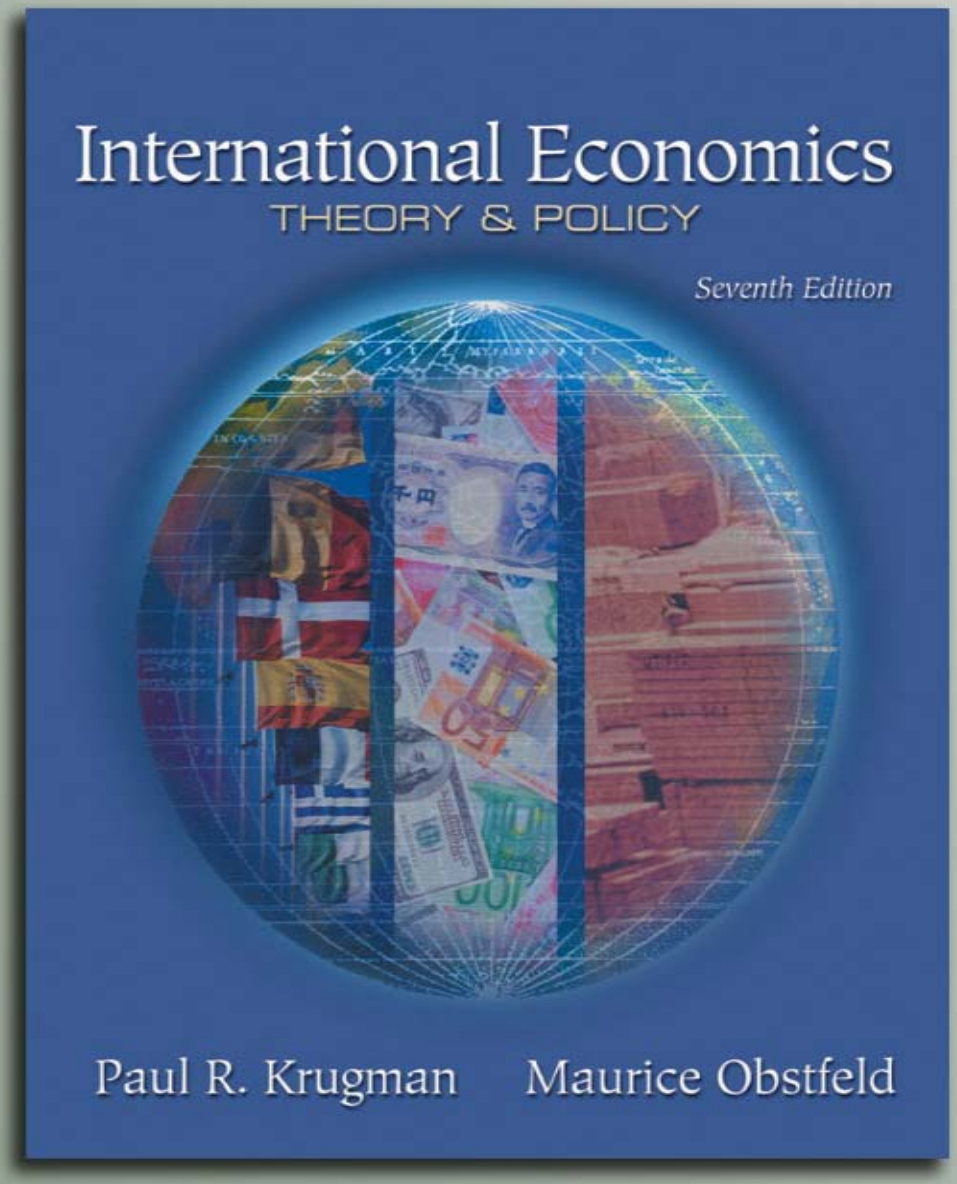

Chapter 15

Price Levels and the Exchange Rate in the Long Run

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Preview

- Law of one price
- Purchasing power parity
- Long run model of exchange rates: monetary approach
- Relationship between interest rates and inflation: Fisher effect
- Shortcomings of purchasing power parity
- Long run model of exchange rates: real exchange rate approach
- Real interest rates

The Behavior of Exchange Rates

- What models can predict how exchange rates behave?
  - In last chapter we developed a short run model and a long run model that highlighted movements in the money supply.
  - In this chapter, we develop two more models, building on the long run approach from last chapter.
  - “Long run” means that prices of goods and services, and of the factors of production that build those goods and services, adjust to supply and demand conditions so that their markets and the money market all reflect full employment.
  - Because prices are allowed to change, they will influence interest rates and exchange rates in the long run models.

The Behavior of Exchange Rates (cont.)

- The long run models are not intended to be completely realistic descriptions about how exchange rates behave in the short run, but they help in modeling how market participants form expectations about future exchange rates.

Law of One Price

- The **law of one price** simply says that the *same* good in different competitive markets must sell for the same price, when transportation costs and barriers between markets are not important.
  - Why? Suppose the price of pizza at one restaurant is $20, while the price of the same pizza at a similar restaurant across the street is $40.
  - What do you predict would happen?
  - Many people would buy the $20 pizza, few would buy the $40.

Law of One Price (cont.)

- Due to the increased demand, the price of the $20 pizza would tend to increase.
- Due to the decreased demand, the price of the $40 pizza would tend to decrease.
- People would have an incentive to adjust their behavior and prices would tend to adjust to reflect this changed behavior until a single, uniform price is achieved across markets (restaurants).

Law of One Price (cont.)

- Consider a pizza restaurant in Seattle and one across the border in Vancouver.
- The law of one price says that the price of the same pizza (using a common currency to measure the price) in the two cities must be the same if barriers between competitive markets and transportation costs are not important:

$$P^{pizza}_{US} = (E_{US\$/Canada\$}) \times (P^{pizza}_{Canada})$$

P^{pizza}_{US} = price of pizza in Seattle

P^{pizza}_{Canada} = price of pizza in Vancouver

$E_{US\$/Canada\$}$ = US dollar/Canadian dollar exchange rate

Purchasing Power Parity

- **Purchasing power parity** is the application of the law of one price across countries for *all* goods and services, or for representative groups ("baskets") of goods and services.

$$P_{US} = (E_{US\$/Canada\$}) \times (P_{Canada})$$

P_{US} = price level of goods and services in the US

(dollar price of a standard US consumption basket)

P_{Canada} = price level of goods and services in Canada

$E_{US\$/Canada\$}$ = US dollar/Canadian dollar exchange rate

Purchasing Power Parity (cont.)

- Purchasing power parity implies that

$$E_{\text{US\$/Canada\$}} = P_{\text{US}}/P_{\text{Canada}}$$

  - The relative price levels determine the exchange rate.
  - If the price level in the US is US$200 per consumption basket, while the price level in Canada is C$400 per basket, PPP implies that the US$/C$ exchange rate should be US$200/C$400 = US$ 1/C$ 2
  - Purchasing power parity says that each country's currency has the *same purchasing power*: 2 Canadian dollars buy the same amount of goods and services as does 1 US dollar, since prices in Canada are twice as high.
  - Equivalently, PPP states that countries' price levels are ***equal*** when measured in the same currency.

Purchasing Power Parity (cont.)

- Purchasing power parity comes in 2 forms:
- **Absolute PPP**: purchasing power parity that has already been discussed. Exchange rates equal price *levels* across countries.

$$E_{\$/€} = P_{US}/P_{EU}$$

- **Relative PPP**: *changes* in exchange rates equal *changes* in prices (inflation) between two periods:

$$(E_{\$/€,t} - E_{\$/€,\,t-1})/E_{\$/€,\,t-1} = \pi_{US,\,t} - \pi_{EU,\,t}$$

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

(Absolute implies relative.)

Monetary Approach to Exchange Rates

- **Monetary approach to the exchange rate***:* uses monetary factors to predict how exchange rates adjust in the long run.
  - It assumes absolute version of PPP.
  - It assumes prices adjust immediately to their long run levels.
  - In particular, price levels adjust to equate real (aggregate) money supply with real (aggregate) money demand. This implies:

$$P_{US} = M^{s}_{US}/L\,(R_{\$},\ Y_{US})$$

$$P_{EU} = M^{s}_{EU}/L\,(R_{€},\ Y_{EU})$$

Monetary Approach to Exchange Rates (cont.)

- To the degree that PPP holds and to the degree that prices adjust to equate real money supply with real money demand, we have the following prediction:
- The exchange rate is determined in the long run by prices, which are determined by the relative supply of money across countries and the relative real demand of money across countries.

Monetary Approach to Exchange Rates (cont.)

Predictions about changes in:

1. *Money supply*: a permanent rise in the domestic money supply
   - causes a proportional increase in the domestic price level,
   - causing a proportional depreciation in the domestic currency (through PPP).
   - same prediction as long run model without PPP
2. *Interest rates*: a rise in the domestic interest rate
   - lowers domestic money demand,
   - increasing the domestic price level,
   - causing a proportional *depreciation* of the domestic currency (through PPP).

Monetary Approach to Exchange Rates (cont.)

3. *Output level*: a rise in the domestic output level
   - raises domestic money demand,
   - decreasing the domestic price level,
   - causing a proportional appreciation of the domestic currency (through PPP).

- All 3 changes affect money supply or money demand, thereby causing prices to adjust to maintain equilibrium in the money market, thereby causing exchange rates to adjust to maintain PPP.

Monetary Approach to Exchange Rates (cont.)

- A change in the *level* of the money supply results in a change in the price *level*.
- A change in the money supply *growth rate* results in a change in the *growth rate* of prices (inflation).
  - Other things equal, a constant growth rate in the money supply results in a persistent growth rate in prices (persistent inflation) at the same constant rate.
  - Inflation does not affect the productive capacity of the economy or real output in the long run.
  - Inflation, however, does affect nominal interest rates. How?

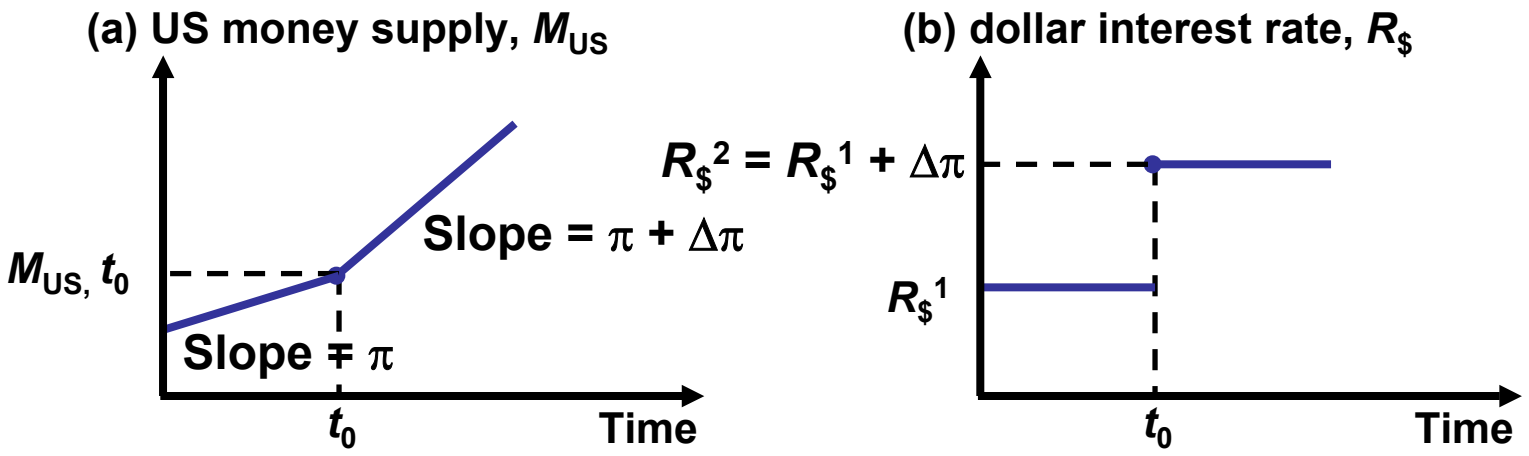
The Fisher Effect

- The **Fisher effect** (named after Irving Fisher) describes the relationship between nominal interest rates and inflation.
  - Derive the Fisher effect from the interest parity condition: $R_{\$} - R_{€} = (E^{e}_{\$/€} - E_{\$/€})/E_{\$/€}$
  - If financial markets expect (relative) PPP to hold, then expected exchange rate changes will equal expected inflation between countries: $(E^{e}_{\$/€} - E_{\$/€})/E_{\$/€} = \pi^{e}_{US} - \pi^{e}_{EU}$
  - $R_{\$} - R_{€} = \pi^{e}_{US} - \pi^{e}_{EU}$
  - The Fisher effect: a rise in the domestic inflation rate causes an equal rise in the interest rate on deposits of domestic currency in the long run, with other things held constant.

Monetary Approach to Exchange Rates

- Suppose that the Federal Reserve unexpectedly increases the money supply growth rate at time t_0.
- Suppose also that the inflation rate is π in the US before t_0 and $\pi + \Delta\pi$ after this time. Suppose inflation is consistently 0% in Europe.
- The interest rate adjusts according to the Fisher effect to reflect this higher inflation rate.

Monetary Approach to Exchange Rates (cont.)



Monetary Approach to Exchange Rates (cont.)

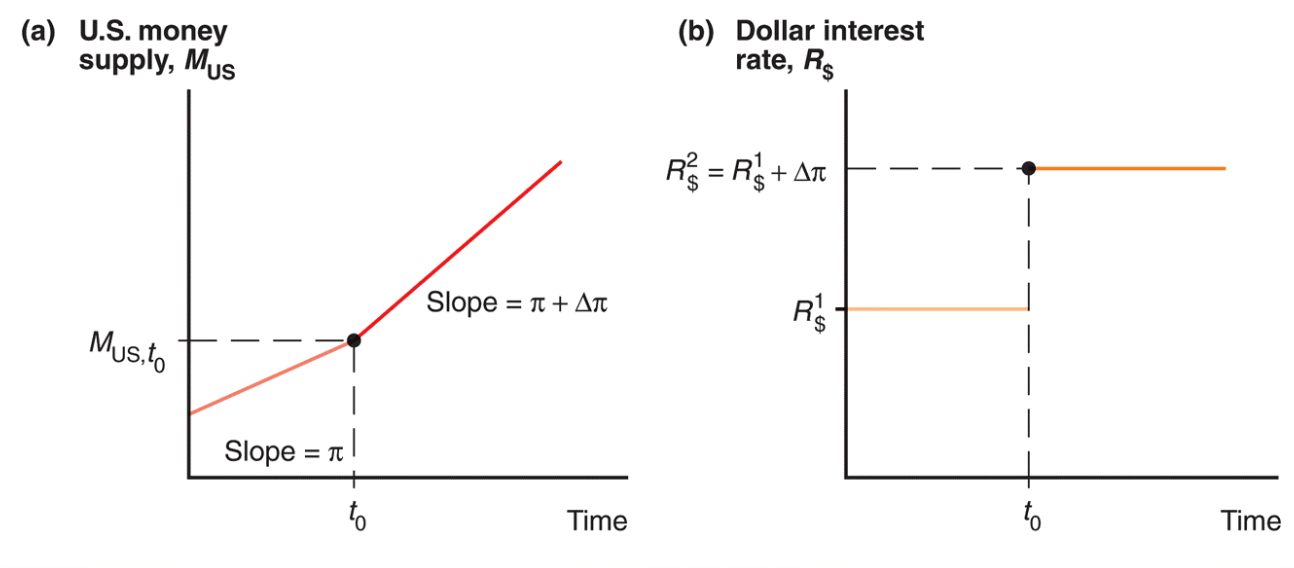
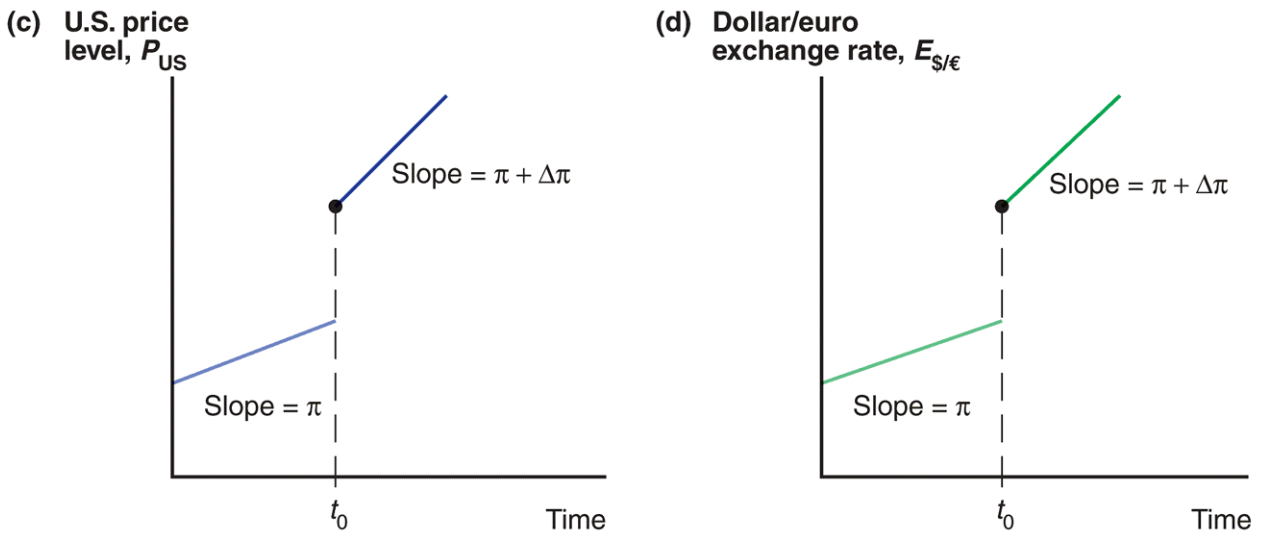


Figure 15-1

Long-Run Time Paths of U.S. Economic Variables After a Permanent Increase in the Growth Rate of the U.S. Money Supply

After the money supply growth rate increases at time t_0 in panel (a), the interest rate (in panel (b)), price level (in panel (c)), and exchange rate (in panel (d)) move to new long-run equilibrium paths. (The money supply, price level, and exchange rate are all measured on a *natural logarithmic* scale, which makes variables that change at constant proportional rates appear as straight lines when they are graphed against time. The slope of the line equals the variable's proportional growth rate.)

Monetary Approach to Exchange Rates (cont.)



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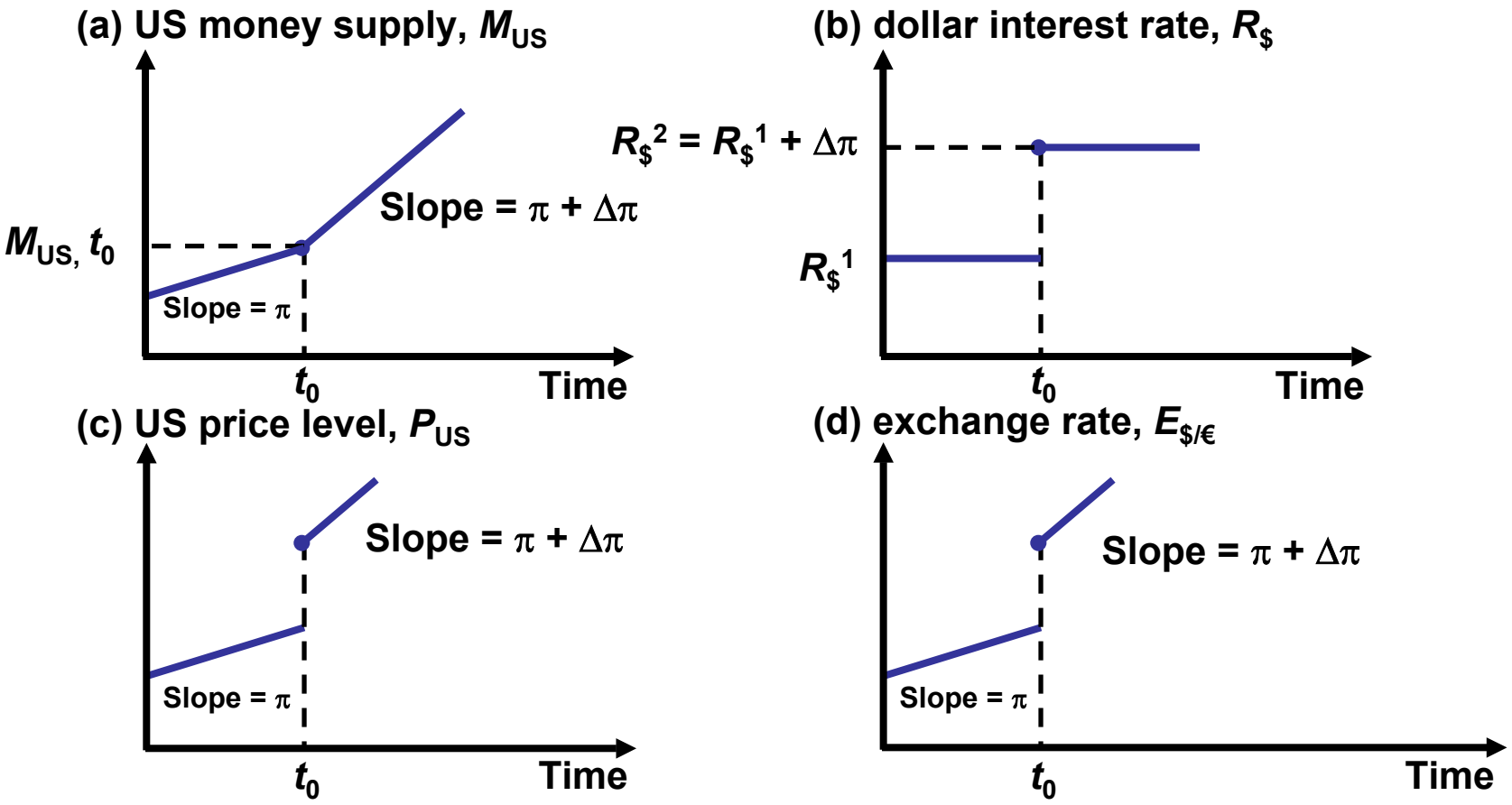
Monetary Approach to Exchange Rates (cont.)

- The increase in the nominal interest rate decreases real money demand.
- To maintain equilibrium in the money market, prices must jump so that $P_{US} = M^{s}_{US}/L\ (R_{\$},\ Y_{US})$.
- To maintain PPP, the exchange rate will then jump (the dollar will sharply depreciate): $E_{\$/€} = P_{US}/P_{EU}$
- Thereafter, the money supply and prices grow at rate $\pi + \Delta\pi$ and the domestic currency depreciates at the same rate.

Monetary Approach to Exchange Rates (cont.)



The Role of Inflation and Expectations

- In the monetary approach (with PPP), the rate of inflation increases permanently because the *growth rate* of the money supply increases permanently.
- With persistent inflation (above foreign inflation), the monetary approach also predicts an increase in the nominal interest rate.
- *Expectations of higher domestic inflation* cause the purchasing power of foreign currency to increase over time relative to the purchasing power of domestic currency, thereby making the domestic currency *depreciate*.

The Role of Inflation and Expectations (cont.)

- In the sticky-price model, expectations of inflation cause the exchange rate to overshoot (cause the domestic currency to depreciate more than) its long run value.
- In the monetary approach (with PPP), the price level adjusts with expectations of inflation, causing the domestic currency to depreciate, but with no overshooting.

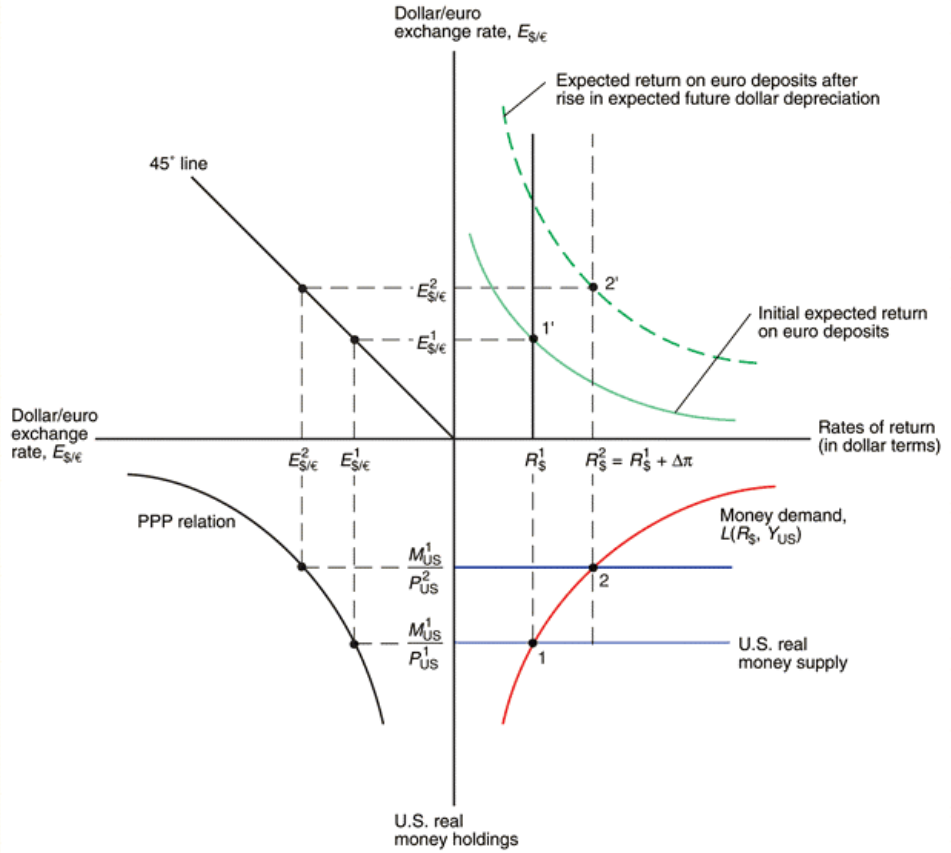


Figure 15A-1

How a Rise in U.S. Monetary Growth Affects Dollar Interest Rates and the Dollar/Euro Exchange Rate When Goods Prices Are Flexible

When goods prices are perfectly flexible, the money market equilibrium diagram (southeast quadrant) shows two effects of an increase, $\Delta\pi$, in the future rate of U.S. money supply growth. The change (i) raises the dollar interest rate from $R^1_\$$ to $R^2_\$ = R^1_\$ + \Delta\pi$, in line with the Fisher effect, and (ii) causes the U.S. price level to jump upward, from P^1_{US} to P^2_{US}. Money market equilibrium therefore moves from point 1 to point 2. (Because M^1_{US} doesn't change immediately, the real U.S. money supply falls to M^1_{US}/P^2_{US}, bringing the real money supply into line with reduced money demand.) The PPP relationship in the southwest quadrant shows that the price level jump from P^1_{US} to P^2_{US} requires a depreciation of the dollar against the euro (the dollar/euro exchange rate moves up, from $E^1_{\$/€}$ to $E^2_{\$/€}$). In the foreign exchange market diagram (northeast quadrant), this dollar depreciation is shown as the move from point 1′ to point 2′. The dollar depreciates despite a rise in $R_\$$ because heightened expectations of future dollar depreciation against the euro cause an outward shift of the locus measuring the expected dollar return on euro deposits.

Shortcomings of PPP

- There is little empirical support for purchasing power parity.
  - The prices of identical commodity baskets, when converted to a single currency, differ substantially across countries.
- Relative PPP is more somewhat consistent with data, especially over the very long run, but it performs poorly in predicting exchange rates.

Shortcomings of PPP (cont.)

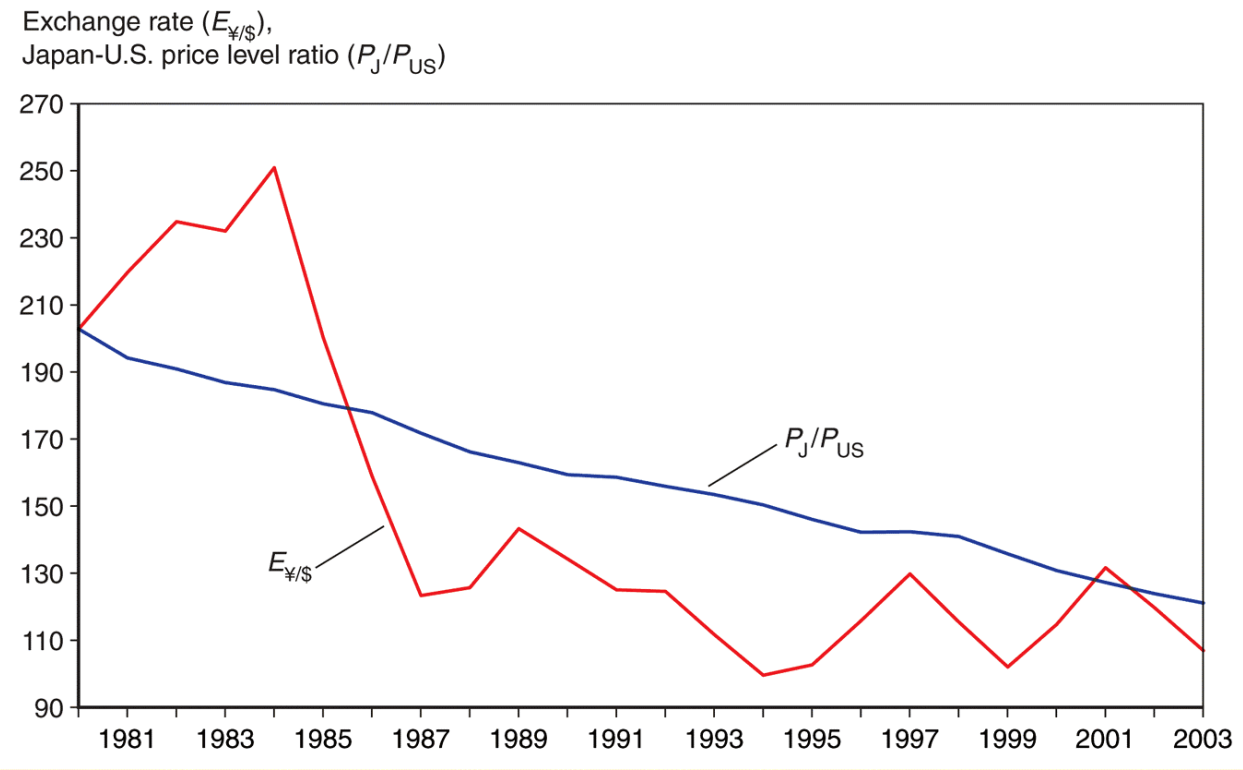


Figure 15-2

The Yen/Dollar Exchange Rate and Relative Japan-U.S. Price Levels, 1980–2003

The graph shows that relative PPP did not explain the yen/dollar exchange rate after 1980.

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

Shortcomings of PPP (cont.)

Reasons why PPP may not be a good theory:

1. Trade barriers and non-tradable goods and services
2. Imperfect competition
3. Differences in price level measures

Shortcomings of PPP (cont.)

- **Trade barriers and non-tradables**
  - Transport costs and governmental trade restrictions make trade expensive and in some cases create non-tradable goods or services.
  - Services are often not tradable: services are generally offered within a limited geographic region (e.g., haircuts).
  - The greater the transport costs, the greater the range over which the exchange rate can deviate from its PPP value.
  - So the same price need not hold in two separated markets.

Shortcomings of PPP (cont.)

- **Imperfect competition** may result in price discrimination: “pricing to market”.
  - A firm sells the same product for different prices in different markets to maximize profits, based on expectations about what consumers are willing to pay.
- **Differences in price level measures**
  - price levels differ across countries because of the way representative groups (“baskets”) of goods and services are measured.
  - Because measures of goods and services are different, the measure of their prices need not be the same.

Law of One Price for Hamburgers?

Big Mac prices (in U.S. dollars)			
United States	2.90	Malaysia	1.33
Argentina	1.48	Mexico	2.08
Australia	2.27	New Zealand	2.65
Brazil	1.70	Peru	2.57
Britain	3.37	Philippines	1.23
Canada	2.33	Poland	1.63
Chile	2.18	Russia	1.45
China	1.26	Singapore	1.92
Czech Republic	2.13	South Africa	1.86
Denmark	4.46	South Korea	2.72
Egypt	1.62	Sweden	3.94
Euro Area	3.28	Switzerland	4.90
Hong Kong	1.54	Taiwan	2.24
Hungary	2.52	Thailand	1.45
Indonesia	1.77	Turkey	2.58
Japan	2.33	Venezuela	1.48

Source: *Economist,* May 27, 2004.

The Real Exchange Rate

- Because of the shortcomings of PPP, economists have tried to generalize the monetary approach so that it does not necessarily assume PPP.
- The **real exchange rate** is the *rate of exchange for real goods and services* across countries.
- In other words, it is the relative value/price/cost of goods and services across countries.
- It can be defined as the dollar price of a reference European consumption basket of goods and services relative to the dollar price of the same reference basket in the US:

$$q_{US/EU} = (E_{\$/€} \times P_{EU})/P_{US}$$

The Real Exchange Rate (cont.)

$$q_{US/EU} = (E_{\$/€} \times P_{EU})/P_{US}$$

- If the EU basket costs €100, the US basket costs $120 and the nominal exchange rate is $1.20 per euro, then the real exchange rate is 1 US basket per EU basket.
- A *real depreciation* of the dollar (a rise in $q_{US/EU}$) means a fall in a US consumption basket's purchasing power over EU baskets – a rise in the price of EU products in terms of US products (since consumption is intensive in domestic goods).
- This implies that US goods become less expensive compared with EU goods.

The Real Exchange Rate (cont.)

$$q_{US/EU} = (E_{\$/€} \times P_{EU})/P_{US}$$

- A *real appreciation* of the dollar (a fall in $q_{US/EU}$) means a rise in a US consumption basket's purchasing power over EU baskets – a fall in the price of EU products in terms of US products.
- This implies that US goods become more expensive compared with EU goods.
- From now on, when we refer to simply "the exchange rate" we will mean the *nominal* exchange rate *E*; when we mean the real exchange rate *q* we will say so explicitly.

The Real Exchange Rate (cont.)

- According to PPP, nominal exchange rates are determined by relative price ratios:

$$E_{\$/€} = P_{US}/P_{EU}$$

- According to the more general real exchange rate approach, nominal exchange rates may also be influenced by the real exchange rate:

$$E_{\$/€} = q_{US/EU} \times P_{US}/P_{EU}$$

- So: what influences the real exchange rate?

The Real Exchange (cont.)

- A **change in relative demand** for US products
  - An increase in relative demand for US output causes the price of US goods and services to rise relative to the price of foreign goods and services.
  - This is a real appreciation of the dollar: P_{US} rises relative to $E_{\$/€} \times P_{EU}$
  - The increase in the relative price of US goods makes US exports more expensive and imports into the US less expensive, thereby altering trade flows.
  - A decrease in relative demand for US output leads to a fall in the relative price of US goods.

The Real Exchange Rate (cont.)

- A **change in relative supply** of US products
  - An increase in relative supply of US output (caused by an increase in US productivity) causes the price of US goods to fall relative to the price of foreign goods.
  - This is a real real depreciation of the US dollar: P_{US} falls relative to $E_{\$/€}$ x P_{EU}
  - The real depreciation of the dollar makes US exports less expensive for foreign buyers and imports into the US more expensive for Americans, thereby increasing the relative demand for US products to match their increased relative supply.
  - A decrease in relative US aggregate supply causes a real appreciation of the US dollar.

Determining the Long Run Real Exchange Rate

In the long run, the supply of goods and services in each country depends on factors of production like labor, capital and technology—not prices or exchange rates.

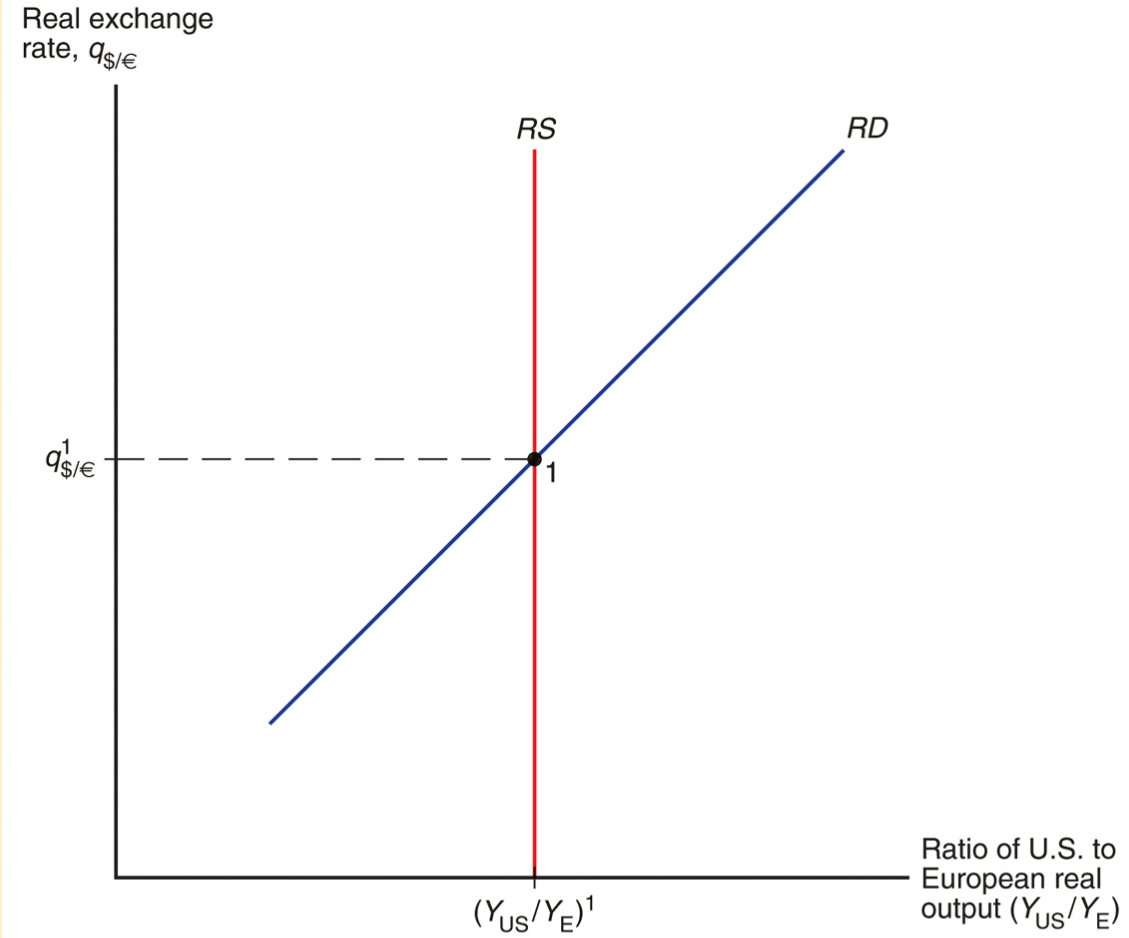


Figure 15-4

Determination of the Long-Run Real Exchange Rate

The long-run equilibrium real exchange rate equates world relative demand to the full-employment level of relative supply.

Determining the Long Run Real Exchange Rate (cont.)

The demand for US products relative to the demand for EU products depends on the relative price of these products, or the real exchange rate. When the real exchange rate, $q_{US/EU} = (E_{\$/€}P_{EU})/P_{US}$ is high, the relative demand for US products is high.

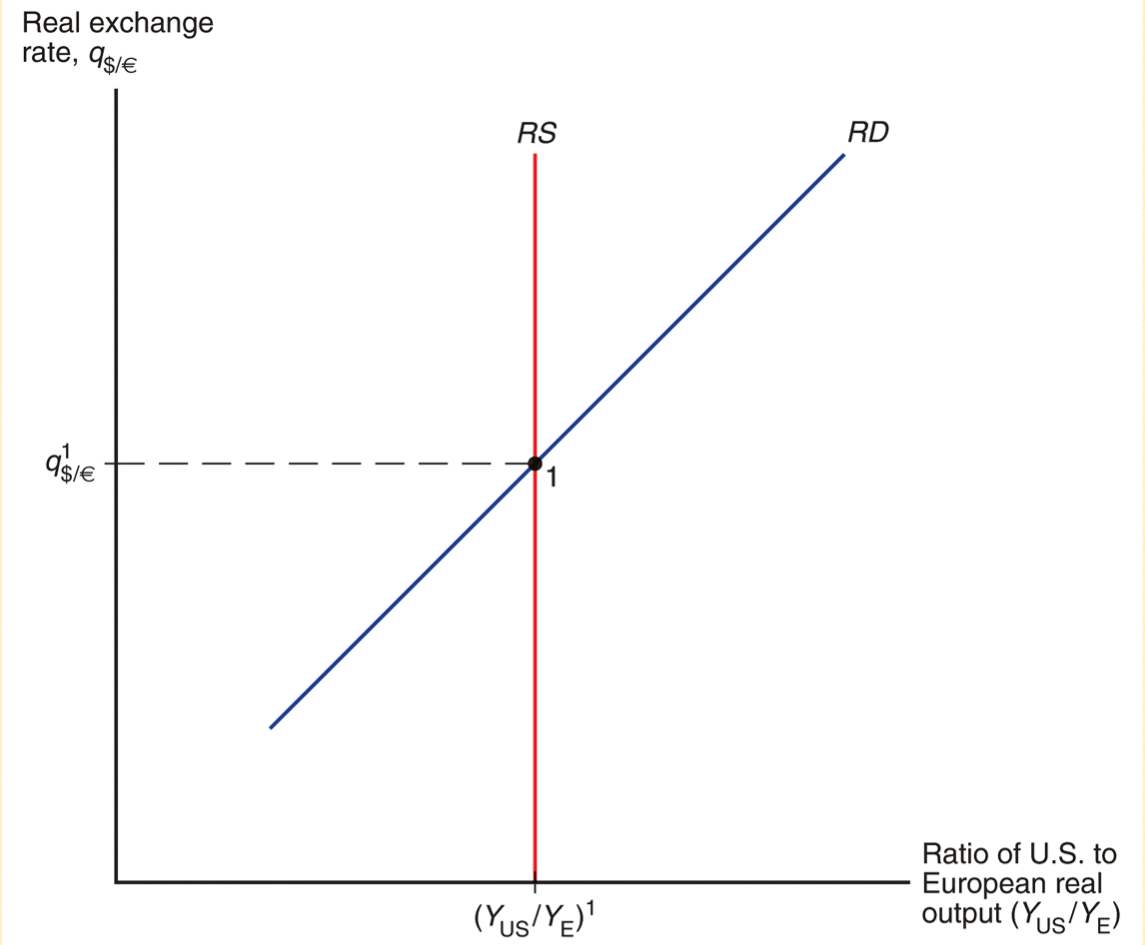


Figure 15-4

Determination of the Long-Run Real Exchange Rate

The long-run equilibrium real exchange rate equates world relative demand to the full-employment level of relative supply.

Determining the Long Run Real Exchange Rate (cont.)

When the relative supply of US products matches the relative demand for US products, there is no tendency for the price of US products relative to EU products to change.

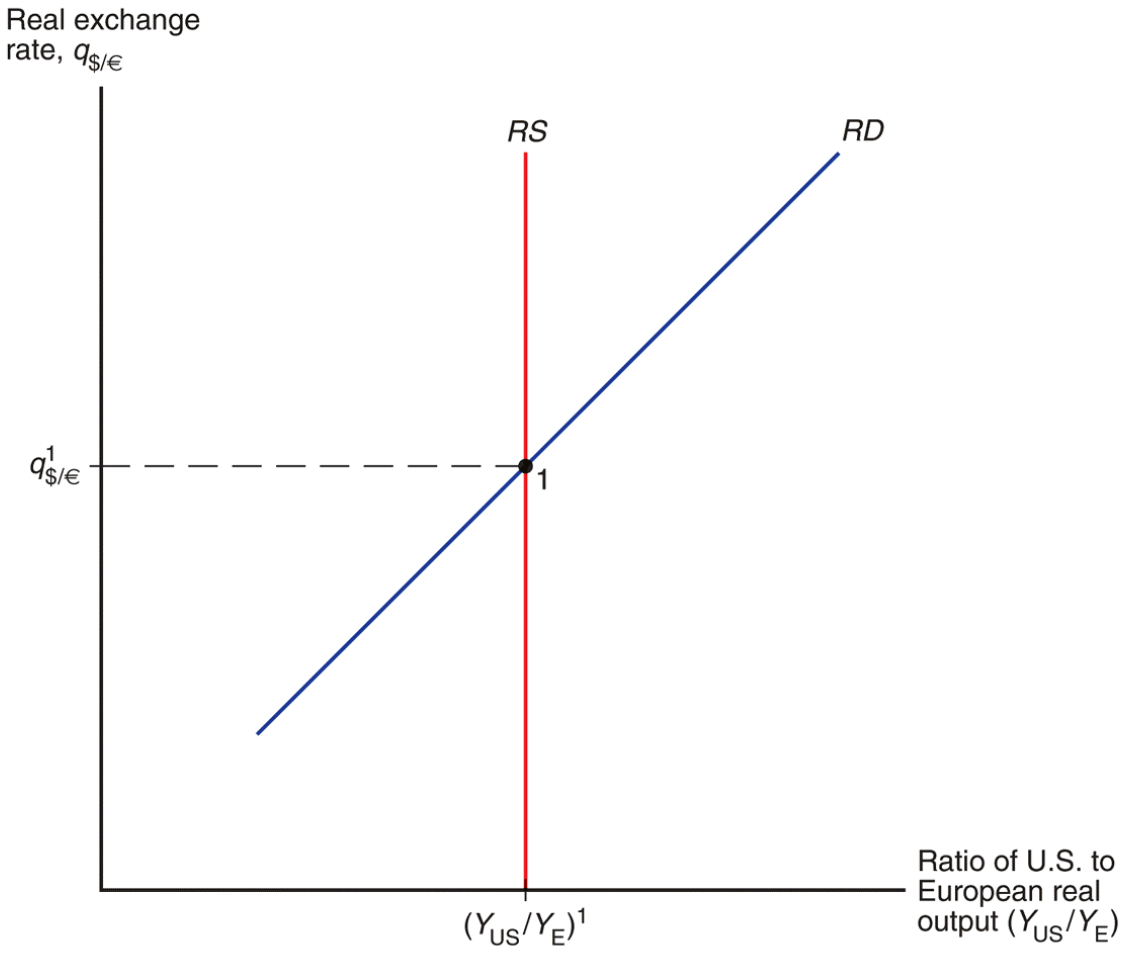


Figure 15-4

Determination of the Long-Run Real Exchange Rate

The long-run equilibrium real exchange rate equates world relative demand to the full-employment level of relative supply.

Why Price Levels Are Higher in Richer Countries

- You might think that since richer countries have higher output, their price levels are lower than in poorer countries.
- Not so!
- The opposite regularity, shown on the next slide, is called the *Balassa-Samuelson* effect.

Global Price Levels and Incomes, 2000

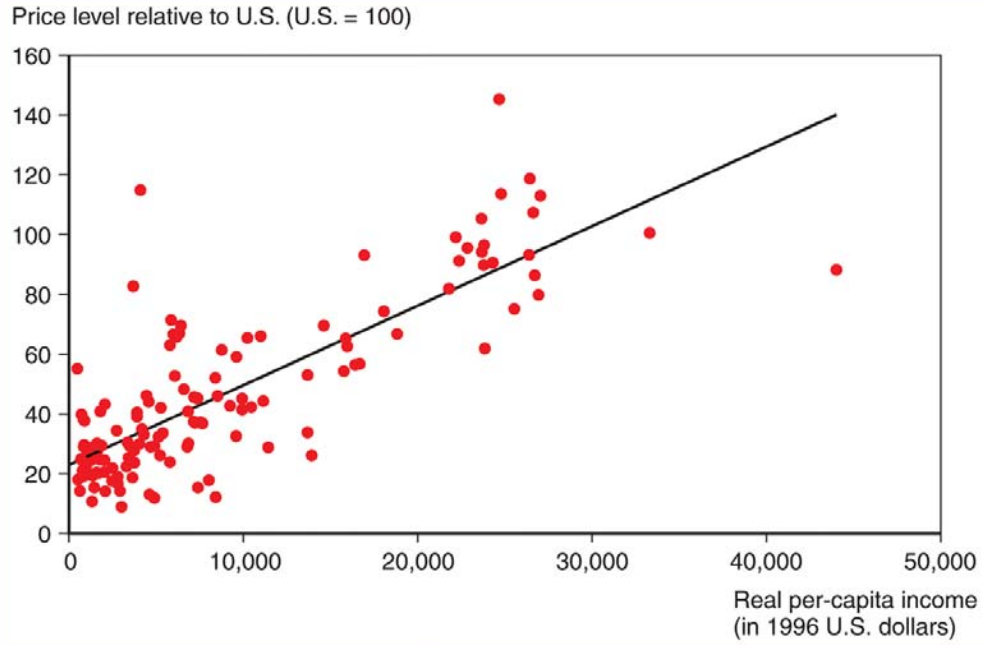


Figure 15-3

Price Levels and Real Incomes, 2000

Countries' price levels tend to rise as their real incomes rise. Each dot represents a country. The straight line indicates a statistician's best prediction of a country's price level relative to the United States based on knowing its real per-capita income.

Source: Penn World Table, Mark 6.1.

Why Price Levels Are Higher in Richer Countries (cont.)

- Suppose Law of One Price holds for tradables. (Actually, for industrial countries, it does not.)
- In rich countries productivity is much higher in tradables but not so much in non-tradables (esp. services). (What about the Wal Mart effect?)
- This means demand for non-tradables relatively higher than supply in rich countries.
- Implies real appreciation of rich-country currencies due to the relative demand channel raising prices of non-tradables.
- Our “long-run” flexible price model doesn’t capture “real-side” factors that operate in the long run to dampen relative international tradable-goods prices.

The Real Exchange Rate in a General Long-Run Model of the Nominal Rate

- Allowing the real exchange rate to change allows a more general approach to explaining exchange rates. Now, both monetary factors *and real* factors influence nominal exchange rates:

  1a. changes in *money supply levels*, leading price level changes and proportional changes in long-run expected exchange rates.

  1b. changes in *money supply growth rates*, leading to persistent inflation and changes in expectations of inflation and depreciation.

  2a. changes in *relative demand*: increase in relative demand for domestic products leads to a real appreciation.

  2b. changes in *relative supply*: increase in relative supply of domestic products leads to a real depreciation.

The Real Exchange Rate (cont.)

- What are the effects on the nominal exchange rate?

$$E_{\$/€} = q_{US/EU} \times P_{US}/P_{EU}$$

- When only monetary factors change and PPP holds, we have the same predictions as before.
  - no changes in the real exchange rate ever occur
- When factors influencing real output change, the real exchange rate changes.
  - With an increase in relative demand for US products, the real exchange rate change determines the nominal exchange rate change. $q_{US/EU}$ falls; because price levels are unchanged (why?), the nominal rate $E_{\$/€}$ falls (an appreciation of $) too.
  - With an increase in relative supply of domestic products, the situation is more complex…

The Real Exchange Rate (cont.)

- With an increase in the relative supply of domestic products, the domestic currency depreciates in real terms – the relative price of domestic output falls. But there are also more market transactions domestically.
  - This second effect increases real money demand in the domestic economy relative to that in the foreign economy:

$$P_{US} = M^{s}_{US}/L\,(R_{\$},\ Y_{US})$$

  - The domestic price level decreases relative to the foreign price level.
  - The net effect on the nominal exchange rate is ambiguous:

$$E_{\$/€} = q_{US/EU} \times P_{US}/P_{EU}$$

$$? \qquad \uparrow \qquad \downarrow$$

The Real Exchange Rate (cont.)

- When all economic changes are the result of monetary factors, nominal exchange rates are will behave in accordance with (relative) PPP – over the long run (though not in the short run as we shall see later).
- When economic changes are the result of factors that affect real output, exchange rates will not follow relative PPP even in the long run: real exchange rate changes (which are deviations from PPP) will occur.

TABLE 15-1 **Effects of Money Market and Output Market Changes on the Long-Run Nominal Dollar/Euro Exchange Rate, $E_{\$/€}$**

Change	Effect on the long-run nominal dollar/euro exchange rate, $E_{\$/€}$
Money market	
1. Increase in U.S. money supply level	Proportional increase (nominal depreciation of $)
2. Increase in European money supply level	Proportional decrease (nominal depreciation of euro)
3. Increase in U.S. money supply growth rate	Increase (nominal depreciation of $)
4. Increase in European money supply growth rate	Decrease (nominal depreciation of euro)
Output market	
1. Increase in demand for U.S. output	Decrease (nominal appreciation of $)
2. Increase in demand for European output	Increase (nominal appreciation of euro)
3. Output supply increase in the United States	Ambiguous
4. Output supply increase in Europe	Ambiguous

Interest Rate Differences

- A useful equation for differences in nominal interest rates across countries can be derived from:

$$(q^e_{US/EU} - q_{US/EU})/q_{US/EU} = [(E^e_{\$/€} - E_{\$/€})/E_{\$/€}] - (\pi^e_{US} - \pi^e_{EU})$$

$$R_{\$} - R_{€} = (E^e_{\$/€} - E_{\$/€})/E_{\$/€}$$

$$R_{\$} - R_{€} = (q^e_{US/EU} - q_{US/EU})/q_{US/EU} + (\pi^e_{US} - \pi^e_{EU})$$

- Under interest parity, the difference in nominal interest rates can be viewed as the sum of:
  - The expected rate of depreciation in the value of domestic goods relative to that of foreign goods
  - The expected inflation difference between the domestic economy and the foreign economy

Real Interest Rates

- Real interest rates are inflation-adjusted interest rates:

$$r^e = R - \pi^e$$

- where π^e represents expected inflation and R represents nominal interest rates.
- Real interest rates are measured in terms of real output: what quantity of real goods and services can you earn in the future by saving real resources today?
- What should be the differences in real interest rates across countries?

Real Interest Rates (cont.)

- Real interest rate differentials are derived from

$$r^e_{US} - r^e_{EU} = (R_{\$} - \pi^e_{US}) - (R_{€} - \pi^e_{EU})$$

$$R_{\$} - R_{€} = (q^e_{US/EU} - q_{US/EU})/q_{US/EU} + (\pi^e_{US} - \pi^e_{EU})$$

$$\Rightarrow \quad r^e_{US} - r^e_{EU} = (q^e_{US/EU} - q_{US/EU})/q_{US/EU}$$

- The last equation is called **real interest parity**.
  - It says that the differences in real interest rates (return on saving in terms of real resources) between countries is equal to the expected change in the real exchange rate.

Summary

1. The law of one price says that in different competitive markets, the same good must sell for the same price -- absent transportation costs and other barriers to market arbitrage.
2. Purchasing power parity generalizes the law of one price to cover all goods and services produced in a country.
   - Absolute PPP says that the currencies of any two countries must have the same purchasing power.
   - Relative PPP says that the change in the nominal exchange rate between two countries equals the difference in inflation rates between the two countries.

Summary (cont.)

3. The monetary approach to exchange rates is based on PPP and money-market equilibrium.
   - Changes in the growth rate of the money supply influence inflation and exchange rates.
   - Expectations about inflation influence the exchange rate.
   - The Fisher effect shows that differences in nominal interest rates are equal to differences in inflation rates.
4. Empirical support for PPP is weak.
   - Trade barriers, non-tradable products, imperfect competition and differences in price measures may all contribute to the empirical shortcomings of PPP.

Summary (cont.)

5. Allowing for real exchange rate changes allowed us to generalize the simplistic monetary approach.
   - The real exchange rate of a currency is the price of foreign products in general in terms of domestic products in general.
   - Relative demand and relative supply changes to influence real and hence nominal exchange rates.
   - Interest rate differences are explained by a more general concept: expected changes in the value of domestic products relative to the value of foreign products plus the difference of inflation rates between the domestic and foreign economies.