

Purchasing Power Parity

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Date: Oct. 6, 2014

¹I wish to acknowledge Battista Severgnini for providing last year's slides to me. His generosity saved me much time, and these slides are partially based on his. Any errors are of course my own.

Last Time

- ▶ Chapter 15

- ▶ Money

- ▶ What is special about it?
 - ▶ How is it measured?
 - ▶ What determines how much people want?

- ▶ A Short-run model of the money market

- ▶ Adjustment in the Long-run

- ▶ Why exchange rates are so volatile

- ▶ Chapter 16

- ▶ The law of one price

- ▶ Purchasing Power Parity

- ▶ Relative vs. Absolute PPP

This time

- ▶ Chapter 16:
 - ▶ Purchasing Power Parity
 - ▶ The law of one price
 - ▶ Relative vs. Absolute PPP
 - ▶ Exchange rates and PPP
 - ▶ Long-run, monetary approach
 - ▶ Clash of predictions
 - ▶ Fisher effect
 - ▶ Empirical evidence on PPP
 - ▶ It bad
 - ▶ Why it bad
 - ▶ A generalized PPP model
 - ▶ Real exchange rate
 - ▶ Interest and the real exchange rate
 - ▶ Real interest rate parity

But first a review

Chapter 16: Price Levels and the Exchange Rate in the Long Run

This chapter: More long run models

- ▶ In Chapter 15, we saw short run and long run models of money supply and exchange rate
 - ▶ One-time change in money supply
 - ▶ No long run change in real money supply
 - ▶ No long run change in interest rate
- ▶ In this chapter, permanent changes in the interest rate and exchange rates
 - ▶ Only possible if the growth rate of the money supply changes
 - ▶ Different instrument, no change in current money supply
 - ▶ Long-run: increase in growth rate leads to depreciation of currency
 - ▶ Model based on something called Purchasing Power Parity

How we are going to get there

1. What is PPP?
2. Model based on PPP

The Law of One Price

The prices of identical goods sold in different countries must be the same when expressed in terms of the same currency.

- ▶ The same doner kebab has to be the same price anywhere on Jagtsvej in Nørrebro
 - ▶ Otherwise hipsters would mostly go to the cheapest kebab shop
 - ▶ CBS students would buy kebab from the cheap shop, and sell outside the expensive shop for a profit
- ▶ Technically only works if customers have time and don't mind walking

Beer

- ▶ Price of a Carlsberg can't be too different on opposite sides of the Danish-German border
- ▶ If we ignore transport and other border costs, *law of one price*:

$$P_{DK}^{\text{beer}} = (E_{DKK/EURO}) \times (P_E^{\text{beer}})$$

- ▶ where:
 - ▶ P_{DK}^{beer} is the DKK price of a Carlsberg when sold in DK
 - ▶ P_E^{beer} is the corresponding Euro price in the Euro zone
 - ▶ $(E_{USD/EURO})$ is the DKK/Euro exchange rate

Purchasing Power Parity

- ▶ PPP is the application of the law of one price across countries:
 - ▶ Price of a basket goods should be independent of currency
 - ▶ Compares general price level across countries
 - ▶ Neither implies nor requires law of one price to hold
- ▶ PPP predicts a DKK/Euro exchange rate of

$$E_{DKK/EURO} = \frac{P_{DK}}{P_E}$$

- ▶ where
 - ▶ P_{DK} is the DKK price of a reference commodity basket sold in Denmark
 - ▶ P_E is the euro price of the same basket in the Euro zone

Purchasing Power Parity (PPP)

- ▶ PPP predicts a DKK/Euro exchange rate of

$$E_{DKK/EURO} = \frac{P_{DK}}{P_E}$$

- ▶ Rearranging,

$$P_{DK} = (E_{DKK/EURO}) \times (P_E)$$

- ▶ People have the same purchasing power with their currency regardless of country
- ▶ Prices twice as high only if currency half as valuable

PPP & Law of One Price

- ▶ The law of one price applies to individual commodities
- ▶ PPP applies to the general price level
- ▶ PPP neither implies nor requires law of one price
- ▶ But, law of one price both implies and requires PPP to hold
 - ▶ If the law of one price holds true for every commodity \Rightarrow PPP must hold for the same reference baskets across countries
 - ▶ If PPP holds, this does not mean that law of one price is respected

Flavors of Purchasing Power Parity

1. Absolute PPP: exchange rates equal relative price levels

$$E_{DKK/EURO} = \frac{P_{DK}}{P_E}$$

2. Relative PPP: the percentage change in the exchange rate between two currencies equals the difference between the percentage changes in national price levels.

$$\frac{(E_{DKK/EURO,t} - E_{DKK/EURO,t-1})}{E_{DKK/EURO,t-1}} = \pi_{DK,t} - \pi_{E,t}$$

where π_t = inflation rate from period $t - 1$ to t

$$\pi_t = \frac{P_t - P_{t-1}}{P_{t-1}}$$

- Relative PPP is an approximation of the following relation:

$$\frac{E_{DKK/EURO,t}}{E_{DKK/EURO,t-1}} = \frac{\frac{P_{DK,t}}{P_{E,t}}}{\frac{P_{DK,t-1}}{P_{E,t-1}}}$$

Absolute & Relative PPP

- ▶ Relative PPP is an approximation of the following relation:

$$\frac{E_{DKK/EURO,t}}{E_{DKK/EURO,t-1}} = \frac{\frac{P_{DK,t}}{P_{E,t}}}{\frac{P_{DK,t-1}}{P_{E,t-1}}}$$

- ▶ If absolute PPP holds \Rightarrow relative PPP holds

Absolute & Relative PPP

Not the other way around!

- ▶ Relative PPP is an approximation of the following relation:

$$\frac{E_{DKK/EURO,t}}{E_{DKK/EURO,t-1}} = \frac{\frac{P_{DK,t}}{P_{E,t}}}{\frac{P_{DK,t-1}}{P_{E,t-1}}}$$

- ▶ Relative PPP does not imply absolute PPP

$$\frac{8}{4} = \frac{4}{2} \not\rightarrow 8 = 4$$

Pause

- ▶ We have defined the law of one price
- ▶ We have defined absolute PPP
 - ▶ Law of one price \rightarrow absolute PPP
 - ▶ Absolute PPP \nrightarrow law of one price
- ▶ We have defined relative PPP
 - ▶ Absolute PPP \rightarrow relative PPP
 - ▶ Relative PPP \nrightarrow absolute PPP
- ▶ Does law of one price imply relative PPP?
 - ▶ Each condition weaker than the last
- ▶ Next: how do changes in inflation affect exchange rate?

Long-Run Model with absolute PPP

- ▶ *Monetary approach* to the exchange rate
- ▶ Switch to USD and Euro to use plots from text
- ▶ Money demand and supply as previous:

1. In the United States:

$$P_{US} = \frac{M_{US}^s}{L(R_{USD}, Y_{US})}$$

2. In Europe:

$$P_E = \frac{M_E^s}{L(R_{EURO}, Y_E)}$$

PPP and Money Market

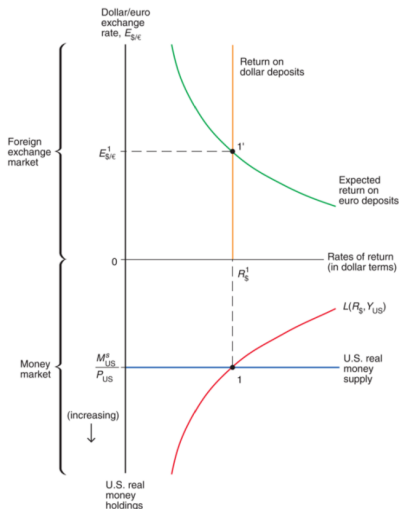
$$E_{USD/EURO} = \frac{P_{US}}{P_E} = \frac{\frac{M_{US}^s}{L(R_{USD}, Y_{US})}}{\frac{M_E^s}{L(R_{EURO}, Y_E)}}$$

Specific Predictions:

1. Money supplies: if $M_{US}^s \uparrow \Rightarrow$ long-run depreciation of the dollar against the euro
2. interest rates: if $R_{USD} \uparrow \Rightarrow$ causes a depreciation of the dollar against the euro
3. Output levels: a rise if $Y_{US} \uparrow \Rightarrow$ causes an appreciation of the dollar against the euro.

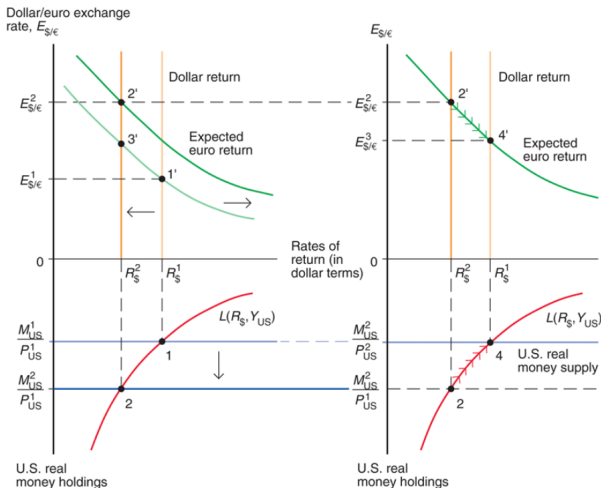
Whoops!

- interest rates: if $R_{USD} \uparrow \Rightarrow$ causes a depreciation of the dollar against the euro



Not as bad as it seems

- ▶ Comparing short run with long-run
- ▶ In previous chapter, long-run interest rate cannot move



(a) Short-run effects

(b) Adjustment to long-run equilibrium

Long-run interest rate changes

- ▶ What could cause a permanent (long-run) change in the interest rate?
- ▶ Solution: a change in the growth rate of money supply (inflation)

Inflation

- ▶ Central banks in the real world typically gradually increases the money supply
 - ▶ Money supply grows at a constant rate
 - ▶ Price inflation at the same rate

Inflation and interest rates

- ▶ Interest rate parity still has to hold:

$$R_{USD,t} = R_{EURO,t} + \left(\frac{E_{USD/EURO,t+1}^e - E_{USD/EURO,t}}{E_{USD/EURO,t}} \right)$$

- ▶ Relative PPP holds (implied by absolute PPP)

$$\frac{(E_{USD/EURO,t} - E_{USD/EURO,t-1})}{E_{USD/EURO,t-1}} = \pi_{US,t} - \pi_{E,t}$$

$$R_{USD} - R_{EURO} = \pi_{US}^e - \pi_E^e$$

or

$$R_{USD} - \pi_{US}^e = R_{EURO} - \pi_E^e$$

- ▶ *Real* interest rates are the same

The Fisher Effect

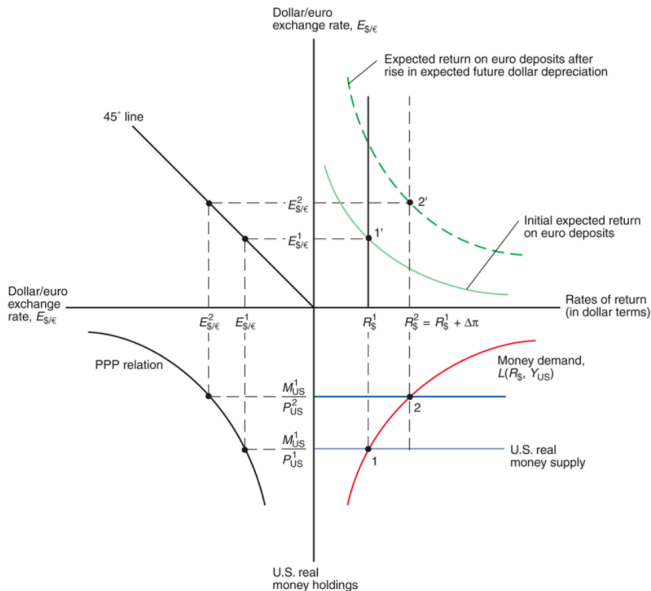
$$R_{USD} - R_{EURO} = \pi_{US}^e - \pi_E^e$$

- ▶ A rise in a country's expected inflation rate will eventually cause an equal rise in the interest rate that deposits of its currency offer
 - ▶ In the long run, purely monetary developments should have no real effects (neutrality of money)
 - ▶ Expected growth in money supply affects the interest rate through inflation

Interest and Monetary Policy

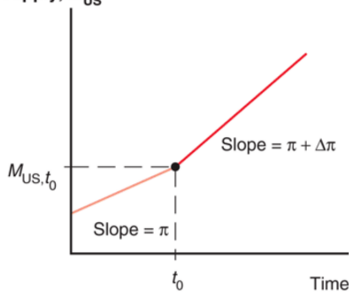
- ▶ If growth in M_{US}^s changes permanently from π to $\pi + \Delta\pi$ (and M_E^s is constant) such that $\pi_{US,t}$ and π_{US}^e increases from π to $\pi + \Delta\pi$
- ▶ R_{US} increases by $\Delta\pi$ (and R_e is unchanged)

Money growth and exchange rates

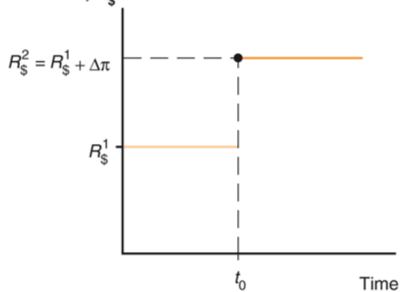


(Long-term) Time trends following a change in growth rate

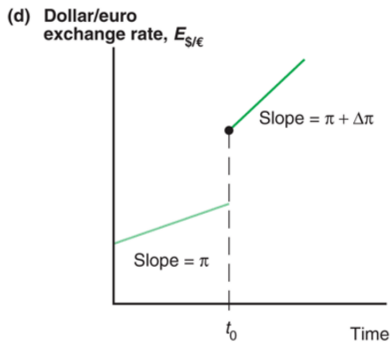
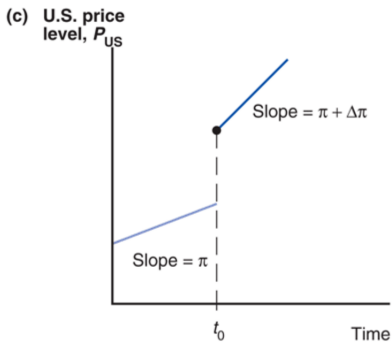
(a) U.S. money supply, M_{US}



(b) Dollar interest rate, $R_{\$}$



(Long-term) Time trends following a change in growth rate



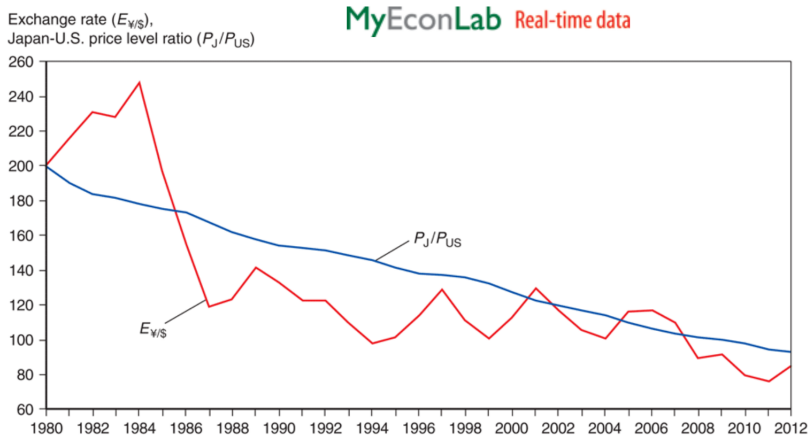
Pause

- ▶ We defined Purchasing Power Parity
- ▶ We derived the inflation rate/rate of return connection
- ▶ We saw the three predictions of the PPP long-run model
 - ▶ $M_{US}^s \uparrow \Rightarrow E_{\$/\epsilon} \uparrow$
 - ▶ $R_{USD} \uparrow \Rightarrow E_{\$/\epsilon} \uparrow$
 - ▶ $Y_{US} \uparrow \Rightarrow E_{\$/\epsilon} \downarrow$
- ▶ Next empirical evidence on the PPP long-run model
 - ▶ Preview: Not good

Empirical Evidence on PPP (1)

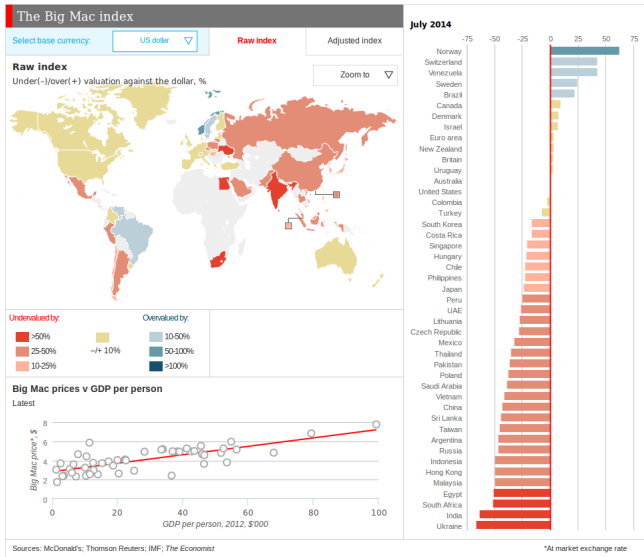
- ▶ The empirical support for PPP and the law of one price is weak.
- ▶ The prices of identical commodity baskets, when converted to a single currency, differ substantially across countries.
- ▶ Relative PPP also performs poorly.

The Yen/Dollar Exchange Rate and Relative Japan-U.S. Price Levels, 1980-2012

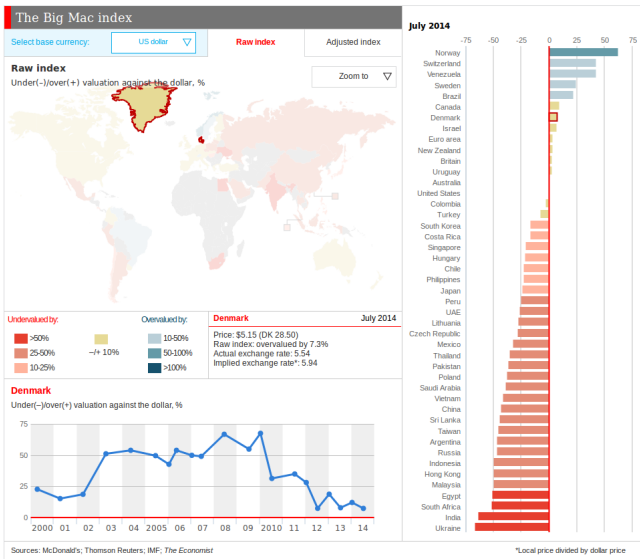


Source: IMF, *International Financial Statistics*. Exchange rates and price levels are end-of-year data.

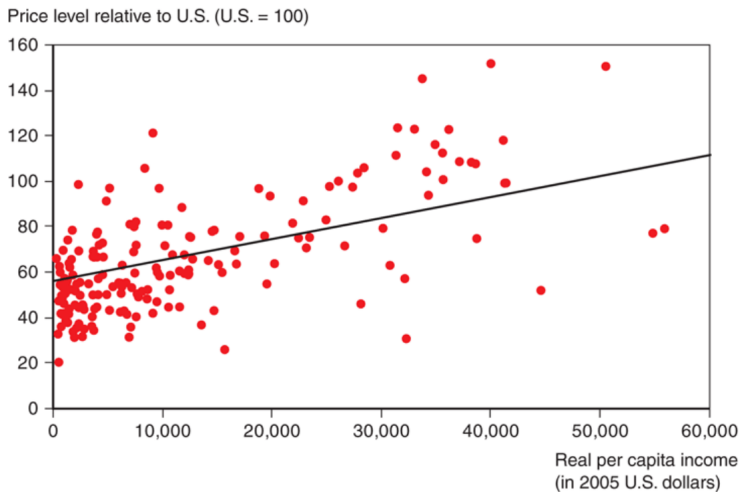
Big Mac Index



Big Mac Index - Denmark



Balassa Samuelson theory



Source: Penn World Table, version 7.1.

Why does PPP do so badly

1. Trade barriers and non-tradable products
2. Imperfect competition
3. Differences in measures of average prices for baskets of goods and services

Trade barriers and non-tradables

- ▶ Trade policy – trade barriers drive a wedge between prices
- ▶ Transport costs are a non-negligible trade barrier
- ▶ Non-tradables enter consumption basket, cheaper in developing countries
- ▶ This explains departure from absolute PPP, but not relative PPP!

Pricing to market

- ▶ Companies that export charge each country a different price
- ▶ Strong evidence that this is happening
- ▶ Markups are complicated

Basket differences

- ▶ Data on price levels based on government baskets
- ▶ Governments use baskets to make CPI
- ▶ Baskets differ between countries
- ▶ Baskets also differ over time!
- ▶ Can screw up both relative and absolute PPP

Swedish-Finish duty free

- ▶ Paper by Marcus Asplund, my colleague
- ▶ Sweden to Finland ferry duty free
 - ▶ Duty free catalogue printed only occasionally
 - ▶ Exchange rate fluctuations made PPP violations
 - ▶ Still Swedes paid kroner, and Finns paid markka
 - ▶ Even when printing, some pricing to market
- ▶ Empirical evidence that prices are sticky
- ▶ Empirical evidence of pricing to market