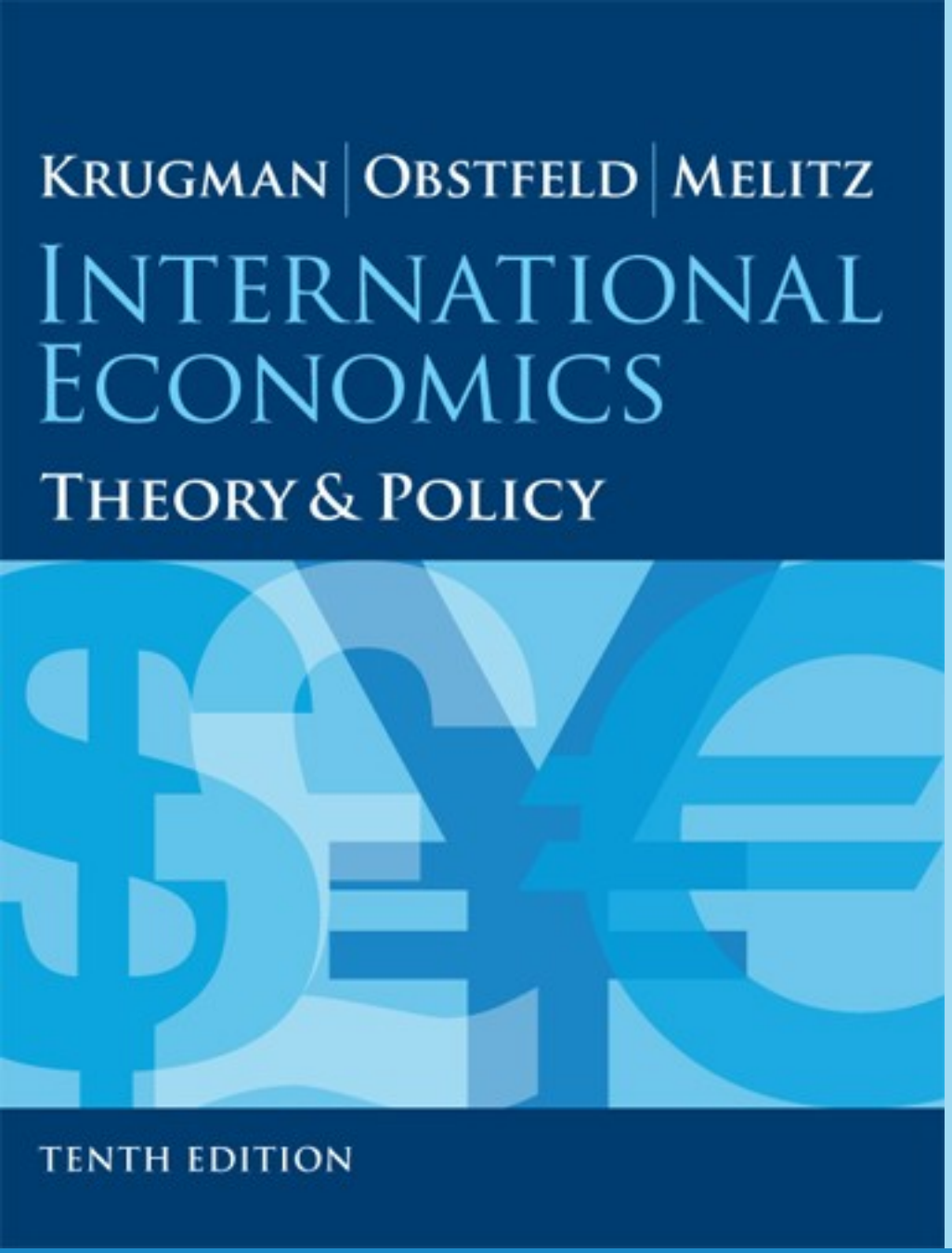


Chapter 16

Price Levels and the Exchange Rate in the Long Run

Preview

- Law of one price
- Purchasing power parity
- Long-run model of exchange rates: monetary approach (based on absolute version of PPP)
- Shortcomings of purchasing power parity
- Long-run model of exchange rates: real exchange rate approach (based on relative version of PPP)

Models of Exchange Rate Behavior

- In the last chapter we developed a short and long-run model that used movements in the money supply.
- In this chapter, we develop 2 more models, building on the long-run approach from last chapter.
  - Long run means a sufficient amount of time for prices of all goods and services to adjust to market conditions so that their markets and the money market are in equilibrium.
- The long-run models are not intended to be completely realistic descriptions about how exchange rates behave
  - How market participants may form expectations about future exchange rates and how exchange rates tend to move over long periods.

Law of One Price

- The **law of one price** says that the *same* good in different competitive markets must sell for the same price (using a common currency), when transportation costs and barriers between markets are not important.
  - Why? The reason is an arbitrage which should eliminate the price differentials among different markets.
- Consider a pizza in Seattle and in Vancouver.

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

P_{US} is price of pizza in Seattle

P_{Can} is price of pizza in Vancouver

$E_{US/Can}$ is U.S. dollar/Canadian dollar exchange rate

Purchasing Power Parity

- **Purchasing power parity** is the application of the law of one price across countries for representative baskets of goods and services:

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

P_{US} is price level in the U.S.

P_{Can} is price level in Canada

$E_{US/Can}$ is U.S. dollar/Canadian dollar exchange rate

Purchasing Power Parity

- Purchasing power parity (PPP) implies that the exchange rate is determined by price levels:

$$E_{US/Can} = P_{US}/P_{Can}$$

  - If the price level in the U.S. is US$200 per basket, while the price level in Canada is C$400 per basket, PPP implies that the C$/US$ exchange rate should be C$400/US$200 = C$2/US$1.
  - Predicts that people in all countries have the same purchasing power with their currencies: 2 Canadian dollars buy the same amount of goods as 1 U.S. dollar, since prices in Canada are twice as high.

Purchasing Power Parity

- Purchasing power parity (PPP) comes in 2 forms:
- **Absolute PPP**: purchasing power parity that has already been discussed. Exchange rates equal the *level* of relative average prices 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

Monetary Approach to Exchange Rates

- Monetary approach to the exchange rate is based on the absolute version of PPP and uses monetary factors to predict how exchange rates adjust in the long run
  - It predicts that levels of average prices across countries adjust so that the quantity of real monetary assets supplied will equal the quantity of real monetary assets demanded:

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

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

- According to the monetary approach:
  - The exchange rate is determined in the long run by price levels, which are determined by the relative supply and demand of real monetary assets in money markets across countries.

Predictions of Monetary Approach to Exchange Rates

- The fundamental equations of the monetary approach

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

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

$$E_{\$/€} = P_{US}/P_{EU}$$

1. *Money supply*: a permanent rise in the domestic money supply
   - causes a proportional increase in the domestic price level,
   - thus causing a proportional depreciation in the domestic currency (through PPP). This is same prediction as long-run model without PPP.

Predictions of Monetary Approach to Exchange Rates

- The fundamental equations of the monetary approach

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

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

$$E_{\$/€} = P_{US}/P_{EU}$$

2. *Interest rates*: a rise in domestic interest rates

   - lowers the demand of real monetary assets and is associated with a rise in domestic prices,
   - thus causing a proportional *depreciation* of the domestic currency (through PPP).

Predictions of Monetary Approach to Exchange Rates

- The fundamental equations of the monetary approach

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

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

$$E_{\$/€} = P_{US}/P_{EU}$$

3. *Output level*: a rise in the domestic level of output

   - raises domestic demand of real monetary assets and is associated with a decreasing level of average domestic prices (for a fixed quantity of money supplied),
   - thus causing a proportional appreciation of the domestic currency (through PPP).

Predictions of Monetary Approach to Exchange Rates

- A change in the money supply results in a change in the level of average prices.
- A change in the *growth rate* of the money supply results in a change in the *growth rate* of prices (inflation).
  - A constant growth rate in the money supply results in a persistent growth rate in prices (persistent inflation) at the same constant rate, when other factors are constant.
  - Inflation does not affect the productive capacity of the economy and real income from production in the long run.
  - Inflation, however, does affect nominal interest rates. How?

The Fisher Effect

- The **Fisher effect** (named after Irving Fisher) describes the relation 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: $(E^{e}_{\$/€} - E_{\$/€})/E_{\$/€} = \pi^{e}_{US} - \pi^{e}_{EU}$
  - Therefore, $R_{\$} - R_{€} = \pi^{e}_{US} - \pi^{e}_{EU}$
  - 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, when other factors remain constant.

Fig. 16-1: Long-Run Time Paths of U.S. Economic Variables After a Permanent Increase in the Growth Rate of the U.S. Money Supply

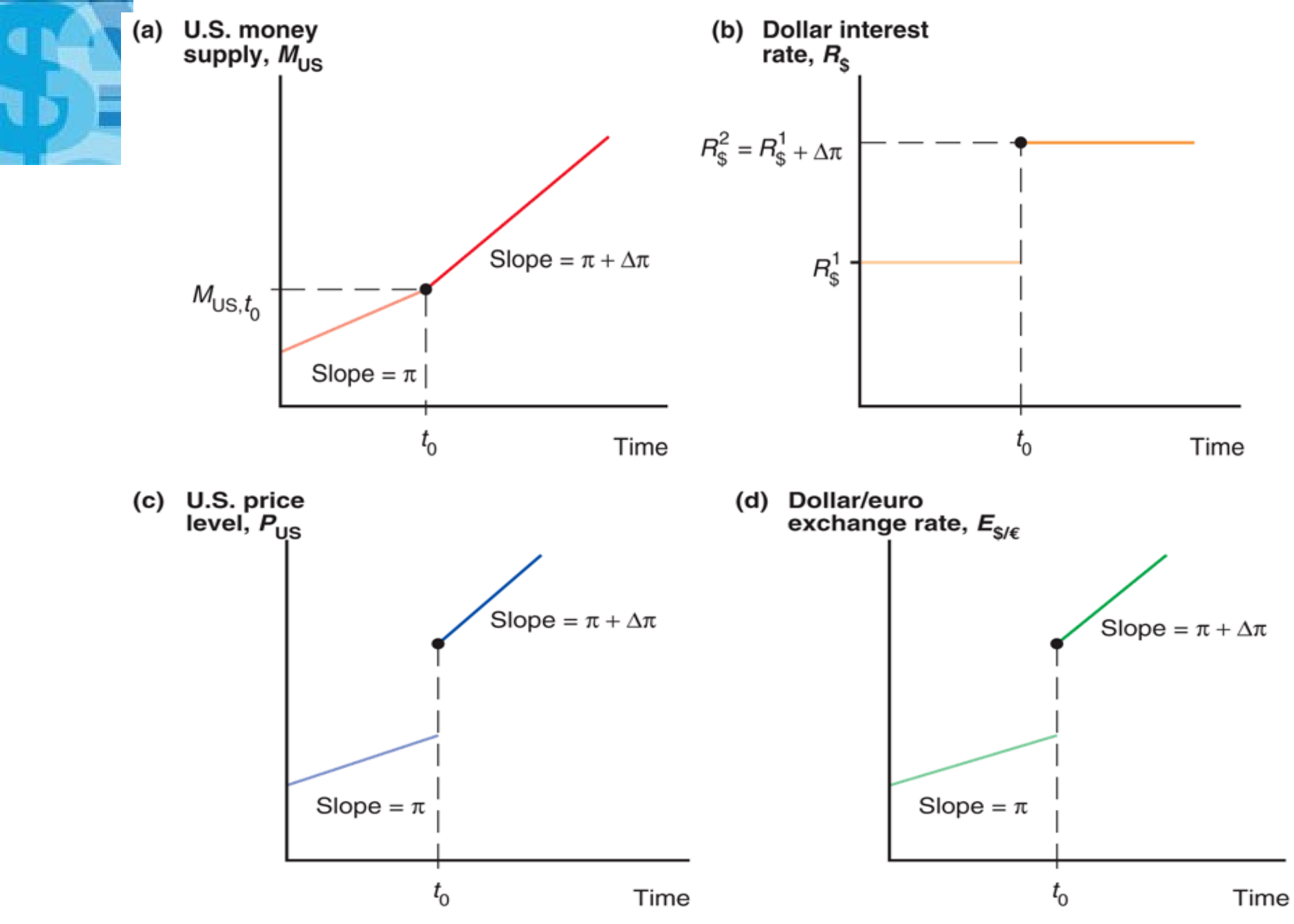


Fig. 16-1: Long-Run Time Paths of U.S. Economic Variables After a Permanent Increase in the Growth Rate of the U.S. Money Supply

Suppose that the U.S. central bank unexpectedly increases the growth rate of the money supply 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, but that the European inflation rate remains at 0%.

According to the Fisher effect, the interest rate in the U.S. will adjust to the higher inflation rate.

The increase in nominal interest rates decreases the demand of real monetary assets. In order for the money market to maintain equilibrium in the long run, prices must jump so that: $P_{US} = M^s_{US}/L\ (R_\$, Y_{US})$

In order to maintain PPP, the exchange rate must jump (the dollar must depreciate) so that: $E_{\$/€} = P_{US}/P_{EU}$

Thereafter, the money supply and prices are predicted to grow at rate $\pi + \Delta\pi$ and the domestic currency is predicted to depreciate at the same rate.

The Role of Inflation and Expectations

In the short-run model without PPP:

- An increase in interest rate is caused by lower supply of real money balances or by higher demand for real money balances. The reason is that the price level is fixed in the short run.
- This increase in interest rate is associated with **lower expected inflation** and a long-run appreciation, so the currency **appreciates immediately**.

In the long-run model based on PPP:

- An increase in interest rate is caused by **higher expected inflation** (through the Fisher effect) which is caused by higher expected money growth rate in the future.
- A higher expected inflation leads to an immediate **currency depreciation**.

The Role of Inflation and Expectations

- In order to examine the relation between interest rates and exchange rates, it is important to know:

1. What factors caused the interest rate to move
   - change of a money supply level versus change of a money supply growth rate
   - one-time increase of money supply level does not affect expected inflation while an increase of a money supply growth rate does affect (increase) expected inflation
2. What time horizon do we assume
   - short-run horizon implicitly assumes a fixed price level
   - long-run horizon implicitly assumes flexible price level

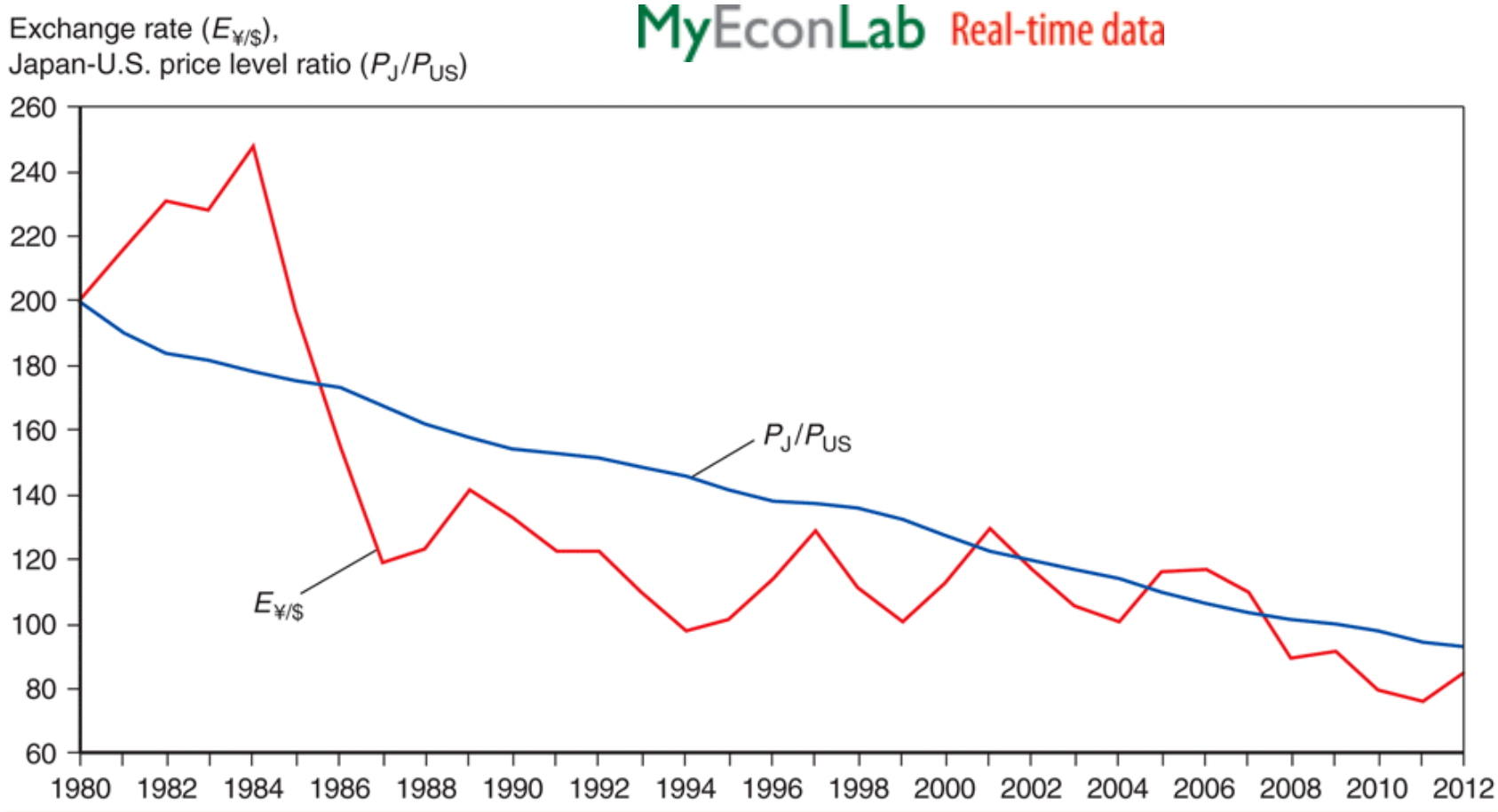
Shortcomings of PPP

- There is little empirical support for absolute purchasing power parity, see Fig. 16-2.
  - The prices of identical commodity baskets, when converted to a single currency, differ substantially across countries.
- Relative PPP is more consistent with data, but it also performs poorly to predict exchange rates.

Reasons why PPP may not be accurate:

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

Fig. 16-2: 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.

Shortcomings of PPP

- **Trade barriers and nontradable products**
  - Transport costs and governmental trade restrictions make trade expensive and in some cases create nontradable goods or services.
  - Services are often not tradable: services are generally offered within a limited geographic region (for example, haircuts).
  - The greater the transport costs, the greater the range over which the exchange rate can deviate from its PPP value.

Shortcomings of PPP

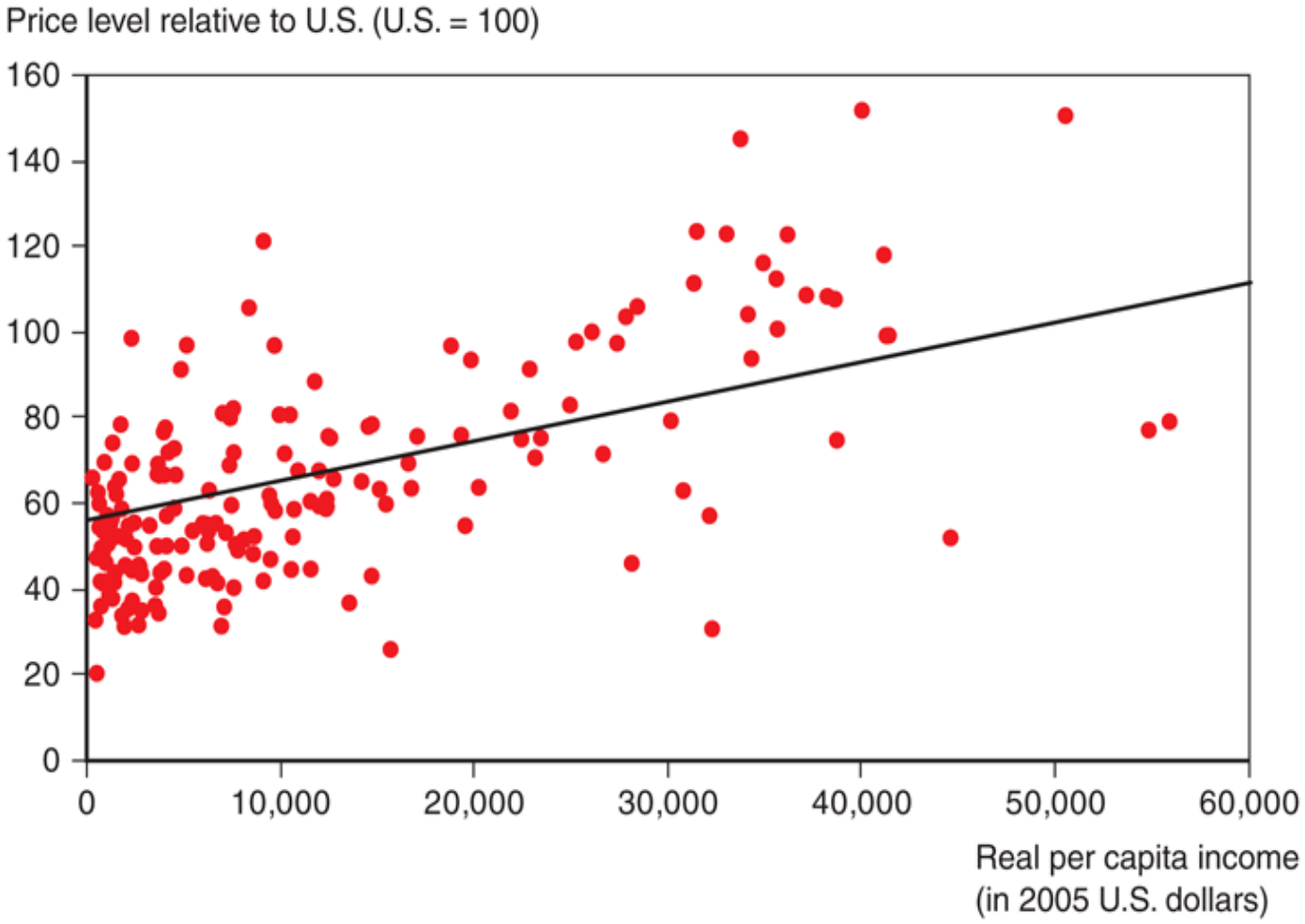
- **Imperfect competition** may result in price discrimination: "pricing to market."
  - A firm sells the same product for different prices in different markets to maximize profits, based on expectations about what consumers are willing to pay.
- **Differences in the measure of average prices for goods and services**
  - Countries differ in how their representative baskets of goods and services look like.
  - Because measures of groups of goods and services are different, the measure of their average prices need not be the same.

Why Price Levels Are Lower in Poorer Countries?

- Price levels in poorer countries are systematically lower than in richer countries, see Fig. 16-3
  - The main reason are price differences in non-tradable goods among countries
  - Prices of tradable goods do not differ so much among countries
- 2 theories are able to explain this stylized fact:

1. Balassa-Samuelson effect
   - Rich and poor countries differ in the productivity in tradable goods while they do not differ so much in productivity in non-tradable goods.
2. Bhagwati-Kravis-Lipsey effect
   - Rich and poor countries differ in the capital-labor ratio.

Fig. 16-3: Price Levels and Real Incomes, 2010



Source: Penn World Table, version 7.1.

Each dot corresponds to one country.

It is clear from the figure that countries with higher GDP per capita have also relatively higher price levels.

Why?

Balassa-Samuelson effect, see Fig. 16-3.

- Let's assume that
  - rich countries have relatively higher productivity in tradable goods
  - productivity in non-tradable goods does not differ so much among rich and poor countries
- If the prices of tradable goods are roughly similar among countries then
  - higher productivity in the tradable sector in rich countries results in relatively higher wages in this sector
  - It consequently also leads to higher wages in the non-tradable sector. Higher wages in this sector means higher costs in the production of non-tradable goods. As a result, prices of non-tradable goods are relatively higher in the richer countries.

Bhagwati-Kravis-Lipsey effect, see Fig. 16-3.

- Poor countries have lower capital-labor ratios than rich countries.
  - Marginal product of labor in poor countries is therefore lower and wages are thus lower too.
- The production of non-tradable goods (e.g. services) is labor-intensive
- Labor in poor countries is cheaper and because it is intensively used in the production of non-tradable goods, non-tradable goods should be cheaper in poor countries.
- As a result, the price levels should be lower in poor countries.

The Real Exchange Rate

- Because of the shortcomings of PPP, economists have tried to generalize the monetary approach to PPP to make a better theory.
- The **real exchange rate** is the *rate of exchange for goods and services* across countries.

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

  - For example, it is the dollar price of a European group of goods and services relative to the dollar price of an American group of goods and services:
  - If the EU basket costs €100, the U.S. basket costs $120, and the nominal exchange rate is $1.20 per euro, then the real exchange rate is 1 U.S. basket per 1 EU basket.

Real Appreciation and Depreciation

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

- A real depreciation (a rise in $q_{US/EU}$) means a fall in a dollar's purchasing power of EU products relative to a dollar's purchasing power of U.S. products.
  - This implies that U.S. goods become less expensive and less valuable relative to EU goods.
- A real appreciation (a fall in $q_{US/EU}$) means a rise in a dollar's purchasing power of EU products relative to a dollar's purchasing power of U.S. products.
  - This implies that U.S. goods become more expensive and more valuable relative to EU goods.

The Real Exchange Rate Approach to Exchange Rates

- According to PPP, exchange rates are determined by relative average prices:

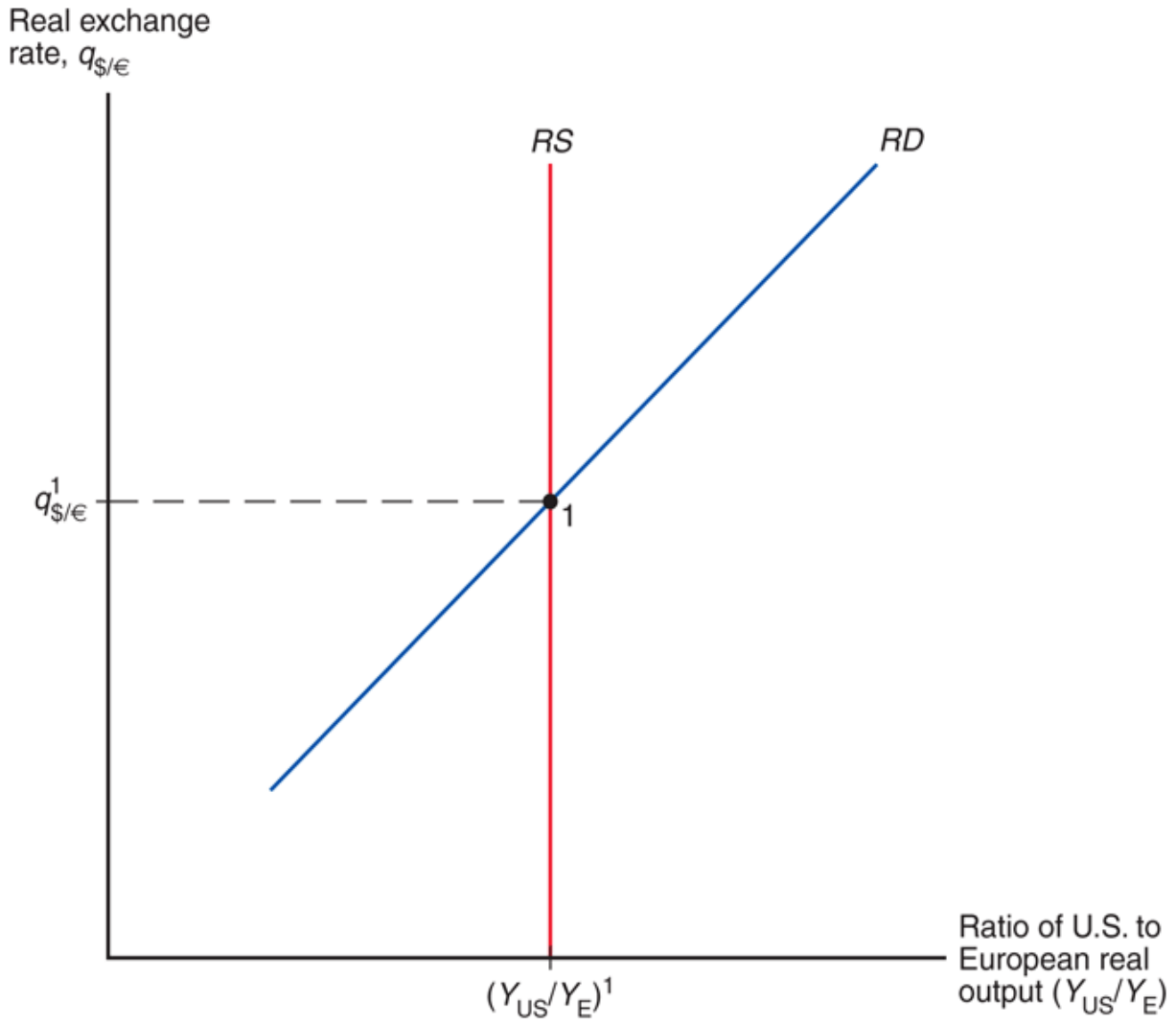
$$E_{\$/€} = P_{US}/P_{EU}$$

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

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

- What influences the real exchange rate?
  - A **change in relative demand** of U.S. products
  - A **change in relative supply** of U.S. products

Fig. 16-4: Determination of the Long-Run Real Exchange Rate



Relative supply is vertical, i.e. it does not depend on the real exchange rate, as the product in the long-run is determined by factor supplies and productivity.

Relative demand is upward sloping. A rise in the real exchange rate (depreciation) makes the U.S. export cheaper and the demand for U.S. products thus rises.

The Real Exchange Rate Approach to Exchange Rates

- An **increase in relative demand** for U.S. products increases the price of U.S. goods relative to the price of foreign goods.
  - A real appreciation of dollar: P_{US} rises relative to $E_{\$/€}$ x P_{EU}.
  - The real appreciation of dollar makes U.S. exports more expensive and imports into the U.S. less expensive.
- An **increase in relative supply** of U.S. products decreases the price of U.S. goods relative to the price of foreign goods.
  - A real depreciation of dollar: P_{US} falls relative to $E_{\$/€}$ x P_{EU}.
  - The real depreciation of dollar makes U.S. exports less expensive and imports into the U.S. more expensive.

The Real Exchange Rate Approach to Exchange Rates

- In this general model, both monetary and real factors influence nominal exchange rates:

1a. Increases in *monetary levels* lead to temporary inflation, real exchange rate does not change and nominal exchange rate depreciates according to the relative PPP.

1b. Increases in *monetary growth rates* lead to persistent inflation, real exchange rate does not change and nominal exchange rate depreciates according to the relative PPP.

2a. Increases in *relative demand* of domestic products lead to a real appreciation. As the price levels do not change (no changes on money markets), it leads to nominal appreciation.

2b. Increases in *relative supply* of domestic products lead to a real depreciation, the impact on nominal exchange rate is not clear. **Why?**

The Real Exchange Rate Approach to Exchange Rates

- An increase in the relative supply of domestic products leads to

1. depreciation of the real exchange rate
2. increase of domestic output

- An increase in domestic output rises the transaction demand for real money balances in domestic economy:

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

  - Thus the level of average domestic prices is predicted to decrease relative to the level of average foreign prices.
  - The effect on the nominal exchange rate is ambiguous:

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

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

Table 16-1: 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

The Real Exchange Rate Approach to Exchange Rates

- When economic changes are influenced only by monetary factors, and when the assumptions of PPP hold, nominal exchange rates are determined by PPP.
  - The real exchange rate does not change.
- When economic changes are caused by factors that affect real output, exchange rates are not determined by PPP only, but are also influenced by the real exchange rate.
  - An increase in *relative demand* for domestic products leads to real as well as nominal appreciation.
  - An increase in *relative supply* of domestic products leads to real depreciation, the impact on nominal exchange rate is ambiguous.

Interest Rate Differences

- Derivation of a general equation for differences in nominal interest rates across countries:

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

  - Definition of real exchange rate expressed in growth rates

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

  - Interest parity

$$R_{\$} - R_{€} = (q^e_{US/EU} - q_{US/EU})/q_{US/EU} + (\pi^e_{US} - \pi^e_{EU}) \qquad (16\text{-}9)$$

  - Combination of previous two equations

- The difference in nominal interest rates is equal to
  - the expected rate of dollar depreciation plus
  - the difference in expected inflation rates between economies.

Real Interest Rates

- Real interest rates are inflation-adjusted interest rates:

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

where π^e represents the expected inflation rate and R represents a measure of nominal interest rates.

- Real interest rates are measured in terms of real output.
- What are the predicted differences in real interest rates across countries?

Real Interest Parity

- Derivation of real interest parity condition:

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

  - definition of real interest rates

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

  - equation (16-9), see 2 slides back

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

  - previous two equations combined

- The last equation is called **real interest parity**.
  - differences in real interest rates are equal to the expected change of the real exchange rate.

Summary

1. The law of one price 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.
2. Purchasing power parity applies the law of one price for all goods and services among all countries.
   - Absolute PPP says that currencies of two countries have the same purchasing power.
   - Relative PPP says that changes in the nominal exchange rate between two countries equals the difference in the inflation rates between the two countries.

Summary

3. Empirical support for PPP is weak.
   - Trade barriers, nontradable products, imperfect competition and differences in price measures may cause the empirical shortcomings of PPP.
4. The monetary approach to exchange rates uses PPP and the supply and demand of real monetary assets.
5. The Fisher effect shows that differences in nominal interest rates are equal to differences in inflation rates.

Summary

6. The real exchange rate approach to exchange rates generalizes the monetary approach.
   - It defines the real exchange rate as the value/price/cost of domestic products relative to foreign products.
   - It predicts that changes in relative demand and relative supply of products influence real and nominal exchange rates.
   - Interest rate differences are equal to the expected percentage change of real exchange rate plus the difference of inflation rates between the domestic and foreign economies.
7. Real interest rate is inflation-adjusted interest rate.
8. Real interest parity shows that differences in real interest rates between countries equal to the expected percentage change of real exchange rate.