Lecture 4: **Intermediate macroeconomics, spring 2016**

Lars Calmfors

Literature: ***Krugman–Obstfeld–Melitz, chapters 14 and 15, Mankiw, chapter 4.***

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What have we done so far? Where are we going?

- **Lecture 1: National income, saving and investment in closed and small open economies**
- **Lecture 2: Economic growth**
- **Lecture 3: The labour market**
- **Lectures 4-7: Analytical framework for the analysis of macroeconomic policy in a small open economy**
- **Lectures 8-10: In-depth analysis of specific topics**

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Where are we going?

Short-run macroeconomic equilibrium under floating and fixed exchange rates

Monetary union and the euro

- **Lecture 4:**
  - **Exchange rates and interest rates (Krugman-Obstfeld-Melitz ch. 14)**
  - **The role of money (Mankiw chapter 4, Krugman-Obstfeld-Melitz chapter 15)**
- **Lecture 5:**
  - **Price levels and the exchange rate in the long run (Krugman-Obstfeld-Melitz chapter 16)**
  - **Output and the exchange rate in the short run (Krugman-Obstfeld-Melitz chapter 17)**
- **Lecture 6:**
  - **Stabilisation policy under a flexible exchange rate (Krugman-Obstfeld-Melitz chapter 17)**
  - **Fixed exchange rates (Krugman-Obstfeld-Melitz chapter 18)**
- **Lecture 7:**
  - **Optimal currency areas and EMU (Krugman-Obstfeld-Melitz chapter 21, EEAG chapters 1 and 3.**

Topics for today

- **Exchange rate determination**
- **Non-covered and covered interest rate parity**
- **Money supply**
- **Money demand**
- **Equilibrium interest rates**
- **Determination of the long-run price level**
- **Neutrality of money**
- **The exchange rate under inflation targeting**

The definition of exchange rates in Krugman-Obstfeld-Melitz

Real exchange rate: the relative price between goods in different countries

Nominal exchange rate: the relative price between different currencies

Two ways of expressing the nominal exchange rate

- **Direct (American) terms – units of domestic currency per unit of foreign currency: SEK/$; SEK/€**
- **Indirect (European) terms – units of foreign currency per unit of domestic currency: $/SEK; €/SEK**

Krugman-Obstfeld-Melitz use the number of units of domestic currency per unit of foreign currency (SEK/$). Mankiw does the reverse.

With the Krugman-Obstfeld-Melitz definition

***E*↑**	**SEK/$↑**	**Depreciation (devaluation) of the krona**
***E*↓**	**SEK/$↓**	**Appreciation (revaluation) of the krona**

- **The terms depreciation and appreciation are used for exchange rate changes in a floating exchange rate system.**
- **The terms devaluation and revaluation are used for exchange rate changes in a fixed-exchange rate system (parity changes)**

Krugman-Obstfeld-Melitz definition of the real exchange rate for the Swedish krona (Sweden)

$P_{US}E/P_{SW}$

P_{US} **= US product price in $**

E **= nominal exchange rate (SEK/$)**

P_{SW} **= Swedish product price in SEK**

Mankiw has the reverse definition:

$P_{SW}E'/P_{US}$

E' **= $/SEK**

With the Krugman-Obstfeld-Melitz definition

$P_{US}E/P_{SW}\uparrow$

Real depreciation (Swedish goods become relatively cheaper)

A real depreciation occurs if $E\uparrow$**,** $P_{US}\uparrow$ **or** $P_{SW}\downarrow$

$P_{US}E/P_{SW}\downarrow$

Real appreciation (Swedish goods become relatively more expensive)

A real appreciation occurs if $E\downarrow$**,** $P_{US}\downarrow$ **or** $P_{SW}\uparrow$

The real exchange rate cont.

- **At a given relative price in national currencies, a change in the nominal exchange rate implies a change in the real exchange rate.**
- **Since prices are sticky, the relative price in national currencies is given in the short run.**
- **The nominal exchange rate is thus the most important determinant of real exchange rate changes in the short run.**
- **The real exchange rate is usually defined in terms of consumer prices while Krugman-Obstfeld-Melitz uses producer prices.**

Agents in the foreign currency market

- **Commercial banks (interbank trading)**
- **Corporations (multinationals)**
- **Non-bank financial institutions (pension funds, hedge funds etc.)**
- **Central banks**

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Arbitrage

All cross exchange rates must be consistent with each other

- **Spot exchange rates**
- **Forward exchange rates**

- **Forward contract – a contract to buy or sell currency at a given price at a given future point of time**
- **Futures contract – a contract to buy or sell currency at a given price at a given future point of time that can be traded in the market**
- **Option – the right to buy or sell currency at a certain price at a certain future point of time**
- **Swap – a combination of a spot and a forward transaction in the currency market**

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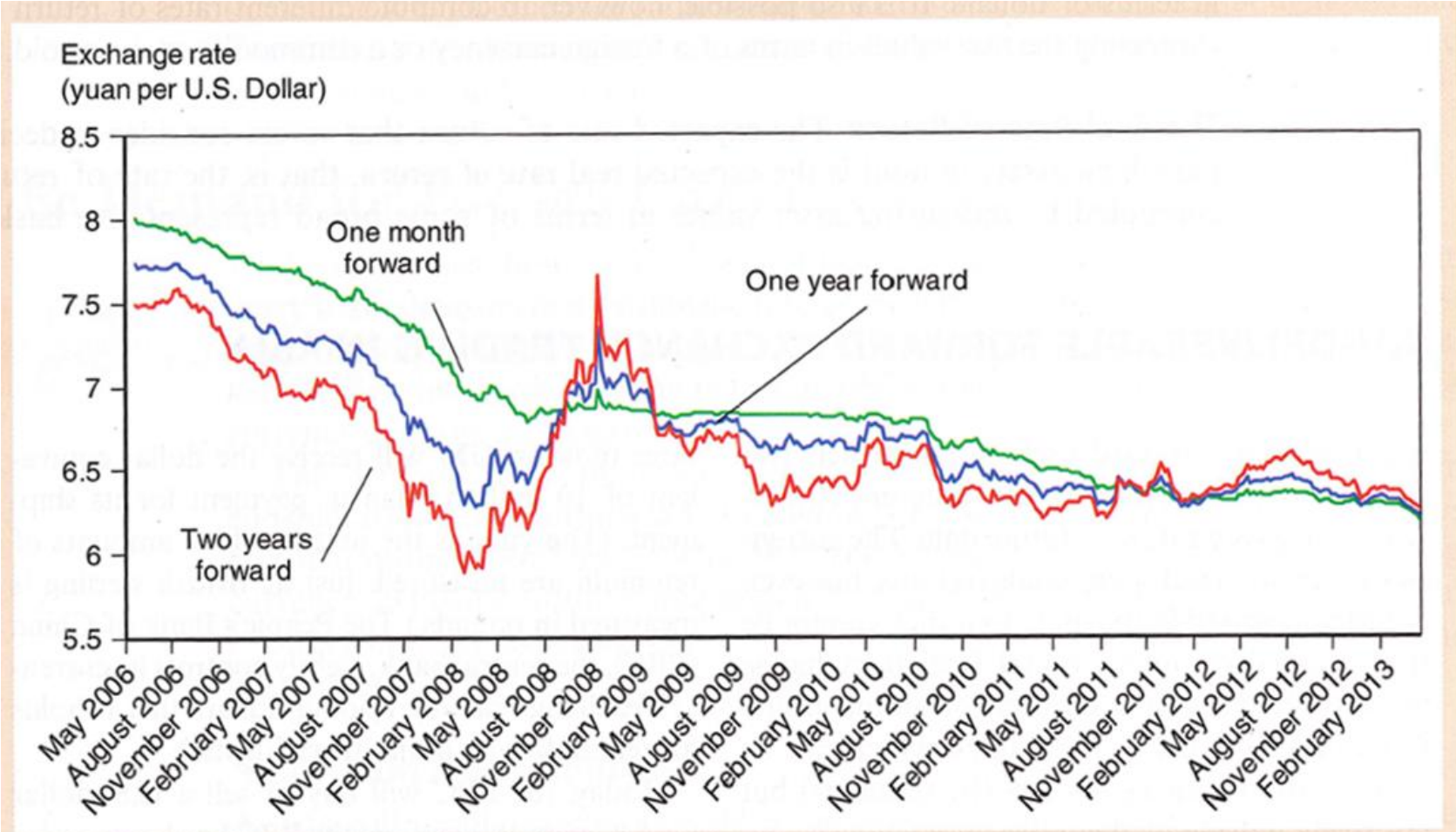

Nondeliverable Forward Exchange Rates, China Yuan per Dollar

Source: *Datastream*.

Demand for currencies

- **Investors care about the real return (nominal return less inflation)**
- **When investors compare investments in different currencies, only differences in nominal returns matter for an investor from a particular country**

Relevant factors

1. **Nominal return**
2. **Risk**
3. **Liquidity**

- **For most OECD countries risk and liquidity is more or less the same, so it is mainly differences in expected returns that matter.**
- **But in some situations, for example during the euro crisis, default risk may matter**
  - **banks**
  - **treasury bills**

Equilibrium in the foreign currency market

Think in terms of an American investor, who compares returns in dollars

US interest rate: $R_{\$}$

Eurozone interest rate: $R_{€}$

Expected exchange rate gain from a euro investment:

$(E^{e}_{\$/€} - E_{\$/€})/E_{\$/€}$

Expected return of a euro investment: $R_{€} + (E^{e}_{\$/€} - E_{\$/€})/E_{\$/€}$

Difference in returns: $R_{\$} - R_{€} - (E^{e}_{\$/€} - E_{\$/€})/E_{\$/€}$

Interest rate parity

$$R_{\$} = R_{€} + (E^{e}_{\$/€} - E_{\$/€})/E_{\$/€}$$

A higher interest rate in the US than in the euro area must be matched by an expected exchange rate gain on a euro investment

$$R_{\$} - R_{€} > 0 \Leftrightarrow (E^{e}_{\$/€} - E_{\$/€})/E_{\$/€} > 0.$$

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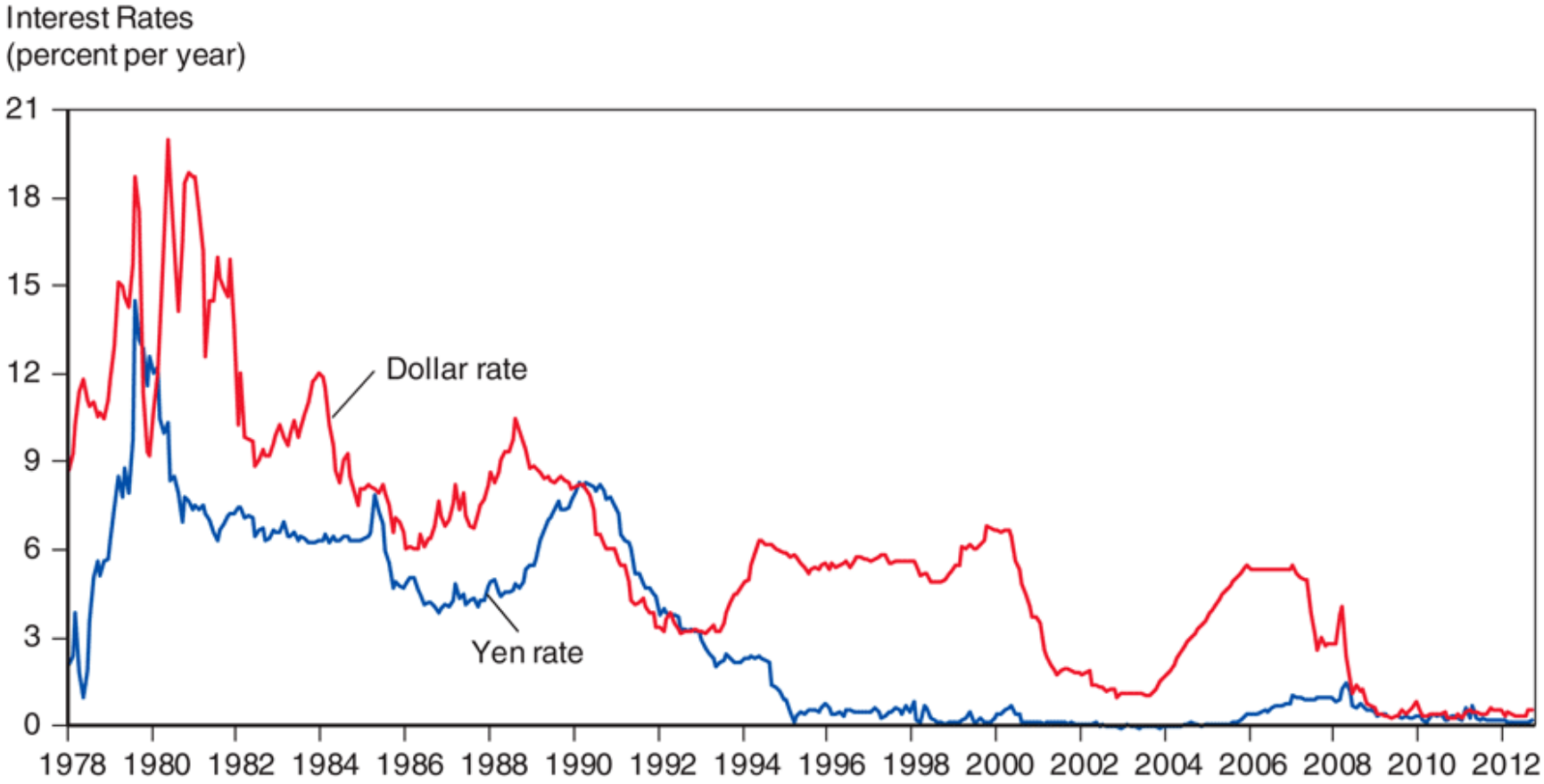
Fig. 14-2: Interest Rates on Dollar and Yen Deposits, 1978–2011



Source: *Datastream*. Three-month interest rates are shown.

Fig. 14-3: The Relation Between the Current Dollar/Euro Exchange Rate and the Expected Dollar Return on Euro Deposits

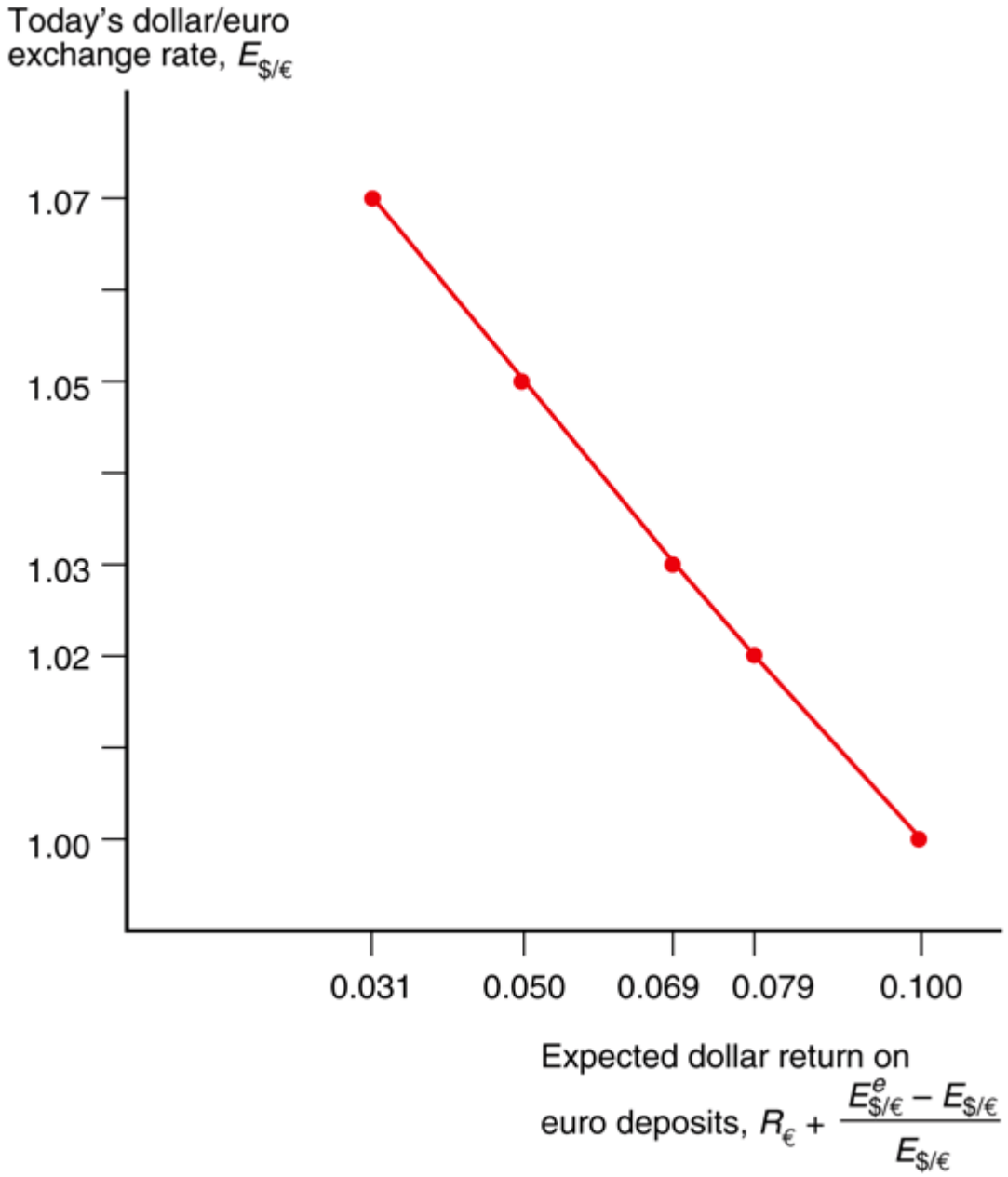


Fig. 14-4: Determination of the Equilibrium Dollar/Euro Exchange Rate

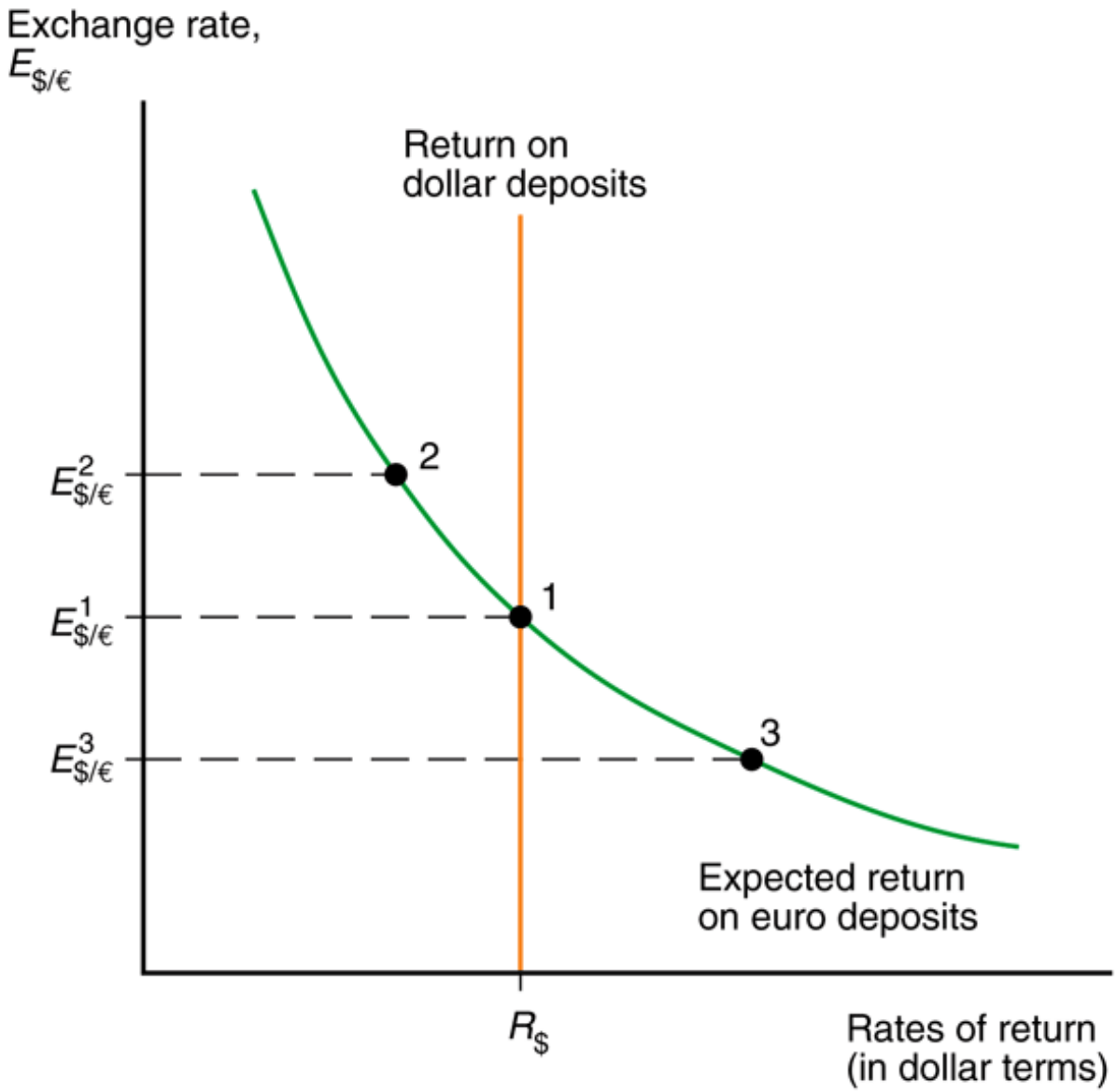


Fig. 14-5: Effect of a Rise in the Dollar Interest Rate

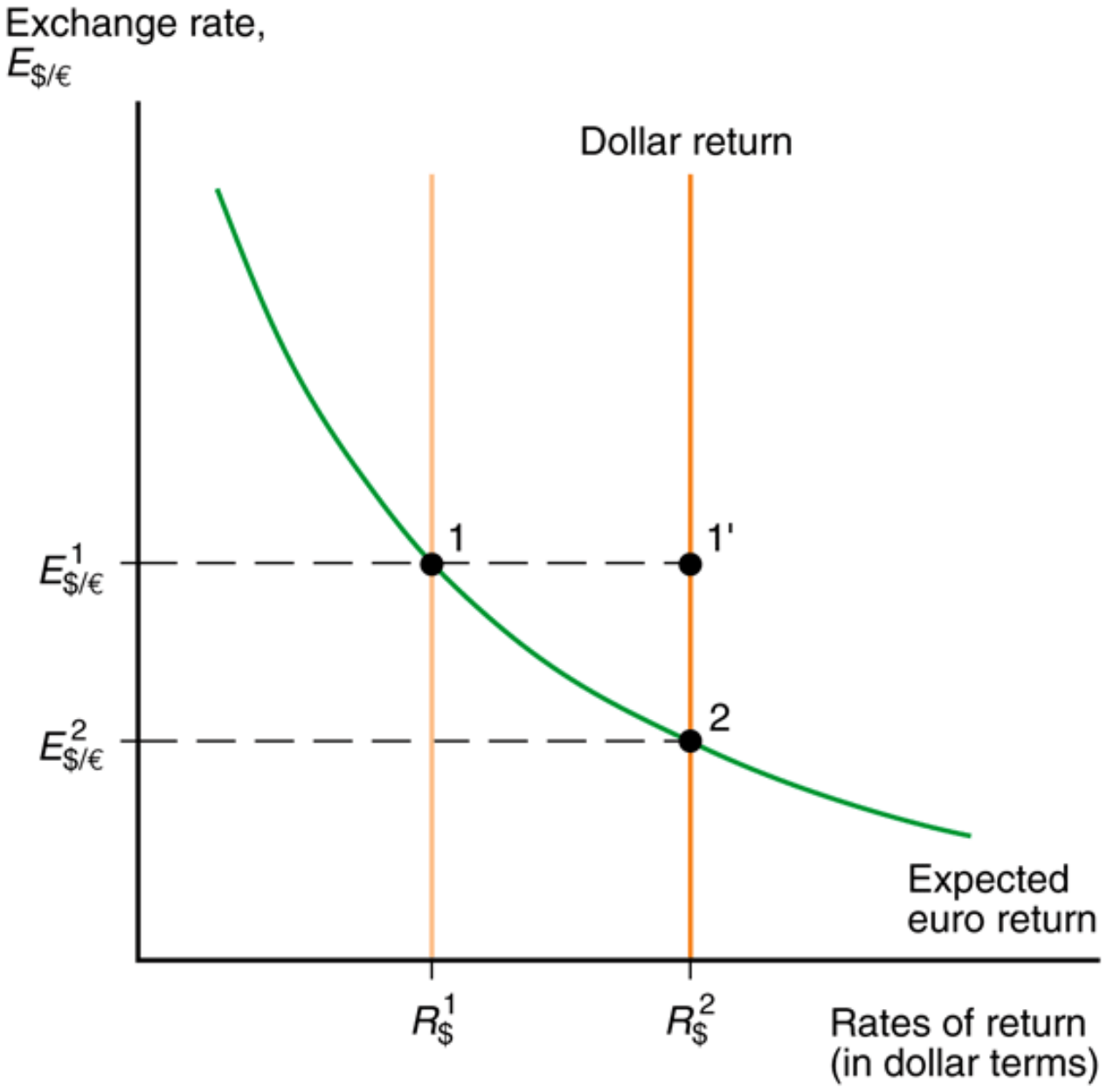
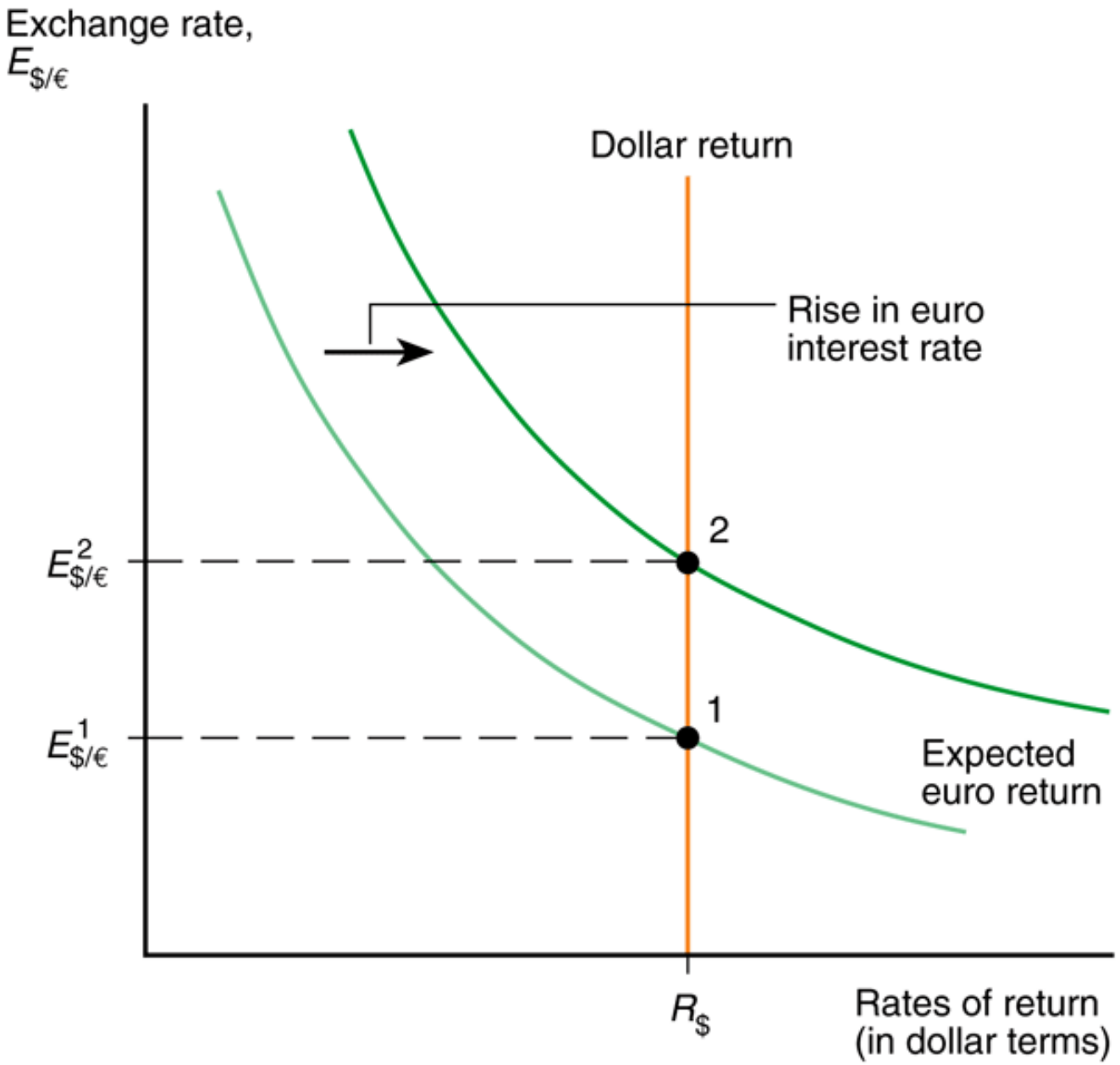


Fig. 14-6: Effect of a Rise in the Euro Interest Rate



- **Figure 14-6 can also be used to illustrate an expected depreciation of the dollar (= appreciation of the euro)**
  $R_{\$} = R_{€} + (E^e - E)/E$
- **Assume that** $R_{\$} = R_{€}$
- **Then** $E^e = E$
- $E^e \uparrow \Rightarrow E \uparrow$ **– equal changes**
- **An *expected* ten per cent depreciation leads to an *actual* ten per cent depreciation**

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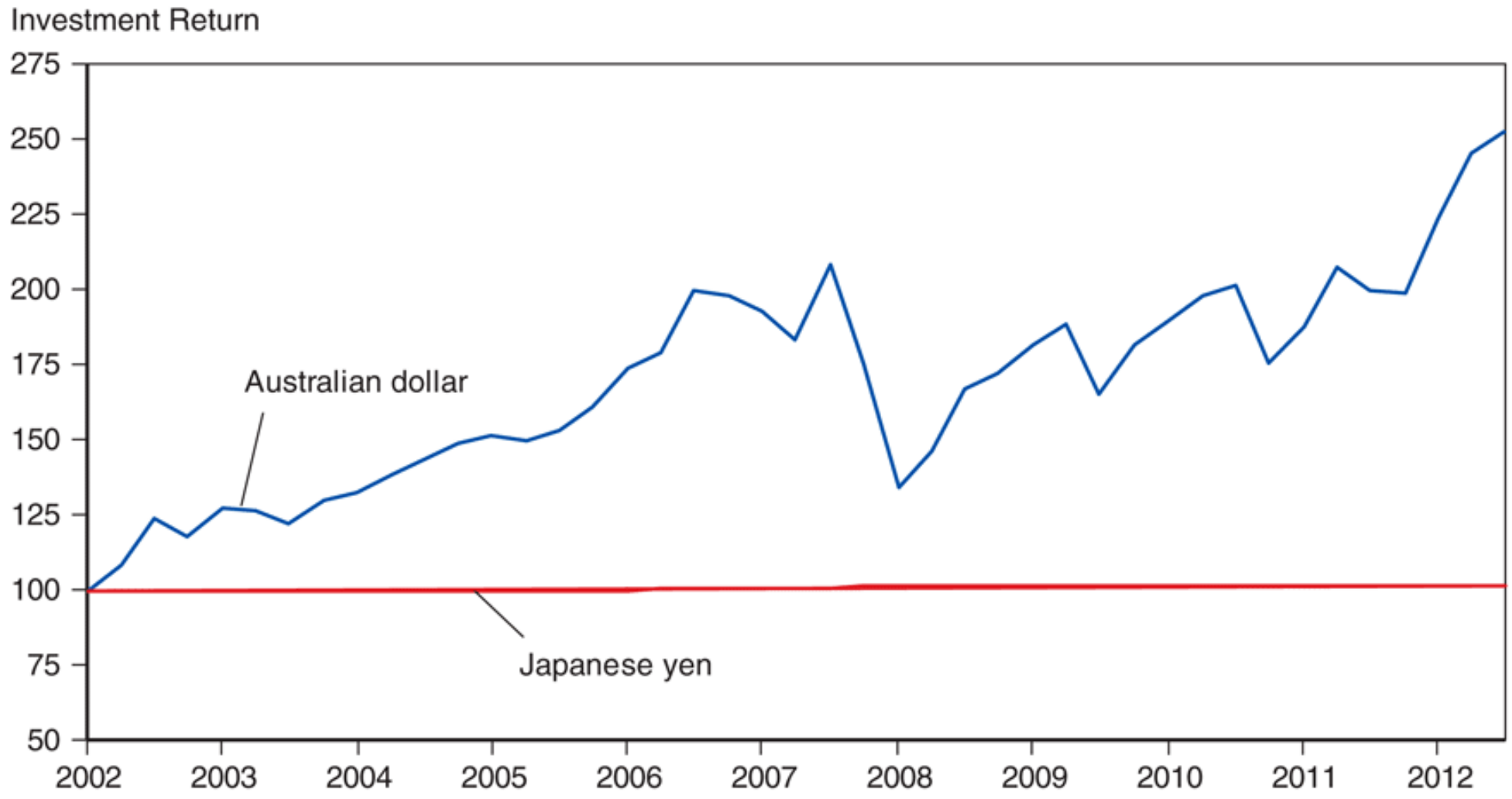
Carry trade

- **Borrow low-interest currency: funding currency (Japanese yen)**
- **Buy high-interest currency: investment currency (Australian dollar)**
- **Profitable over long periods**
  - **gradual appreciation of investment currency**
  - **sudden crash (depreciation) of investment currency**

Fig. 14-7: Cumulative Total Investment Return in Australian Dollar Compared to Japanese Yen, 2002-2012



Source: Exchange rates and three-month treasury yields from Global Financial Data.

Possible explanation of carry trade

- **90 per cent probability of 1 per cent annual appreciation of Australian dollar**
- **10 per cent probability of 40 per cent annual depreciation**

Expected appreciation: $0.9 \times 1 - 0.1 \times 40 = -3.1$ per cent

Probability that a crash does not occur in year 1: 0.9

Probability that a crash does not occur in years 1–2: 0.9^2

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Probability that a crash does not occur in years 1–5: 0.9^5

Probability that a crash does not occur in years 1–6: 0.9^6

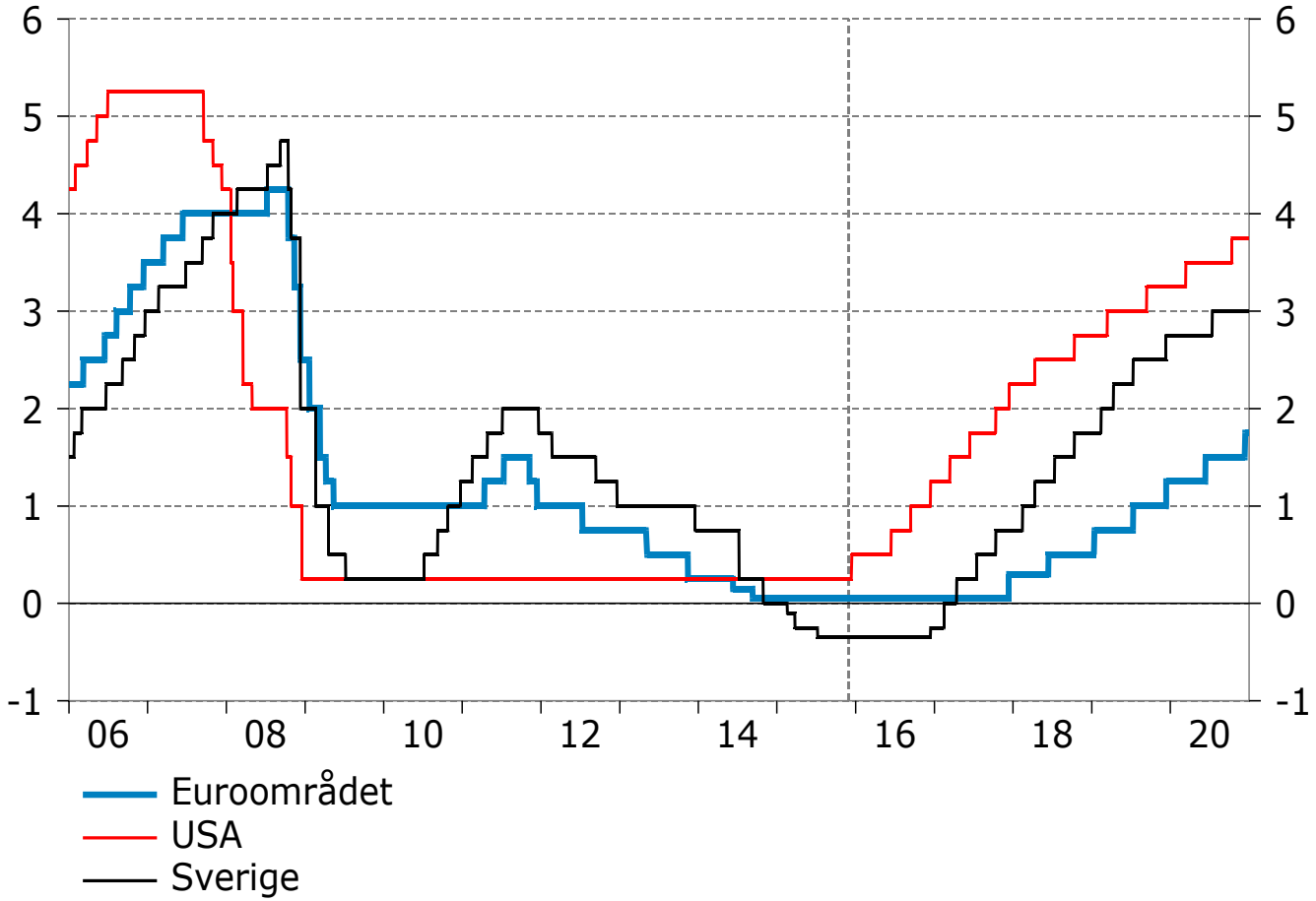
Probability that a crash occurs in years 1–6:

$1 - 0.9^6 \approx 1 - 0.53 = 0.47 < 0.5$

Complications

- **R should be interpreted as short-run interest rate, which is usually taken to be controlled by the central bank.**
- **Long-term interest rates are determined in the market and do not have a strong relationship to current short-term interest rates – they reflect future expected short-term interest rates.**
- **During the financial crisis interbank lending interest rates diverged dramatically from central bank policy rates.**

Central bank interest rates



Source: Konkunjunkturinstitutet.

The relationship between non-covered and covered interest rate parity

- **Think in terms of an American investor who considers a financial investment in the euro area with a certain maturity that will be exchanged back into dollars (either via the spot or the forward currency market)!**

Non-covered interest rate parity

$R = R^* + (E^e - E)/E$

Covered interest rate parity

$R = R^* + (F - E)/E$

F **= forward exchange rate**

$(F - E)/E$ **= forward exchange rate premium on dollar relative to euro**

Simultaneous non-covered and covered interest rate parity require that $F = E^e$**.**

$F < E^e \Rightarrow (F - E)/E < (E^e - E)/E$**. If so, the expected return from a forward transaction is lower than from a spot transaction. This reduces the demand for dollars in the forward exchange market, which causes a depreciation of the forward dollar exchange (**$F\uparrow$**).**

Money supply

- **Quantity of money = money supply**
- **The central bank controls the money supply through monetary policy**
- **open market operations: purchases and sales of mainly government bonds**

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Table 4-1: The measures of money

Symbol	Assets Included	Amount in July 2011 (billions of dollars)
C	Currency	972
*M*1	Currency plus demand deposits, traveler's checks, and other checkable deposits	2,006
*M*2	*M*1 plus retail money market mutual fund balances, saving deposits (including money market deposit accounts), and small time deposits	9,314

Source: Federal Reserve.

The role of banks for the money supply

Money Supply = Currency + Demand Deposits

$$M = C + D$$

100 - Percent-Reserve Banking

Firstbank's balance sheet

Assets	Liabilities
Reserves $1000	Deposits $1000

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Fractional-reserve banking

Reserve-deposit ratio = 20 per cent

Firstbank

Assets	Liabilities
Reserves $200	Deposits $1000
Loans $800	

Secondbank

Assets	Liabilities
Reserves $160	Deposits $800
Loans $640	

Thirdbank

Assets	Liabilities
Reserves $128	Deposits $640
Loans $512	

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Money creation

Original Deposit = 1000

Firstbank Lending = $(1 - rr) \times 1000$

Secondbank Lending = $(1 - rr)^2 \times 1000$

Thirdbank Lending = $(1 - rr)^3 \times 1000$

Total Money Supply

$[1 + (1 - rr) + (1 - rr)^2 + (1 - rr)^3 + \ldots] \times 1000 =$

$= 1/[1-(1-rr)] \times 1000 = (1/rr) \times 1000$

$rr = 0.2 \Rightarrow (1/rr) \times 1000 = (1/0.2) \times 1000 = 5000$

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A model of the money supply

B = Monetary base

C = Currency held by the public

R = Bank reserves

D = Demand deposits held by the public

$rr = R/D$ = Banks' reserve-deposit ratio

$cr = C/D$ = The public's currency-deposit rate

$$M = C+D$$

$$B = C+R$$

Divide the two equations by each other:

$$\frac{M}{B} = \frac{C+D}{C+R}$$

Divide RHS by D:

$$\frac{M}{B} = \frac{C/D+1}{C/D+R/D}$$

$$\frac{M}{B} = \frac{cr+1}{cr+rr} = m$$

$$M = m\,B$$

$$m = \frac{cr+1}{cr+rr} = \text{the money multiplier}$$

cr = 0.8 and rr = 0.1 ⇒

$$m = \frac{0.8+1}{0.8+0.1} = 2.0$$

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A model of the money supply, cont.

1. **Money supply is proportional to the monetary base**

2. **$rr \downarrow \Rightarrow m \uparrow \Rightarrow M \uparrow$, i.e. a lower reserve-deposit ratio increases the money multiplier and the money supply**

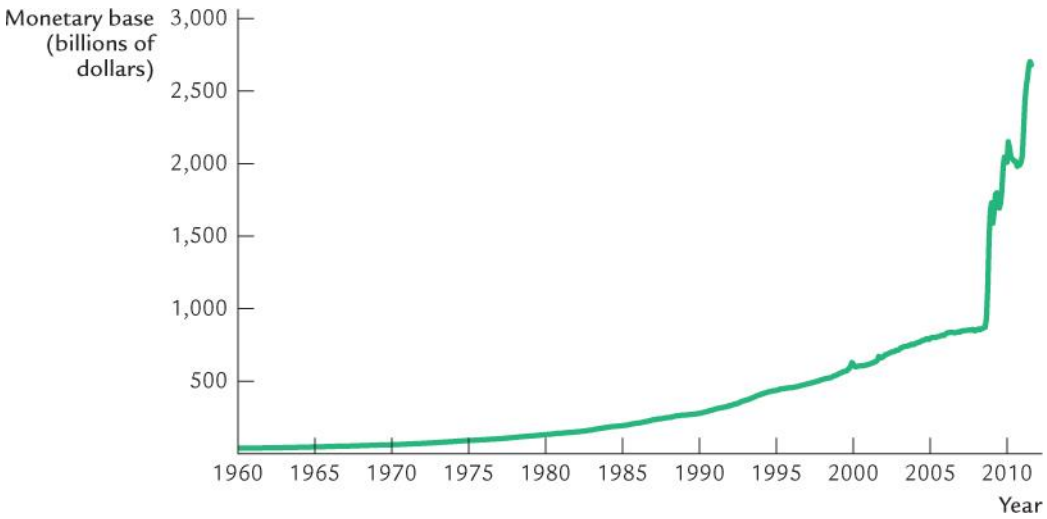
3. **$cr \downarrow \Rightarrow m \uparrow \Rightarrow M \uparrow$, i.e. a lower credit-deposit ratio increases the money multiplier and the money supply**

The central bank changes the money supply

- **Changes in the monetary base**
  - **purchases and sales of government bonds (usually repo, i.e. repurchase, transactions)**
  - **lending of reserves to banks**

- **Changes in the reserve-deposit ratio**
  - **reserve requirements**
  - **interest on reserves**

Figure 4-1: The monetary base



Determinants of money demand

1. **Expected return relative to other assets**
2. **Risk**
3. **Liquidity**

Arguments in the money demand function

1. **Interest rate (the opportunity cost of holding money)**
2. **Price level (the value of each transaction)**
3. **Real income (the number of transactions)**

$$M^d = P \cdot L(R, Y)$$

$$M^d/P = L(R, Y)$$

Real money demand

Demand for real cash balance

Equilibrium in the money market

$$M^s = M^d = P \times L(R, Y)$$

$$M^s/P = M^d/P = L(R, Y$$

Fig. 15-1: Aggregate Real Money Demand and the Interest Rate

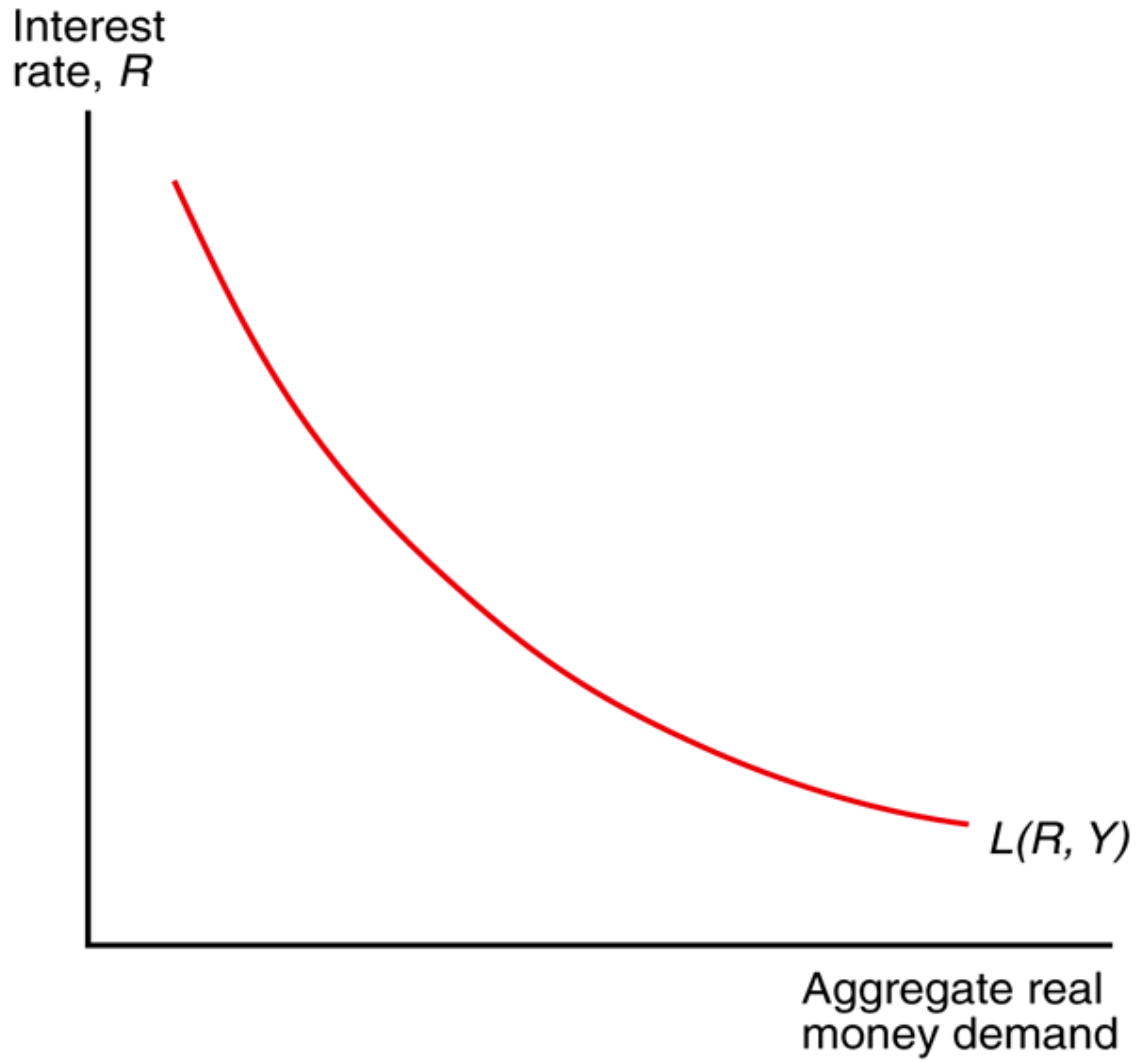


Fig. 15-2: Effect on the Aggregate Real Money Demand Schedule of a Rise in Real Income

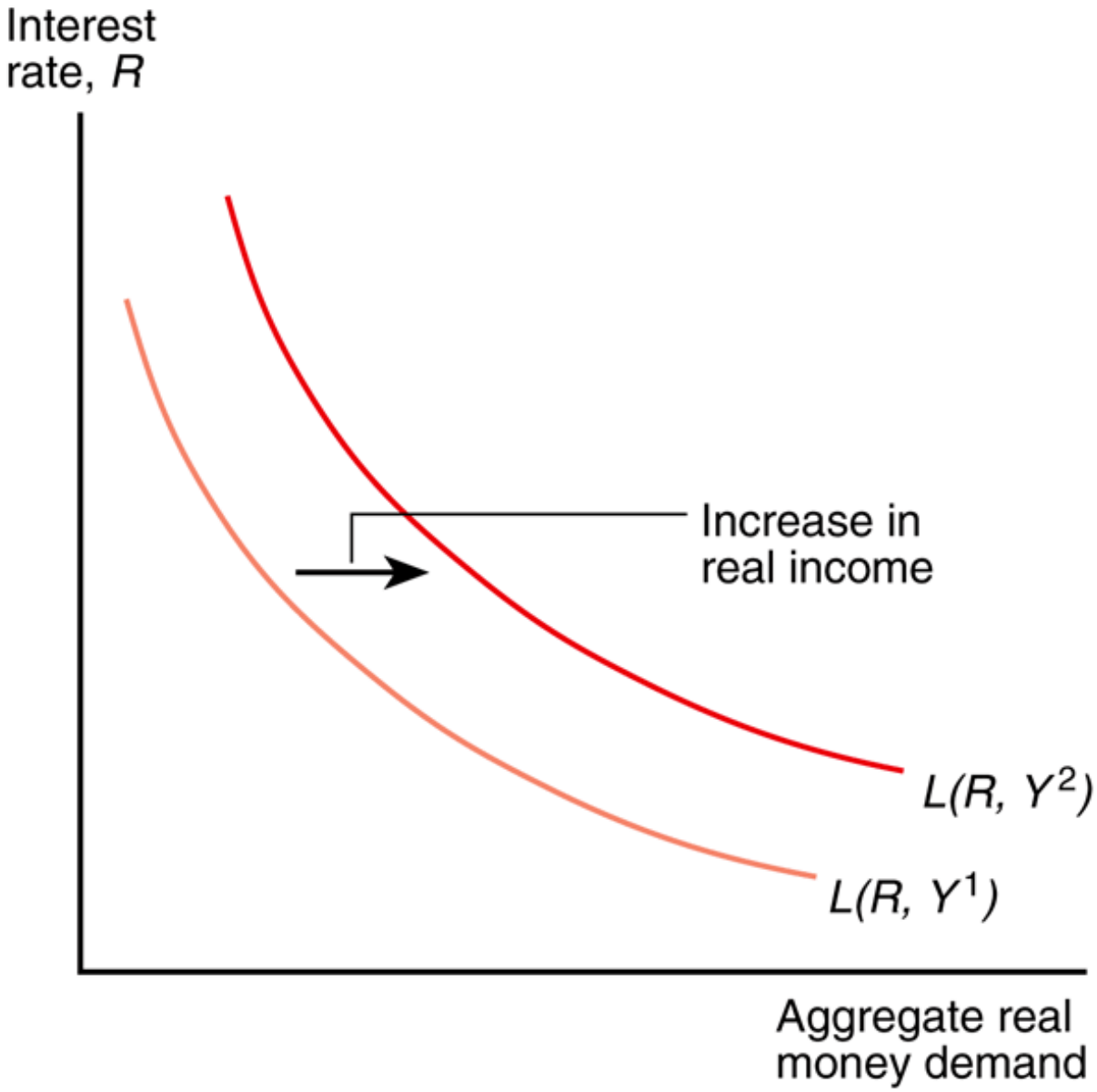


Fig. 15-3: Determination of the Equilibrium Interest Rate

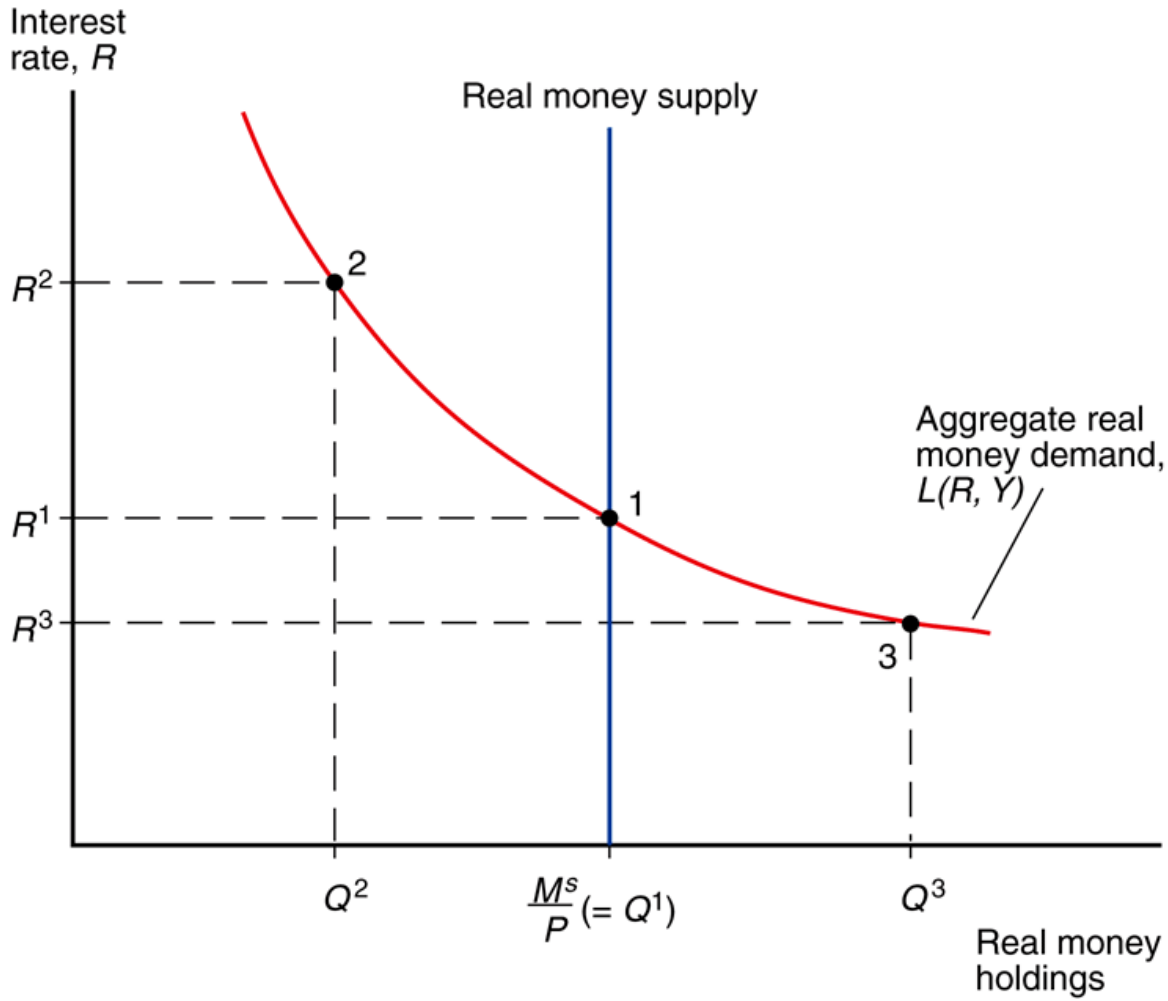


Fig. 15-4: Effect of an Increase in the Money Supply on the Interest Rate

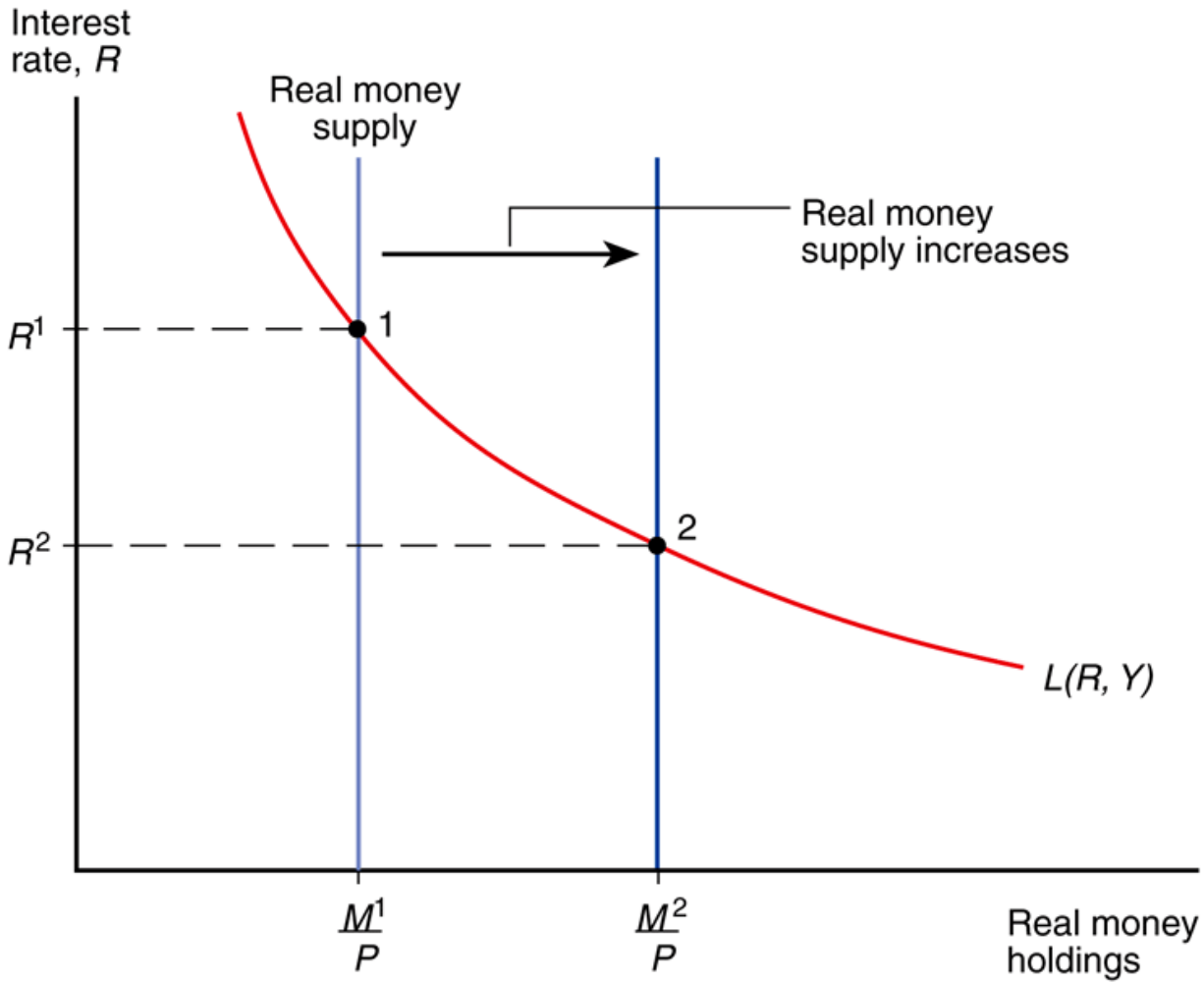


Fig. 15-5: Effect on the Interest Rate of a Rise in Real Income

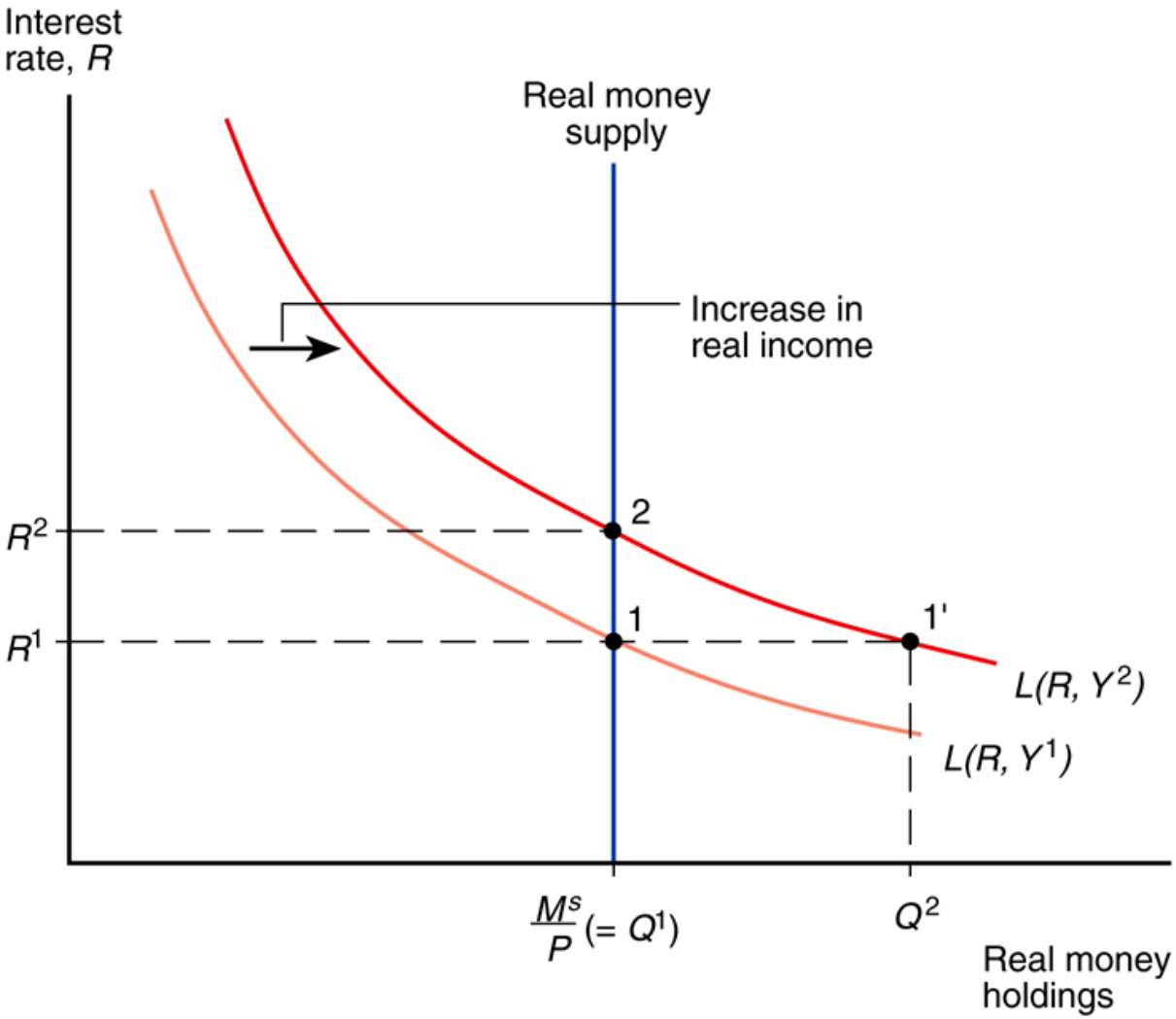


Fig. 15-6: Simultaneous Equilibrium in the U.S. Money Market and the Foreign Exchange Market

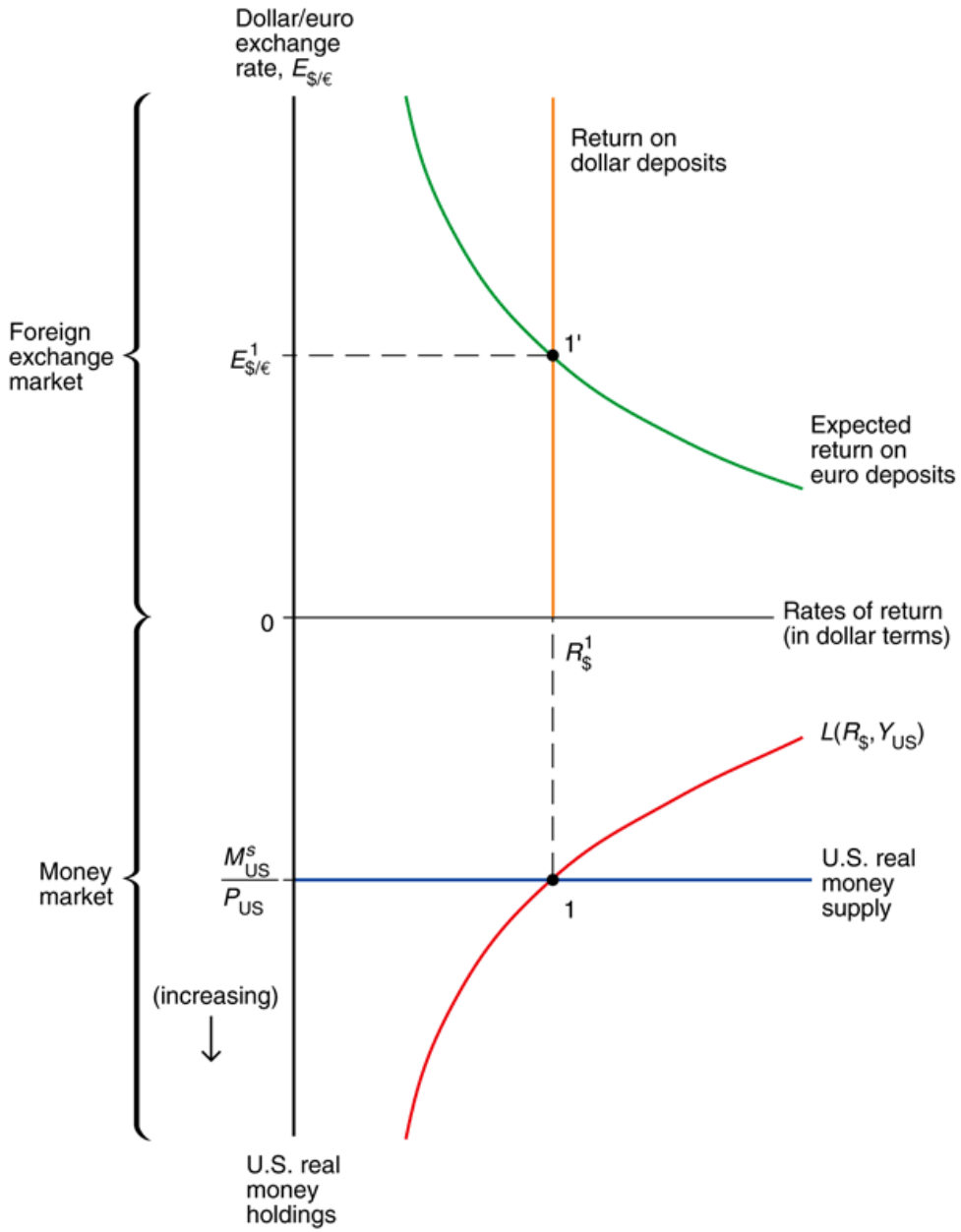


Fig. 15-7: Money Market/Exchange Rate Linkages

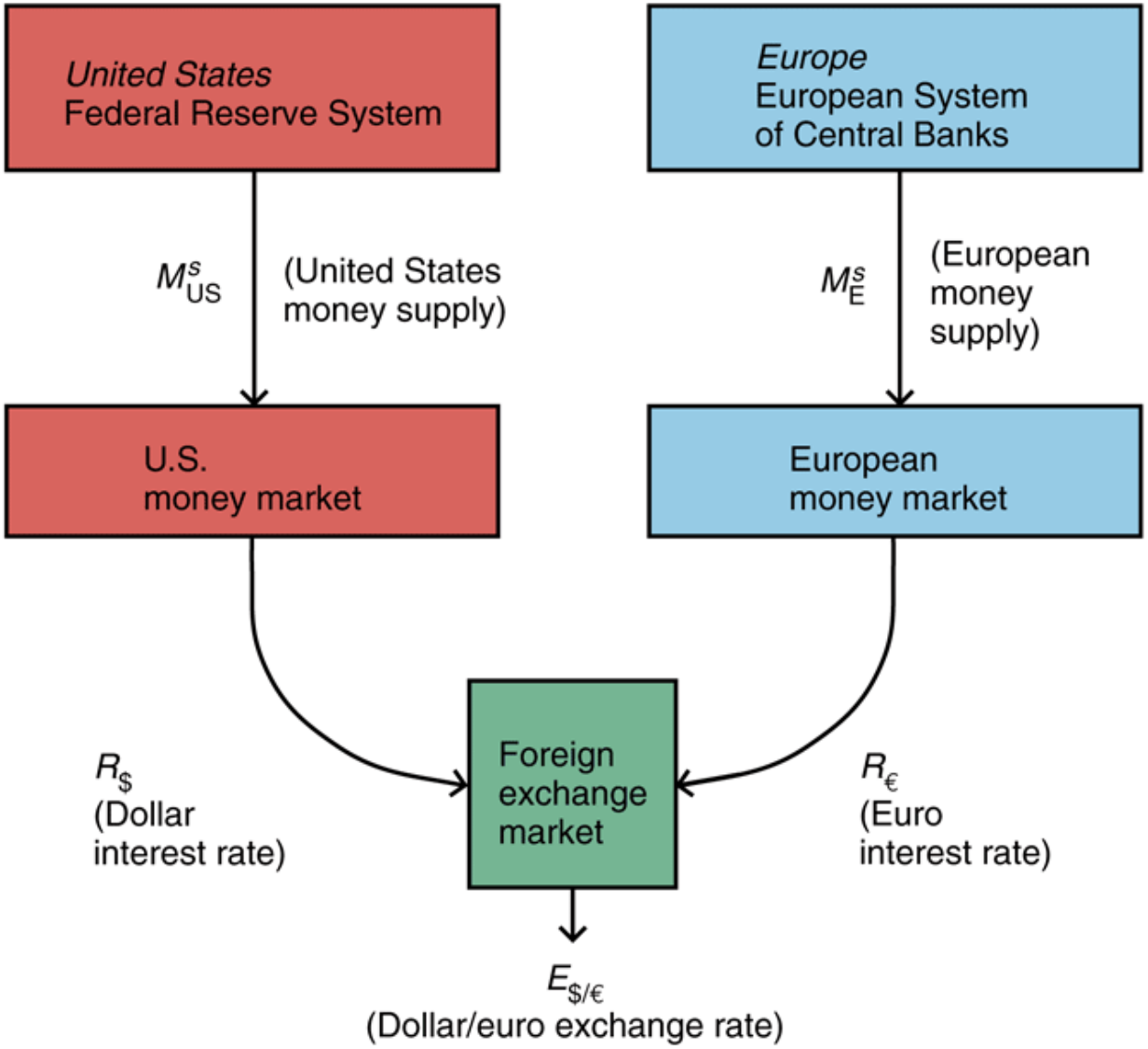


Fig. 15-8: Effect on the Dollar/Euro Exchange Rate and Dollar Interest Rate of an Increase in the U.S. Money Supply

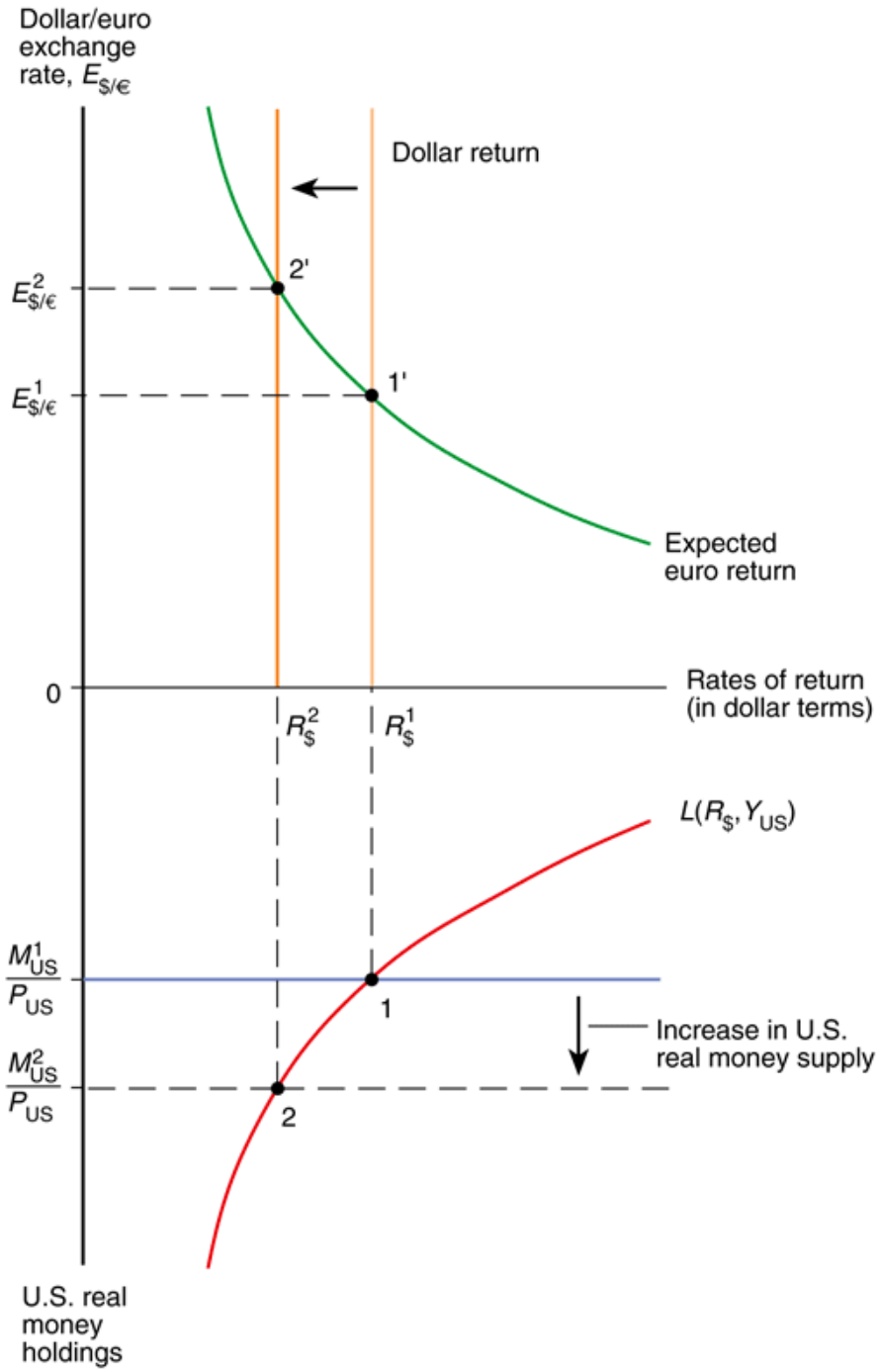
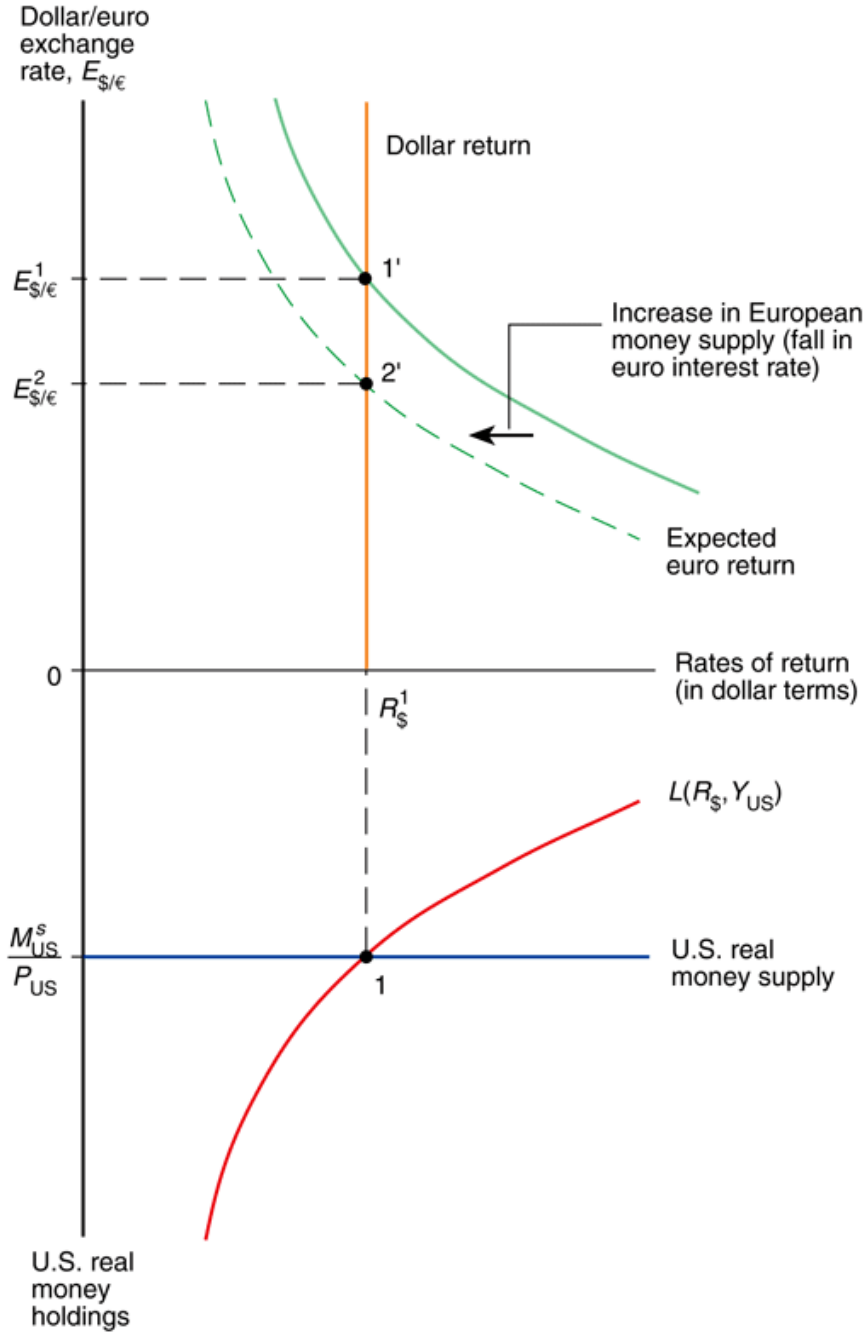


Fig. 15-9: Effect of an Increase in the European Money Supply on the Dollar/Euro Exchange Rate



Different time horizons

1. **Instantaneous effects (day, week, month)**

- **Given output**
- **Given price level**

2. **Short run (1-2 years)**

- **Flexible output**
- **Given price level**

3. **Long run (5 years or more?)**

- **Given output (equilibrium level, natural rate, potential level, full-employment level)**
- **Flexible price level**

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The determination of the long-run price level

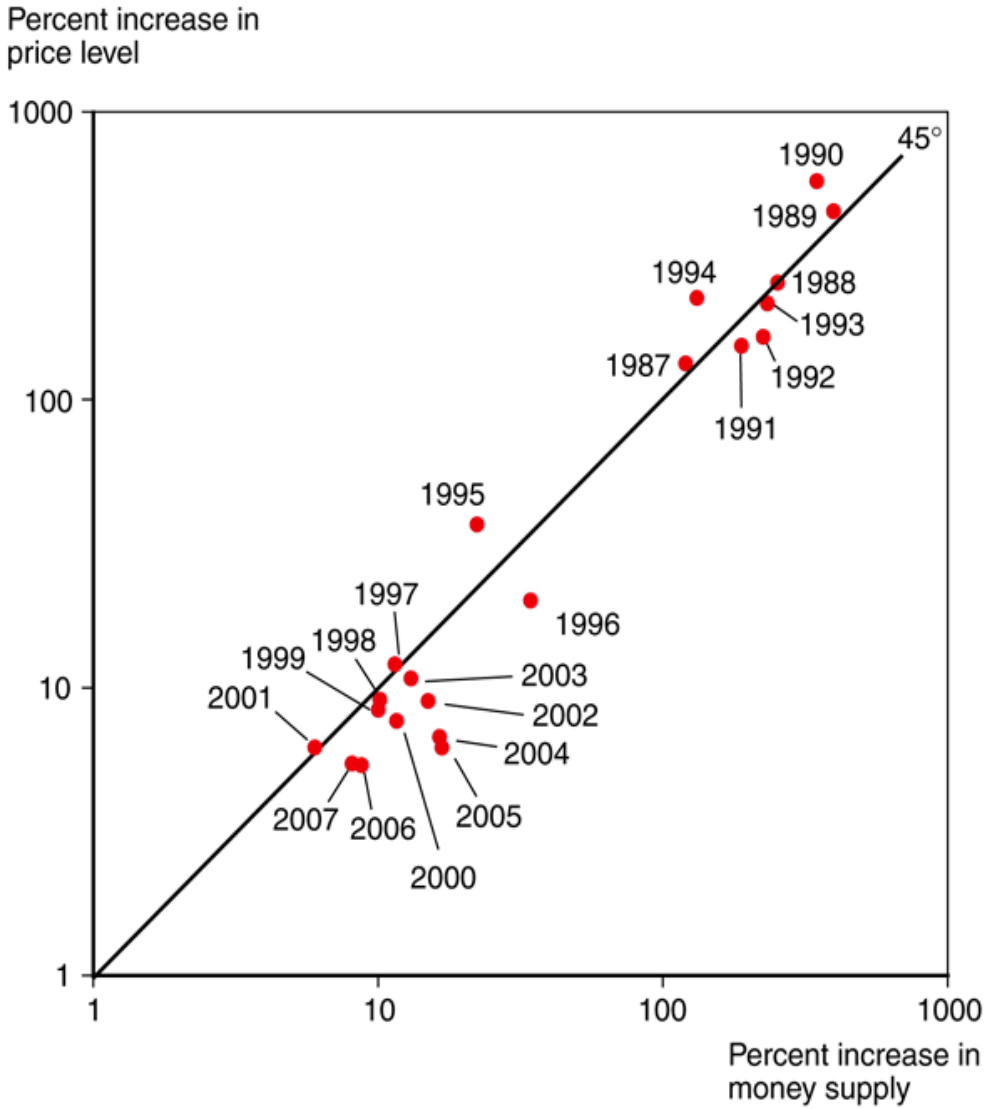
Money market equilibrium:

$M^s/P = M^d/P = L(R, Y)$

$P = M^s/ L(R, Y)$

- **In the long run R and Y are at their equilibrium levels**
- **Long-run neutrality of money**
- **The price level is proportional to the money supply in the long run (the price level is doubled if the money supply is doubled etc.)**

Fig. 15-10: Average Money Growth and Inflation in Western Hemisphere Developing Countries, by Year, 1987–2007



Source: IMF, World Economic Outlook, various issues. Regional aggregates are weighted by shares of dollar GDP in total regional dollar GDP.

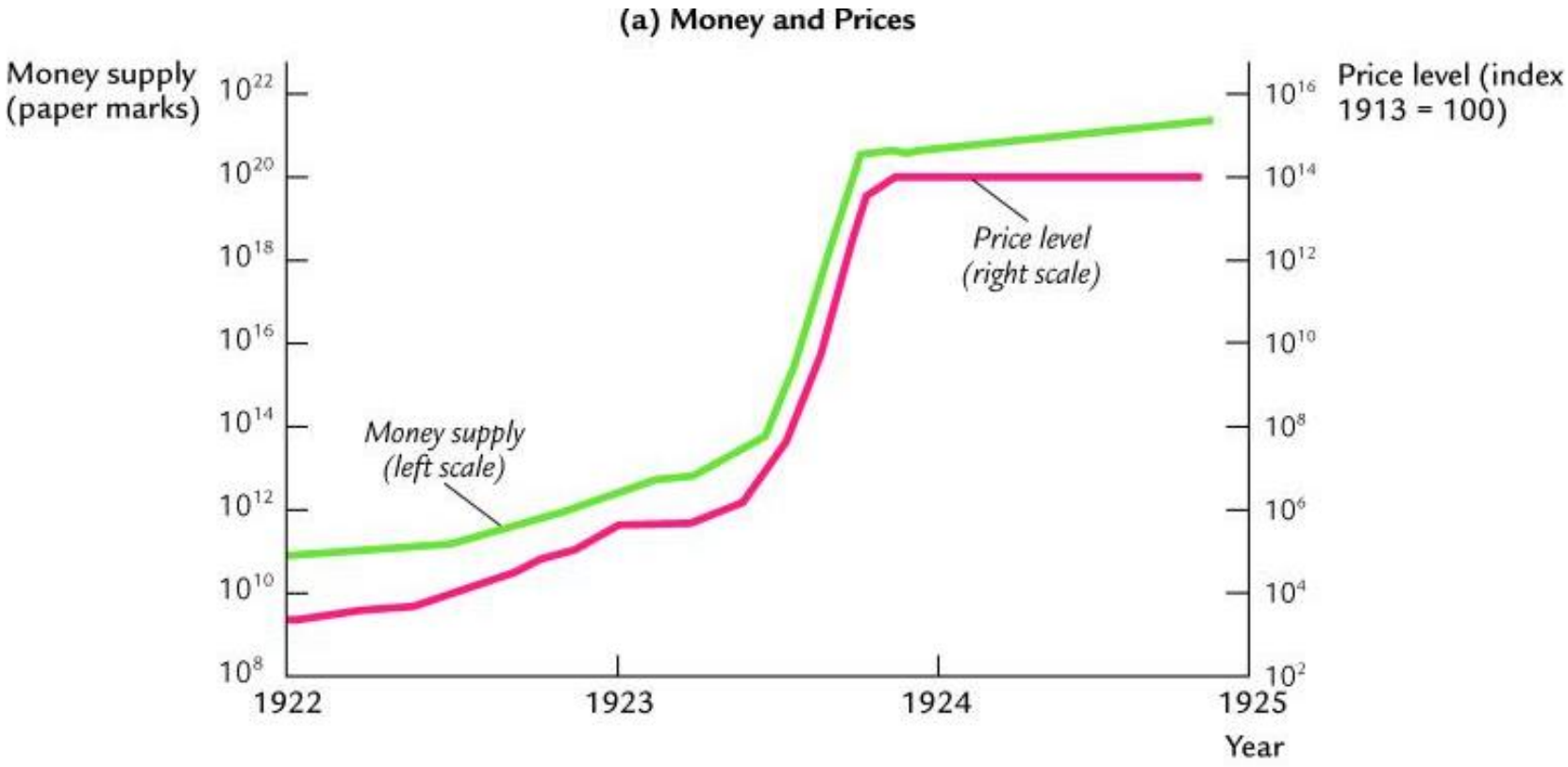
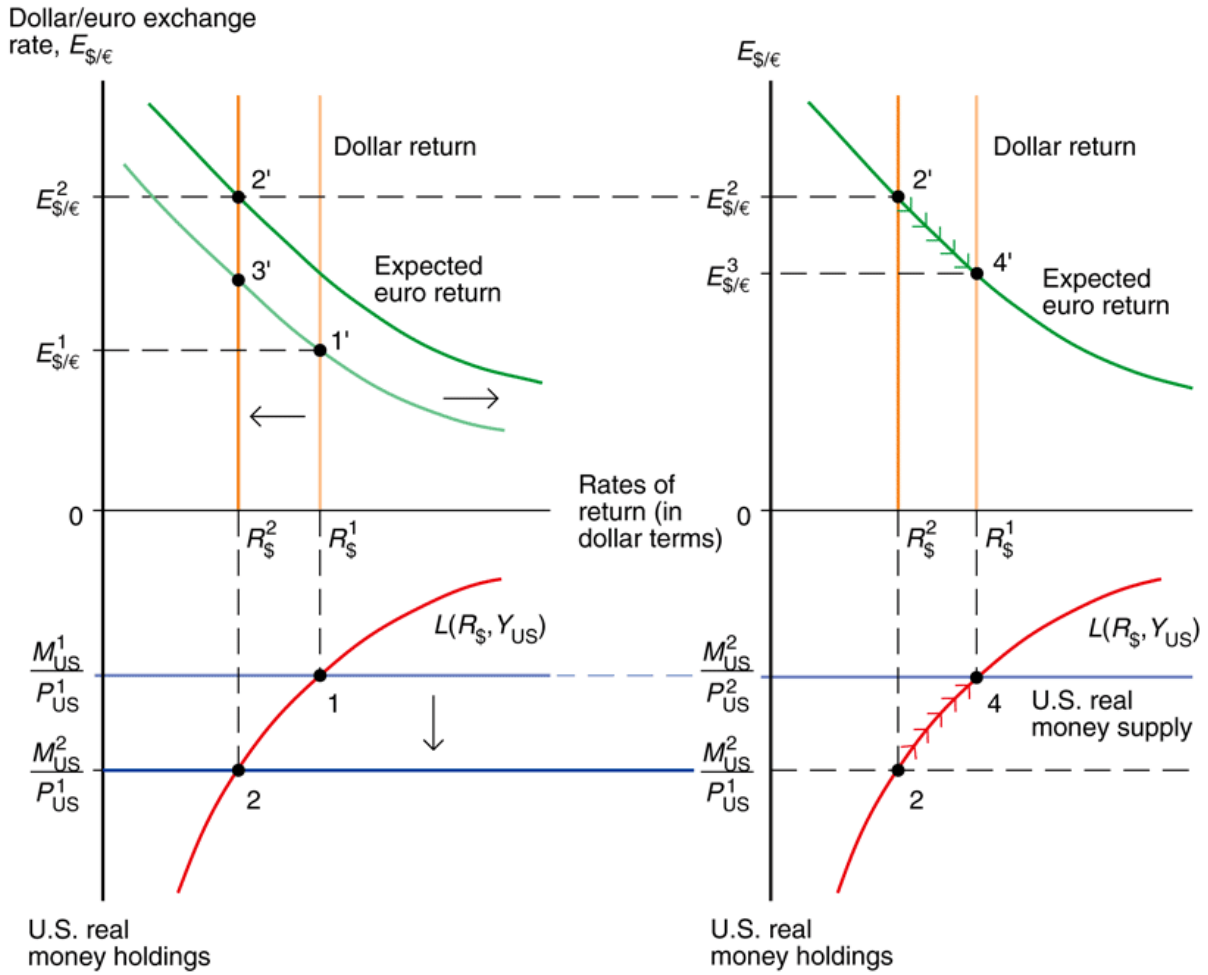


Figure 4-6a: Money and Prices in Interwar Germany

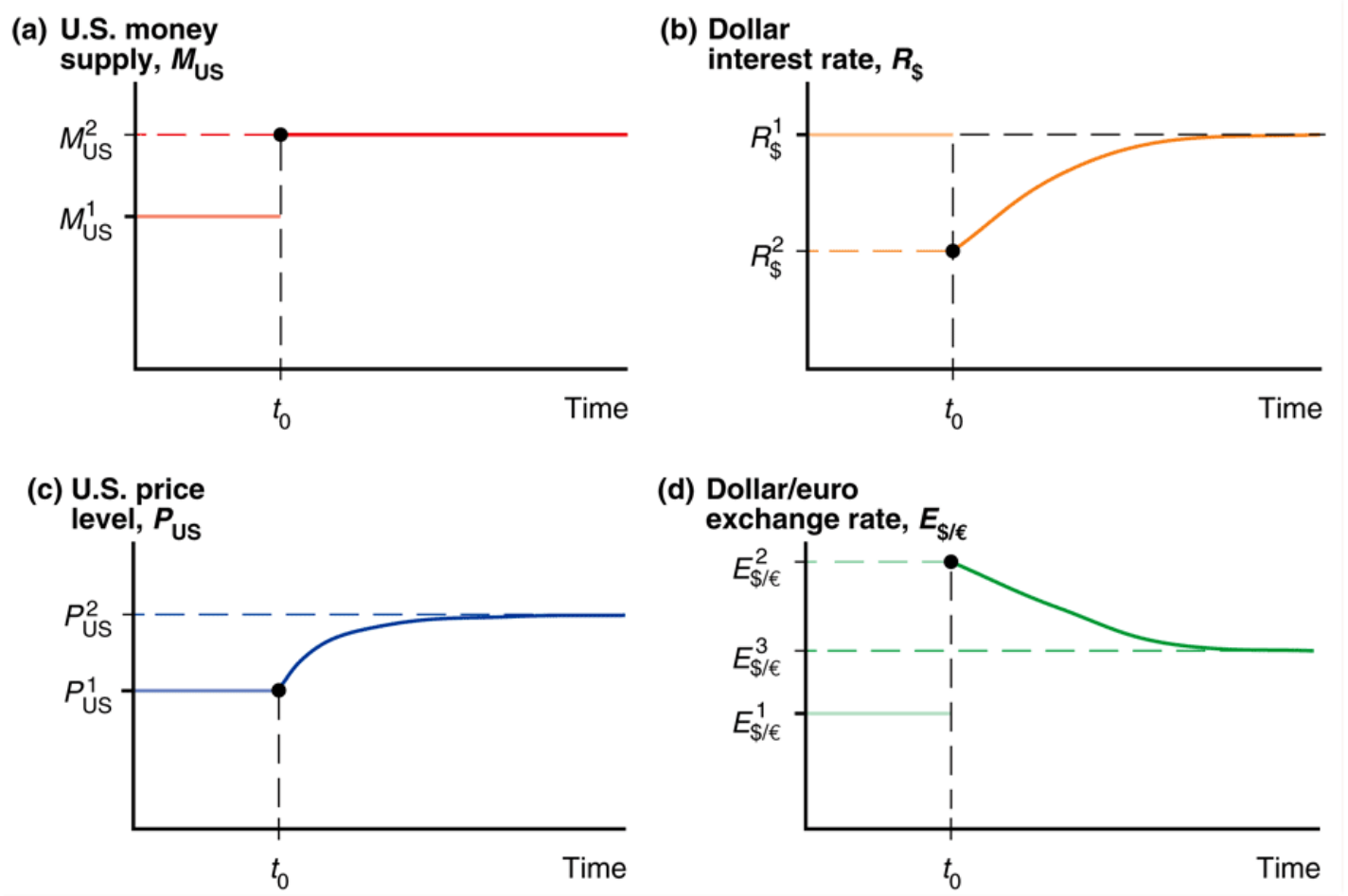
Fig. 15-12: Short-Run and Long-Run Effects of an Increase in the U.S. Money Supply (Given Real Output, *Y*)



Channels from money to prices

1. **Excess demand for output and labour**
2. **Inflationary expectations**
3. **Exchange rate and import prices**

Fig. 15-13: Time Paths of U.S. Economic Variables After a Permanent Increase in the U.S. Money Supply



How good are exchange rate models for forecasting?

The models are better for the long run than for the short run.

The best short-run model is a "random walk" (like for the weather forecast):

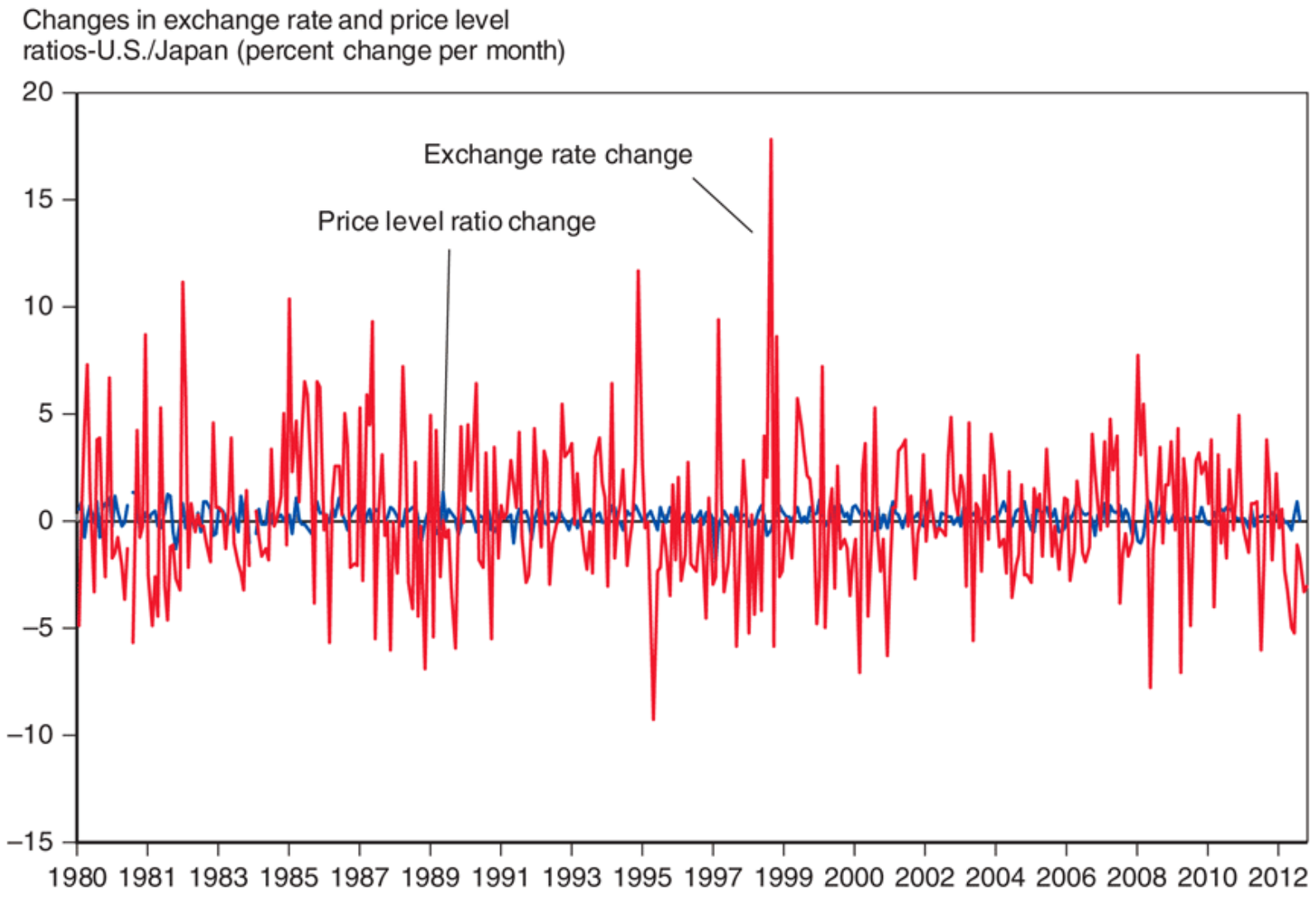
$E_t = E_{t-1} + \varepsilon_t$

ε_t **is a random variable with expected value = 0**

The exchange rate has the same characteristics as all asset prices (including stock prices): all available information is discounted in the price.

Only *new* information (which by definition is unknown now and therefore random) can change the price.

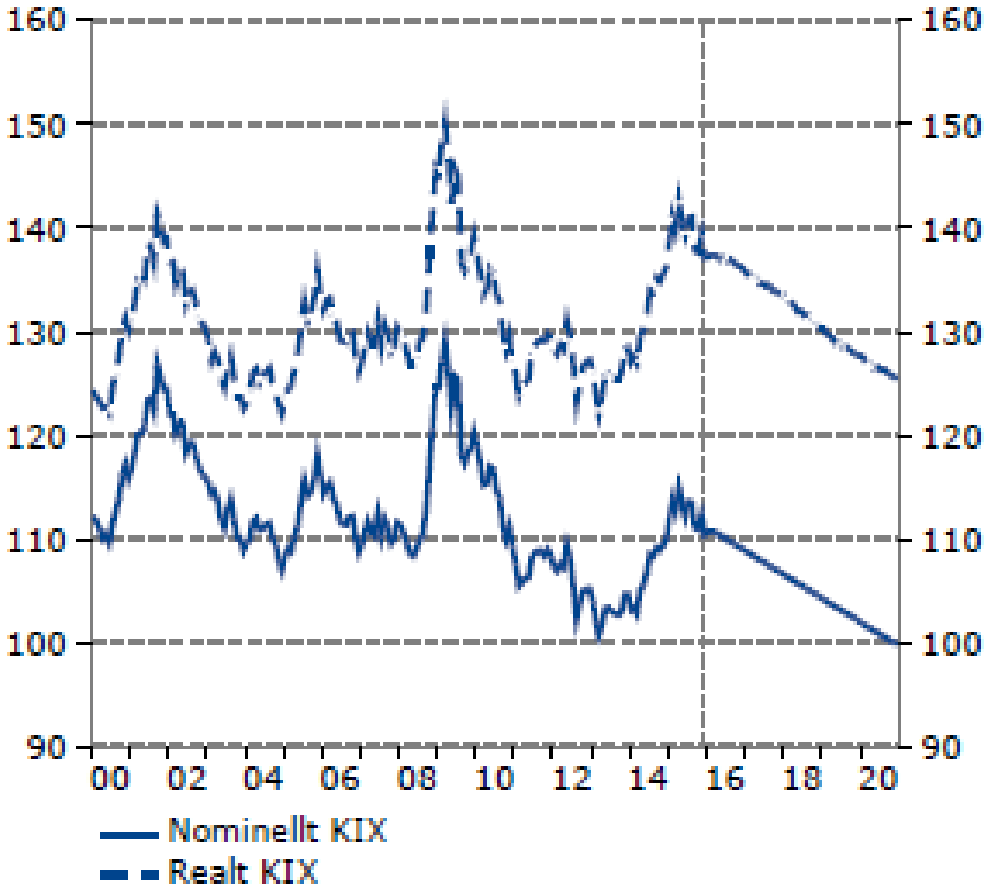
Fig. 15-11: Month-to-Month Variability of the Dollar/Yen Exchange Rate and of the U.S./Japan Price Level Ratio, 1980–2013



Source: Price levels from International Monetary Fund, *International Financial Statistics*. Exchange rate from Global Financial Data.

The effective exchange rate for the Swedish krona - KIX

Index 1992-11-18 = 100, monthly value



The exchange rate under inflation targeting

- **Modern central banks set the interest rate to reach an inflation target**
  - **If inflation rises above the target, the interest rate is raised and vice versa**
  - **Monetary policy is framed in terms of interest rates rather than money supply growth**

- **An increase in inflation (the price level) above the target typically causes an appreciation of the currency**
  - **the central bank is expected to raise the interest rate to bring down inflation again (the price level)**
  - **if unchanged price levels (and money supply) in the future, the future expected exchange rate is unchanged**
  - **interest rate parity requires that there is an expected exchange rate loss to compensate for the interest rate differential**
  - **this only occurs if the exchange rate appreciates today**
  - **empirical evidence in favour of this**