# IMEP 2014 Lectures 9 and 10

## Investment and the current account &

## Exchange rates and purchasing power parity

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# Outline of today's lectures

**Lecture 9**

- Investment and the current account
- Introducing investment in the two-period model
- The production possibility frontier (PPF)
- Current account policy implications

**Lecture 10**

- Purchasing power parity and the law of one price (LOOP)
- Implications of PPP for exchange rates
- Empirical evidence on PPP and the 'PPP puzzle'

# Lecture 9 – The Current Account and Investment

Key reading: Obstfeld and Rogoff, Chapter 1.2 to 1.2.4

# Investment and the current account

- Investment is important for understanding both the magnitude of the current account and how it changes over time

- In an economy with investment, the current account is

$$\text{Current account} = S - I$$

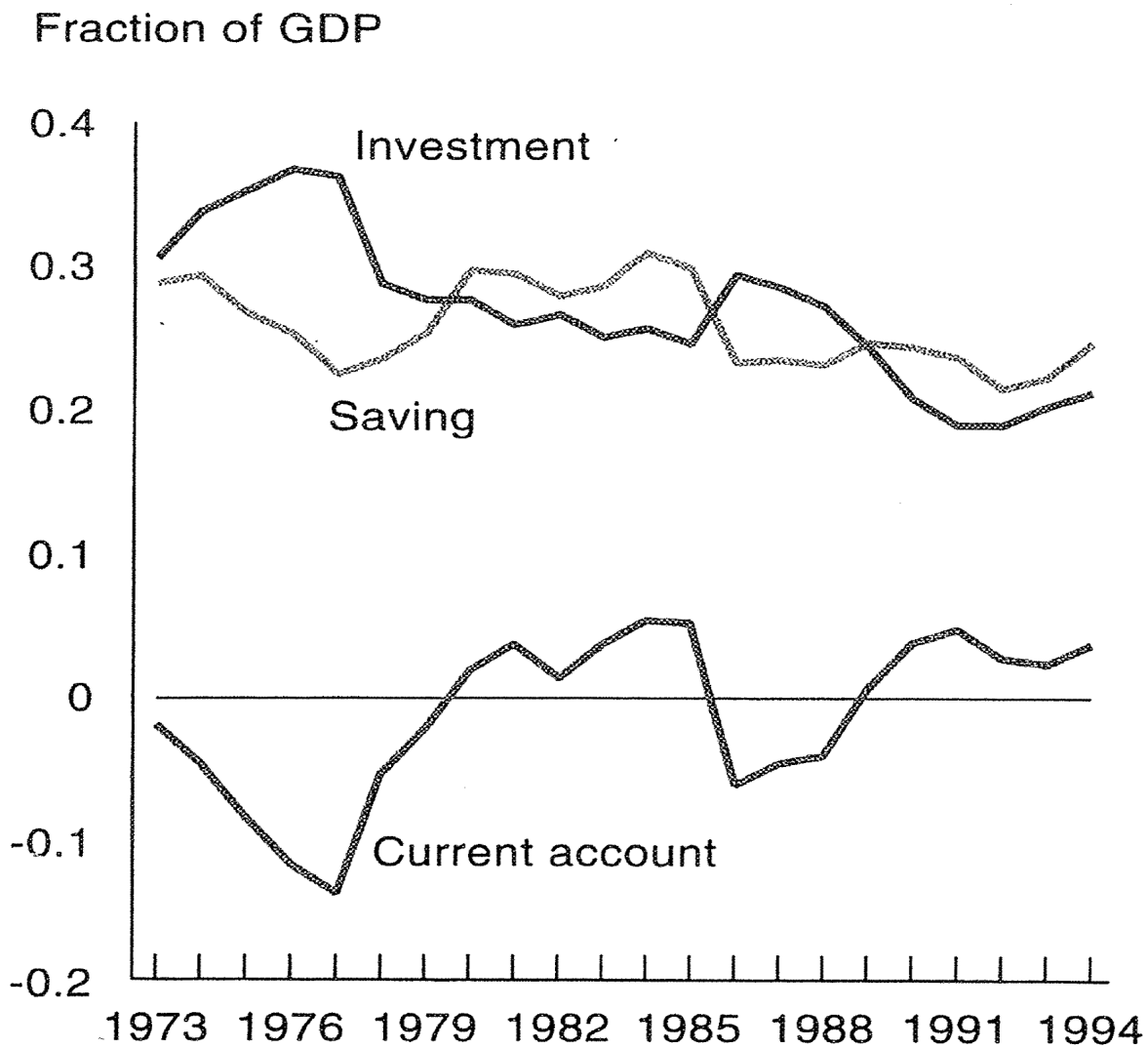
**Example 1:**

- Norway and Britain developed their North Sea oil reserves after oil prices roughly trebled over the period 1973-74 (see next slide)

**Example 2:**

- 19th century railroad companies in the New World drew on large amounts of capital from Britain (see O&W, pp. 208-212)

# The Norwegian current account 1973-94 (O&R Fig 1.2)



# Introducing investment in the two-period model

- Including investment also means that output in the home economy is produced using capital
- The economy's production function is

$$Y = F(K) \qquad \text{with } F'(K) > 0 \text{ and } F''(K) < 0$$

where $K$ is the stock of physical capital

- Additionally, we will assume that capital does not depreciate. So, investment = change in the capital stock over period $t$:

$$I_t = K_{t+1} - K_t$$

where $K_{t+1}$ is the capital stock at the end of period $t$

# Introducing investment in the two-period model

- The current account equation becomes

$$CA_t = B_{t+1} - B_t = Y_t + r_t B_t - C_t - G_t - I_t$$

- We can write this equation as

$$CA_t = S_t - I_t$$

where $S_t = Y_t + r_t B_t - C_t - G_t$ is total domestic saving

- The lifetime budget constraint is now

$$C_1 + I_1 + \frac{C_2 + I_2}{1+r} = Y_1 - G_1 + \frac{Y_2 - G_2}{1+r}$$

- Finally, there are initial and terminal conditions on capital: $K_1 = \overline{K} > 0$ and $K_3 = 0$

# Solving the two-period model with investment

- **Step 1:** Substitute for $I_2 = -K_2 = -(K_1 + I_I)$ in budget constraint and then rearrange for $C_2$
- **Step 2:** We can then solve the following problem:

$$\max_{C_1, I_1} u(C_1) + \beta u \left( \underbrace{\begin{array}{c}(1+r)(F(K_1) - C_1 - G_1 - I_1) \\ +F(I_1 + K_1) - G_2 + I_1 + K_1\end{array}}_{C_2} \right)$$

- The first-order condition for $C_1$ gives the Euler equation as before
- The first-order condition for $I_1$ is

$$\beta(1+r)u'(C_2) = \beta(\ 1 + F'(K_2)\ )u'(C_2)$$
$$\Rightarrow F'(K_2) = r$$

# Solving the two-period model with investment

- The result that $F'(K_2) = r$ is another example of MB = MC
- Investing one more unit domestically delivers extra output $F'(K_2)$ (marginal benefit), but this means one less unit of foreign investment, so the net return $r$ is foregone (marginal cost)
- **Intuition:** invest at home up to the point where the return from doing so matches that available from lending to foreigners

# Solving the model graphically

- To solve graphically we use the **production possibility frontier (PPF)**, which shows the technological possibilities for transforming period 1 consumption into period 2 consumption

- Assume $G_1 = G_2 = 0$, so that

$$\begin{aligned} C_2 &= Y_2 - I_2 \\ &= Y_2 + K_2 \\ &= F(K_2) + K_2 \\ &= F(K_1 + I_1) + K_1 + I_1 \\ &= F(K_1 + F(K_1) - C_1) + K_1 + F(K_1) - C_1 \end{aligned}$$

- The last equation enables us to plot $C_2$ against $C_1$, given the economy's technology $F(K)$ and initial capital $K_1$. This is the PPF.

# Properties of the PPF

## Shape of the PPF

- Its slope is: $\frac{\partial C_2}{\partial C_1} = -(1 + F'(K_2)) < 0$
- Slope = opportunity cost of consuming one more unit in period 1. PPF is strictly concave due to diminishing returns (ie $F''(K) < 0$).

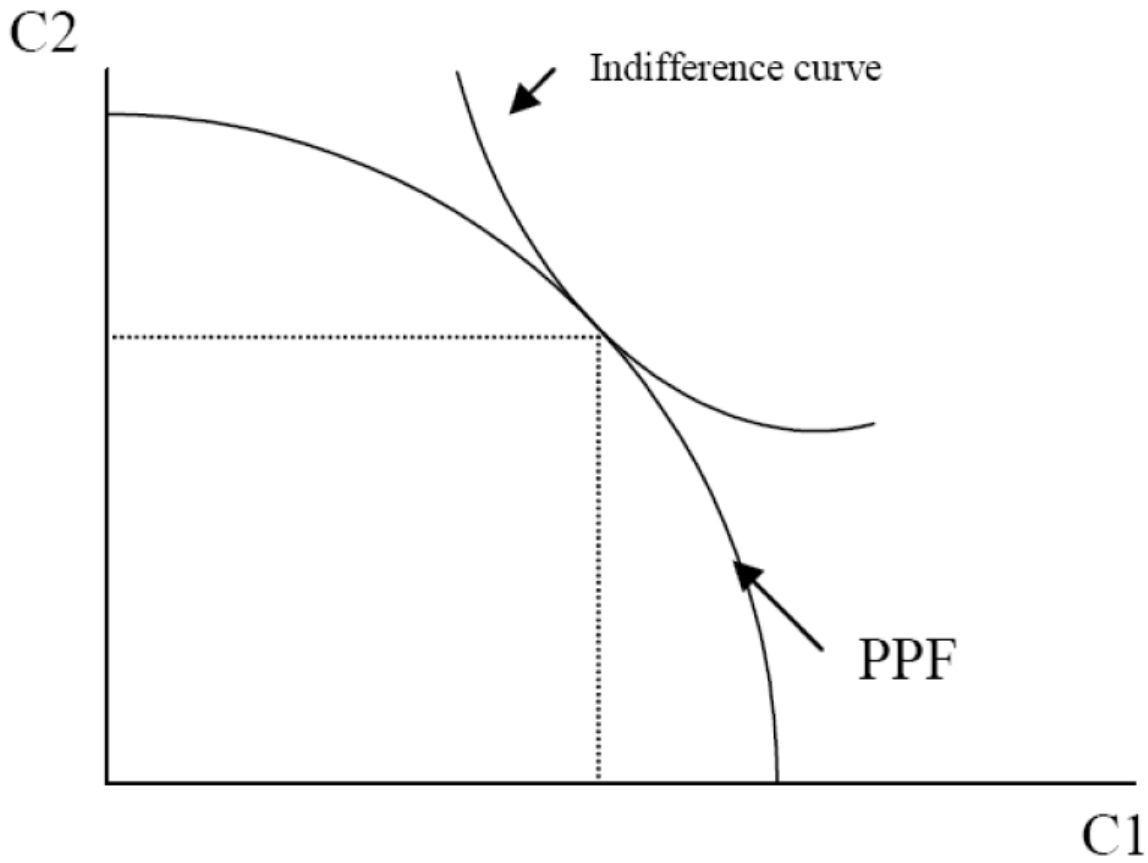
## Intercepts of the PPF

- Max period 1 consumption when investment minimised:
  $C_1 = K_1 + F(K_1), \quad C_2 = 0 \quad$ (ie set $K_2 = 0$ so that $I_1 = -K_1$)
- Max period 2 consumption when all period 1 output invested:
  $C_1 = 0, \quad C_2 = F(K_1 + F(K_1)) + K_1 + F(K_1)$

# Optimal production and consumption

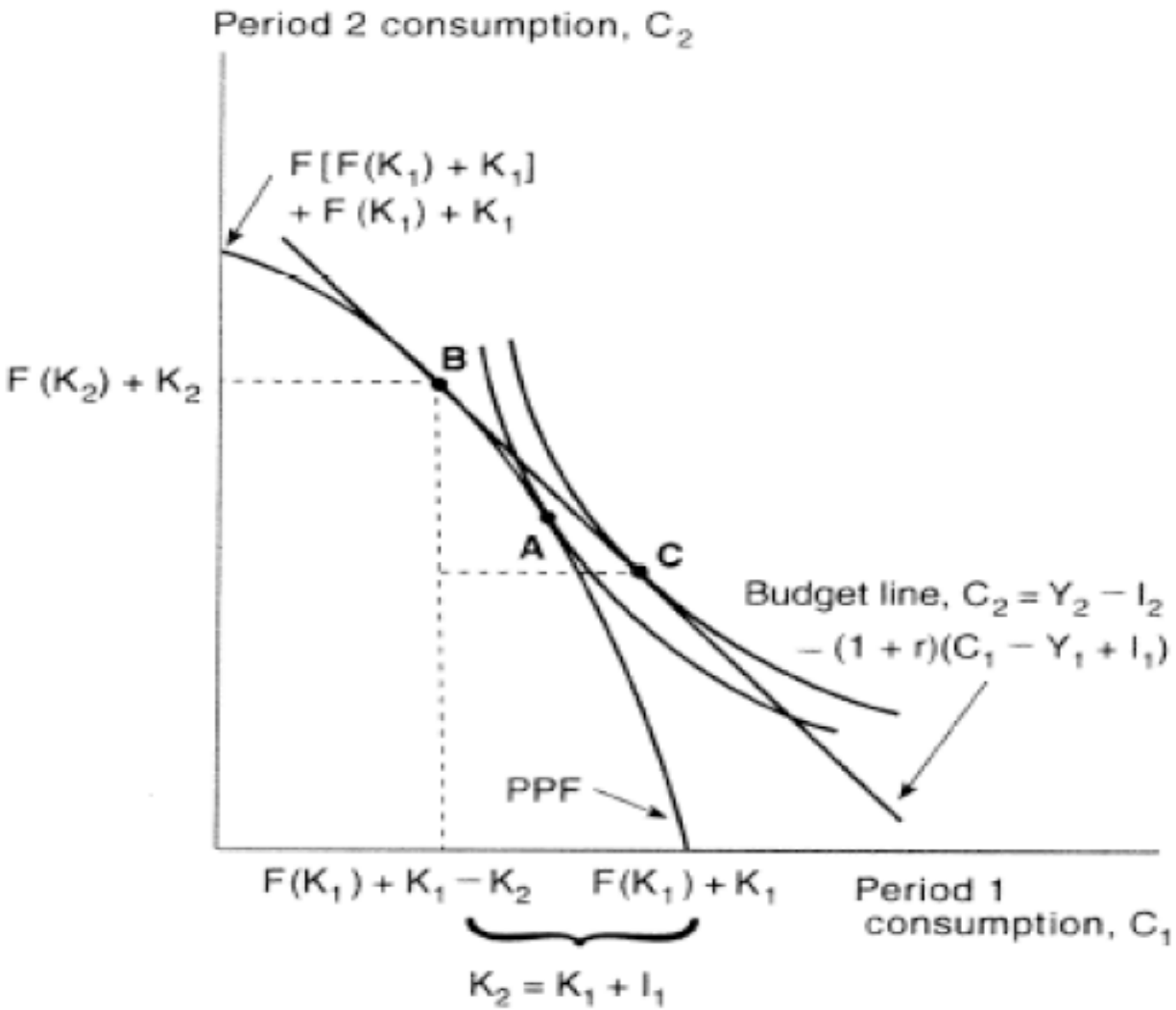
- Production takes place where the slope of the PPF equals the slope of the budget constraint: $\frac{\partial C_2}{\partial C_1} = -(1+r)$
- Consumption takes place where the slope of the indifference curve is equal to: $-(1+r)$
- In an open economy, there is no reason why consumption should coincide with production. But in autarky the two MUST coincide, because the economy cannot borrow or lend.
- Comparing autarky and the open economy case reveals the production and utility gains from trade

# Production and consumption and under autarky




- The PPF and indifference curve determine the autarky interest rate:
$-(1+r^A) = -(1+F'(K_2)) = -\frac{u'(Y_1)}{\beta u'(Y_2)}$

# Production and consumption with trade (O&R Fig 1.3)




- A is autarky. Free trade: B is production, C is consumption.

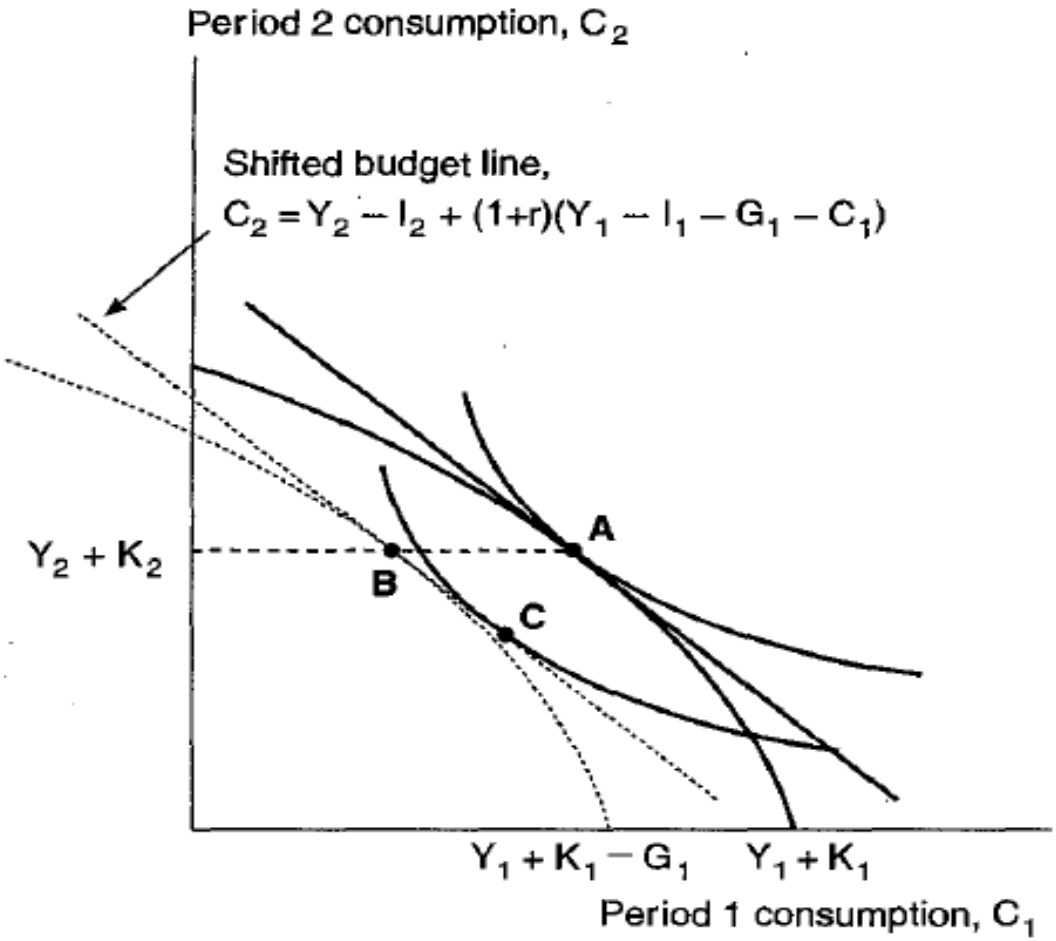
# Diagram analysis

- Horizontal distance between A and B shows the extra investment generated by trade. Horizontal distance between A and C shows the extra first period consumption.
- Since C is on a higher indifference curve than A, there is a welfare gain from trade. Horizontal distance between B and C shows the first period current account deficit.
- Diagram shows the case where $r_A > r$
- **Exercise:** repeat this analysis for the case where $r_A < r$

# Diagram analysis

- With investment, the present value of output is higher under trade than autarky. In fact, production at B maximises the present value of output (see O&R, p. 21).
- Budget line shows all the ways this output can be allocated between period 1 and period 2 consumption
- Because PV(output) is higher at B than A, the economy can consume outside its PPF under trade. Point C is the consumption allocation on the budget line that maximises utility.
- **Lesson 1:** with investment, the economy gains from higher production, which in turn improves consumption possibilities

# A temporary shock to government spending (O&R Fig 1.4)




- Positive shock to government spending in period 1 makes $G_1 > 0$

# Diagram analysis

- Suppose we start off at A with a balanced current account. The positive shock to government spending in period 1 shifts the PPF and the budget line to the left.
- New production is at B and new consumption at C. Under autarky, new consumption is at B, where the current account is balanced. Horizontal distance from C to B = first period current account deficit.
- The CA deficit helps agents smooth consumption: instead of a big drop in period 1 consumption and no change in period 2, there is a modest reduction in both periods. Consequently, utility rises.
- **Lesson 2:** free trade also stabilises consumption in response to unanticipated changes in government spending

# Summary of trade and the current account

- Trade has both short run and long run benefits:
  1. In an economy with investment, trade raises production and so can improve long run consumption possibilities
  2. In general, trade facilitates consumption smoothing, since the current account acts like a 'shock absorber'
- Our model assumes that international contracts are respected, but this is not always the case in practice – eg Russian default in 1998
- However, potential loss of reputation and the possibility of retaliation reduce the likelihood of default
- **Policy implication:** there are gains to be had from trade, but trading partners should be chosen carefully

# Lecture 10 – Purchasing power parity and the PPP puzzle

Key reading: Rogoff (1996), *Journal of Economic Literature* 34(2)

# What is purchasing power parity?

- PPP is a simple theory of exchange rates whose main prediction is that national price levels will be equal
- In other words, purchasing power should be equalised across countries when measured in terms of a common currency
- **Example:** \$1000 should be able to purchase the same basket of goods in China as it can in the US, once it is converted into RMB
- The theory of PPP is built upon the law of one price (LOOP)
- PPP is not new: it can be traced back to 16th century Spain, and English economist David Ricardo (1772-1823) was aware of the idea

# The law of one price (LOOP)

- LOOP states that for any good $j$ the home and foreign price will be equal when expressed in terms of a common currency:

$$P_j = SP_j^*$$

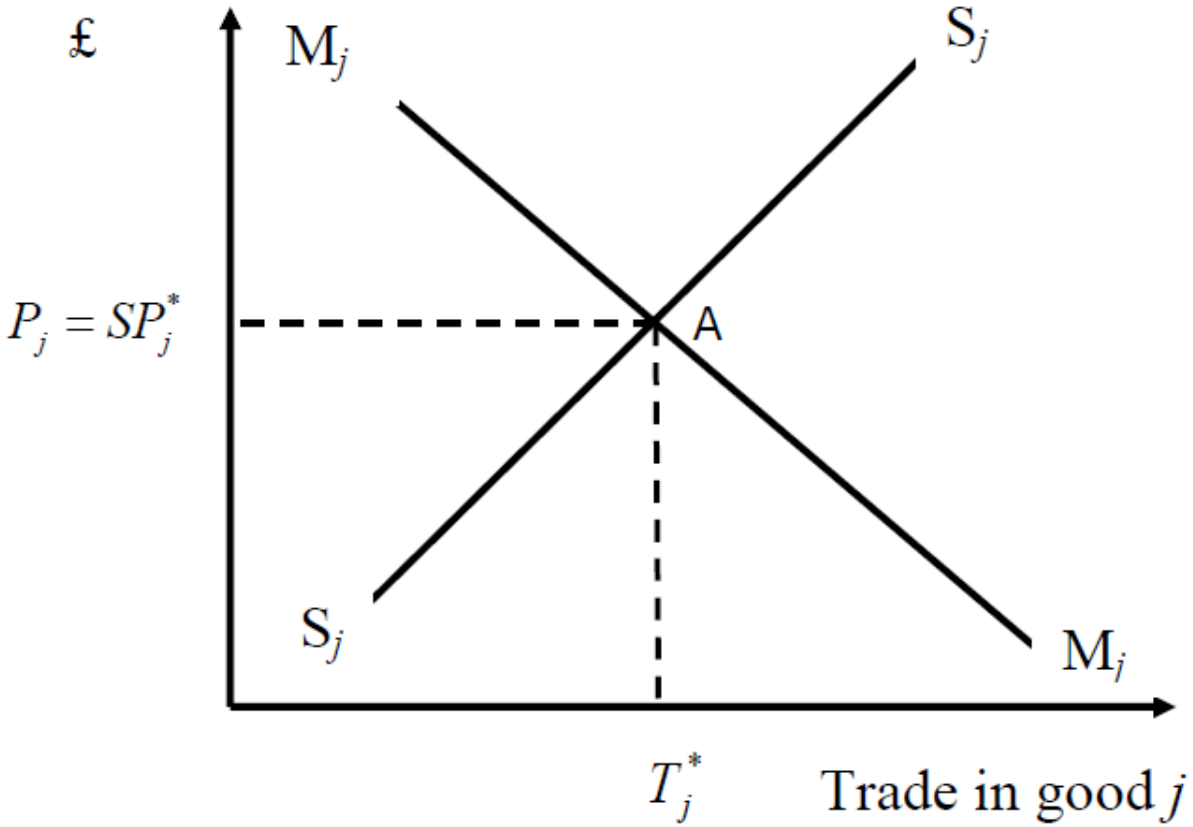
where $P_j$ is the home price, and $P_j^*$ is the foreign price

- Here, $S$ is the nominal exchange rate, defined as the home-currency price of foreign currency

- **Example:** if the home country is the UK and the foreign country is the US, then $S =$ £0.61 per \$ as of Feb 1 2014

- If $S$ rises we say that the home currency depreciates because £1 will purchase fewer dollars

# The LOOP diagram




- **Note:** foreign price $P_j^*$ is in dollars so we need to multiply by $S$ to convert this into a price in pounds

# LOOP diagram

- LOOP implies that we will be at A. To see why, consider a situation where $T_j < T_j^*$, so that $P_j > SP_j^*$. Suppose the price difference is £1.
- A home firm could then import good $j$ and sell it domestically for (say) 50p less than the current price, giving 50p profit a unit.
- But this firm could then be undercut by another that settles for 49p profit a unit and captures the whole domestic market. In turn, this firm could be undercut...and so on until profit is pushed down to zero.
- Consequently, trade in good $j$ increases and its domestic price falls. We end up at A where LOOP holds.
- **Key concept:** The process of profit-driven buying and selling by which the economy ends up at A is known as *arbitrage*

# LOOP assumptions

- We also require other assumptions in addition to arbitrage:
  1. Transport costs are zero
  2. No tariff or non-tariff barriers to trade
  3. Perfect competition between firms and flexible prices
  4. We have assumed goods can be transported in their final form, but some goods are *non-traded* (eg haircuts or a hot Big Mac)
  5. Goods in both locations must be identical
  6. No *non-traded inputs* are used to make traded goods

- **Example:** you can cook a Big Mac from scratch in the UK using imported beef and baps, but wages and rents differ

# Empirical evidence on LOOP (1)

**Table 1 - The law of one price for gold**

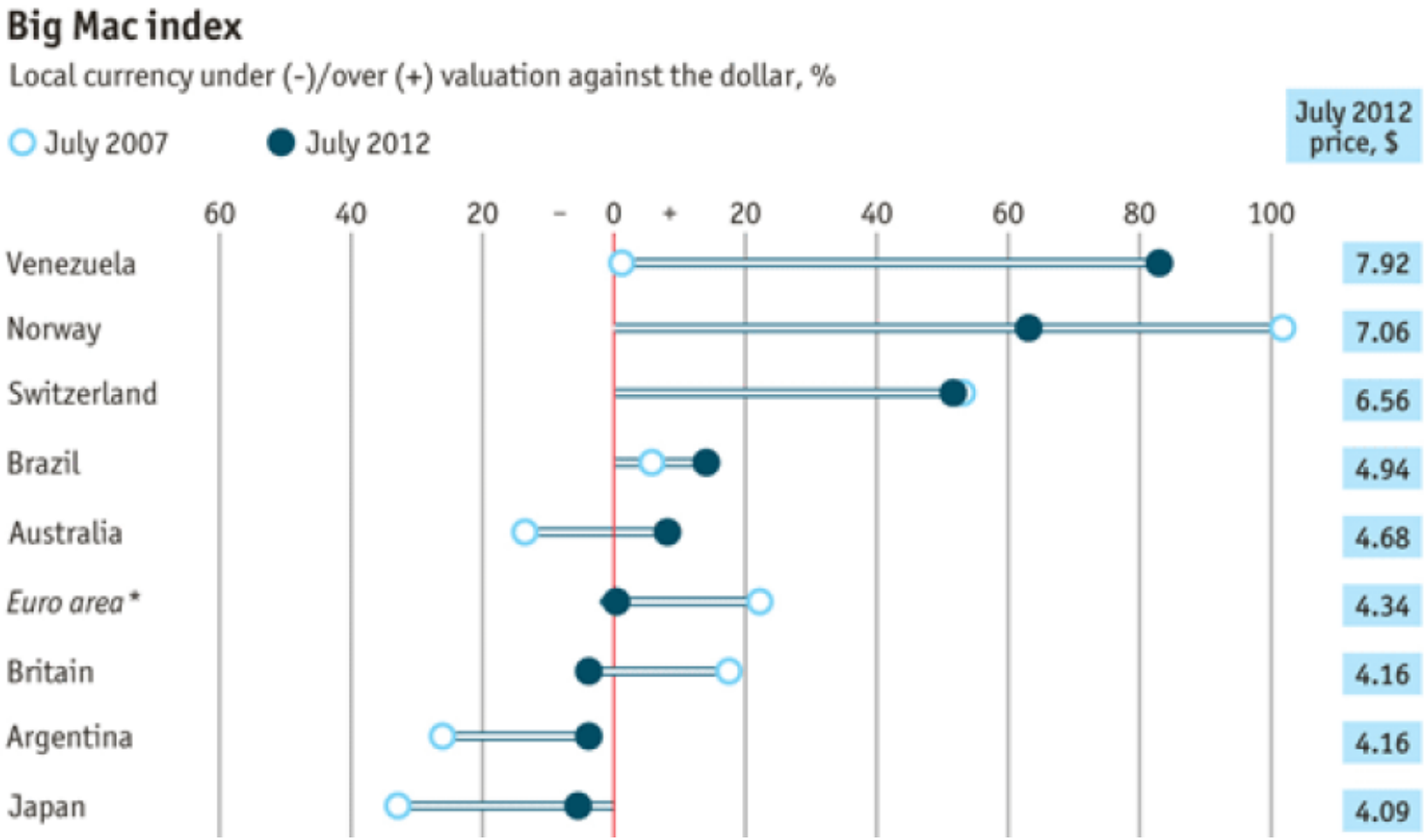
| City | Price of 1 Troy Ounce (in $) |
|---|---|
| Hong Kong | 379.35 |
| London | 379.25 |
| Paris | 378.81 |
| Frankfurt | 378.87 |
| Zürich | 379.10 |
| New York | 397.10 |

Source: Rogoff (1996), Table 2, p. 650

- The close alignment of prices internationally reflects the fact that gold is a highly-traded, homogenous commodity

# Empirical evidence on LOOP (2)

- The Economist's Big Mac Index is far less supportive:




Source: The Economist (July 26, 2012)

# Purchasing power parity

- PPP holds if international price levels are equal when expressed in terms of a common currency
- This will be the case if LOOP holds for all goods *j:*

$$P_j = SP_j^* \quad \text{for all } j \Longrightarrow \sum P_j = S \sum P_j^*$$
$$\Longrightarrow \quad P = SP^*$$

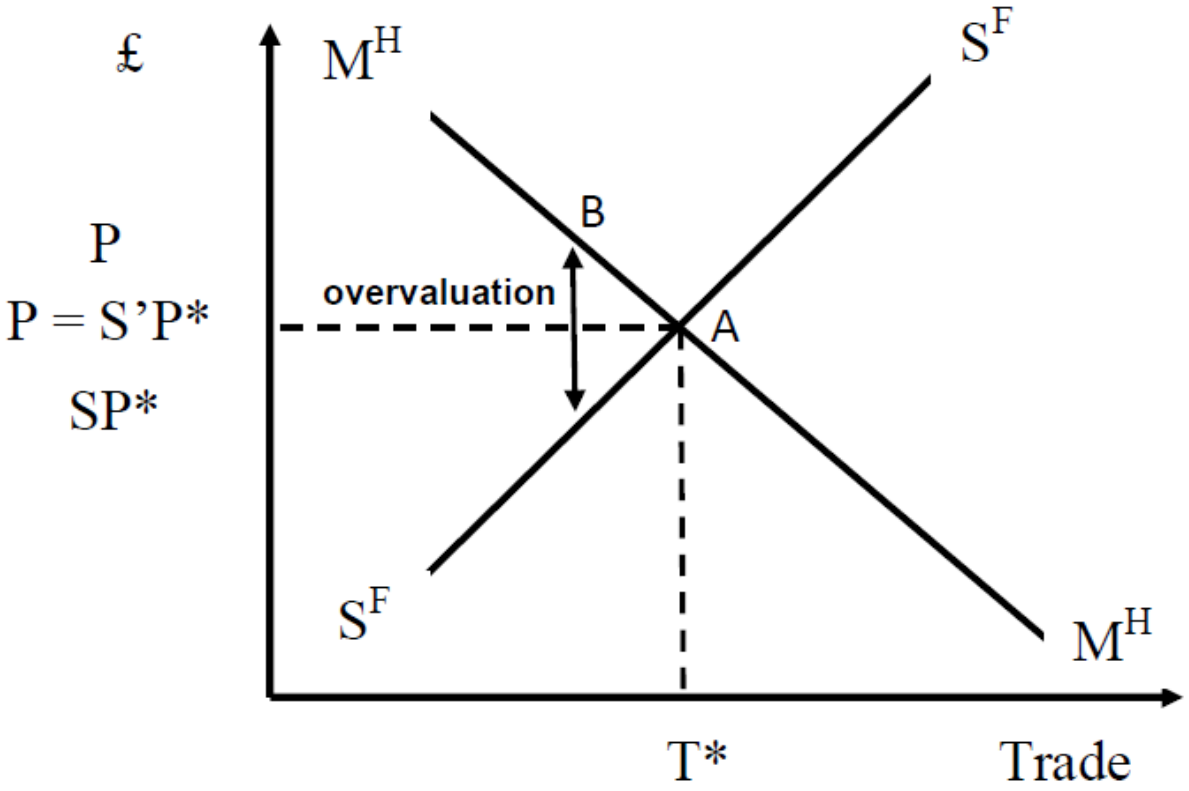
where $P$ and $P^*$ are consumer price indexes

- Exchange rates tells us whether a country's currency is overvalued or undervalued relative to PPP
- **Example:** Pound is 'overvalued' if PPP requires a depreciation:

$$P > SP^* \Longrightarrow S \text{ rises to } S' \Longrightarrow P = S'P^*$$

# PPP diagram

- PPP predicts that the overvaluation $P - SP^*$ will be eliminated by price arbitrage, taking us from B to A. This raises $S$ because home residents buy foreign currency to import goods.




- **Key concept:** the exchange rate $S'$ is the *PPP exchange rate*

# PPP comparisons

- PPP comparisons can be useful in practice:
  1. Individual investors can use this information to help decide whether to buy or sell a currency
  2. Policymakers can assess whether domestic firms are internationally competitive on price
  3. PPP exchange rates can be used for international comparisons of living standards (see Lafrance and Schembri 2002, pp. 29-30)

- But consumer price indexes are not perfect for PPP comparisons:
  1. Consumer price indexes are reported relative to a base year such as $1995 = 100$ and not in absolute terms (eg £s)
  2. These indexes do not include an internationally standardised basket of goods (see Rogoff 1996, p. 650)

# PPP and the real exchange rate

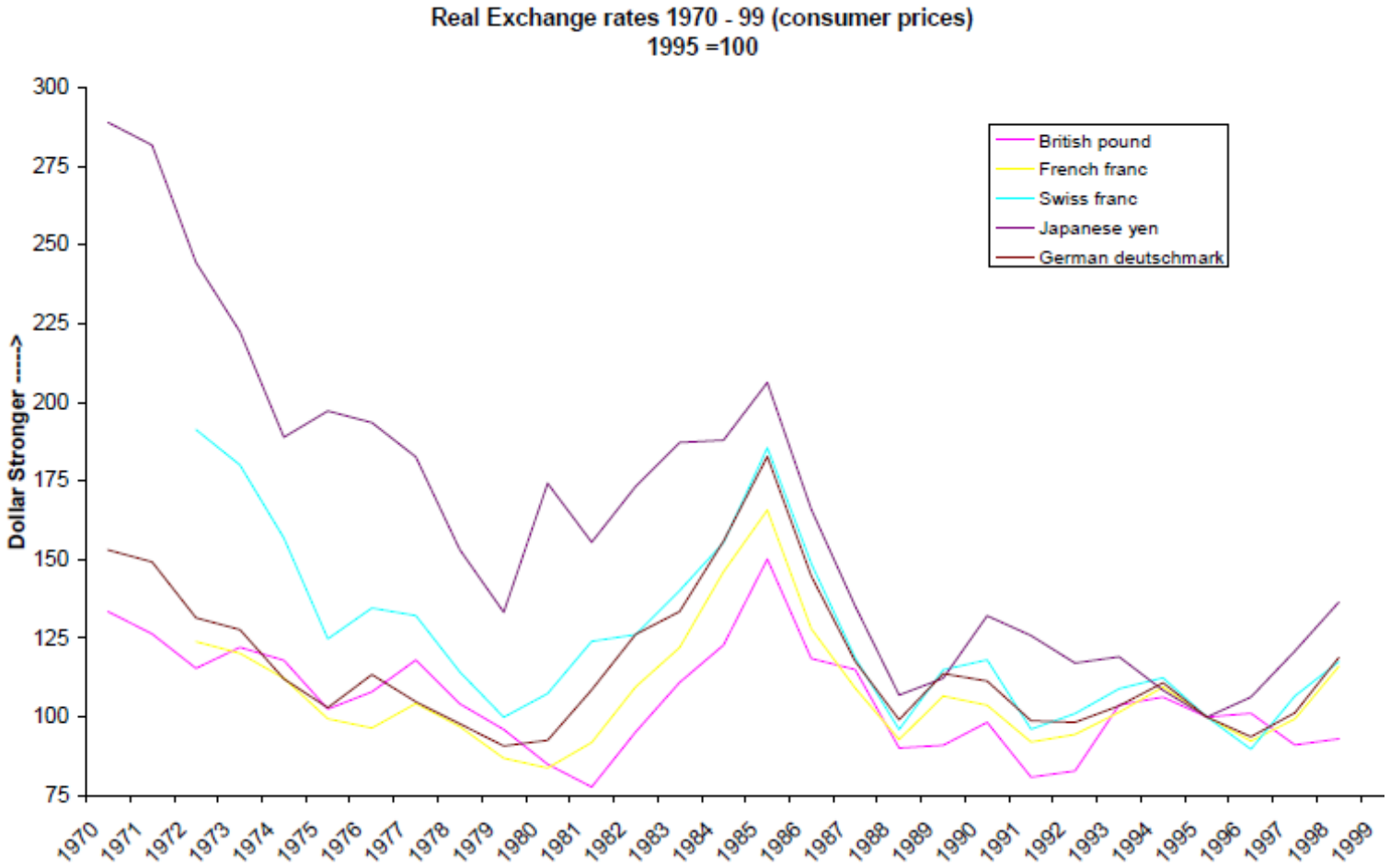
- The real exchange rate is the relative price of foreign to domestic goods and services, ie $Q = \frac{SP^*}{P}$
- Note that $Q$ is 'unitless': $P$ and $SP^*$ are measured in the domestic currency, so dividing the two gives a number like 1.5
- This feature means that real exchange rates can be used to measure a country's price competitiveness internationally
- PPP predicts a constant real exchange rate equal to 1:

$$Q = \frac{SP^*}{P} = \frac{SP^*}{SP^*} = 1$$

- Index numbers are often used for REX comparisons against a base year

# Empirical evidence from the real exchange rate (1970-99)

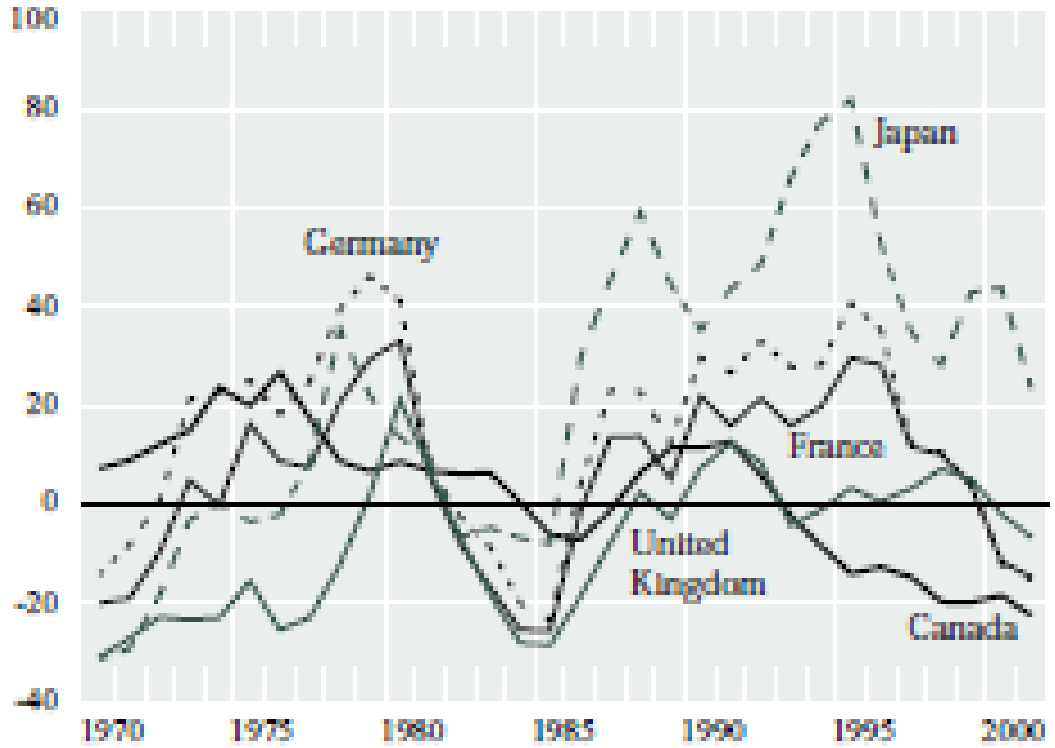
- Real exchange rates are clearly not constant as PPP predicts:




Source: Copeland Fig. 2.1. See also Figs 2.2-4 (pp. 69-70).

# Empirical evidence on PPP exchange rates (1970-2001)

- Percentage deviations from PPP exchange rates are substantial and long-lasting:




Source: Lafrance and Schembri (2002, Chart 3, p. 31)

# Long run empirical evidence on PPP

- Long run evidence is more supportive, suggesting that PPP is a long run equilibrium relationship to which exchange rates revert over time
- The simplest long run test of PPP is a regression with the null hypothesis of a unit root in the real exchange rate
- Recent evidence uses panel data or longer time series. It points to rejection of a unit root, with an autocorrelation coefficient in the range 0.8-0.9 for annual data
- Hence Rogoff (1996, p. 647) reports that

  *PPP deviations damp out at a rate of roughly 15% per year*

- This rate of decay implies a **half-life of PPP deviations of 3-5 years**

# The 'PPP puzzle'

- As argued by Rogoff (1996), it is puzzling that PPP holds only as a long run relationship
- Rogoff contrasts the volatility of real exchange rates with the slow rate at which deviations from PPP 'die out' (see p. 647)
- His point is exchange rates are moving about a lot, but not in a way that restores PPP – except in the long run
- Let's consider some explanations for the PPP puzzle

# Explanation 1: Nominal rigidity (Rogoff, pp. 647-8)

- In the short run, price levels are 'sticky' due to nominal rigidities
- For example, an average firm changes its prices only once or twice a year, so national price levels may not move to ensure that PPP holds over short horizons
- With price stickiness $P^*/P$ will be stable in the short run, implying that movements in real exchange rates will be driven by changes in nominal exchange rates
- It could be that these movements reflect short-term asset price bubbles and unexpected changes in monetary policy
- While nominal rigidity can explain why PPP does not hold in the short run, it does not provide a convincing explanation for medium or long run deviations from PPP

# Explanation 2: Market structure (Copeland Ch. 2.6.4)

- If markets are competitive, firms cannot set their own product prices
- But in practice, many firms operate in markets where they have monopoly power. This affects whether LOOP holds.
  1. Pricing to market – in this case the firm sets a different price in the home and export market according to demand conditions
  2. Incomplete pass-through – firms do not pass on changes in the exchange rate to foreign consumers (eg few firms change prices with daily fluctuations in exchange rates)
- Less than 100% pass-through could be the result of potential loss of goodwill or inconvenience (ie 'menu costs')

# Explanation 3: Traded and non-traded goods

- Suppose that home and foreign price levels depend on price levels in the traded and non-trade goods sectors:

$$P = P_T^{\alpha} P_{NT}^{1-\alpha} \qquad \text{and} \qquad P^* = P_T^{*\alpha} P_{NT}^{*1-\alpha} \qquad (0 < \alpha < 1)$$

  where $\alpha$ reflects the relative importance of traded goods

- In this case, the real exchange rate is NOT equal to 1 even if PPP holds for traded goods (ie $P_T = SP_T^*$):

$$Q = \frac{SP^*}{P} = S\frac{P_T^{*\alpha} P_{NT}^{*1-\alpha}}{P_T^{\alpha} P_{NT}^{1-\alpha}} = S\frac{P_T^*}{P_T}\left[\frac{P_{NT}^*/P_T^*}{P_{NT}/P_T}\right]^{1-\alpha}$$
$$= 1 \times \left[\frac{SP_{NT}^*/P_{NT}}{SP_T^*/P_T}\right]^{1-\alpha} = \left[SP_{NT}^*/P_{NT}\right]^{1-\alpha}$$

- Since LOOP does not apply to non-traded goods $SP_{NT}^*/P_{NT} \neq 1$, which implies that $Q \neq 1$

# Explanation 4: International goods market integration

- In concluding, Rogoff (1996) argues that the persistence of PPP deviations is due to international goods markets being less well integrated than domestic ones
- This could be due to trading frictions such as transport costs, trade barriers, or information costs of exploiting arbitrage opportunities
- Consistent with this argument, real exchange rates revert back to mean only after large deviations (see Sarno and Taylor, pp. 71-73)
- A second supportive finding in relation to LOOP is that

> *An international border has the same effect [on price] as an additional 75,000 miles between cities in the same country [!]*

(Copeland Ch. 2.7, p. 78)

# Next time...

- In Lecture 11 we will consider a different explanation for the PPP puzzle – the Balassa-Samuelson model
- Then, in Lecture 12, we will introduce the concept of uncovered interest parity (UIP), before turning to the flexible-price monetary model of exchange rates
- You will learn to solve flex-price model fully under the assumption of rational expectations

# References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