INTRODUCTION TO THE EXCHANGE RATES AND THE FOREIGN EXCHANGE MARKET

Thematic Area 4

MSc in ISFM

DETERMINATION OF THE EXCHANGE RATE IN THE SHORT-RUN:
THE ASSETS APPROACH

EXCHANGE RATES

- **Exchange rates** largely affect the flows of international trade by influencing the **prices in different currencies**

- The **Foreign Exchange Market** facilitates massive flows of international transactions, e.g., the financing of exports and imports, international services (banking, transportation) international investment (FDI), stock and bond trades, etc.

- In the **Foreign Exchange Market**, *trillions* of dollars/euros, and excessively large sums of other currencies are traded each day

- The economic implications of shifts in the market can be dramatic for the global economy

EXCHANGE RATES

- **An exchange rate (*E*):** *is* the **relative price** of two currencies, (i.e., **the price of one currency in terms of another**)

- It may be defined (quoted) **in <u>either of two alternative ways</u>**:

1. **The "American definition": The price of foreign currency, in units of domestic currency:** The number of **"home currency"** units (e.g., euro) required to buy one unit of **"foreign currency"** (e.g., British pound, US$). For example, 1.1627 € to buy a UK £ , or 0.9091 € to buy a US $

1. **The "European definition": The price of home currency, in units of foreign currency:** The number of "foreign currency" units (e.g., British pound, US$) required to buy one unit of "home currency" (e.g., euro). For example, 0.86 UK £ (=1/1.1627) to buy a €, or 1.10 US $ to buy a €

EXCHANGE RATES

- **The practice of quoting exchange rates differs among countries**

- **The U.S.** quotes the exchange rate between the U.S. dollar and the euro to be, e.g., $E_{\$/€}$ **=**1.10. US $ 1.10 dollars are required to buy 1 euro (**the price of foreign currency in terms of domestic**)

- It is equivalent to a euro area resident thinking that the $E_{€/\$}$ exchange rate is 1/1.10=0.9091 € per dollar

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- To date, given the prominence of the U.S. in the global economy, there is a tacit agreement o follow the **American definition** of foreign exchange rates (per our definition 1)

EXCHANGE RATES

Using the American definition, then:

- When the exchange rate ***$E_{€/\$}$ rises***, more euros are required to buy one dollar, the **€ depreciates vis-à-vis the \$ → the \$ appreciates vis-à-vis the €**

- When the exchange rate ***$E_{€/\$}$ falls***, fewer euros are required to buy one dollar, the **€ appreciates vis-à-vis the \$ → the \$ depreciates vis-à-vis the €**

- **The exchange rate between two currencies is called a bilateral exchange rate**

Exchange Rates: Appreciations and Depreciations

- **Key points:**
  - When the exchange rate **$E_{\$/€}$ rises** the **dollar depreciates against the euro**
  - When the exchange rate **$E_{\$/€}$ falls** the **dollar appreciates against the euro**

  - **Also, the % depreciation (appreciation) of the home currency approximates the % appreciation (depreciation) of the foreign currency**

    - The exchange rates are reciprocals of each other
    - The approximation is valid for small changes

Examples of Exchange Rate Quotations

Country (currency)	Currency Symbol	EXCHANGE RATES ON JUNE 30, 2010 (1) Per $	(2) Per £	(3) Per €	EXCHANGE RATES ON JUNE 30, 2009 *ONE YEAR PREVIOUSLY* (4) Per $	(5) Per £	(6) Per €
Canada (dollar)	C$	1.063	1.590	1.302	1.161	1.913	1.629
Denmark (krone)	DKr	6.081	9.098	7.449	5.309	8.743	7.447
Euro (euro)	€	**0.816**	1.221	—	**0.713**	1.174	—
Japan (yen)	¥	88.49	132.39	108.39	96.49	158.90	135.34
Norway (krone)	NKr	6.503	9.729	7.966	6.437	10.600	9.028
Sweden (krona)	SKr	7.782	11.643	9.532	7.748	12.760	10.868
Switzerland (franc)	SFr	1.078	1.613	1.321	1.088	1.791	1.526
United Kingdom (pound)	£	0.668	—	0.819	0.607	—	0.852
United States (dollar)	$	—	1.496	**1.225**	—	1.647	**1.403**

$E_{\$/€}$ = 1.225 = U.S. exchange rate (American terms)

$E_{€/\$}$ = 0.816 = Eurozone exchange rate (European terms)

$$E_{\$/€} = \frac{1}{E_{€/\$}} \qquad 1.225 = \frac{1}{0.816}$$

The Effective Exchange Rate (*EER*)

- **Example:** Home (country's) trade is 40% with country 1 and 60% is with country 2

- Home's currency appreciates 10% against 1's currency but depreciates 30% against 2's currency

- To calculate the **change in Home's *EER***, we multiply each exchange rate percentage change by the corresponding trade share and then add up:
- $(-10\% \bullet 40\%) + (30\% \bullet 60\%) = (-0.1 \bullet 0.4) + (0.3 \bullet 0.6) = -0.04 + 0.18 = 0.14 = +14\%$.

- **Home's *EER* has, ON AVERAGE, depreciated by 14%**

Multilateral Exchange Rates

- **..in general, Computing the *EER*:**
  - If the home country trades with countries 1,…,N then the fractional (%) change in Nominal Effective Exchange Rate (***NEER***) relative to the base year is given by finding the trade-weighted average change in each bilateral

$$\frac{\Delta E_{\text{effective}}}{E_{\text{effective}}} = \underbrace{\frac{\text{Trade}_1}{\text{Trade}}\frac{\Delta E_1}{E_1} + \frac{\text{Trade}_2}{\text{Trade}}\frac{\Delta E_2}{E_2} + \ldots + \frac{\text{Trade}_N}{\text{Trade}}\frac{\Delta E_N}{E_N}}_{\text{trade-weighted average of bilateral nominal exchange rate changes}}$$

Why are exchange rates useful?

The only meaningful way to compare the prices in different countries/locations, expressed in different currencies, is to convert prices into a common currency

Example: Using Exchange Rates to Compare Prices in a Common Currency (U.K. £)

Scenario		1	2	3	4
Cost of the tuxedo in local currency	London	£2,000	£2,000	£2,000	£2,000
	Hong Kong	HK$30,000	HK$30,000	HK$30,000	HK$30,000
	New York	$4,000	$4,000	$4,000	$4,000
Exchange rates	HK$/£	15	16	14	14
	$/£	2.0	1.9	2.1	1.9
Cost of the tuxedo in pounds	London	£2,000	£2,000	£2,000	£2,000
	Hong Kong	£2,000	£1,875	£2,143	£2,143
	New York	£2,000	£2,105	£1,905	£2,105

Changes in the exchange rate cause changes in the

1. **Nominal prices** of foreign goods expressed in the home currency. Of home goods expressed in foreign currency

2. **Relative prices** of goods produced in the home and foreign countries

- **Home country's exchange rate depreciation:** Home exports become cheaper as imports to foreigners. Foreign exports become more expensive as imports to home residents

- **Home country's exchange rate appreciation:** Home export goods become more expensive as imports to foreigners. Foreign export goods become cheaper as imports to home residents.

Exchange Rate Regimes: Fixed versus Floating (How is the value of the exchange rate set?)

Fixed (pegged) exchange rate regimes: a country's exchange rate fluctuates in a narrow range (or not at all) against some *base currency* over a sustained period, usually a year or longer. A country's exchange rate can remain rigidly fixed for long periods. This requires that the government/central bank intervenes in the foreign exchange market in one or both countries

Floating (flexible) exchange rate regimes: a country's exchange rate fluctuates in a wider range, based on market supply and demand conditions, and the government makes no attempt to fix it against any base currency. **Appreciations** and **depreciations** may occur from year to year, each month, by the day, or every minute

Fixed vs Floating Exchange Rates: Central Banks

•**Governments** may allow the private market for foreign exchange function to operate but they may also try to fix or control foreign exchange (FOREX) prices in the market through **intervention,** a job typically given to a **nation's central bank**.

•To maintain a **fixed exchange rate**, the central bank must stand ready to buy or sell its own currency, in exchange for the base foreign currency, at a fixed price.

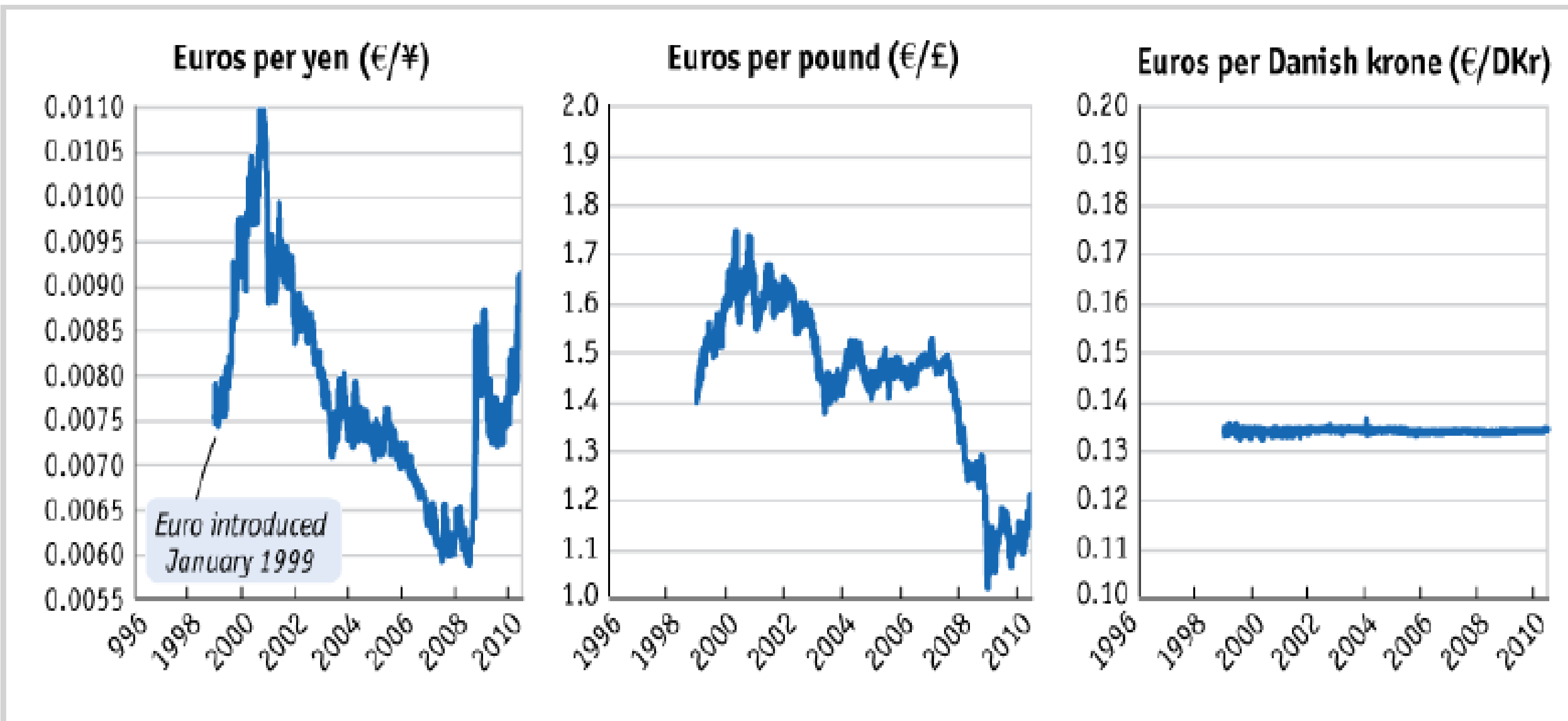
•In practice, keeping some **foreign currency reserves** may be costly and uncertain, as resources are tied up in foreign currency and reserves may run out.

Exchange Rate Volatility

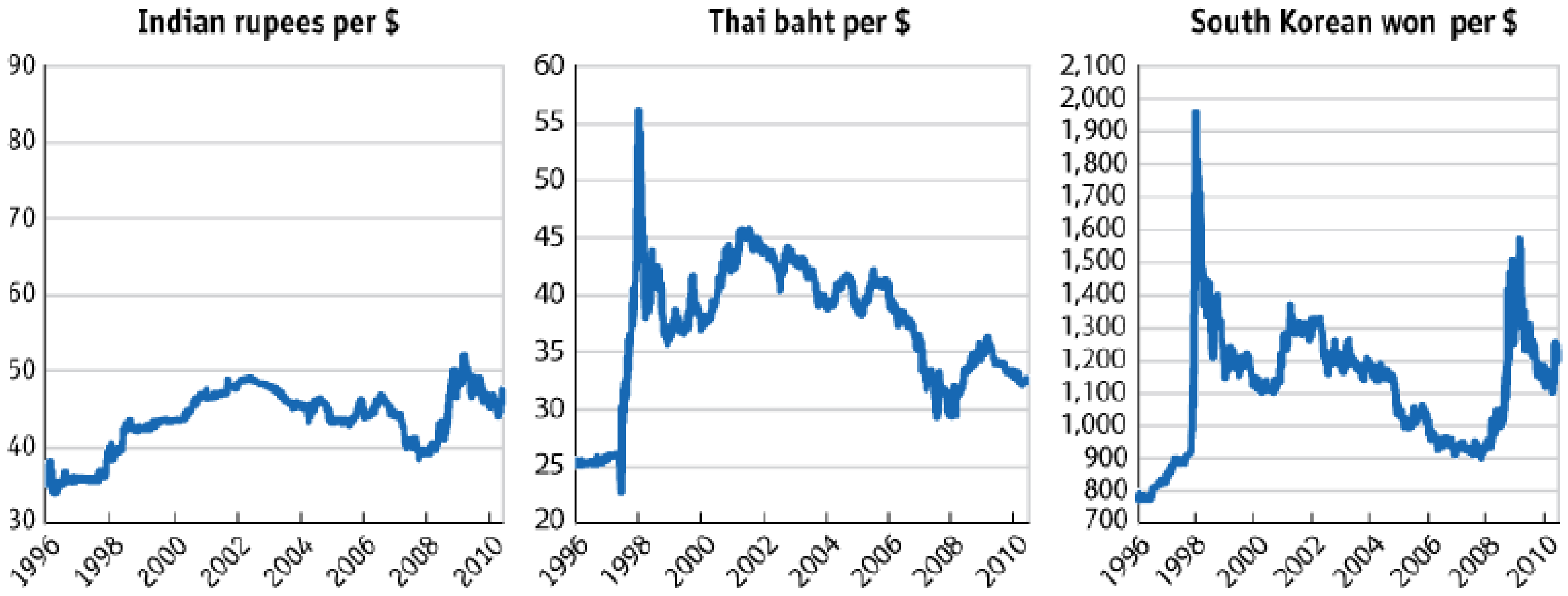
Exchange rates in developing countries can be much more volatile than those in developed countries

- India is an example of a middle ground, somewhere between a fixed rate and a free float, called a **managed float** (also known as **dirty float**, or a policy of limited flexibility)

- Dramatic depreciations, such as those of Thailand and South Korea in 1997, are called **exchange rate crises** and they are more common in developing countries than in developed countries



Euros per yen (€/¥)
0.0110
0.0105
0.0100
0.0095
0.0090
0.0085
0.0080
0.0075
0.0070
0.0065
0.0060
0.0055
Euro introduced January 1999
996
1998
2000
2002
2004
2006
2008
2010
Euros per pound (€/£)
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
1996
1998
2000
2002
2004
2006
2008
2010
Euros per Danish krone (€/DKr)
0.20
0.19
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.10
1996
1998
2000
2002
2004
2006
2008
2010



Indian rupees per $
90
80
70
60
50
40
30
1996
1998
2000
2002
2004
2006
2008
2010
Thai baht per $
60
55
50
45
40
35
30
25
20
1996
1998
2000
2002
2004
2006
2008
2010
South Korean won per $
2,100
2,000
1,900
1,800
1,700
1,600
1,500
1,400
1,300
1,200
1,100
1,000
900
800
700
1996
1998
2000
2002
2004
2006
2008
2010


Argentine pesos per $
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
1996
1998
2000
2002
2004
2006
2008
2010
Colombian pesos per $
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
1996
1998
2000
2002
2004
2006
2008
2010
Ecuadorean sucres per $
29,000
27,000
25,000
23,000
21,000
19,000
17,000
15,000
13,000
11,000
9,000
7,000
5,000
3,000
Dollarization completed by end of 2000
1996
1998
2000
2002
2004
2006
2008
2010

Currency Unions and Dollarization

(How to avoid deep fluctuations of the E.R.)

Under a **currency union** (**monetary union**), there is some form of **transnational structure** such as a **single central bank or monetary authority** that is accountable to the member nations

The most prominent example of a currency union is the **Eurozone** (not yet an … actual.. monetary union...despite the "EMU" adjective…)

"**Dollarization**": **A country <u>unilaterally adopts</u> the currency of another country**. Reasons: A small size, poor record of managing monetary affairs, seize of using the national currency and switch "*en masse*" to an alternative.

Foreign Exchange Market

- Day by day, and minute by minute, exchange rates over the world are set in the **Foreign Exchange Market** (or **FOREX** or **FX Market**)

- The **FOREX Market** is like any other market. It is a collection of private individuals, corporations, and public institutions that buy and sell currencies (home and foreign)

- The value of trades conducted in the **FOREX Market** is to the order of trillion euros/dollars per day!

Foreign Exchange Market: The Spot Contract

- The simplest **FOREX** transaction is a contract for the **immediate exchange** of one currency for another between two parties. This is known as a **spot contract**

- The **exchange rate** for this transaction is often called the **spot exchange rate**, and the related market **Spot FOREX Market**

- Here, we use the term "exchange rate" always to refer to the spot exchange rate

- The spot contract is the most common type of trade and appears in almost 90% of all **FOREX** transactions

- Trades (participants) spread over most time zones

Foreign Exchange Market: Derivatives

- **Derivatives are foreign exchange contracts with pricing derived from the spot exchange rate. Derivatives, i.e., foreign exchange contracts, allow investors to:**
  - Trade foreign exchange for delivery at different times and under different contingencies.
  - Alter future payoffs, affecting the risk associated with their collection of investments (e.g., portfolio).
    - Hedging: risk reduction
    - Speculation: risk taking
- **Types: futures, forwards, swaps,** and **options**

Foreign Exchange Derivatives

- **Futures**
  - **"A" and "B" agree to trade (buy & sell) currencies at set price in the future**. **Standardized contracts**. Either side of contract can be traded to third parties, C, D, E,… i.e., traded-on-exchanges – Secondary Markets. Parties left holding contract must deliver

- **Forwards**
  - Very much similar to **Futures**. **BUT,** (i) traded-over-the-counter (brokers/dealers NOT FOREX markets), (ii) privately negotiated, and (iii) practically no secondary markets

Foreign Exchange Derivatives

- **Swaps**
  - A swap is a **derivative contract** through which two parties **exchange cash flows or liabilities** from two different financial instruments
  - A swap is **an agreement** for a financial exchange in which one of the two parties promises to make, with an established frequency, a series of payments, in exchange for receiving another set of payments from the other party. These flows normally respond to interest payments based on the nominal amount of the swap.
  - **Swaps do not trade-on-exchanges**, and retail investors do not generally engage in swaps. Rather, **swaps are over-the-counter contracts** primarily between (large) businesses, investors, or financial institutions that are customized to the needs of both parties

Swaps (con'ed)

- **The objective of a swap** is to change one scheme of payments into another one of a different nature, which is more suitable to the needs or objectives of the parties. **Examples:**

➢ Large companies finance themselves by issuing debt bonds, on which they pay a fixed interest rate to investors. They may contract a **swap** to transform those fixed payments into variable interest rate payments, which are linked to market interest rates. A reason for such a swap would be to optimize the company's debt structure.

➢ a swap can also be useful for a company that has issued bonds in a foreign currency and wants to convert those payments into local currency by contracting a **cross-currency swap**. Currency swaps may be made because a company receives a loan or revenues in a foreign currency, which must be changed into local currency, or vice-versa.

Foreign Exchange Derivatives

- **Options**
  - **“A” grants to “B” the option to buy (call-position) or sell (put-position) currencies from/to “A”, at set price prior to or on the future date the option is taken out**. **“B” may or may not execute** the option. **IF “B”** opts to execute the contract then **“A”** must deliver

Foreign Exchange Derivatives: How Derivatives Work?

- **Example 1: Hedging**
  - A Chief Financial Officer (CFO) of a U.S. firm expects to receive payment of €1 million in 90 days for exports to France.
  - The current spot rate is US $1.10 per €1.0. The CFO knows that severe losses would be incurred on the deal, if the dollar strengthened (i.e., the euro weakened) to less than $1 per €.
  - **What could the CFO do?**
    - Buy €1 million in call options on $ at rate of $1.05 per euro
    - Insures the firm's euro receipts will sell for at least this rate.
    - The call option guarantees the firm a profit, even if the spot rate falls below $1.05.

Foreign Exchange Derivatives: How Derivatives Work?

- **Example 2: Speculation**
  - One-year euro futures are currently priced at $1.20
  - You expect the dollar to depreciate to $1.32 in the next 12 months
  - **What could you do?.... Buy these futures**

➢ If you are proved right, you will earn a 10% profit. Any level above $1.20 will generate a profit

➢ If the dollar is at or below $1.20 a year from now, however, your investment in futures will be a total loss

Private Actors in the FX Market

•**The key actors in the Forex market are the traders**. Most forex traders work for **commercial banks**

•**Interbank trading** is highly concentrated: about three-quarters of all **Forex market** transactions globally are handled by **just ten banks**

•The vast majority of **Forex** transactions are **profit-driven interbank trades**, and it is the exchange rates for these trades that underlie quoted market exchange rates

•**Major corporations** may trade in the **Forex market** if they are engaged in extensive transactions either to buy inputs or sell products in foreign markets

•Other **nonbank financial institutions**, e.g., mutual fund companies, may favor setting up their own foreign exchange trading operations

Cross Rates and Vehicle Currencies

- There are **over 160 distinct currencies in the world**

- The vast majority of the world's currencies trade directly with only one or two of the major currencies, e.g., the dollar, euro, yen, or pound, and perhaps a few other currencies from neighboring countries.

- Many countries do a lot of business in major currencies such as the Euro and the U.S. dollar, so individuals always have the option to engage in a **triangular trade at the cross rate**.

- **When a third currency, such as the Euro or the U.S. dollar is used in these transactions, it is called a vehicle currency because it is not the home currency of either of the parties involved in the trade and is just used for intermediation**

SHORT-RUN Exchange Rate Determination: The Asset Market Approach

An important goal of players in the FOREX Market is to exploit arbitrage opportunities

- **Arbitrage** refers to a trading strategy that exploits price differences.
- The purest form of arbitrage involves no risk and no capital.
  - **The opportunity to make a riskless profit through trading**

The spot exchange rate is determined through one of two no-arbitrage condition. They describe an equilibrium in which investors are indifferent between the returns on **(un-)hedged interest-bearing bank deposits** in two currencies (where forward contracts are not employed).

(i) The Covered Interest Parity (CIP)

(ii) The Uncovered Interest Parity (UIP)

Arbitrage and Spot Exchange Rates

- **Arbitrage with Two Currencies**
  - **Example**
    - Take advantage of differences in price of dollars quoted in New York and London:

$$E_{£/\$}^{NY} = £0.50 \text{ per dollar}$$

$$E_{£/\$}^{London} = £0.55 \text{ per dollar}$$

- **A trader can make a riskless profit by:** selling \$1 in London for £0.55, using the proceeds to buy 0.55/0.50=\$1.10 in NY.
- **An instant 10% riskless profit!**

Arbitrage with Two Currencies

- **Market adjustment of the £/$ exchange rate:**

➢ **As investors take advantage of this arbitrage opportunity:**

❑ **London: the supply of $ rises, the demand for £ rises. Decrease in the exchange rate (£ price of $ rises) – Appreciation of the £ against the $**

❑ **NY: the demand for $ rises, and supply of £ rises. Increase in the exchange rate (£ price of $ rises) – Appreciation of the $ against the £**

➢ **This process continues until the exchange rates in London and New York converge to the same level**

  - **Differences mean that there are riskless profits lying around**
  - **In today's markets, equalization occurs very, very quickly indeed!**
  - **Miniscule spreads may remain (less than 0.1%), due to transaction costs**

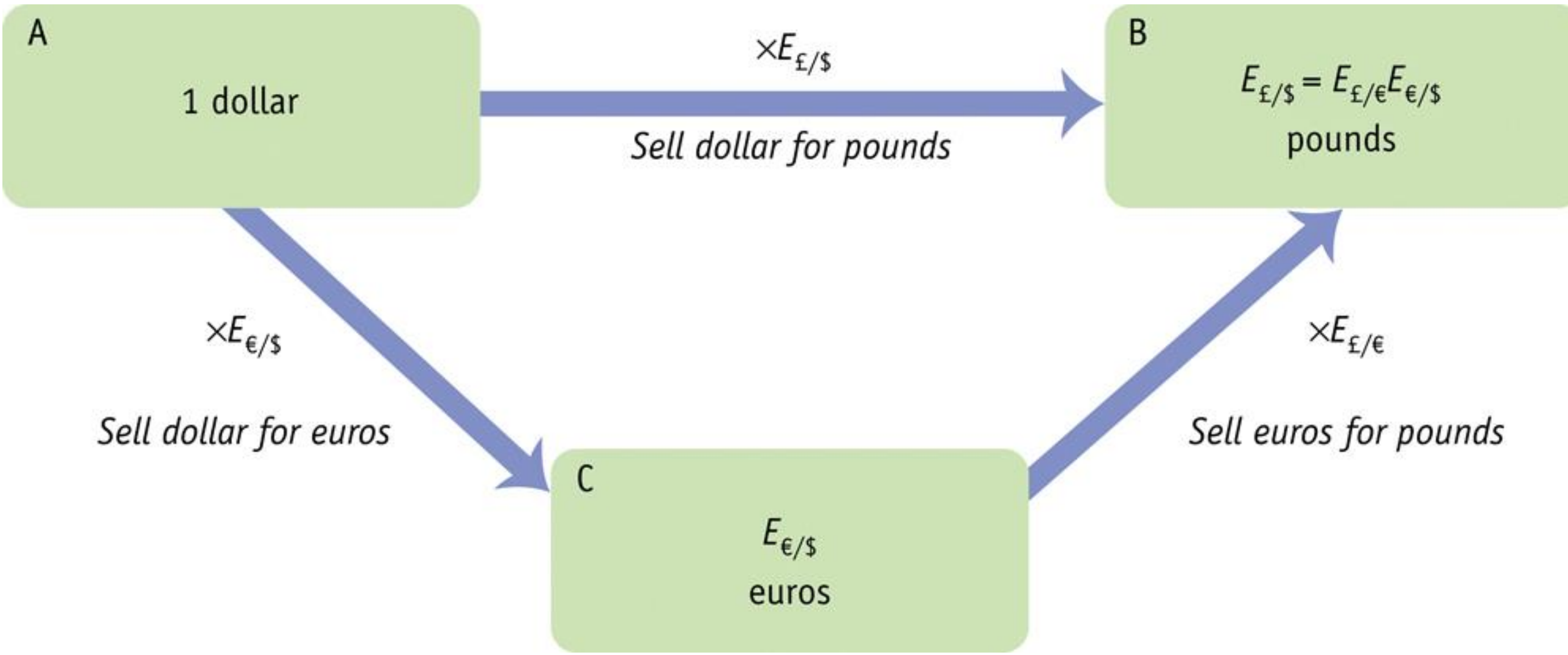
Arbitrage and Spot Exchange Rates

- **Arbitrage with Three Currencies (Cross Exchange Rate):** it allows to compare exchange rates defined in terms of different currencies
- **Consider the bilateral exchange rate** $\mathbf{E_{£/\$}}$: This can be expressed in terms of $\mathbf{E_{€/\$}}$ and $\mathbf{E_{£/€}}$:

$$\underbrace{E_{£/\$}}_{\substack{\text{Direct}\\ \text{exchange rate}}} = E_{£/€}E_{€/\$} = \underbrace{\frac{E_{£/€}}{E_{\$/€}}}_{\text{Cross rate}}$$

The fact that any two currencies must have equal prices in two different locations implies the same for a triangular trade involving three currencies

Arbitrage and Spot Exchange Rates with Three Currencies



Arbitrage and Interest Rates: The Choices of Investors (Un-)Covered Foreign Exchange Risk

- **Overview of the two kinds of arbitrage**
  - Exchange rate risk refers to changes in the value of an asset due to a change in the exchange rate
- **Riskless arbitrage**
  - Investors cover the risk of the exchange rate changing in the future by using a forward contract
  - No exchange rate risk because changes in the exchange rate will not change the contract
  - **No-arbitrage condition** is known as **covered interest parity (CIP)**
- **Risky arbitrage**
  - Investors do not cover the risk. They invests according to the current and expected future exchange rate
  - Since the **future spot exchange** rate is NOT known, there is exchange rate risk – the investor is not covered against this risk
  - **No-arbitrage condition** is known as **uncovered interest parity (UIP)**

Riskless Arbitrage: Covered Interest Parity (CIP)

- **Forward Exchange Rate**
  - The price of forward contracts
  - Forward contracts allow investors holding deposits in foreign currencies to be certain about the future value of these deposits (measured in home currency)
  - No exchange rate risk in the future.
- **Riskless arbitrage** implies that the rate of return on identical investments in two different locations will generate the same rate of return

Riskless Arbitrage: Covered Interest Parity

- **Example: Consider investing \$1 in a bank deposit in two places: New York ($i_\$ = 0.05$) and Europe ($i_€ = 0.03$)**
    - In one year, you will earn a **$\$(1+i_\$)=\$1.05$** rate of return in dollars in the account in New York
    - In one year, you will earn a **$€(1+i_€)= €1.03$** rate of return in euros in the account in Europe
  - **Not comparable! Different currencies!**
  - **We must calculate the dollar return in Europe:**
    - Today, one U.S. dollar buys $1/E_{\$/€}$ (= $E_{€/\$}$) euros (€0.9091 per US \$1.0)
    - In one year, you will have $(1+i_€)/E_{\$/€}$ euros (0.9091(1+0.03)= € 0.936373)
    - **You do not know the $E_{\$/€}$ spot exchange rate that will prevail in one year when you convert your €-earnings back into U.S. dollars**
    - **You employ a forward contract to cover this risk ($F_{\$/€}$ = \$1.15)**
    - In this case, your rate of return on the European deposit would be **$F_{\$/€}\{(1+i_€)/E_{\$/€}\}$ U.S. dollars -→** € 0.936373 x \$1.15= \$1.0768.
    - **Riskless arbitrage implies these two strategies will yield the same rate of return in dollars**

Riskless Arbitrage: Covered Interest Parity

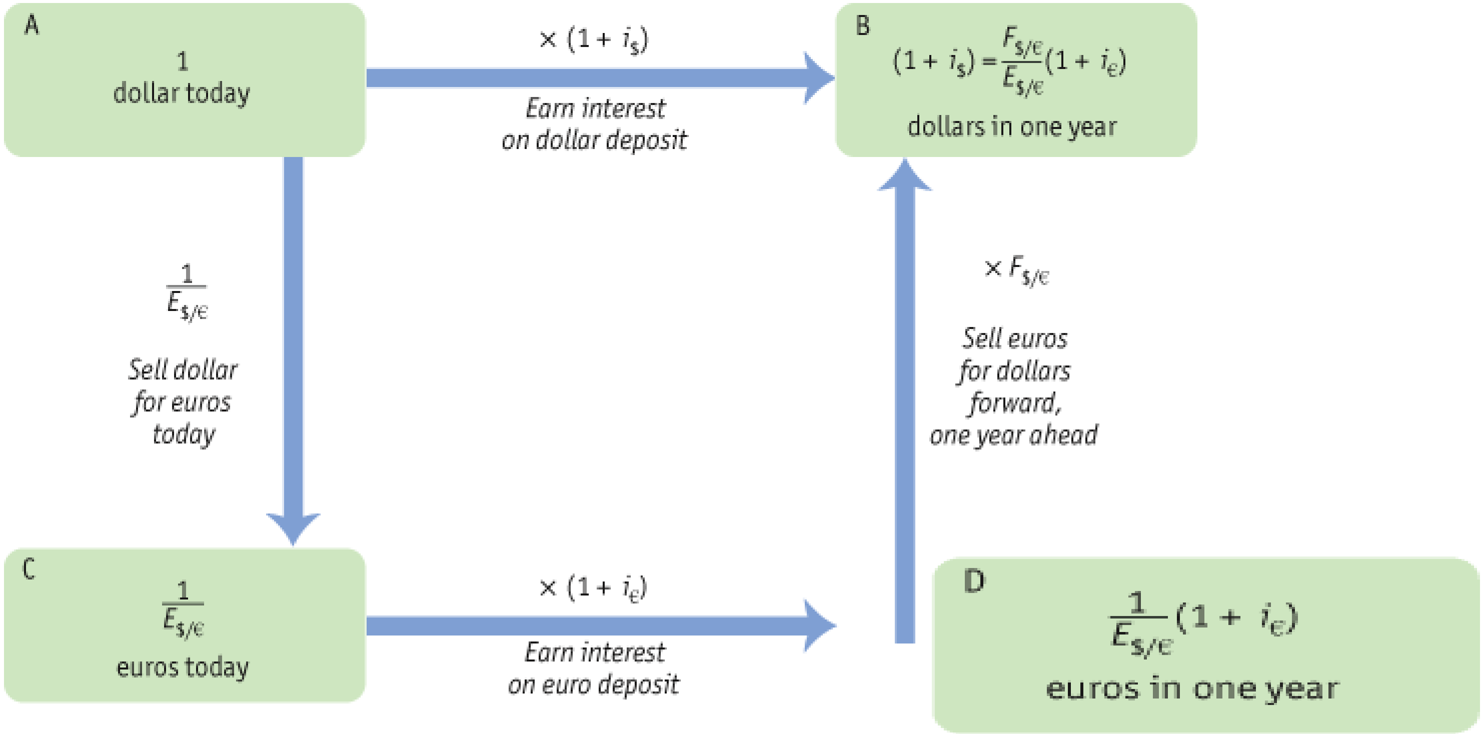
Covered Interest Parity (CIP) condition

- No arbitrage condition

- For the market to be in equilibrium the riskless returns must be equal when expressed in a common currency:

$$\underbrace{\left(1+i_{\$}\right)}_{\text{gross \$ return on \$ deposits}} = \underbrace{\left[\frac{\left(1+i_{€}\right)}{E_{\$/€}}\right]F_{\$/€}}_{\text{gross \$ return on € deposits}}$$

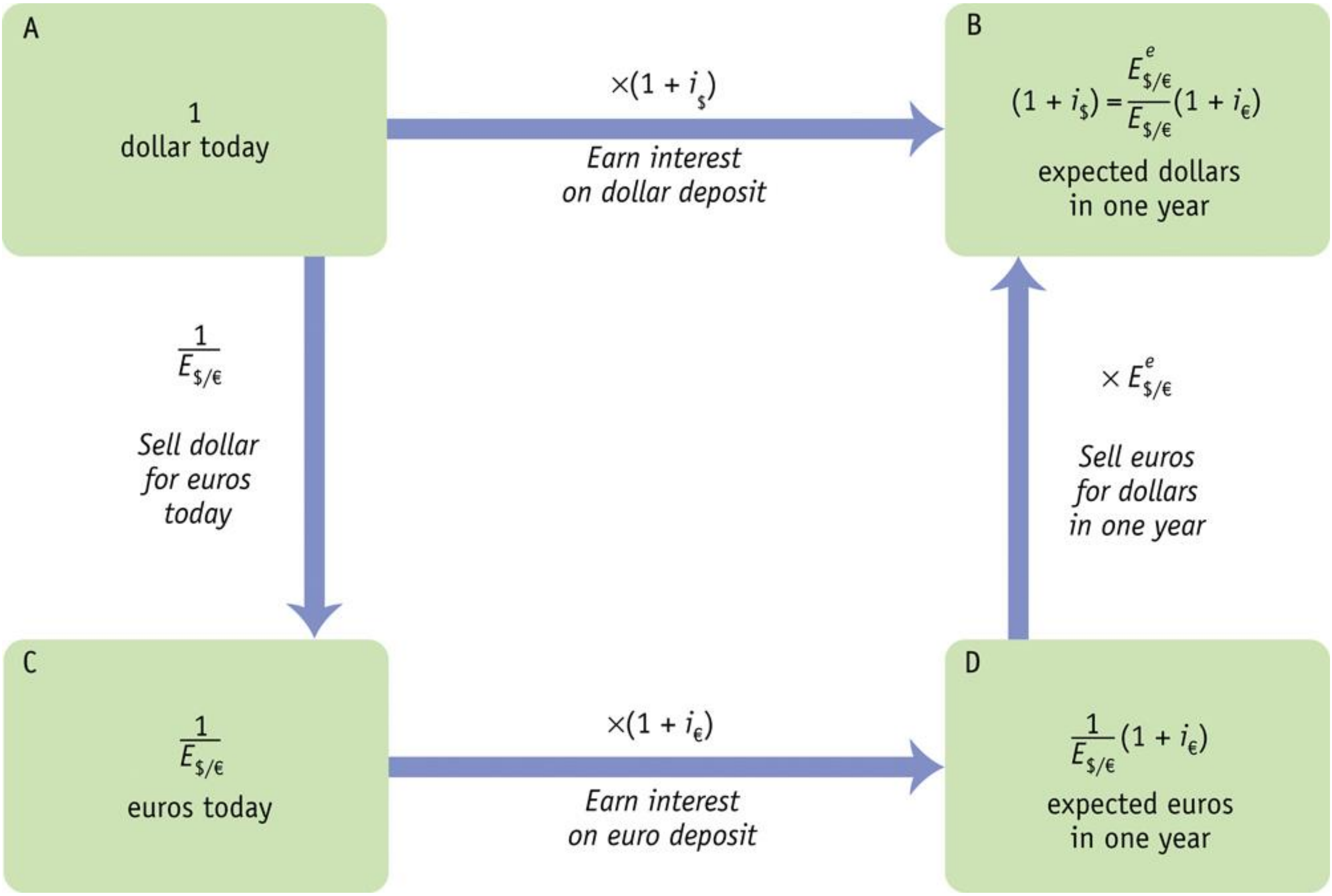
The Choice of Investors: CIP



Risky Arbitrage: Uncovered Interest Parity (UIP)

- **Example: Consider investing \$1 in a bank deposit in two places: New York and Europe**
  - In one year, you will earn a **$\$(1+i_{\$})$** rate of return in dollars in the account in New York
  - In one year, you will earn a $(1+i_{€})$ rate of return in euros in the account in Europe
- **Again we must calculate the dollar return in Europe:**
  - Today, one U.S. dollar buys $1/E_{\$/€}$ euros
  - In one year, you will have $(1+i_{€})/E_{\$/€}$ (€-earnings)
  - **You do not know the $E_{\$/€}$ spot exchange rate that will prevail in one year when you convert your euros back into U.S. dollars**
  - **This time you take the risk, and make some forecast of the expected exchange rate in one year's time $E^e_{\$/€}$**
  - In this case, your rate of return on the European deposit would be **$E^e_{\$/€}\{(1+i_{€})/E_{\$/€}\}$ U.S.** dollars
  - **There is *exchange rate risk* because the future spot exchange rate $E^e_{\$/€}$ is not known when the investments are made**

Risky Arbitrage: UIP



Risky Arbitrage: Uncovered Interest Parity

- **Uncovered Interest Parity (UIP)**
  - No arbitrage condition for *expected returns*
  - States that the expected returns must be equal when expressed in a common currency

$$\underbrace{(1+i_{\$})}_{\text{gross \$ return on \$ deposits}} = \underbrace{\left[\frac{(1+i_{\in})}{E_{\$/\in}}\right] E^{e}_{\$/\in}}_{\text{Expected gross \$ return on } \in \text{ deposits}}$$

- **We assume risk neutrality:** e.g., that a risk neutral investor does not care that the left-hand side is certain, while the right-hand side is risky

UIP: A Convenient Approximation

- **The uncovered interest parity (UIP) equation is the fundamental approach to the short-run determination of the Exchange Rate, i.e., the Asset Approach to Exchange Rates**

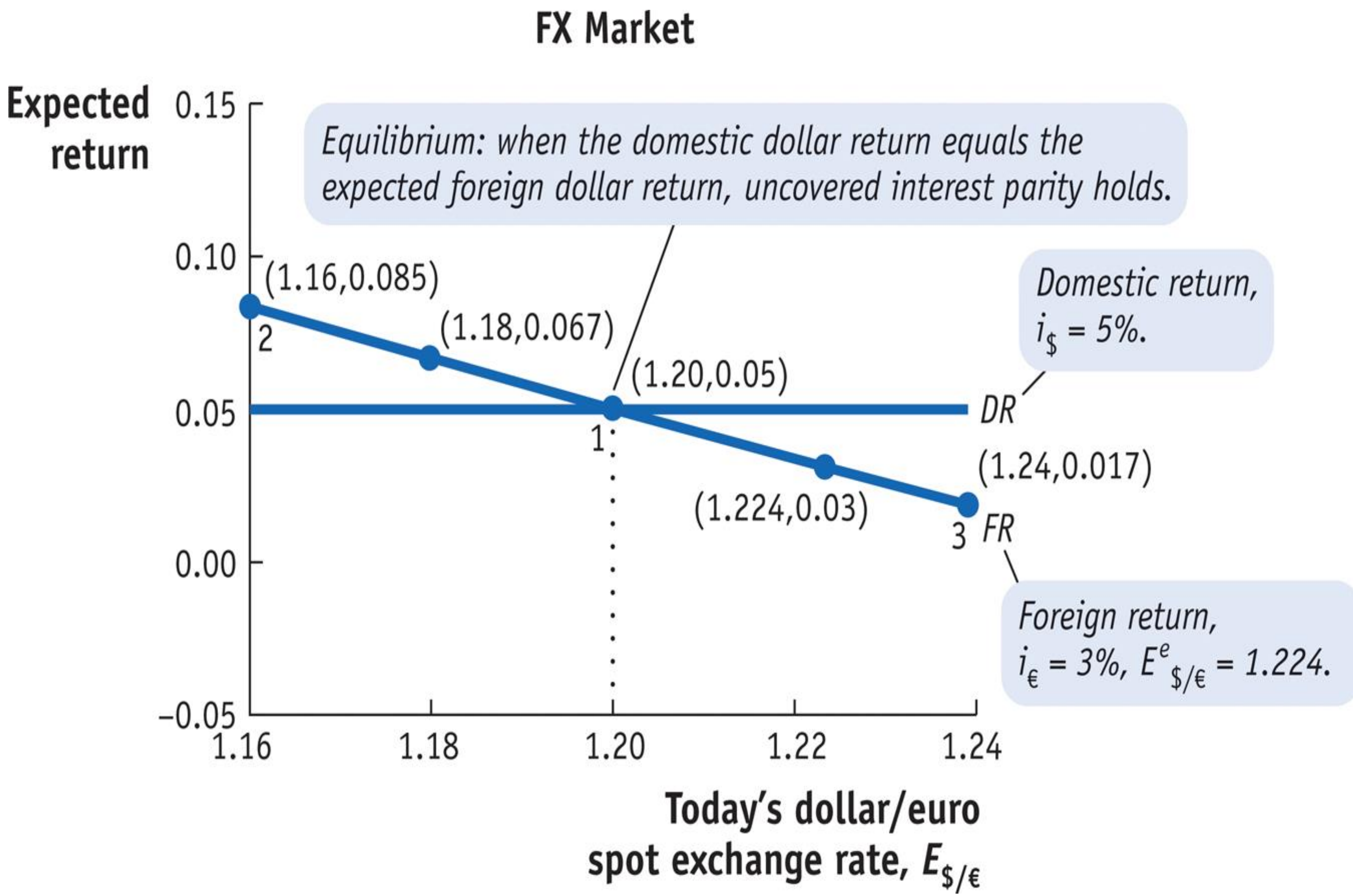
$$\underbrace{i_{\$}}_{\substack{\text{Interest rate} \\ \text{on dollar deposits} \\ = \\ \text{Dollar rate of return} \\ \text{on dollar deposits}}} = \underbrace{\underbrace{i_{\text{€}}}_{\substack{\text{Interest rate} \\ \text{on euro deposits}}} + \underbrace{\frac{(E^{e}_{\$/\text{€}} - E_{\$/\text{€}})}{E_{\$/\text{€}}}}_{\substack{\text{Expected rate of depreciation} \\ \text{of the dollar}}}}_{\substack{\text{Expected dollar rate of return} \\ \text{on euro deposits}}}$$

- **The nominal interest rates and expected future exchange rate are treated as known exogenous variables to predict the unknown endogenous variable the current spot exchange rate**

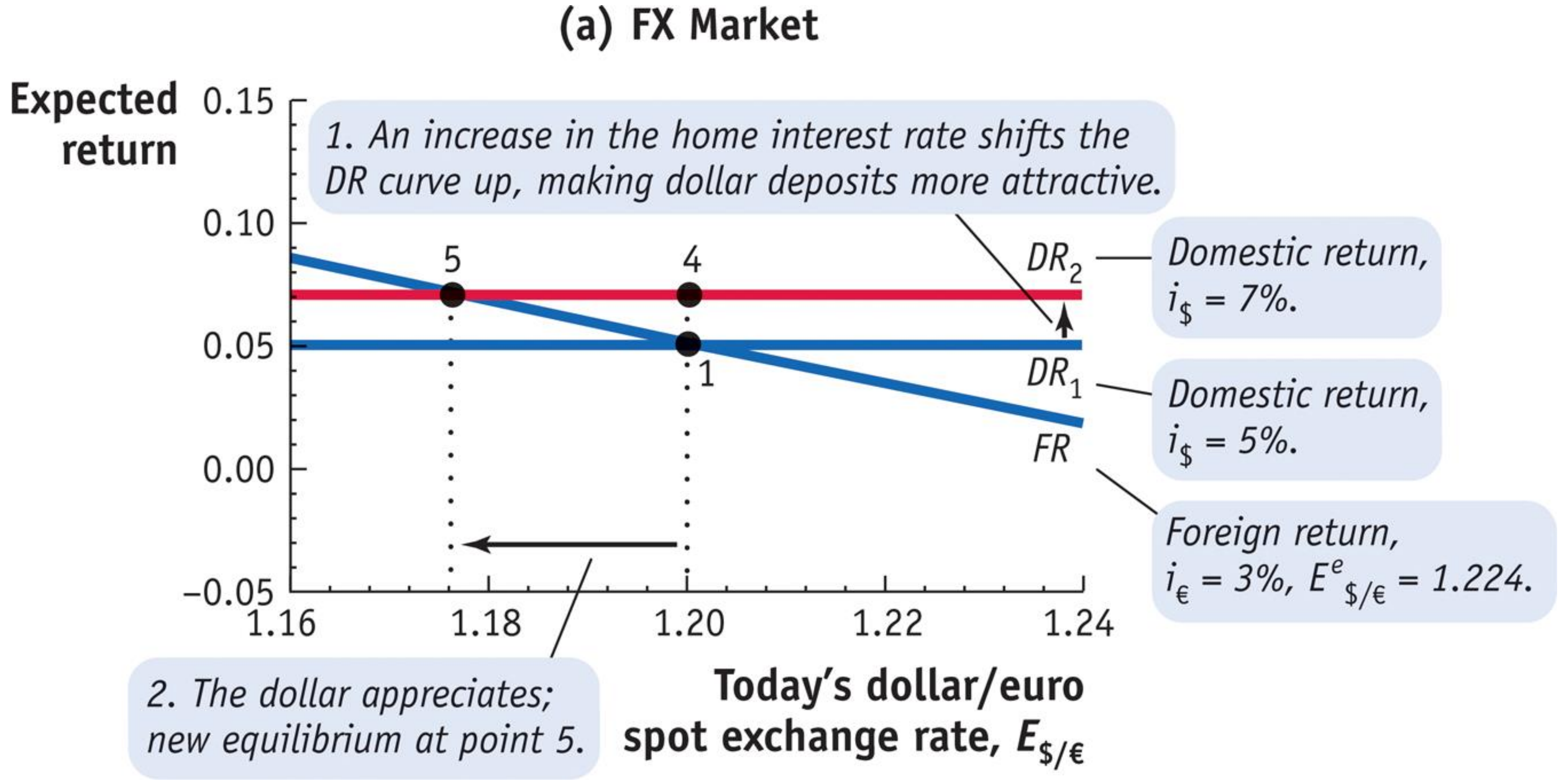
Example of Market Equilibrium

	(1) Interest Rate on Dollar Deposits (annual) Domestic Return ($)	(2) Interest Rate on Euro Deposits (annual)	(3) Spot Exchange Rate (today)	(4) Expected Future Exchange Rate (in 1 year)	(5) Expected Euro Appreciation against Dollar (in 1 year)	(6) = (2) + (5) Expected Dollar Return on Euro Deposits (annual) Foreign Expected Return ($)
	$i_\$$	$i_€$	$E_{\$/€}$	$E^e_{\$/€}$	$\frac{E^e_{\$/€} - E_{\$/€}}{E_{\$/€}}$	$i_€ + \frac{E^e_{\$/€} - E_{\$/€}}{E_{\$/€}}$
	0.05	0.03	1.16	1.224	0.0552	0.0852
	0.05	0.03	1.18	1.224	0.0373	0.0673
Market equilibrium	0.05	0.03	1.20	1.224	0.02	0.05
	0.05	0.03	1.22	1.224	0.0033	0.0333
	0.05	0.03	1.24	1.224	−0.0129	0.0171

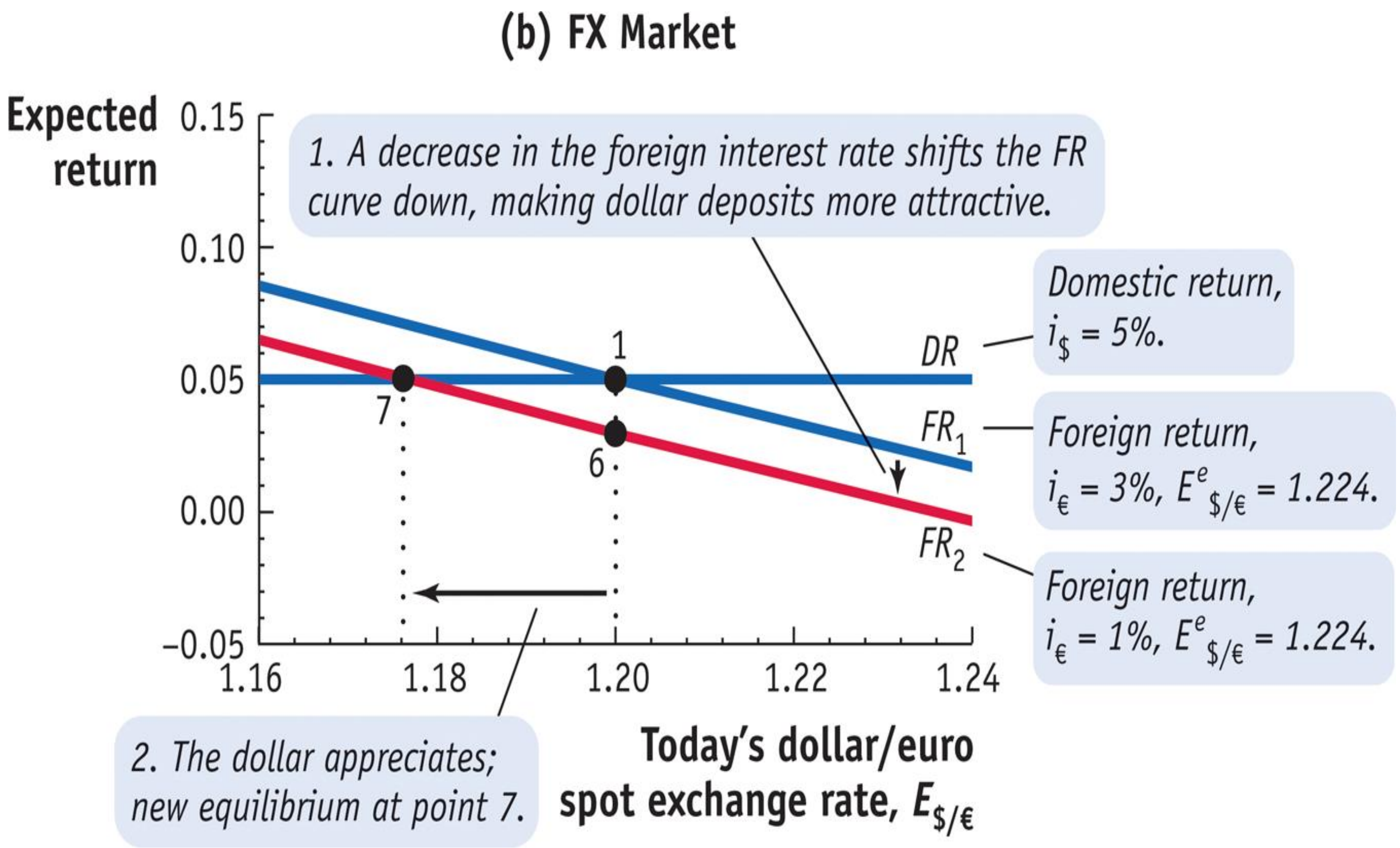
Foreign Exchange Market Equilibrium



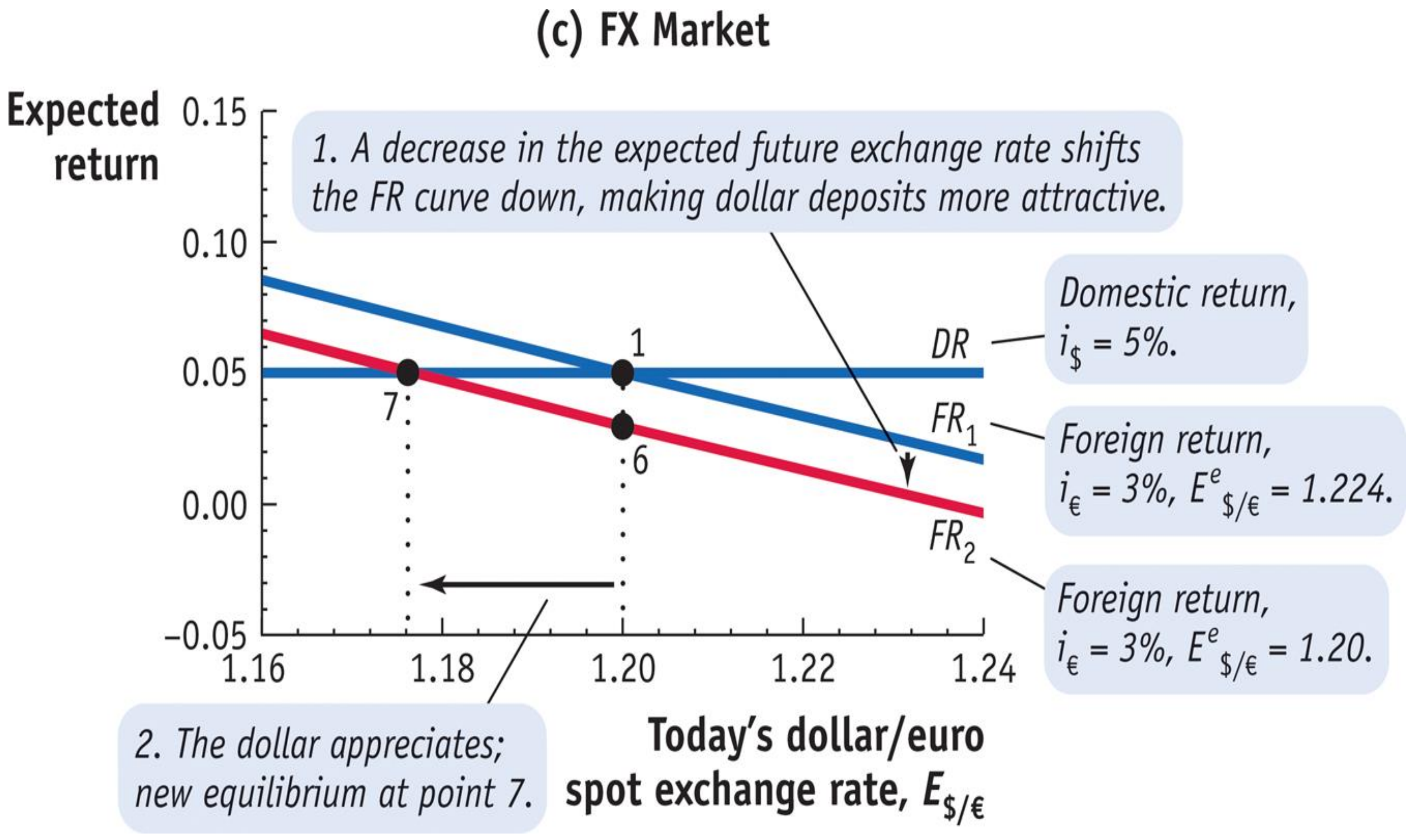
Example of Market Equilibrium



Foreign Exchange Market Equilibrium



Foreign Exchange Market Equilibrium



Interest Parity Conditions

- **CIP:** $$(1+i_{\$}) = (1+i_{€})\frac{F_{\$/€}}{E_{\$/€}}$$

- **UIP:** $$(1+i_{\$}) = (1+i_{€})\frac{E^e_{\$/€}}{E_{\$/€}}$$

- **CIP minus UIP imply:** $$F_{\$/€} = E^e_{\$/€}$$

- **Intuition:** If $F_{\$/€}$ did not equal $E^e_{\$/€}$, then one party to the forward contract would be better off waiting for the more favorable $E^e_{\$/€}$ to materialize (if the investors are risk neutral)

Interest Parity Conditions

- **An important testable implication:**

$$\underbrace{\frac{F_{\$/€}}{E_{\$/€}} - 1}_{\text{Forward premium}} = \underbrace{\frac{E^e_{\$/€}}{E_{\$/€}} - 1}_{\text{Expected rate of depreciation}}$$

- **Left-hand side is the forward premium (+ or –): how much more/less investors are willing to pay for the forward versus the spot**
- **Right-hand side is expected rate of depreciation (+ or –): how much more/less investors are expected to pay for the forward versus the spot**
- **In order to estimate the right-hand side, researchers have used surveys of foreign exchange traders.**

Other Influences on the Spot Exchange Rate

- **Taxation of interest income:** affects the exchange rate, e.g. a *temporary* rise in the tax on interest income in the home (foreign) country reduces the net return on domestic (foreign) deposits, and depreciates (appreciates) the spot exchange rate.
- It is important to keep in mind that the analysis above was conducted on the assumption that the **changes in the exogenous (or, policy) variables are unanticipated**. IF anticipated, market participants adjust to the expected policy change before it actually takes place. This may well explain why the recent (December 2015) rise in the Fed interest rate did not affect the euro/dollar exchange rate after the announcement was made (the euro was depreciating before the announcement on the expectation that the Fed would raise the interest rate).

DETERMINATION OF THE EXCHANGE RATE IN THE LONG-RUN

- If investors are to make **forecasts of future exchange rates**, they need **a plausible theory of how exchange rates are determined in the long run** (i.e. how the expected exchange rate is determined)

- **The theory of long-run determination of the exchange rate has two parts**.
- **First part: Purchasing Power Parity (PPP). Links the exchange rate to price levels in each country in the long run**

- **Second part: Monetary Theory of Price Determination. How price levels are related to monetary conditions in a country**

- **Combining the two: Long-run theory, <u>Monetary Approach to Exchange Rates</u>**

Money, Prices and Exchange Rates in the Long-run

- Just as arbitrage occurs in the international market for financial assets, it also occurs in the international markets for goods: the prices of goods in different countries expressed in a common currency tend to equalize

- **Purchasing Power Parity or** the **law of one price.** Applied to a **single good or** to an **entire basket of goods**

- The **law of one price** (LOOP) states that in the absence of trade frictions (such as transport costs and tariffs), and under conditions of free competition and price flexibility (where no individual sellers or buyers have power to manipulate prices and prices can freely adjust), identical goods sold in different locations must sell for the same price when prices are expressed in a common currency

- By definition, in a **market equilibrium** there are **no arbitrage** opportunities. If diamonds can be freely moved between New York and Amsterdam, both markets must offer the same price. Economists refer to this situation in the two locations as an **integrated market**.

- The equation of price equality is: $$E_{\$/€}P^{g}_{EUR} = P^{g}_{US}$$

- Rearranged it shows that: $$\underbrace{E_{\$/€}}_{\text{Nominal exchange rate}} = \underbrace{\frac{P^{g}_{US}}{P^{g}_{EUR}}}_{\text{Ratio of goods prices}}$$

- **The principle of Purchasing Power Parity (PPP) is the NOMINAL exchange rate is the ratio of domestic prices (expressed in domestic currency) to foreign prices (expressed in foreign currency)**

- **Then, further to this …….**

ABSOLUTE PPP : the exchange rate at which two currencies trade equals the relative price levels of the two countries

The REAL exchange rate. The relative price of the baskets (expressed in a common currency) is one of the most important variables in international macroeconomics

$$\underbrace{q_{US/EUR}}_{\substack{\text{Relative price}\\ \text{of basket}\\ \text{in Europe}\\ \text{versus U.S.}}} = \underbrace{(E_{\$/€}P_{EUR})}_{\substack{\text{European price}\\ \text{of basket}\\ \text{expressed}\\ \text{in \$}}} / \underbrace{P_{US}}_{\substack{\text{U.S. price}\\ \text{of basket}\\ \text{expressed}\\ \text{in \$}}}$$

The exchange rate for currencies is a nominal concept. The real exchange rate is a real concept; it says how many U.S. baskets can be exchanged for one European basket.

- *If **the real exchange rate rises** (more Home goods are needed in exchange for Foreign goods), we say Home has experienced **a real depreciation***

- *If **the real exchange rate falls** (fewer Home goods are needed in exchange for Foreign goods), we say Home has experienced **a real appreciation**.*

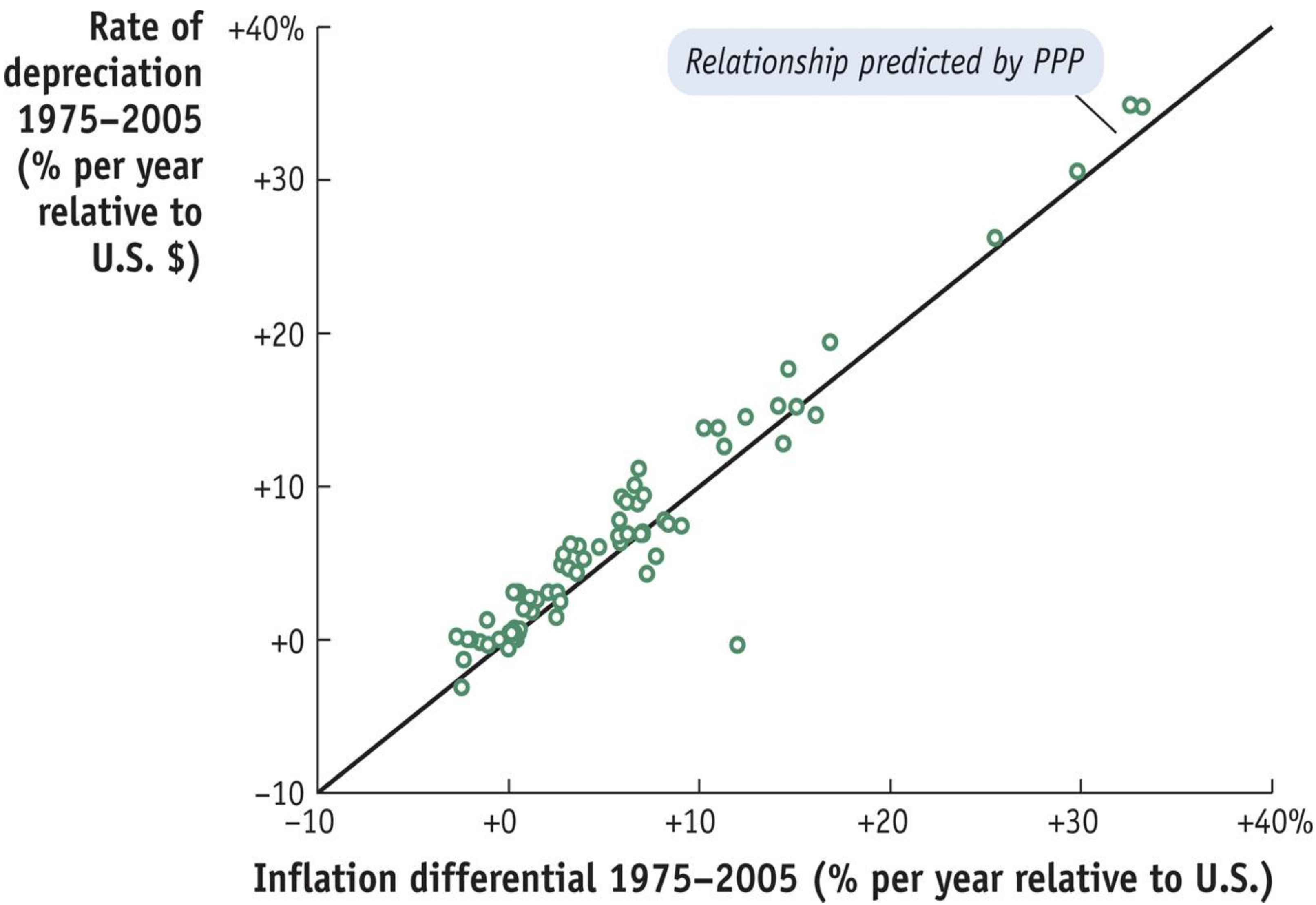
IF PPP HELD AT ALL TIMES, THEN THE REAL EXCHANGE RATE WOULD ALWAYS BE EQUAL TO 1. THIS IS NOT THE CASE IN THE SHORT-RUN, BUT IT (MAY) HOLDS IN THE LONG-RUN…

If ABSOLUTE PPP holds for levels of exchange rates and prices, then it must also hold for rates of change in these variables

$$\underbrace{\frac{\Delta E_{\$/€,t}}{E_{\$/€,t}}}_{\substack{\text{Rate of depreciation} \\ \text{of the nominal exchange rate}}} = \underbrace{\pi_{US,t} - \pi_{EUR,t}}_{\text{Inflation differential}}$$

This way of expressing PPP is called **RELATIVE PPP**: **the rate of depreciation of the nominal exchange rate equals the difference between the inflation rates of two countries** (the inflation differential)

Some evidence in favour of relative PPP in the next diagram…


Rate of depreciation 1975–2005 (% per year relative to U.S. $)
+40%
+30
+20
+10
+0
−10
Relationship predicted by PPP
−10
+0
+10
+20
+30
+40%
Inflation differential 1975–2005 (% per year relative to U.S.)

- We assume that PPP holds in the long run. This implies that in the long run the exchange rate is determined by the ratio of the price levels in two countries.

- **But this prompts a question: What determines those price levels in the long-run?**

- **Monetary theory** supplies an answer: in the long run, price levels are determined in each country by the interaction of money demand and money supply.

- **How is the supply of money determined?** A country's central bank controls the money supply.

- In our analysis, we make the simplifying assumption that the central bank's policy tools are sufficient to allow it to control indirectly, but accurately, the level of the money supply, M.

- **Demand for money:** A simple theory of **household money demand:** the need to conduct transactions is in proportion to an individual's income.

- All else equal, a rise in national dollar income (nominal income) will cause a proportional increase in transactions and, hence, in aggregate money demand.

- Demand for money is proportional to dollar income: **quantity theory of money**:

$$\underbrace{M^d}_{\substack{\text{Demand} \\ \text{for money (\$)}}} = \underbrace{\bar{L}}_{\text{A constant}} \times \underbrace{PY}_{\substack{\text{Nominal} \\ \text{income (\$)}}}$$

- Dividing the previous equation by *P,* the price level, we can derive the ***demand for real money balances***:

$$\underbrace{\frac{M^d}{P}}_{\substack{\text{Demand}\\\text{for real}\\\text{money}}} = \underbrace{\bar{L}}_{\text{A constant}} \times \underbrace{Y}_{\text{Real income}}$$

- **Real money balances** are a measure of the **purchasing power** of the stock of money in terms of goods and services. **The demand for real money balances is strictly proportional to real income**.

The condition for equilibrium in the money market is that the demand for money , M^d , must equal the supply of money, M , i.e. $M^d = M$.

Equilibrium Condition:

$$M = \bar{L}PY$$

or, equivalently…

Equation (2)

$$\frac{M}{P} = \bar{L}Y$$

real money supply is equal to real money demand

If real income (Y) is exogenous in the long run, then equation (2) implies that in the **long run prices are proportional to the money supply** ...

$$P_{US} = \frac{M_{US}}{\bar{L}_{US} Y_{US}} \qquad P_{EUR} = \frac{M_{EUR}}{\bar{L}_{EUR} Y_{EUR}}$$

These two equations are examples of the fundamental equation of the monetary model of the price level. It states that, all else equal, price levels are proportional to the money supply.

In the long run, we assume prices are flexible and will adjust to put the money market in equilibrium.

These two equations can be combined with equation (1), which is the absolute PPP, to give us …

$$E_{\$/€} = \frac{P_{US}}{P_{EUR}} = \frac{M_{US}/M_{EUR}}{L_{US}Y_{US}/L_{EUR}Y_{EUR}}$$

$$E_{\$/€} = \frac{P_{US}}{P_{EUR}} = \frac{M_{US}/M_{EUR}}{L_{US}Y_{US}/L_{EUR}Y_{EUR}}$$

This is the fundamental equation of the monetary approach to exchange rates, and it states that the exchange rate depends on the ratio of relative money supplies and relative money demands.

- Suppose the U.S. money supply increases, all else equal. The right-hand side increases, causing the exchange rate to increase (the U.S. dollar depreciates against the euro).
- Now suppose the U.S. real income level increases, all else equal. Then the right-hand side decreases, causing the exchange rate to decrease (the U.S. dollar appreciates against the euro).

- Another way to state the joint implications of PPP and the monetary theory of the price level is to notice that, for given levels of the foreign country variables, a – once-an-for-all - rise in the domestic money supply will cause an equi-proportionate change in the domestic prices and in the exchange rate, i.e.

$$\Delta M/M=\Delta P/P=\Delta E/E.$$

- Note that in this case, once the new long-run equilibrium is reached, M, P, and E, will remain constant if no further changes in other (exogenous) variables take place.

- We turn now to cases in which there is continuous growth in domestic and foreign variables…

Money Growth, Inflation, and Depreciation

The U.S. money supply is M_{US}, and its growth rate is μ_{US}:

$$\mu_{US,t} = \underbrace{\frac{M_{US,t+1} - M_{US,t}}{M_{US,t}}}_{\text{Rate of money supply growth in U.S.}}$$

The growth rate of real income in the U.S. is g_{US}:

$$g_{US,t} = \underbrace{\frac{Y_{US,t+1} - Y_{US,t}}{Y_{US,t}}}_{\text{Rate of real income growth in U.S.}}$$

Putting all the pieces together, the growth rate of $P_{US} = M_{US}/\bar{L}_{US}Y_{US}$ equals the money supply growth rate μ_{US} minus the real income growth rate g_{US}. The growth rate of P_{US} is the inflation rate π_{US}. Thus, we know that:

$$\pi_{US,t} = \mu_{US,t} - g_{US,t} \qquad (14\text{-}4)$$

The rate of change of the European price level is calculated similarly:

$$\pi_{EUR,t} = \mu_{EUR,t} - g_{EUR,t} \qquad (14\text{-}5)$$

When money growth is higher than income growth, we have “more money chasing fewer goods” and this leads to inflation.

Combining Equation (14-4) and Equation (14-5), we can now solve for the inflation differential in terms of monetary fundamentals and finish our task of computing the rate of depreciation of the exchange rate:

$$\underbrace{\frac{\Delta E_{\$/€t}}{E_{\$/€,t}}}_{\substack{\text{Rate of depreciation}\\ \text{of the nominal exchange rate}}} = \underbrace{\pi_{US,t} - \pi_{EUR,t}}_{\text{Inflation differential}} = (\mu_{US,t} - g_{US,t}) - (\mu_{EUR,t} - g_{EUR,t}) \quad \textbf{(14-6)}$$

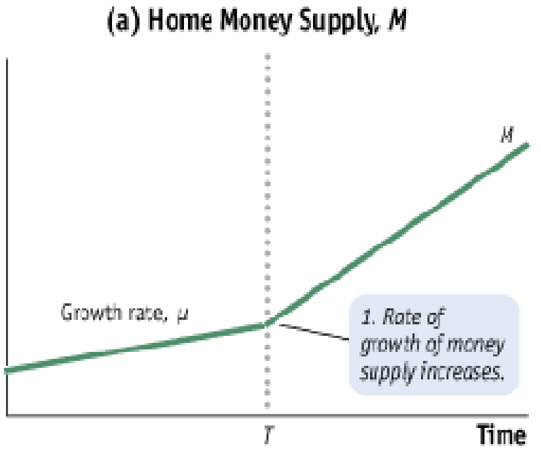
$$= \underbrace{(\mu_{US,t} - \mu_{EUR,t})}_{\substack{\text{Differential in}\\ \text{nominal money supply}\\ \text{growth rates}}} - \underbrace{(g_{US,t} - g_{EUR,t})}_{\substack{\text{Differential in}\\ \text{real output}\\ \text{growth rates}}}.$$

The intuition behind Equation (14-6) is as follows:

- If the United States runs a looser monetary policy in the long run measured by a faster money growth rate, the dollar will depreciate more rapidly, all else equal.
- If the U.S. economy grows faster in the long run, the dollar will appreciate more rapidly, all else equal.

A Diagrammatic Example of a Permanent Increase in the Growth Rate of the Money Supply

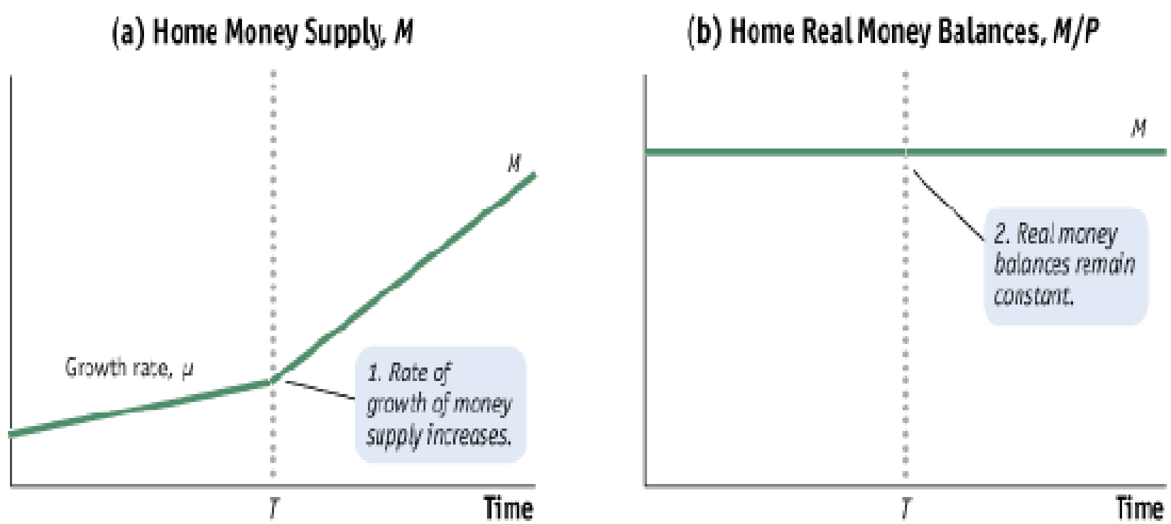
FIGURE 14-6 (1 of 4)



An Increase in the Growth Rate of the Money Supply in the Simple Model

Before time T, money, prices, and the exchange rate all grow at rate μ. Foreign prices are constant.

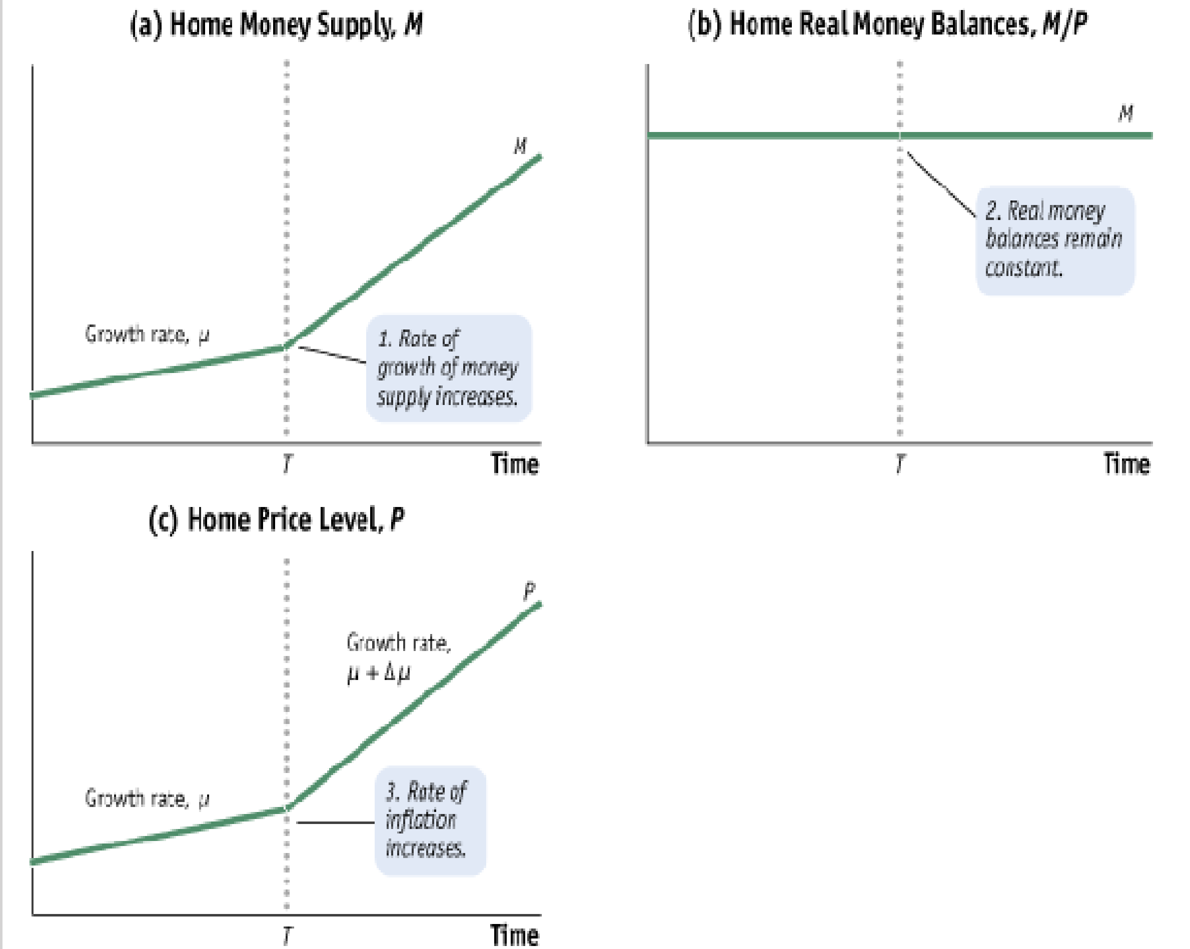
In panel (a), we suppose at time T there is an increase $\Delta\mu$ in the rate of growth of home money supply M.



An Increase in the Growth Rate of the Money Supply in the Simple Model (continued)

In panel (b), the quantity theory assumes that the level of real money balances remains unchanged.

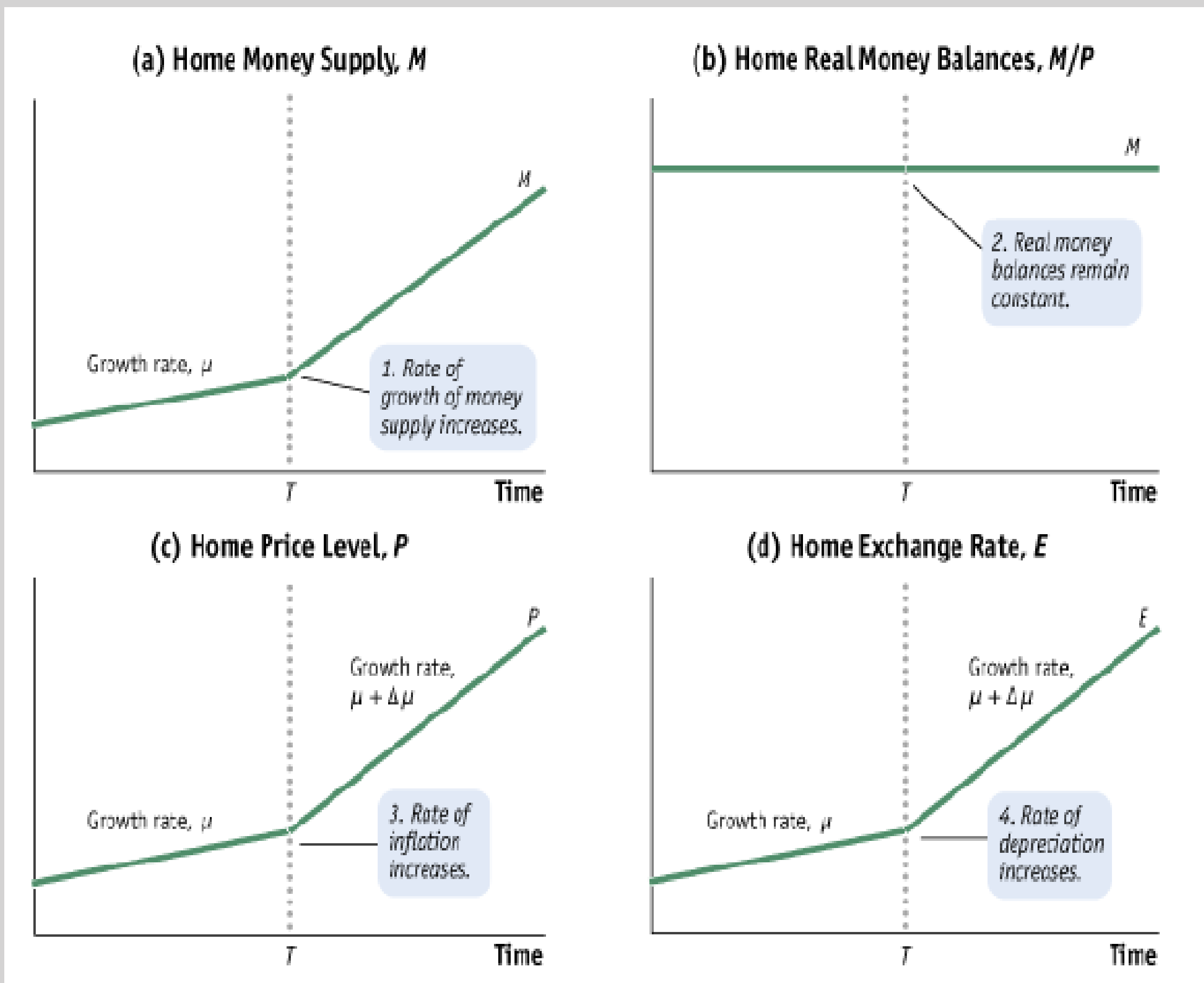
FIGURE 14-6 (3 of 4)



An Increase in the Growth Rate of the Money Supply in the Simple Model (continued)

After time T, if real money balances (M/P) are constant, then money M and prices P still grow at the same rate, which is now $\mu + \Delta\mu$, so the rate of inflation rises by $\Delta\mu$, as shown in panel (c).

FIGURE 14-6 (4 of 4)

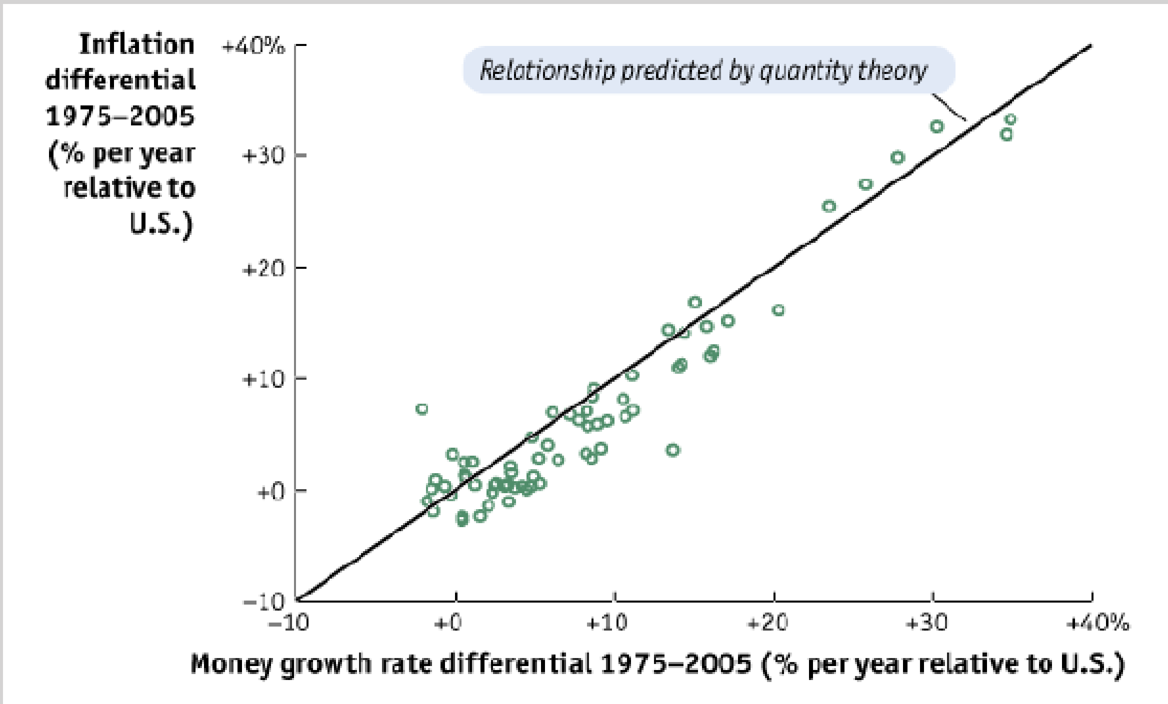


An Increase in the Growth Rate of the Money Supply in the Simple Model (continued)

PPP and an assumed stable foreign price level imply that the exchange rate will follow a path similar to that of the domestic price level, so *E* also grows at the new rate $\mu + \Delta\mu$, and the rate of depreciation rises by $\Delta\mu$, as shown in panel (d).

Evidence for the Monetary Approach

FIGURE 14-7

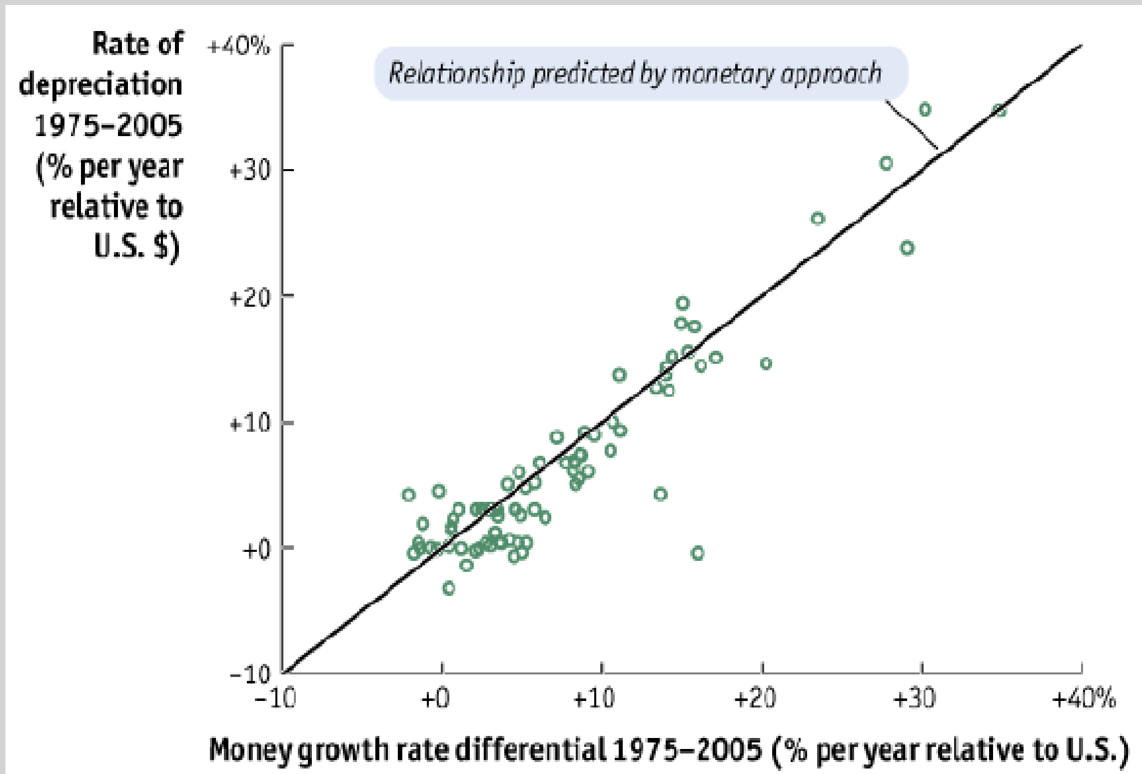


Inflation Rates and Money Growth Rates, 1975–2005

This scatterplot shows the relationship between the rate of inflation and the money supply growth rate over the long run, based on data for a sample of 76 countries.

The correlation between the two variables is strong and bears a close resemblance to the theoretical prediction of the monetary model that all data points would appear on the 45-degree line.

FIGURE 14-8

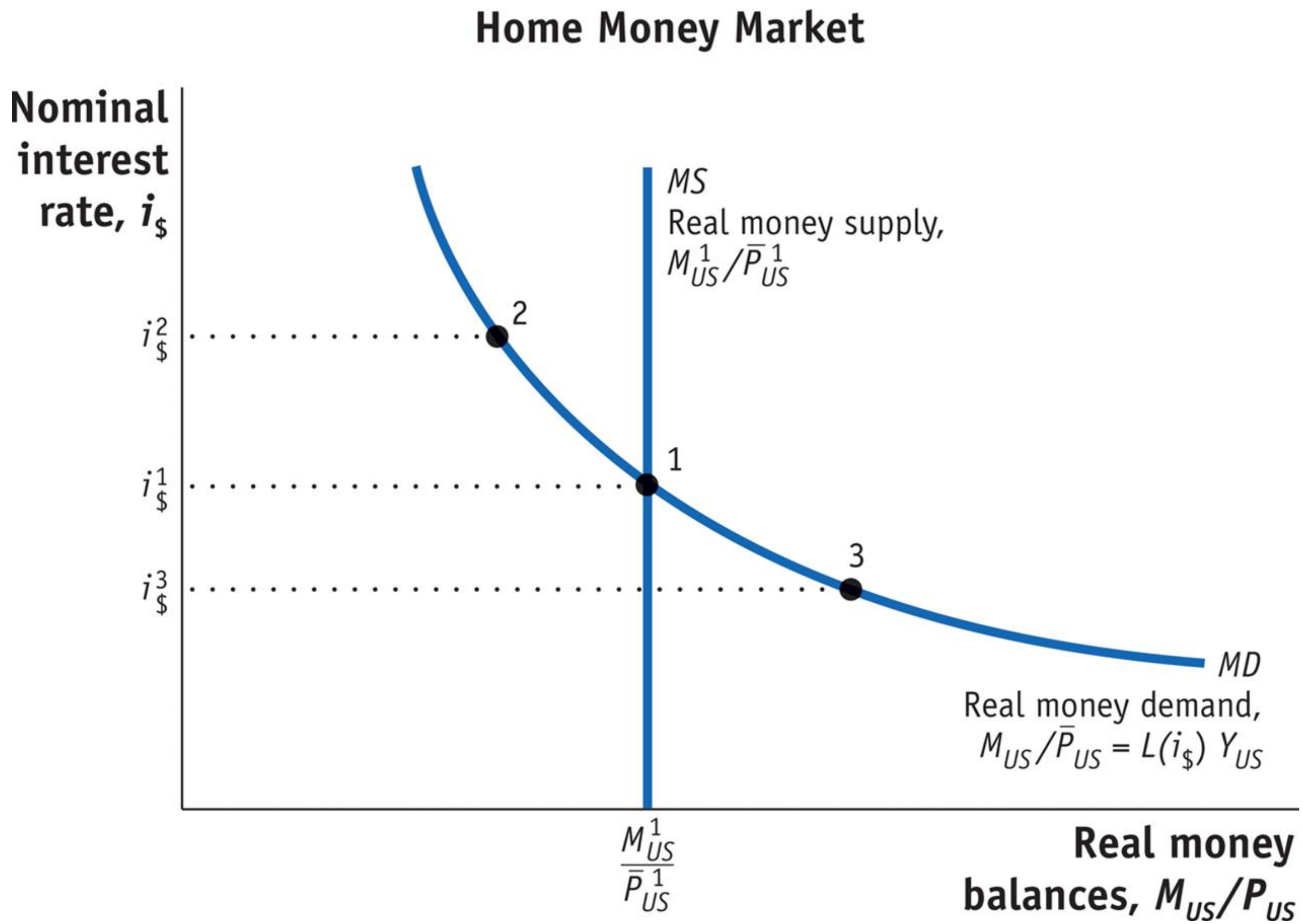


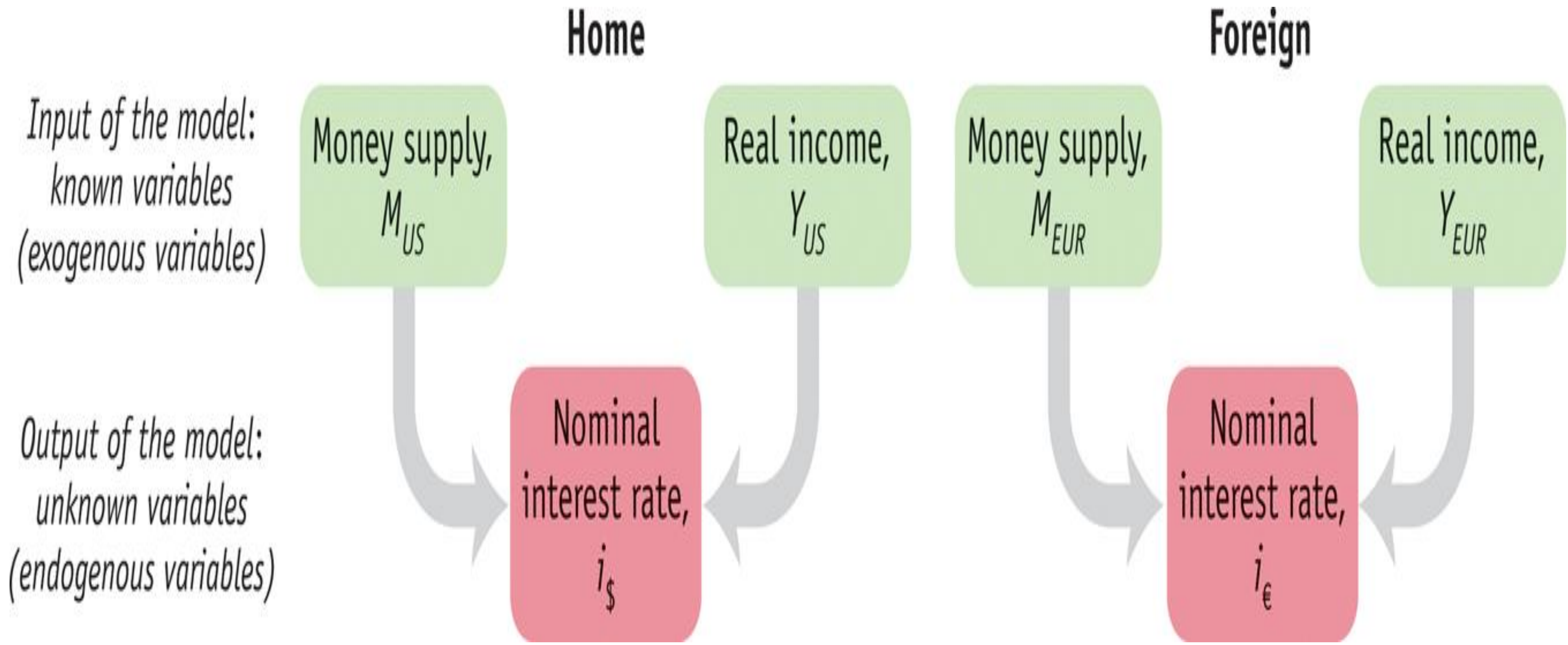
Money Growth Rates and the Exchange Rate, 1975–2005

This scatterplot shows the relationship between the rate of exchange rate depreciation and the money growth rate differential relative to the United States over the long run, based on data for a sample of 82 countries.

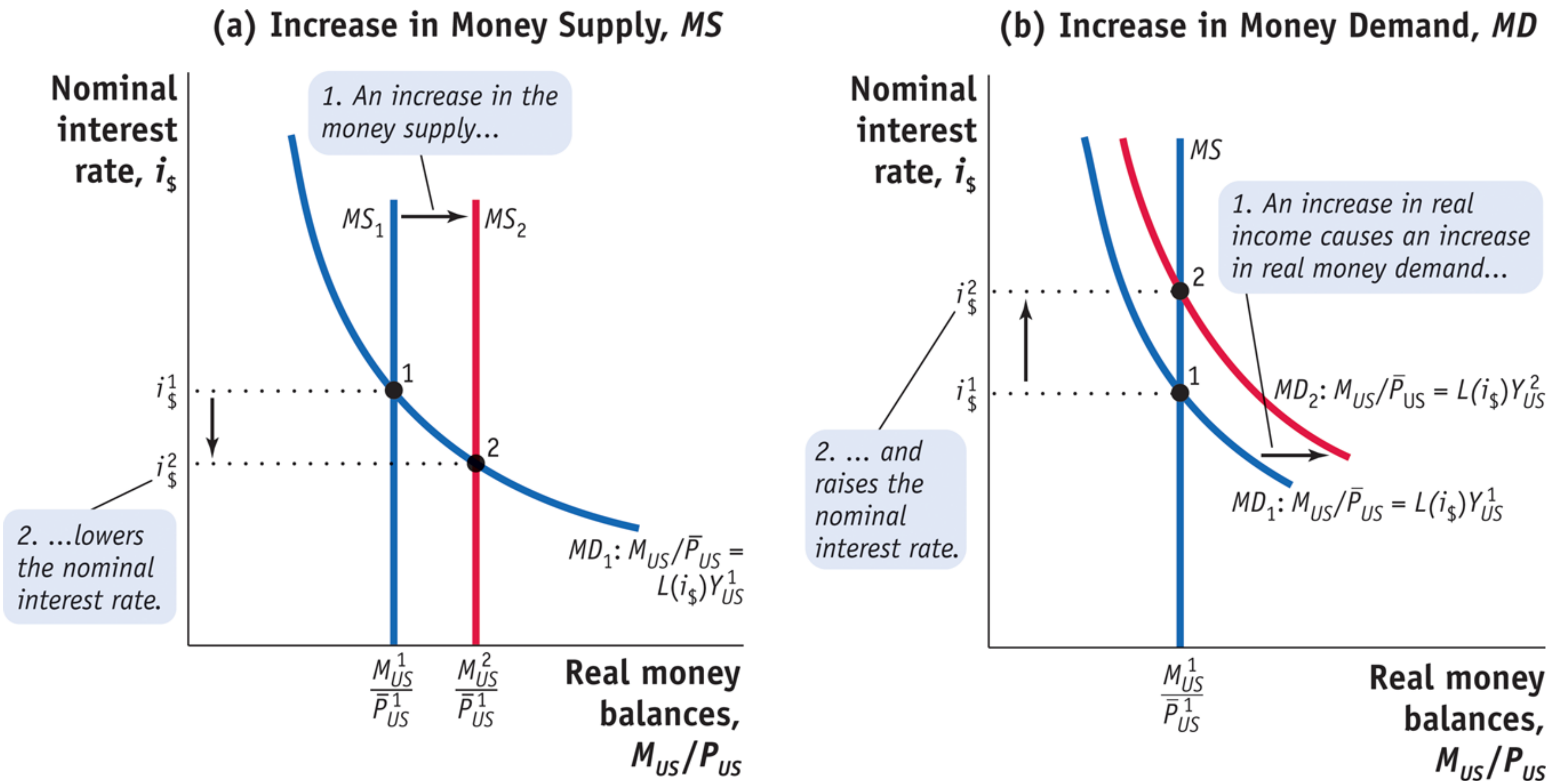
The data show a strong correlation between the two variables and a close resemblance to the theoretical prediction of the monetary approach to exchange rates, which would predict that all data points would appear on the 45-degree line.

Exchange Rate Determination in the Long Run

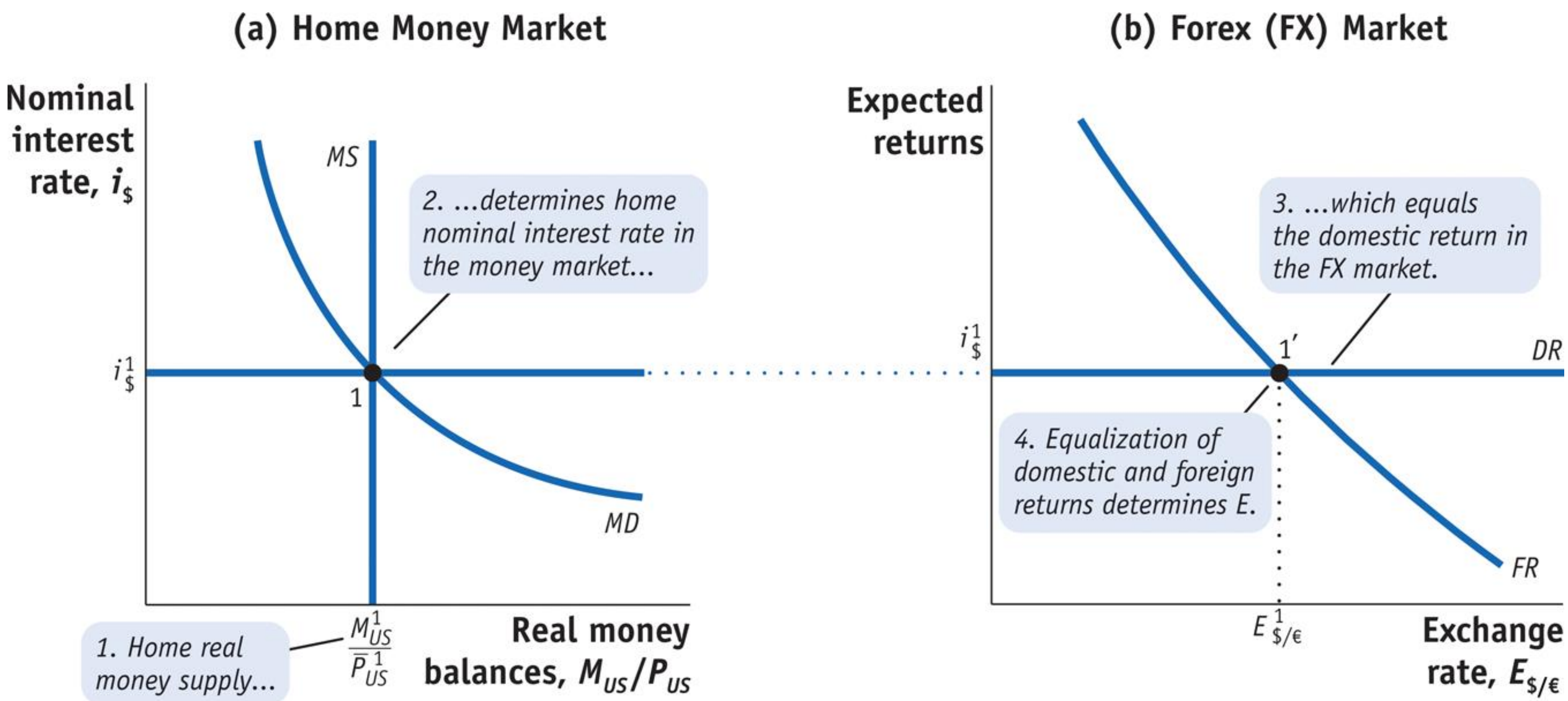



Home
Foreign
Input of the model:
known variables
(exogenous variables)
Money supply,
M_{US}
Real income,
Y_{US}
Money supply,
M_{EUR}
Real income,
Y_{EUR}
Output of the model:
unknown variables
(endogenous variables)
Nominal
interest rate,
$i_{\$}$
Nominal
interest rate,
$i_{€}$

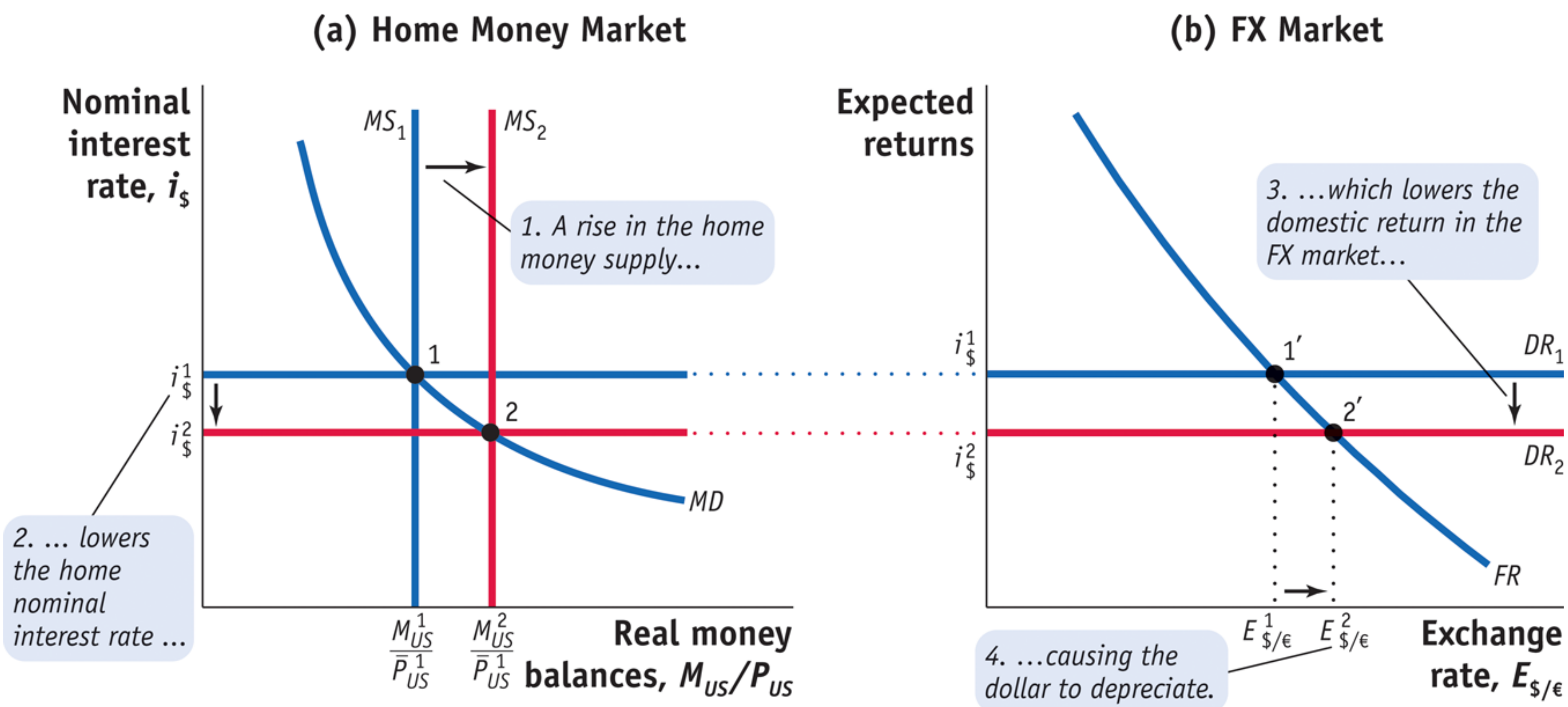
Effects of Changes in Money Supply and Money Demand



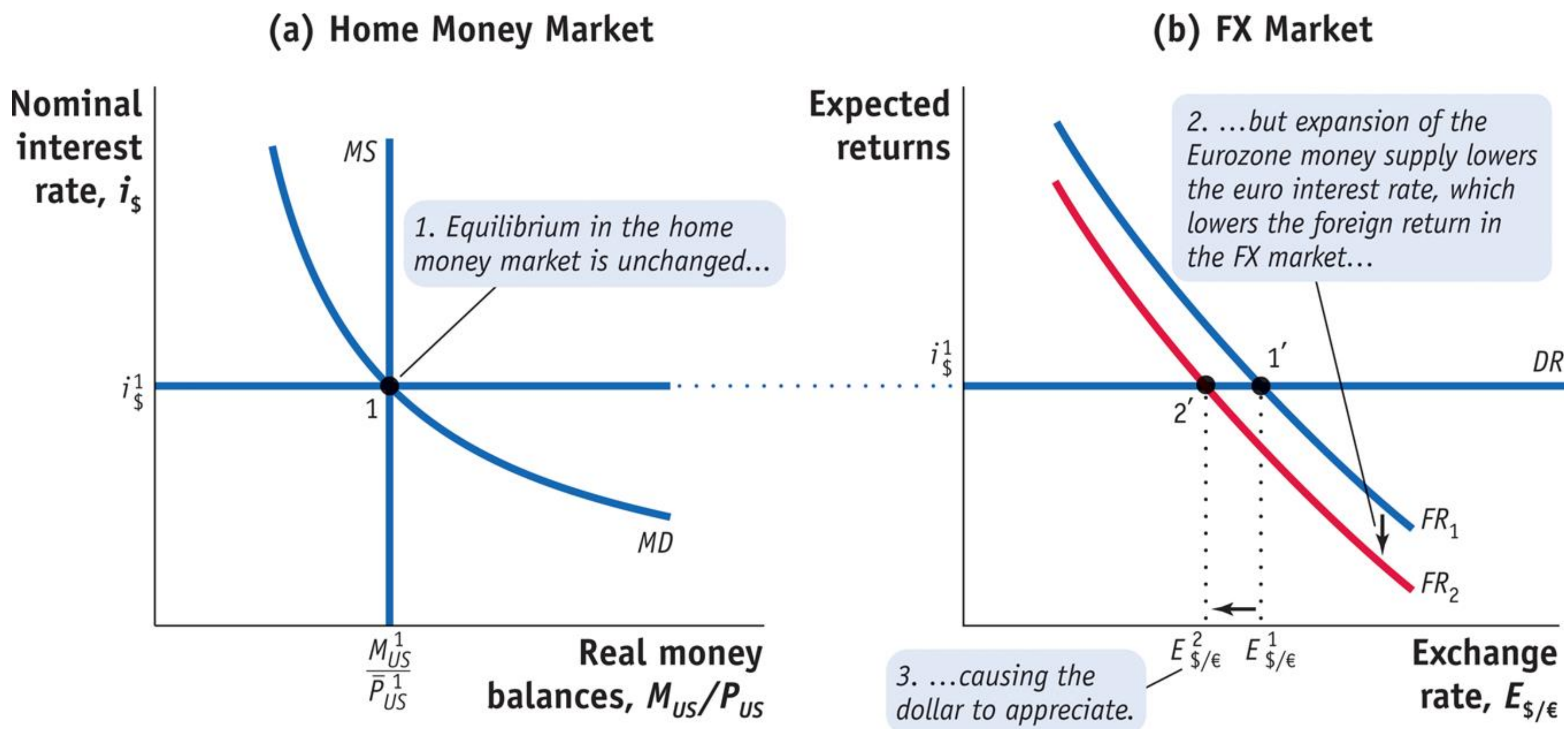
Equilibrium in the Money and FX Markets (SR)



Domestic money supply expansion

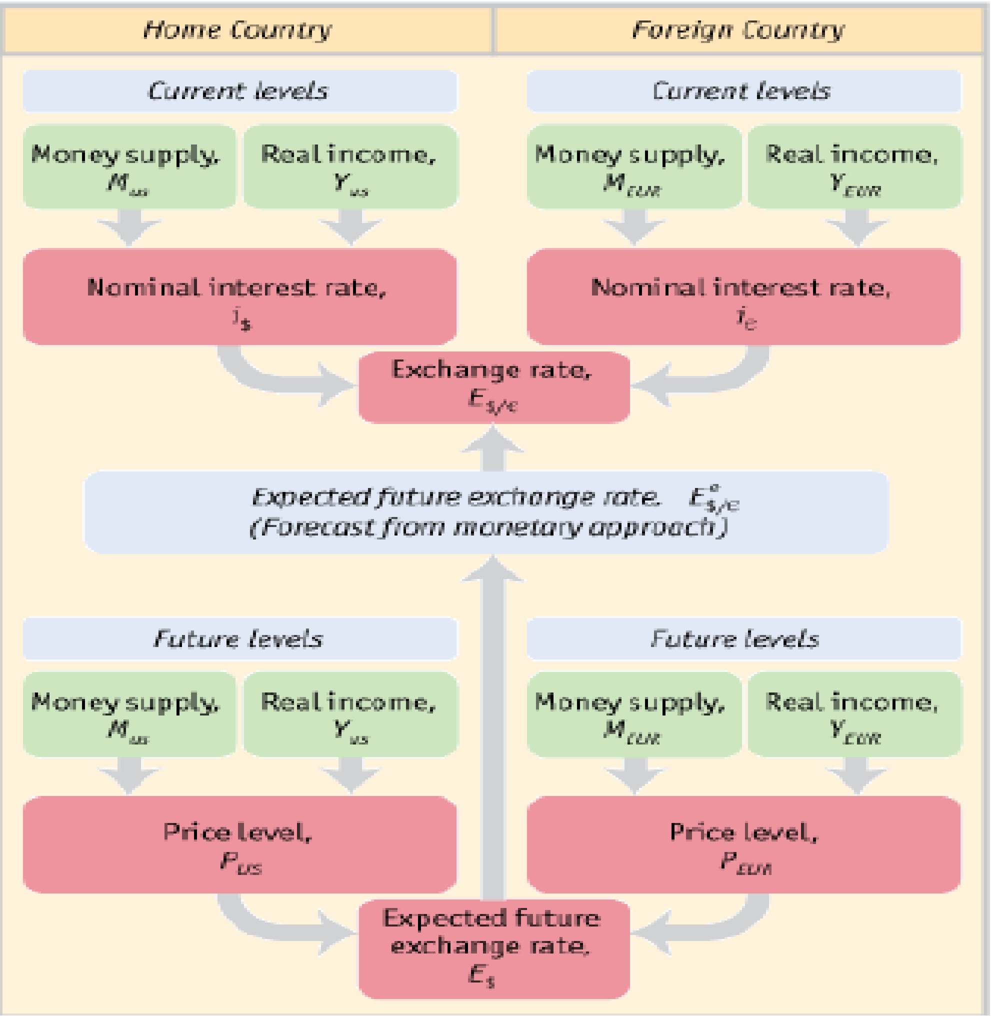


Increase in Foreign Money Supply



Putting the asset and monetary approaches together

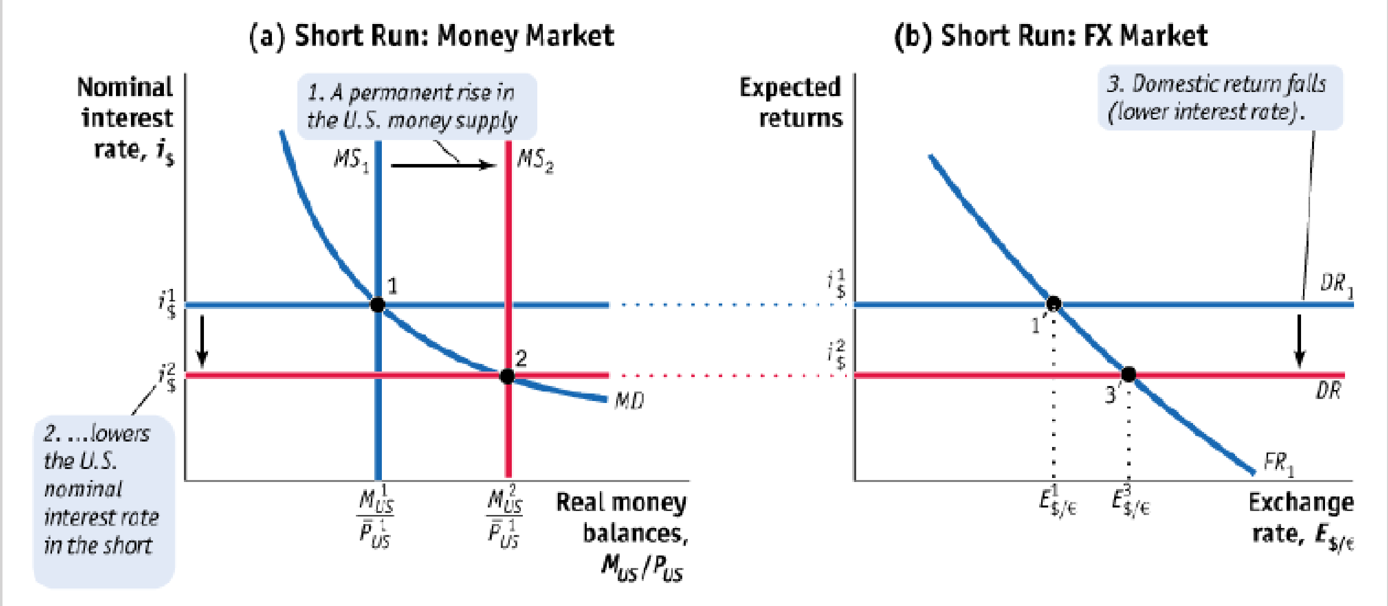
The expected future exchange rate is now endogenous and depends on changes in domestic (and foreign) policy variables…



A Complete Theory of Floating Exchange Rates: All the Building Blocks Together

Inputs to the model are known exogenous variables (in green boxes). Outputs of the model are unknown endogenous variables (in red boxes). The levels of money supply and real income determine exchange rates.

FIGURE 15-12 (1 of 4)

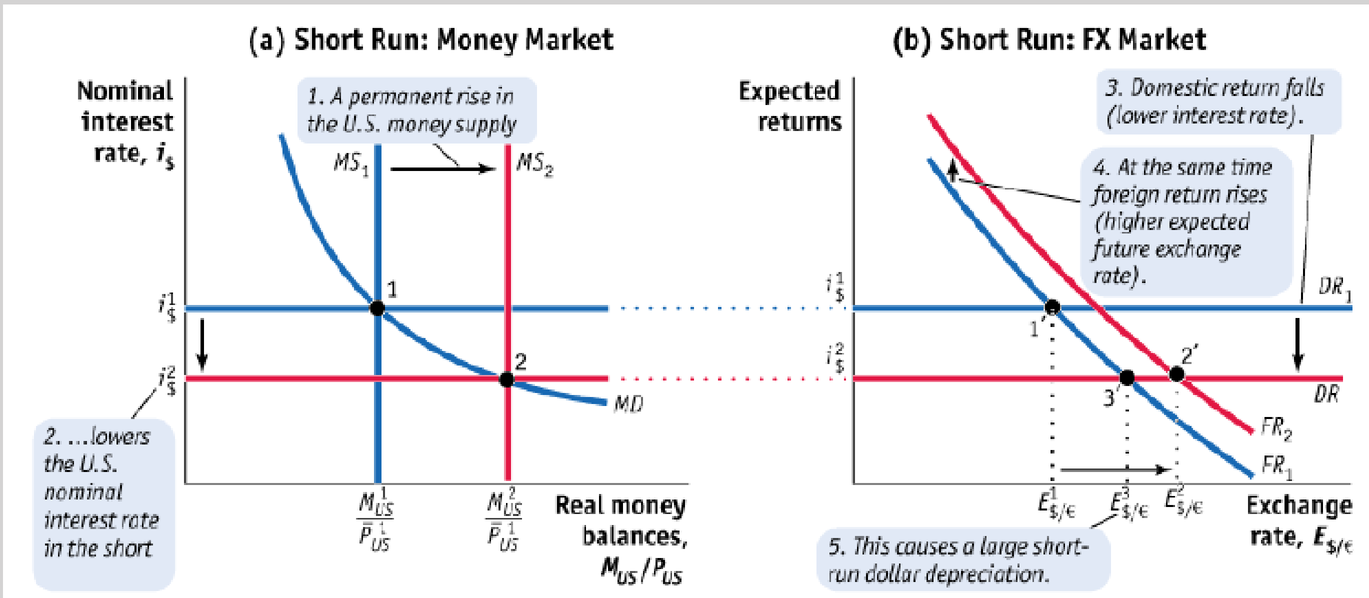


Permanent Expansion of the Home Money Supply Short-Run Impact:

In panel (a), the home price level is fixed, but the supply of dollar balances increases and real money supply shifts out. To restore equilibrium at point 2, the interest rate falls from $i^1_\$$ to $i^2_\$$.

In panel (b), in the FX market, the home interest rate falls, so the domestic return decreases and *DR* shifts down. In addition, the permanent change in the home money supply implies a permanent, long-run depreciation of the dollar.

FIGURE 15-12 (2 of 4)

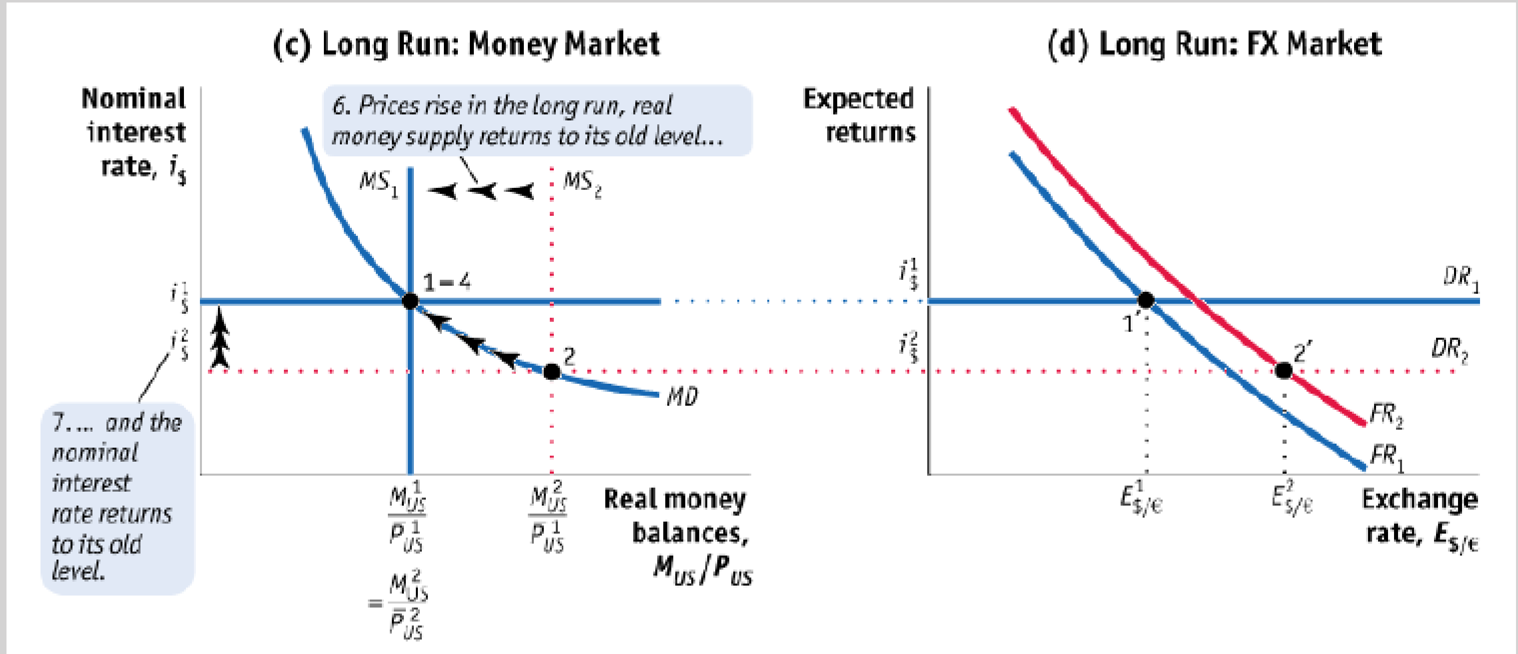


Permanent Expansion of the Home Money Supply Short-Run Impact: (continued)

Hence, there is also a permanent rise in $E^e\$/€$, which causes a permanent increase in the foreign return $i_€ + (E^e_{\$/€} - E_{\$/€})/E_{\$/€}$, all else equal; ***FR*** shifts up from FR_1 to FR_2.

The simultaneous fall in ***DR*** and rise in ***FR*** cause the home currency to depreciate steeply, leading to a new equilibrium at point 2′ (and not at 3′, which would be the equilibrium if the policy were temporary).

FIGURE 15-12 (3 of 4)

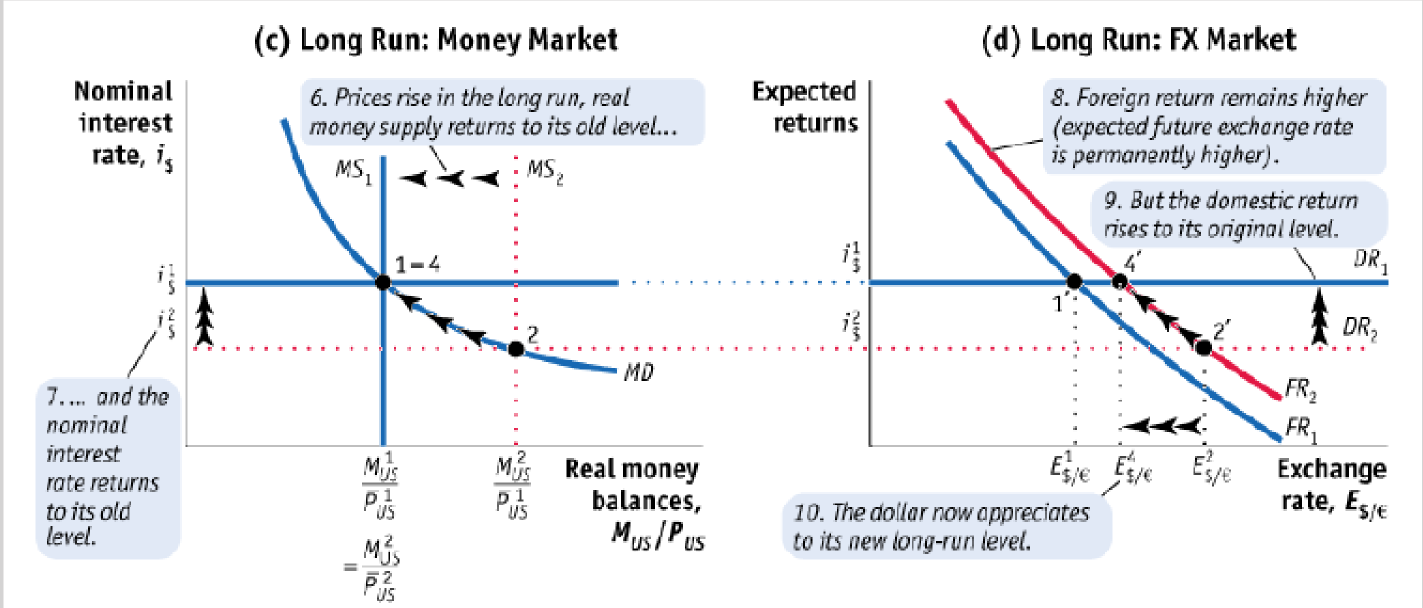


Long-Run Adjustment:

In panel (c), in the long run, prices are flexible, so the home price level and the exchange rate both rise in proportion with the money supply. Prices rise to $\overline{P}^2_{US}$, and real money supply returns to its original level $M^1_{US}/\overline{P}^1_{US}$.

The money market gradually shifts back to equilibrium at point 4 (the same as point 1).

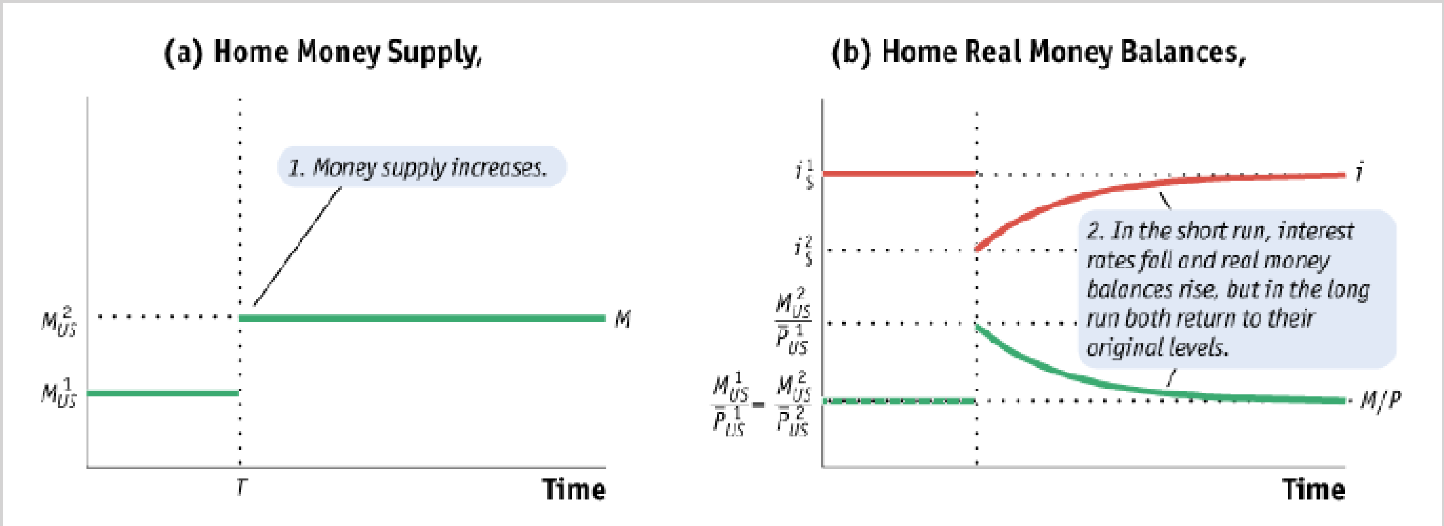
FIGURE 15-12 (4 of 4)



Long-Run Adjustment: (continued) In panel (d), in the FX market, the domestic return *DR*, which equals the home interest rate, gradually shifts back to its original level. The foreign return curve *FR* does not move at all: there are no further changes in the Foreign interest rate or in the future expected exchange rate.

The FX market equilibrium shifts gradually to point 4′. The exchange rate falls (and the dollar appreciates) from $E^2_{\$/€}$ to $E^4_{\$/€}$. Arrows in both graphs show the path of gradual adjustment.

FIGURE 15-13 (1 of 2)



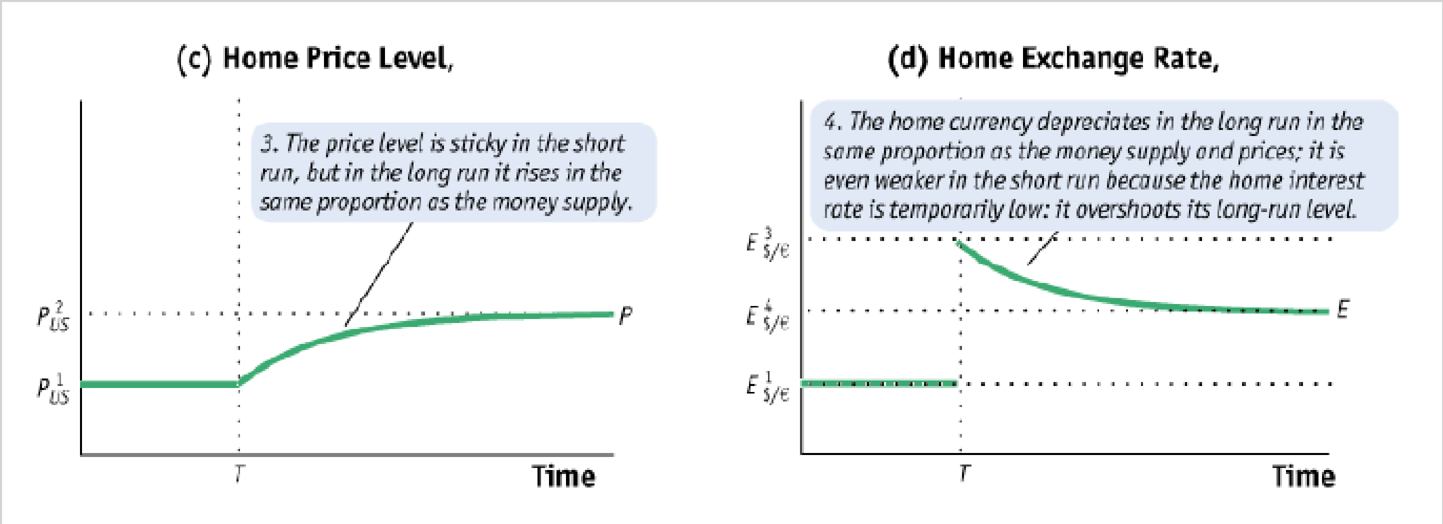
Responses to a Permanent Expansion of the Home Money Supply

In panel (a), there is a one-time permanent increase in home (U.S.) nominal money supply at time *T*.

In panel (b), prices are sticky in the short run, so there is a short-run increase in the real money supply and a fall in the home interest rate.

Overshooting

FIGURE 15-13 (2 of 2)



Responses to a Permanent Expansion of the Home Money Supply (continued)

In panel (c), in the long run, prices rise in the same proportion as the money supply.

In panel (d), in the short run, the exchange rate overshoots its long-run value (the dollar depreciates by a large amount), but in the long run, the exchange rate will have risen only in proportion to changes in money and prices.

*The implication of overshooting is that in the short run PPP does not hold: during the adjustment towards the new long run equilibrium domestic prices are **rising and** the exchange rate is **appreciating.***