Can it hold over large periods of time?
  - Consider the following derivation

$$\log\left(E^t_{\$/£}P^t_{UK}\right) - \log\left(E^{t-n}_{\$/£}P^{t-n}_{UK}\right) \approx \log\left(P^t_{US}\right) - \log\left(P^{t-n}_{US}\right) \implies$$

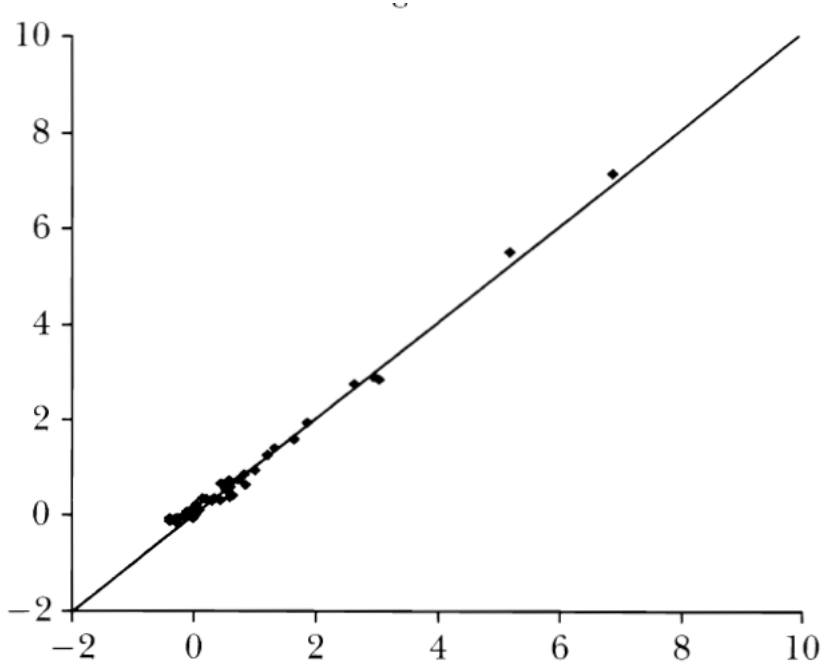
$$\log\left(E^t_{\$/£}/E^{t-n}_{\$/£}\right) + \log\left(P^t_{UK}/P^{t-n}_{UK}\right) \approx \log\left(P^t_{US}/P^{t-n}_{US}\right) \implies$$

$$\log\underbrace{\left(E^t_{\$/£}/E^{t-n}_{\$/£}\right)}_{\text{change in exchange rate}} \approx \log\underbrace{\left(P^t_{US}/P^{t-n}_{US}\right)}_{\text{Ratio of prices in the US (inflation)}} - \log\underbrace{\left(P^t_{UK}/P^{t-n}_{UK}\right)}_{\text{Ratio of prices in the UK (inflation)}}$$

- We can now proceed and look at the empirical counterparts

Relative PPP in the long-run

- **Taylor and Taylor '04 paper. Testing PPP in the long-run**



Note: The figure shows countries' cummulative inflation rate differentials against the United States in percent (vertical axis) plotted against their cumulative depreciation rates against the U.S. dollar in percent (horizontal axis). The sample includes data from 20 industrialized countries and 26 developing countries. Source: Alan M. Taylor and Mark P. Taylor, "The Purchasing Power Parity Debate," *Journal of Economic Perspectives* 18, Fall 2004, 135-158.

Failure to generate PPP

- **Obviously not all goods are tradeable.**
  - Example of non-tradeable goods: haircuts, restaurant meals
  - For many countries, non-tradeable goods are more than 1/2 of GDP.

Interest Rate Arbitrage: Covered & Uncovered Interest Parity

Interest Rate Parity

- **Interest Rate Parity:** Given foreign exchange market equilibrium, the interest rate parity condition implies that the expected return on domestic assets will equal the exchange rate-adjusted expected return on foreign currency assets.

- Two types of interest rate parity
  - **Covered Interest Rate Parity** and **Uncovered Interest Rate parity**

Covered Interest Parity

- **Covered interest rate parity:** no arbitrage condition that states that the interest rate differential is covered with the use of a forward contract:

$$1 + i_t = \underbrace{(1 + r^*)}_{\text{foreign bonds return}} \frac{F_t}{E_t}$$

  - F_t: Forward exchange rate at time t

- This interest rate differential is called covered because the use of the forward exchange rate covers the investor against exchange rate risk.
  - It is expected to hold approximately when capital markets are perfect.

Covered Interest Parity in the Data

Figure: Domestic Interbank minus Eurocurrency 3-month interest rates

Country	1/1/82-1/31/87	2/1/87-6/30/90	7/1/90-5/31/92	6/1/92-4/30/93
France	-2.27	-0.11	0.08	-0.01
Italy	-0.50	0.29	0.56	0.36
Germany	0.17	0.05	-0.05	0.07
Japan	-0.07	-0.60	0.09	0.17

Source: M. Obstfeld, *"International Capital Mobility in the 1990s,"* in Kenen, *Understanding Interdependence: The Macroeconomics of the Open Economy*, Princeton University Press, 1995, table 6.1.

More Evidence on Covered Interest Parity

Figure: Deviations from Covered Interest Parity over time (Source: Courtesy of Lorenzo Caliendo)

Uncovered Interest Parity

- **Uncovered interest rate parity:** a no-arbitrage condition that states that the interest rate differential equals to the expected change of the interest rate (e.g. due to expected inflation in one country)

$$1 + i_t = \underbrace{(1 + r^*)}_{\text{foreign bonds return}} \frac{E^e_{t+1}}{E_t}$$

  - E^e_{t+1}: expected nominal exchange rate at time $t + 1$.
    - In the absense of uncertainty we have $E^e_{t+1} = E_{t+1}$:

$$\underbrace{1 + i_t}_{\text{gross return of domestic bond}} = \underbrace{(1 + r^*) \frac{E_{t+1}}{E_t}}_{\text{return of foreign bonds in domestic currency}}$$

- Limited evidence to support the validity of this assumption: hard to measure E^e_{t+1}

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  - Still a great theoretical device for rational expectation models!
  - Of course if capital markets are perfect and expectations are correct $F_t = E^e_{t+1}$

Nominal Exchange Rate Determination

The Money Demand

- Assume a money demand of the form

$$\frac{M_t}{P_t} = L\left(\bar{C}, i_t\right)$$

  - M_t denotes money
  - P_t denotes price level
  - $\bar{C}$ denotes consumption
  - i_t denotes nominal interest rate
  - $L\left(.,.\right)$ is liquidity preference increasing in $\bar{C}$, decreasing in i

Money Demand

- No barriers to international trade
- PPP implies that $P_t = E_t P_t^*$. Normalize one price (Warlas law) $P_t^* = 1$.
- Combining PPP with money demand, we have

$$\frac{M_t}{P_t} = \frac{M_t}{E_t} = L\left(\bar{C}, i_t\right)$$

Government Budget Constraint

- Govenrment has three sources of income
  - tax revenues, $P_t T_t$, money creation, $M_t - M_{t-1}$, interest from foreign bonds $E_t r^* B^g_{t-1}$
- Spending on new bonds $E_t \left(B^g_t - B^g_{t-1}\right)$, government expenditure,

$$P_t G_t \underbrace{E_t \left(B^g_t - B^g_{t-1}\right)}_{\text{change in bond holdings}} + P_t G_t = P_t T_t + \left(M_t - M_{t-1}\right) + E_t r^* B^g_{t-1}$$

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- Dividing by $P_t = E_t$,

$$B^g_t - B^g_{t-1} = \underbrace{\frac{M_t - M_{t-1}}{P_t}}_{\text{seignorage revenue}} - \underbrace{\left[G_t - T_t - r^* B^g_{t-1}\right]}_{\text{real secondary deficit}}$$

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  - Fiscal deficit must be accompanied by money creation or decline in assets.

Fixed Exchange Rate Regime

- **Fixed exchange regime**: the government intervenes in the foreign exchange market in order to keep the exchange rate at a fixed level

- Government intervenes so that $E_t = E$
  - Given E , PPP implies that $P_t = E$.
  - Also, PPP and uncovered interest rate parity imply $i_t = r^*$.
  - Money demand is thus fixed, $EL\left(\bar{C}, r^*\right) = M_t / P_t = M_t / E$
    - Equilibrium in the money market, implies $M_t = EL\left(\bar{C}, r^*\right) = M_{t-1}$, i.e. money demand is fixed
    - Effectively, seignorage revenue is lost

$$B_t^g - B_{t-1}^g = -\underbrace{\left[G_t - T_t - r^* B_{t-1}^g\right]}_{\text{real secondary deficit}}$$

Floating Exchange Rate Regime

- **Floating Exchange Rate**: the government lets the nominal exchange rate be determined in the foreign exchange market.

- In this case, the model implies (under conditions) that

$$\frac{E_{t+1}}{E_t} = \frac{P_{t+1}}{P_t}$$

- As we have seen there is a strong connection between the exchange rate and the growth of prices