IFM 2014 Lecture 2

Purchasing Power Parity (PPP)

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Outline of lecture

Lecture 2

- PPP and the law of one price (LOOP)
- Empirical evidence on PPP and LOOP
- The PPP puzzle
- Explanations for the PPP puzzle

Purchasing Power Parity (PPP)

- PPP predicts that national price levels will be equal when converted to a common currency
- $\Longrightarrow$ **Purchasing power** should be equalised across countries
- Example: \$100 should buy the same basket of goods in US and China
- PPP is built upon the international law of one price (LOOP), which applies to internationally traded goods
- Goods market **arbitrage** is crucial for LOOP...

The law of one price (LOOP)

- LOOP is basically PPP at the micro level of individual goods
- It states that the domestic and foreign prices of an identical good should be equal when expressed in terms of a common currency
- LOOP implies that for any good j

$$\boxed{P_j = SP_j^*}$$

where

$$P_j = \text{domestic price of good } j$$

$$P_j^* = \text{foreign price of good } j$$

$$S = \text{bilateral nominal exchange rate}$$

LOOP example: iPhones in UK and US

- LOOP requires that

$$P^{UK}_{iPhone} = SP^{US}_{iPhone} \Longrightarrow 500\,GBP = S \times \$750$$

- LOOP therefore predicts

$$S = \frac{500\,GBP}{\$750} = 0.66 \text{ pounds per dollar}$$

- Now suppose that $P^{UK}_{iPhone} = 500\,GBP$ still, but the Pound weakens to $S = 0.80$ pounds per dollar

- For LOOP to hold we now require that

$$P^{US}_{iPhone} = \frac{500\,GBP}{0.80\,GBP \text{ per } \$} = \$625$$

- US price is pushed down by arbitage – cheap UK iPhones imported

LOOP and PPP

- Suppose there are N goods in total and α_j is the weight given to good j in the Consumer Prices Index (CPI)

- CPIs at home and abroad are

$$P = \sum_{j=1}^{N} \alpha_j P_j \qquad \text{and} \qquad P^* = \sum_{j=1}^{N} \alpha_j P_j^*$$

- Multiplying LOOP by α_j on both sides gives $\alpha_j P_j = S\alpha_j P_j^*$

- Summing on both sides implies PPP

$$\boxed{\sum_{j=1}^{N} \alpha_j P_j = S \sum_{j=1}^{N} \alpha_j P_j^* \quad \text{or} \quad P = SP^*}$$

LOOP and PPP: a simple 2-good example

- With 2 goods the home and foreign CPIs are

$$P = \alpha_1 P_1 + \alpha_2 P_2 \qquad \text{and} \qquad P^* = \alpha_1 P_1^* + \alpha_2 P_2^*$$

- LOOP implies that $P_1 = SP_1^*$ and $P_2 = SP_2^*$
- Therefore,

$$\alpha_1 P_1 = \alpha_1 SP_1^* \qquad \text{and} \qquad \alpha_2 P_2 = \alpha_2 SP_2^*$$

- Add these equations together: $\alpha_1 P_1 + \alpha_2 P_2 = S(\alpha_1 P_1^* + \alpha_2 P_2^*)$
- In other words,

$$\boxed{P = SP^*}$$

Absolute PPP

- The equation $P = SP^*$ is known as **Absolute PPP**
- It states that **national price levels are equal** when expressed in terms of a common currency
- APPP requires several **assumptions**:
  1. Perfect competition
  2. Identical goods and tastes across countries
  3. All goods must be traded
  4. No transport costs
  5. No barriers to trade (e.g. tariffs or quotas)

APPP and the real exchange rate

- We define the **real exchange rate** as $Q = \frac{SP^*}{P}$
- The log real exchange rate is $\ln Q = \ln(\frac{SP^*}{P})$, or more compactly

$$\boxed{q = s + p^* - p}$$

where lowercase letters are **natural logarithms** (e.g. $q = \ln Q$)

- If APPP is correct, then $Q = 1$ and $q = \ln(1) = 0$
- **We can test whether these predictions hold true using data**

APPP and trade costs

- If $q \neq 0$ then arbitrage opportunities exist and APPP does not hold. This could be due to transport costs or other trade costs (e.g. tariffs).
- Suppose these costs are equal to some positive constant τ
- Within the 'neutral band' $-\tau$ to $+\tau$, arbitrage will not be profitable
- But outside the band arbitrage will take place, causing q to revert to the neutral band
- MacDonald illustrates this concept in Figure 2.1 (p. 42)

Relative PPP

- It is clear from data that APPP does not hold as an exact relationship
- This is hardly surprising given that trade costs are not zero in reality
- Even if they were, we would get deviations from APPP since
  1. Different countries have different price index weights
  2. Goods are not exactly identical across countries
  3. Different baskets of goods in different countries
- Relative PPP makes allowance for these differences, but it does require that they be stable over time

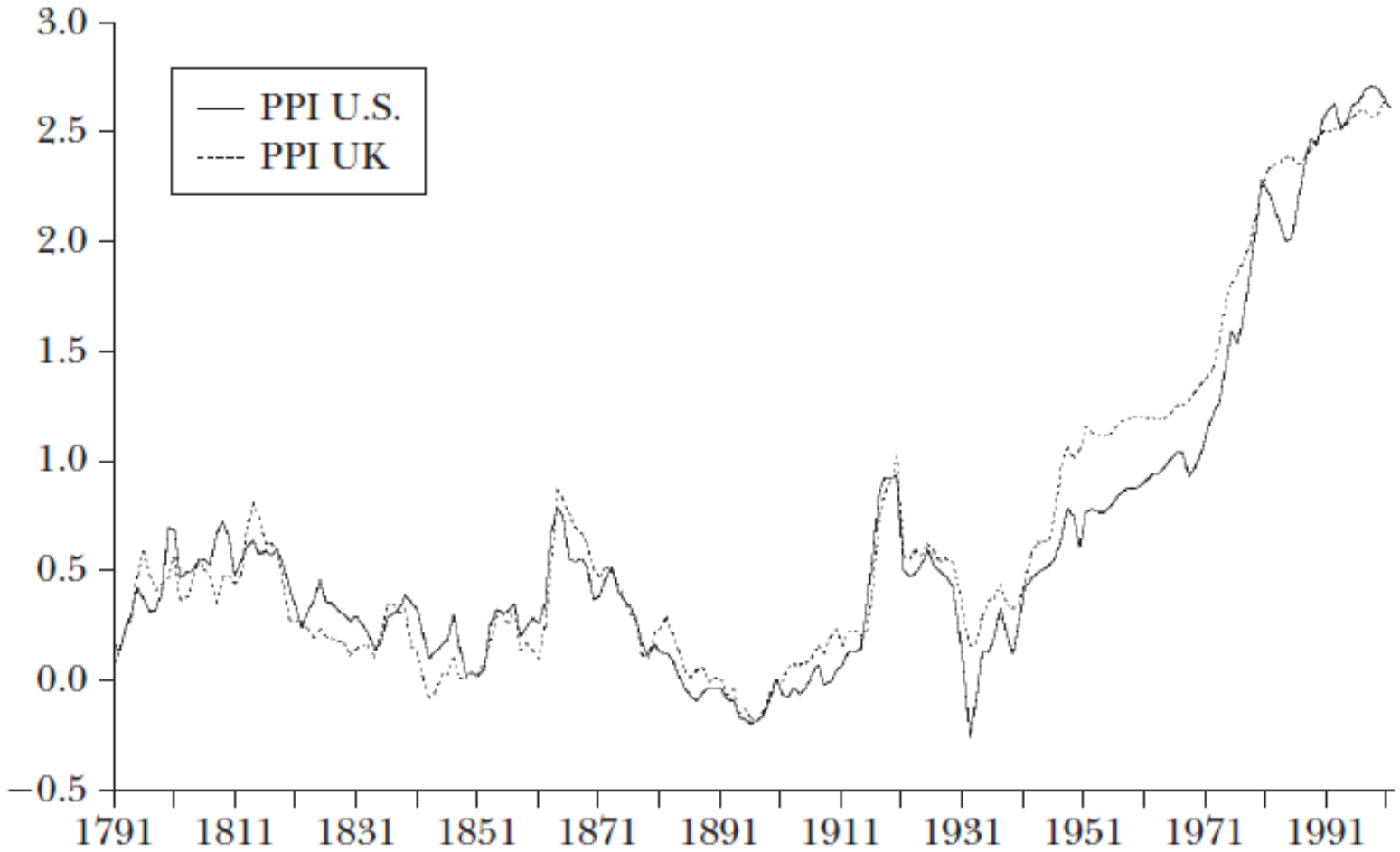
Relative PPP

- Suppose that $s = \tau + p - p^*$, where τ = deviation from APPP
- The real exchange rate is then $q = \tau$
- But because τ is constant by assumption, the **change in S** DOES NOT depend on τ:

$$\boxed{\textbf{RPPP: } \Delta s = \pi - \pi^*}$$

- **Rate of depreciation = home inflation − foreign inflation**
- We can test whether this more realistic PPP theory holds in the data

Empirical evidence on APPP: US vs UK



Source: Taylor and Taylor (2004), Fig 1

Empirical evidence on APPP

- The graph on the last page shows that APP does not hold perfectly and continuously
- Deviations from APPP often last several years – and after 1940 the deviations are rather large
- But overall there is a clear relationship between the two series, so APPP may hold in the long run
- **What can econometrics tell us about whether APPP holds?**

Empirical evidence on APPP

- We can use econometrics to test whether APPP holds as a long run relationship
- **That is: do deviations from APPP 'die out', or are they permanent?**
- To find out we can run a regression of the real exchange rate q on its past value q_{-1}:

$$q = \beta + \rho q_{-1} + \varepsilon$$

- **Two cases:**
  1. $\rho < 1$: Mean-reversion – APPP holds in long run
  2. $\rho = 1$: Unit root – q a random walk so long run APPP rejected

Empirical evidence on APPP

- The extent of mean reversion can be measured using **half-life:**

$$\boxed{\textbf{Half-life} = \frac{\ln(0.5)}{\ln(\widehat{\rho})}}$$

  where $\widehat{\rho}$ is the regression estimate of ρ

- The half-life is the number of years is takes for one-half of a real exchange rate deviation to 'die out'

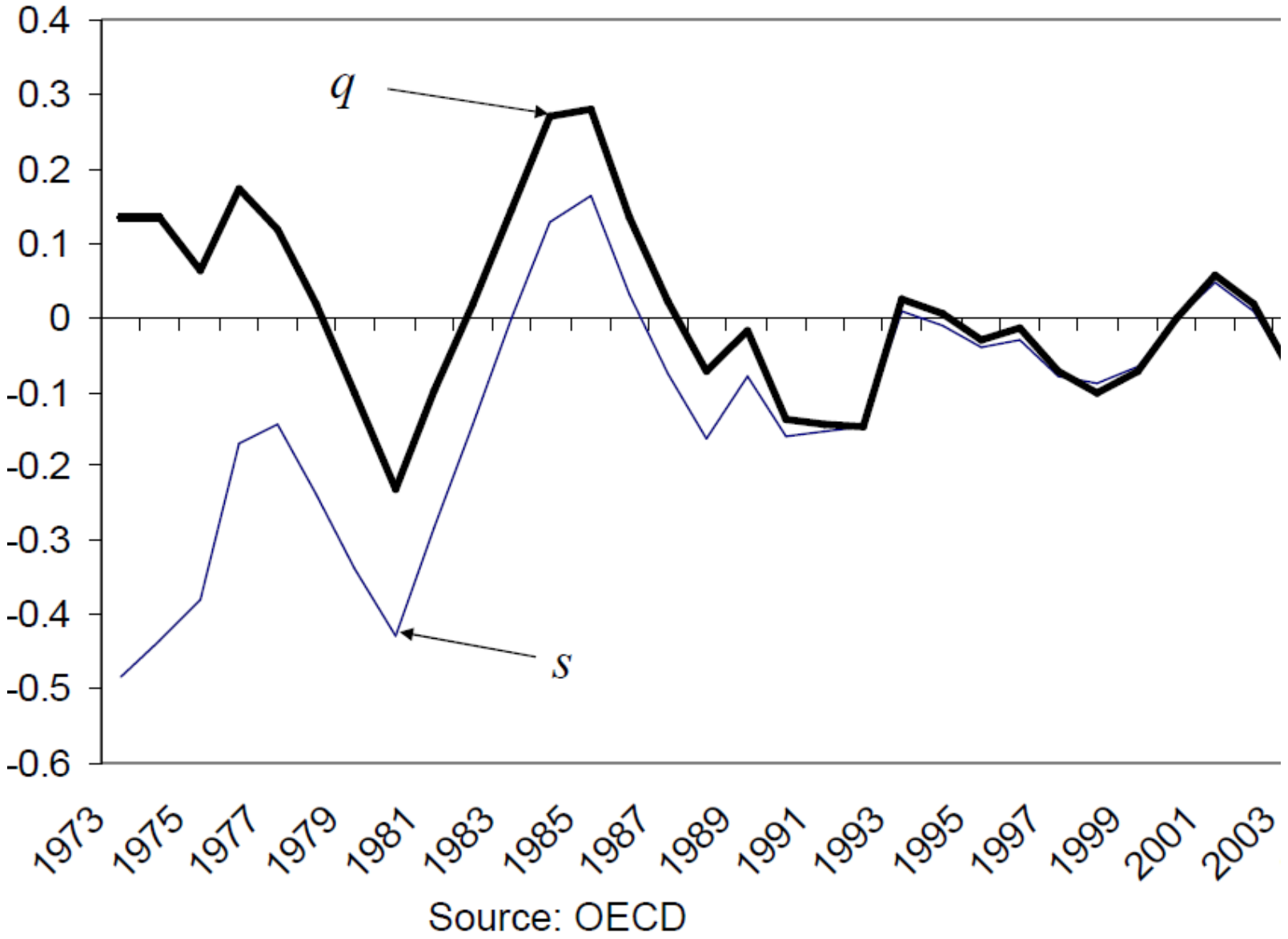
- Typically, we find $\widehat{\rho}$ between 0.80 and 0.87 in annual data, implying a half-life of 3 to 5 years

- Therefore, we conclude that APPP holds in the long run

Empirical evidence on APPP

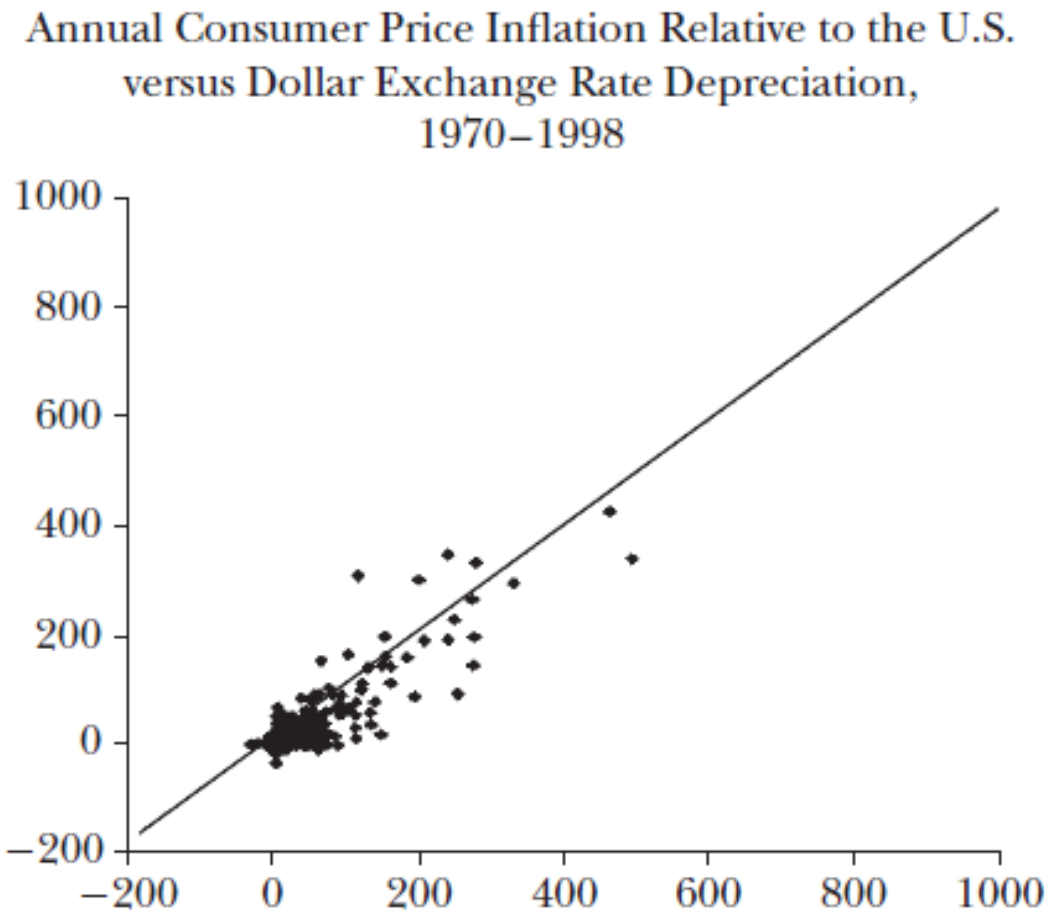
- APPP predicts that real exchange rates are constant, but they are actually very volatile
- For example, real (and nominal) exchange rates are far more volatile than interest rates
- We can see this volatility on the next slide
- We can also see how real exchange rates tend to revert back to mean, as suggested by the half-life results we discussed above

Log exchange rates (GBP per USD)



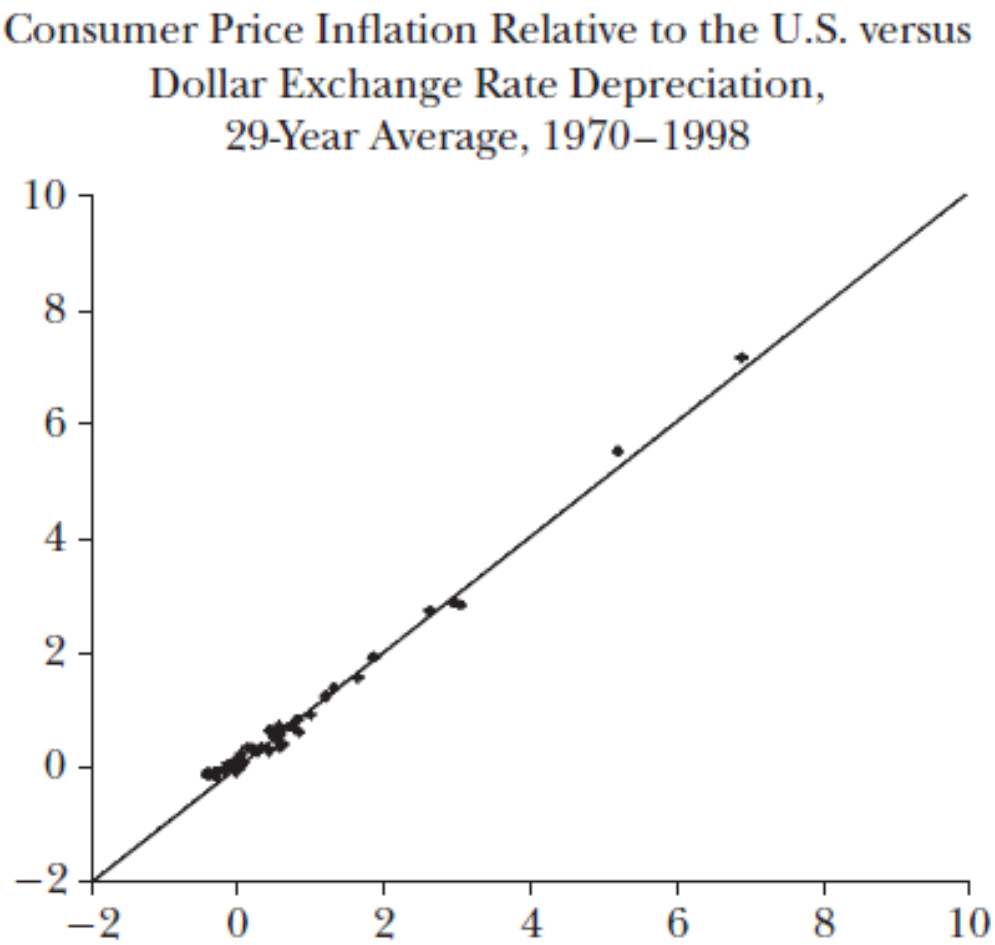
Source: OECD

Empirical evidence on RPPP (short run)



Source: Taylor and Taylor (2004), Fig 2

Empirical evidence on RPPP (long run)



Source: Taylor and Taylor (2004), Fig 2

Empirical evidence on RPPP

- There are substantial deviations from RPPP at a yearly horizon, but when we look at a 29-year average it holds almost exactly
- Taylor and Taylor (2004, pp. 138-9) report that the results for a 10-year average are very similar
- So, although RPPP clearly does not hold at a short horizon, it does appear to hold (at least approximately) at longer horizons such as 10+ years
- This conclusion is not just true for the US – it holds for other industrialised economies as well

Empirical evidence on LOOP

Starbucks Tall Latte Index[a]
(price differentials in US$ terms)

Country	Difference
UK	+17
Euro Area	+33
Japan	+13

(a) The Economist (2004). Figures are % differences.

- The Latte Index and the Big Mac Index indicate substantial deviations from LOOP
- Economic studies reach the same conclusion (see MacDonald p. 48)
- LOOP appears to hold only for a small number of commodities such as gold (see Rogoff 1996, Table 2)

The PPP Puzzle

- It is difficult to explain why deviations from PPP last as long as suggested by a half-life of 3-5 years. Rogoff (1996) therefore argues that there is a **'PPP puzzle'**.
- Price stickiness and unexpected changes in monetary policy could explain large short-term deviations from PPP
- But why do these deviations persist for so long when most prices are changed at least once a year?
- If we can answer that question convincingly we will have a solution to the PPP puzzle
- Let's consider some possible explanations...

PPP Puzzle explanations

- We will look at the following explanations for the PPP puzzle:
  1. Border effects
  2. Pricing to market
  3. The Balassa-Samuelson hypothesis
  4. Aggregation bias
- There are some additional explanations, but these 4 are considered to be some of the most important

Explanation 1: Border effects

- Rogoff (1996, pp. 664-5) concludes that the large and persistent deviations from PPP that we observe must be due to international goods markets being less integrated than domestic markets
- He argues that this could be due to trade costs, additional information costs of exploiting international arbitrage opportunities, or lack of labour mobility between countries
- It may be that real exchange rates only revert to mean after large deviations from PPP because at such times the profits available from arbitrage dominate these costs
- In support of this argument, Engel and Rogers (1996) find that the Canadian-US border is important for explaining price differentials

Explanation 1: Border effects

Engel and Rogers (1996): How wide is the border?

- Consumer prices from US and Canadian cities in USD
- Monthly data: 1978-1994
- If transport costs are an important factor, then price differentials should be large between distant cities **in the same country**
- They are – but borders are much more important, with the same impact upon price differentials as a **distance of 75,000 miles!**
- It is not clear why the border is so important, but this may be due to country-specific productivity shocks or pricing to market

Explanation 2: Pricing to market (PTM)

- In our iPhone example, a depreciation in Sterling made UK iPhones cheaper to US citizens, which in turn drove down USD prices
- This is because under perfect competition there is **full exchange rate pass through**
- But with imperfect competition and differentiated products UK exporters may not reduce the USD price at all – **zero exchange rate pass through**!
- This is because firms with market power can practice price discrimination
- Partial exchange rate pass-through is also a possibility...

Explanation 2: Pricing to market (PTM)

- PTM example: Lindauer in UK and NZ
- **Krugman (1986)** gives the example of European automobile prices in fact rising in USD when European currencies were depreciating
- Krugman also finds formal evidence of PTM by German exporters in the 1980s, albeit that this is confined mainly to machinery and transport equipment
- In a survey of the literature, Goldberg and Knetter (1997) conclude that pass-through from the exchange rate to import prices in the US has been partial – **around 60%**
- There is also evidence that exchange rate pass-through is partial in other economies (see MacDonald p. 84)

Explanation 3: The Balassa-Samuelson hypothesis

- The B-S hypothesis is built on several assumptions:
  1. PPP is assumed to hold in the traded goods sector
  2. Countries with high GDP per capita have higher relative productivity in the traded goods sector
  3. Capital and labour can move freely between sectors in the home country
  4. Capital is mobile internationally, but labour is not
- Suppose the home price index is a weighted average of the price levels in the non-traded and traded sectors:

$$P = \alpha P^{NT} + (1 - \alpha) P^{T}$$

Explanation 3: The Balassa-Samuelson hypothesis

- The simplest possible statement of B-S is

$$P^{NT} = \frac{A^T}{A^{NT}}$$

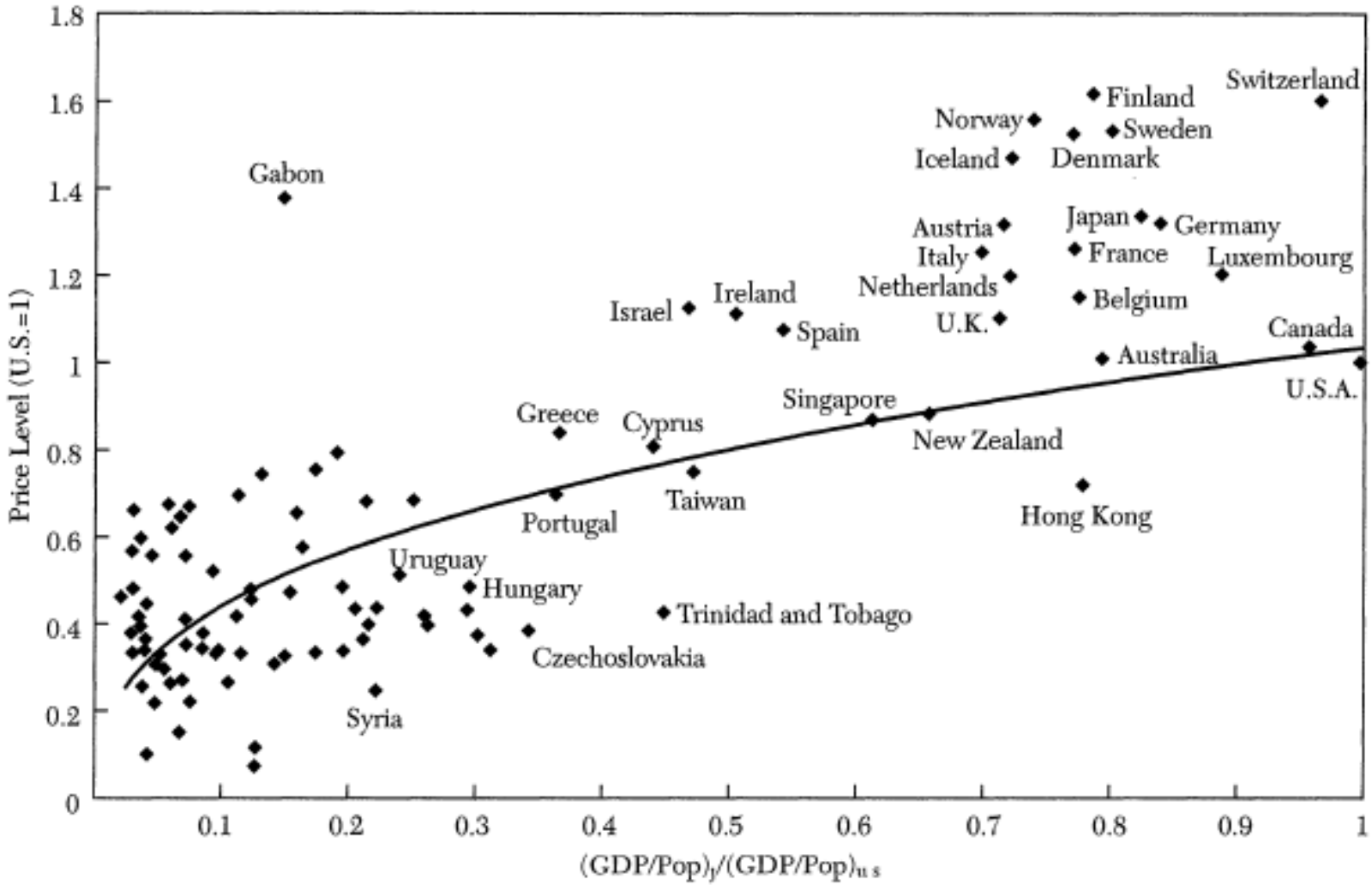
  where $\frac{A^T}{A^{NT}}$ is relative productivity in the traded goods sector

- Therefore, by Assumption 2, the B-S hypothesis predicts the price level in the non-traded goods sector will be higher in rich countries

- With P^T fixed by PPP (Assumption 1), a rise in P^{NT} raises P

- $\Longrightarrow$ Richer countries will have higher price levels and their real exchange rates will appreciate

International price levels vs GDP per head



Source: Rogoff (1996), Fig 3

Explanation 3: The Balassa-Samuelson hypothesis

- But the link between productivity and real exchange rates is less clear
- Japan is often cited as an example where the B-S hypothesis may apply (see Rogoff 1996, pp. 661-2). But the B-S hypothesis does not seem to work as well for other industrialised economies.
- For example, under B-S, productivity in the traded and non-traded sectors should have equal but opposite effects on the real exchange rate, but MacDonald and Ricci (2001) conclusively reject this using OECD sectoral data (MacDonald, pp. 76-77)
- In addition, because technology diffuses across borders, poor countries may be able to adopt rich country technologies over time, but the B-S hypothesis does not allow for this

Explanation 4: Aggregation bias

- Imbs et al. (2002): if the prices of different goods revert to mean at different speeds, then aggregating across prices will introduce a positive bias into estimated half-lives (MacDonald, p. 64-66)
- So, using aggregate data will **overstate the true half-life**
- Using Eurostat data, Imbs et al. find significantly lower half-lives for real exchange rates once the upward bias is removed (e.g. 11 months). They conclude that **AB largely solves the PPP puzzle**.
- Parsley and Wei (2003) use the Big Mac Index and the prices of tradable Big Mac components to avoid the aggregation bias issue
- They find that the half-life of Big Mac deviations is less than 2 years, which provides further support for the findings of Imbs et al.

Explanation 4: Aggregation bias

- Chen and Engel (2005) argue that the analysis of Imbs et al. is flawed and that **"aggregation bias does not explain the PPP puzzle"** (MacDonald, p. 66)
- They argue that **measurement error** in tradables prices was an issue in the original analysis. When they correct for this, they find even higher half-lives than the 3-5 years reported in Rogoff (1996).
- However, Imbs et al. have argued that it is in fact CE who are mistaken, and they refuse to budge from their original conclusion
- In summary, aggregation bias is a possible explanation for the PPP puzzle, albeit a rather controversial one!

Next time...

- In the next lecture we will look at monetary models of exchange rates and their predictions
- You will also be introduced to the concept of uncovered interest parity (UIP)
- **Advance reading:**
  1. Pilbeam Ch. 7.2 or Copeland Ch. 3.1
  2. MacDonald Ch. 4.1 and 5.2 (except 5.2.2)