Lecture Three
Theories of Exchange Rate

Fan Xiaoyan

SOE, Fudan University

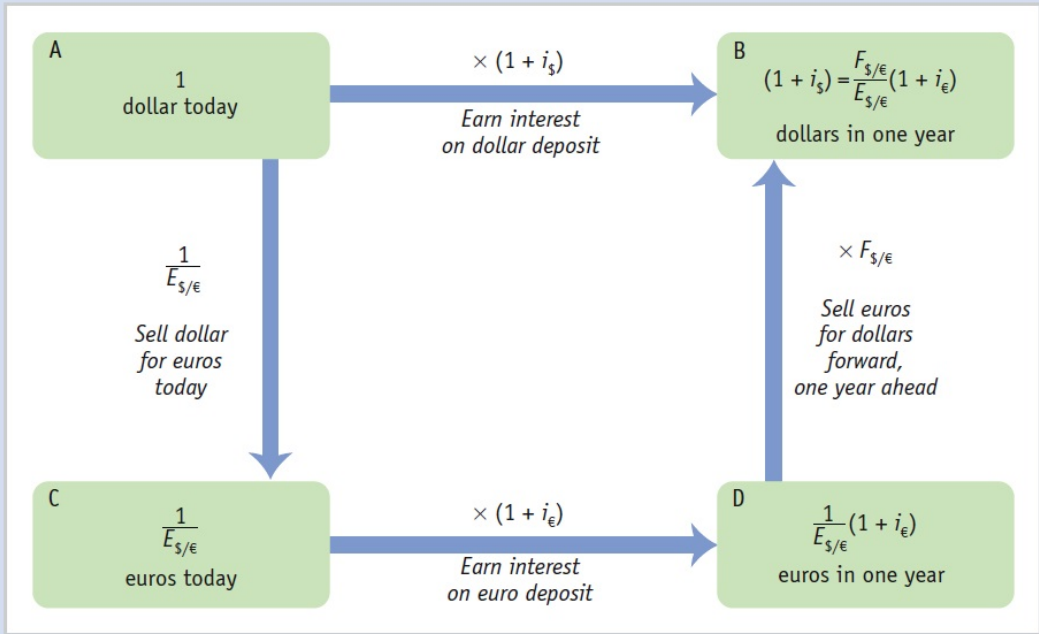
Outline

1. Covered and Uncovered Interest Parity (CIP, UIP)
2. Purchase Power Parity (PPP)
3. The Monetary Approach in the Long Run
4. The Asset Approach in the Short Run
5. Exercise by Group

Covered Interest Parity(CIP)

$$1 + i = \frac{F}{E}(1 + i^*)$$

FIGURE 2-8



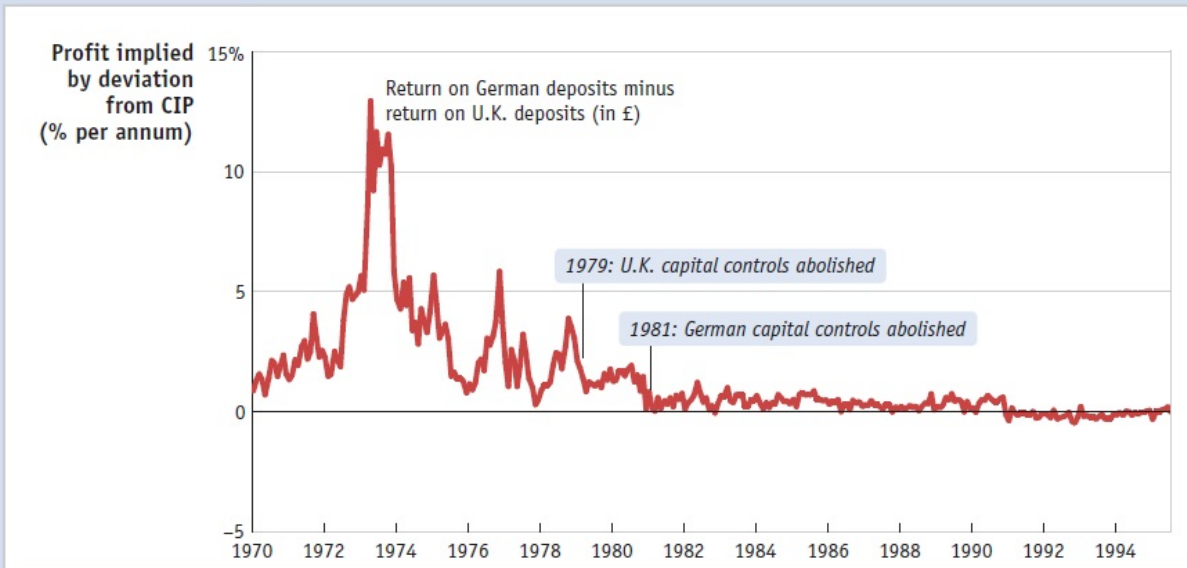
Arbitrage and Covered Interest Parity Under CIP, returns to holding dollar deposits accruing interest going along the path AB must equal the returns from investing in euros going along the path ACDB with risk removed by use of a forward contract. Hence, at B, the riskless payoff must be the same on both paths, and $(1 + i_\$) = \frac{F_{\$/€}}{E_{\$/€}}(1 + i_€)$.

The above expression is called covered interest parity (CIP) because all exchange rate risk on the euro side has been covered by use of the forward contract.

Evidence on Covered Interest Parity

$$Profit = \frac{F}{E}(1+i^*) - (1+i)$$

FIGURE 2-9



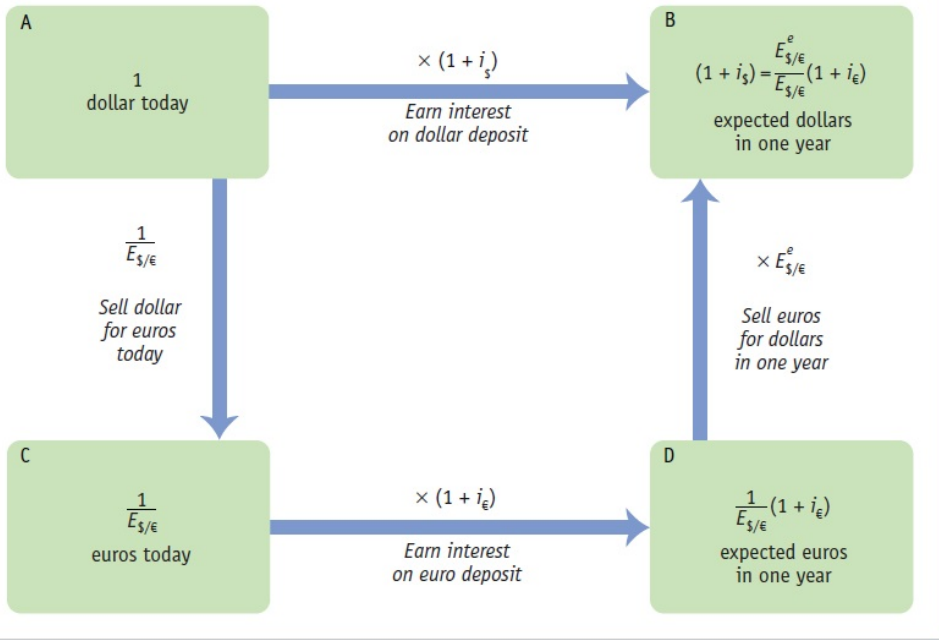
Financial Liberalization and Covered Interest Parity: Arbitrage between the United Kingdom and Germany The chart shows the difference in monthly pound returns on deposits in British pounds and German marks using forward cover from 1970 to 1995. In the 1970s, the difference was positive and often large: traders would have profited from arbitrage by moving money from pound deposits to mark deposits, but capital controls prevented them from freely doing so. After financial liberalization, these profits essentially vanished, and no arbitrage opportunities remained. The CIP condition held, aside from small deviations resulting from transactions costs and measurement errors.

Source: Maurice Obstfeld and Alan M. Taylor, 2004, Global Capital Markets: Integration, Crisis, and Growth, *Japan–U.S. Center Sanwa Monographs on International Financial Markets (Cambridge, UK: Cambridge University Press).*

Uncovered Interest Parity(UIP)

$$1 + i = \frac{E^e}{E}(1 + i^*)$$

FIGURE 2-10



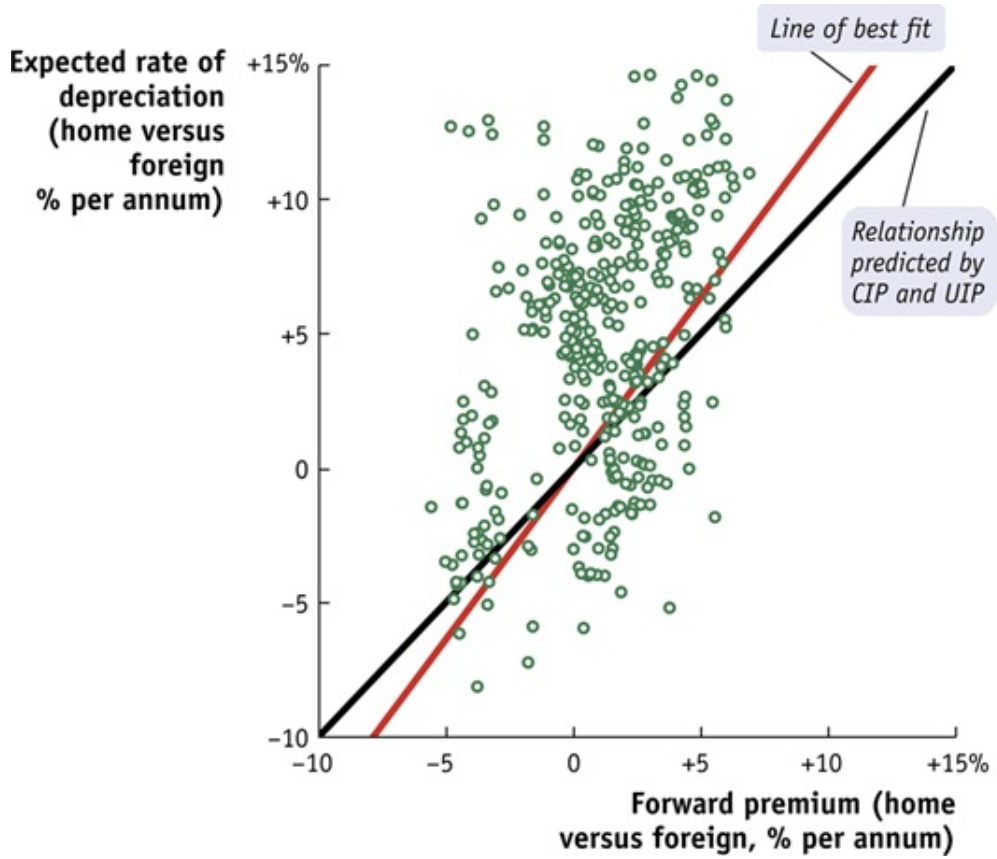
Arbitrage and Uncovered Interest Parity Under UIP, returns to holding dollar deposits accruing interest going along the path AB must equal the *expected* returns from investing in euros going along the risky path ACDB. Hence, at B, the expected payoff must be the same on both paths, and $(1 + i_\$) = \frac{E^e_{\$/€}}{E_{\$/€}}(1 + i_€)$.

The uncovered interest parity (UIP) means that exchange rate risk has been left uncovered by the decision not to hedge against exchange rate risk by using a forward contract and instead simply wait to use a spot contract in a year's time.

Evidence on Uncovered Interest Parity

If $F = E^e$ and both of CIP and UIP hold, then there will be:

$$\underbrace{F/E - 1}_{\text{Forward premium}} = \underbrace{E^e/E - 1}_{\text{Expected rate of depreciation}}$$



Uncovered Interest Parity: A Useful Approximation

$$1 + i = \frac{E^e}{E}(1 + i^*)$$

$$\frac{E^e}{E} - 1 = \frac{1+i}{1+i^*} - 1 = \frac{i-i^*}{1+i^*}$$

$$\left(\frac{E^e}{E} - 1\right)(1 + i^*) = \frac{E^e}{E} - 1 + \left(\frac{E^e}{E} - 1\right) i^* = i - i^*$$

$$\underbrace{\frac{E^e}{E} - 1}_{\text{Expected rate of depreciation}} \approx \underbrace{i - i^*}_{\text{Interest rate gap}}$$

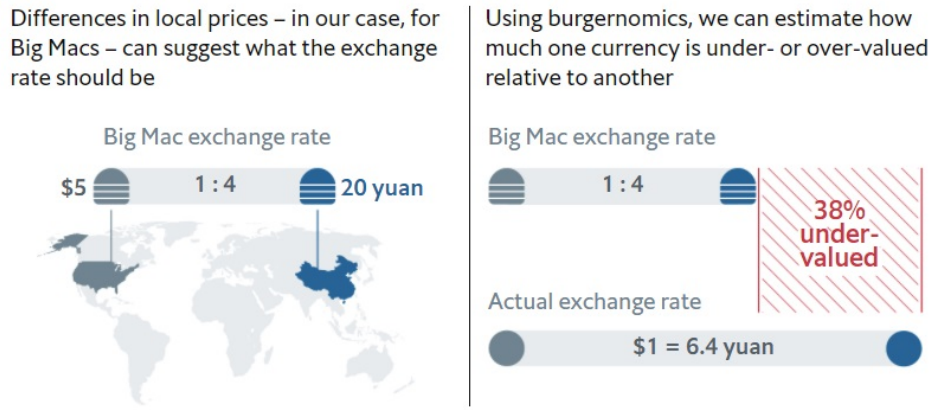
The Law of One Price(LOOP)

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 seller or buyer has the 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.

$$P_{\$} E_{¥/\$} = P_{¥}$$

With the notations of P^* and P as foreign and domestic price index respectively, we have:

$$P^* E = P$$



Source: The Big Mac index in *The Economist*.

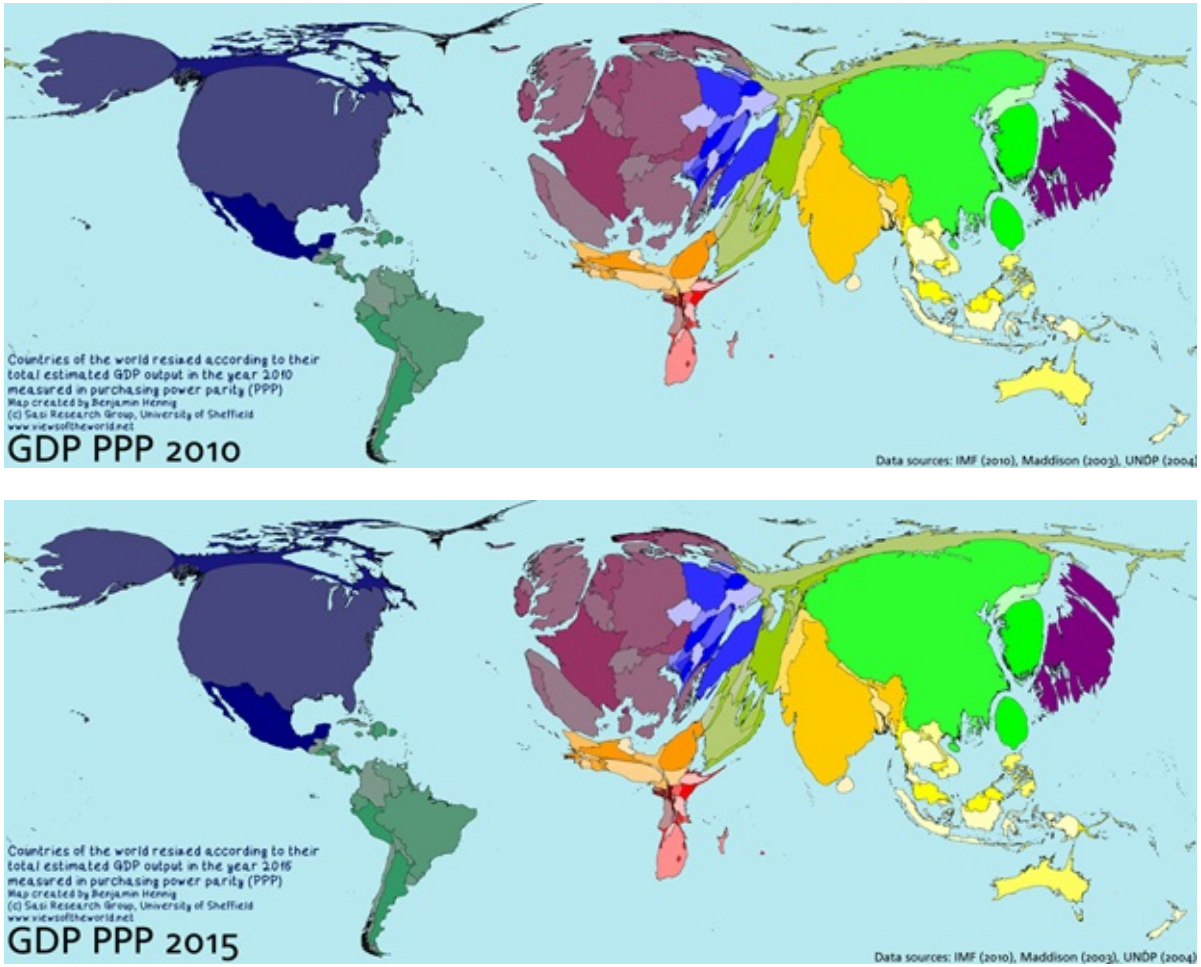
Real Exchange Rate, e

The real exchange rate tells us how many domestic baskets are needed to purchase one foreign basket, which can be calculated with the following fomula:

$$e = \frac{EP^*}{P}$$

- The real exchange rate rises/falls (more/fewer Home goods are needed in exchange for Foreign goods), we say Home has experienced a real depreciation/appreciation.
- When the law of one price (LOOP) holds for all goods, there is $e = 1$.

GDP adjusted by real exchange rate



Source: Views of the World.

Definition: Purchase Power Parity (PPP)

The principle of purchasing power parity (PPP) could be derived from the real exchange rate formula:

$$E = \frac{eP}{P^*}$$

- Absolute PPP holds when price levels in two countries are equal when expressed in a common currency.

$$E = \frac{P}{P^*}$$

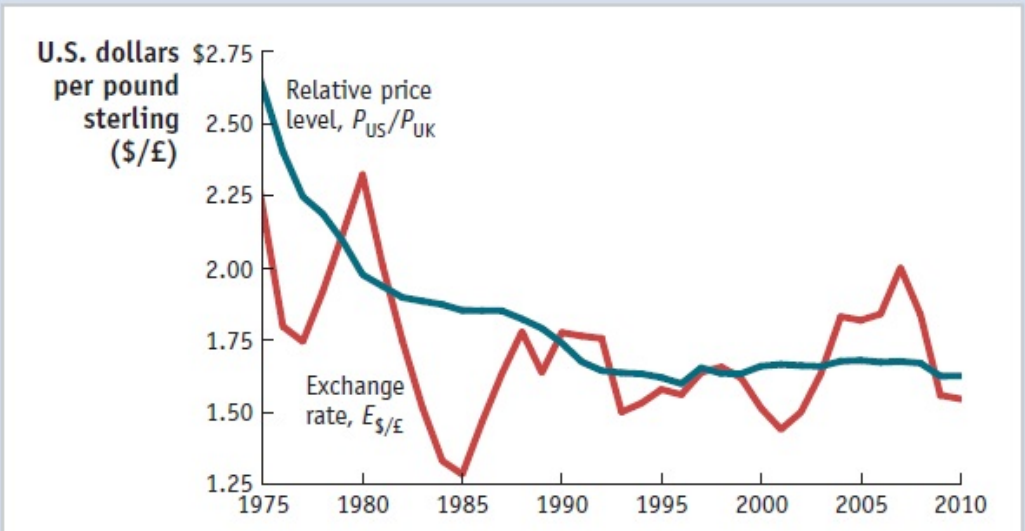
- Relative PPP implies that the rate of depreciation of the nominal exchange rate equals the difference between the inflation rates of two countries (the inflation differential).

$$\frac{\Delta E}{E} = \pi - \pi^*$$

Evidence of absolute PPP

In the short term, the exchange rate deviates significantly from the predicted value of the absolute PPP, but the movement trend is consistent with the theoretical prediction in the long run.

FIGURE 3-3



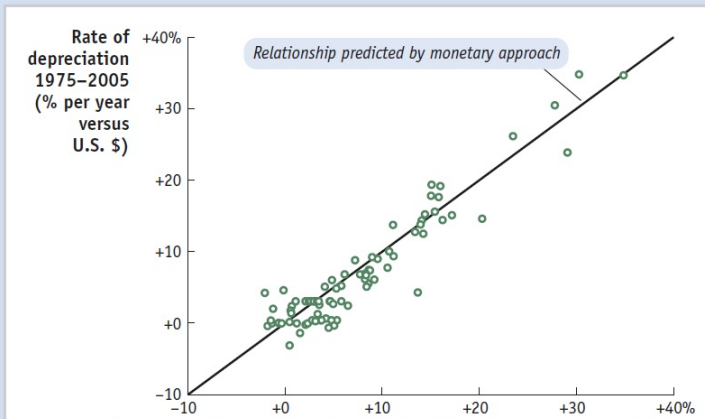
Exchange Rates and Relative Price Levels Data for the United States and United Kingdom for 1975 to 2010 show that the exchange rate and relative price levels do not always move together in the short run. Relative price levels tend to change slowly and have a small range of movement; exchange rates move more abruptly and experience large fluctuations. Therefore, relative PPP does *not* hold in the short run. However, it is a better guide to the long run, and we can see that the two series do tend to drift together over the decades.

Source: Penn World Table, version 7.1.

Evidence of relative PPP

Relative PPP is an approximate, useful guide to the relationship between prices and exchange rates in the long run, over horizons of many years or decades.

FIGURE 3-8

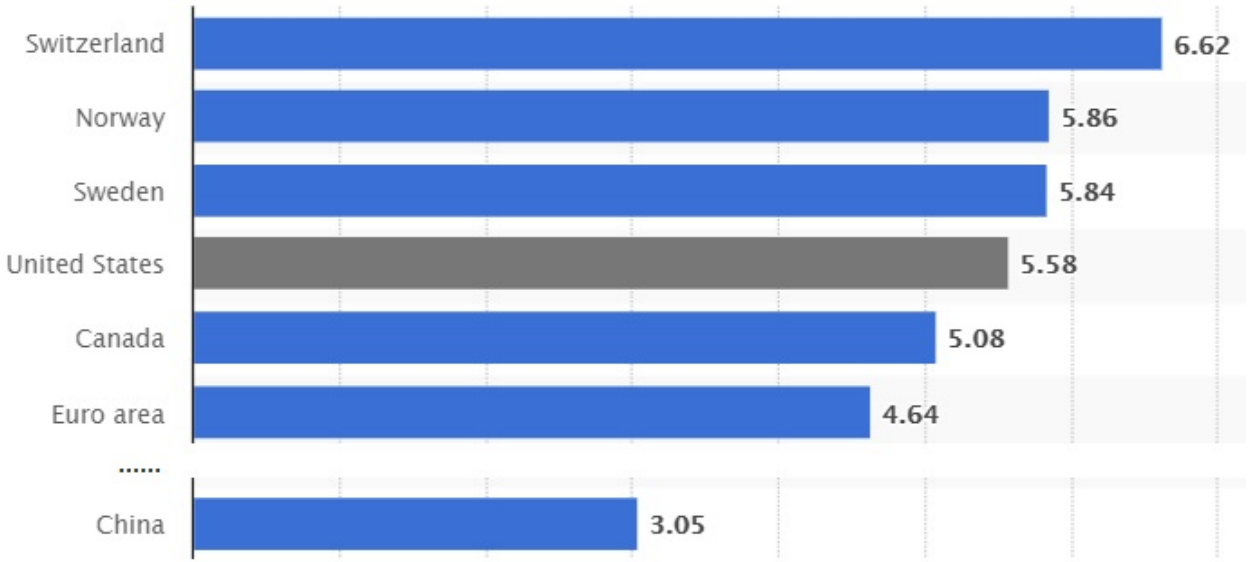


Money Growth Rates and the Exchange Rate, 1975–2005 This scatterplot shows the relationship between the rate of exchange rate depreciation against the U.S. dollar and the money growth rate differential versus the United States over the long run, based on data for a sample of 82 countries. The data show 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.

Source: IMF, International Financial Statistics.

What Explains Deviations from PPP?

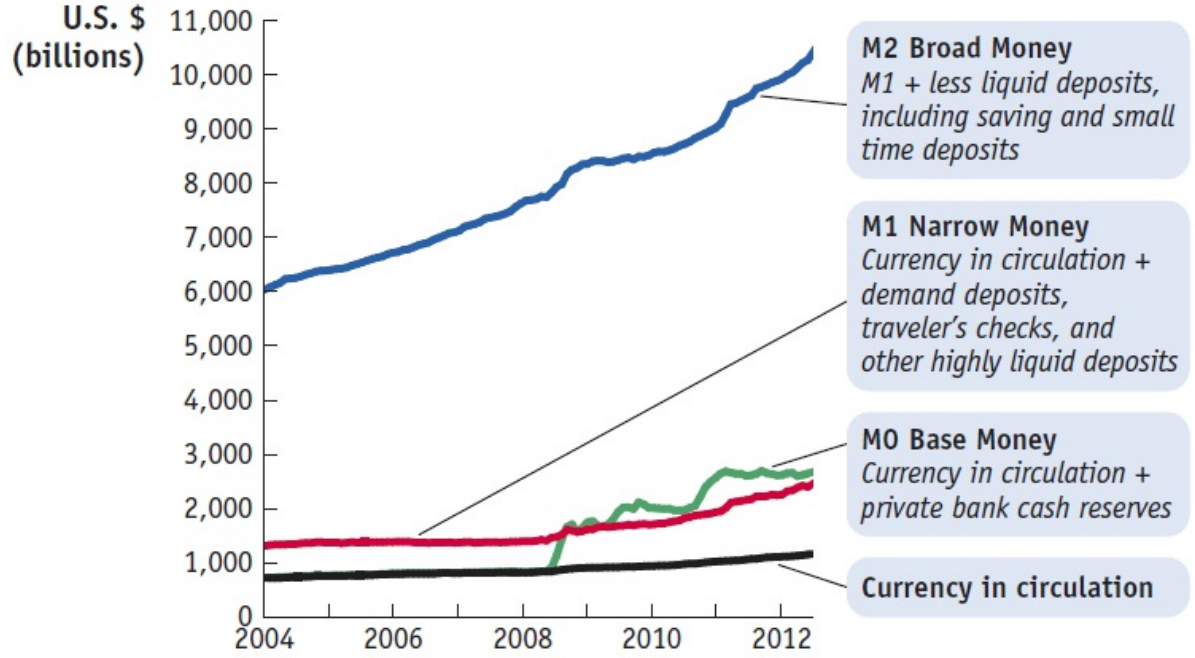
- Transaction costs.
- Nontraded goods.
- Imperfect competition and legal obstacles.



Source: Big Mac index - global prices for a Big Mac in January 2019, by country (in U.S. dollars).

The Measurement of Money

FIGURE 3-4

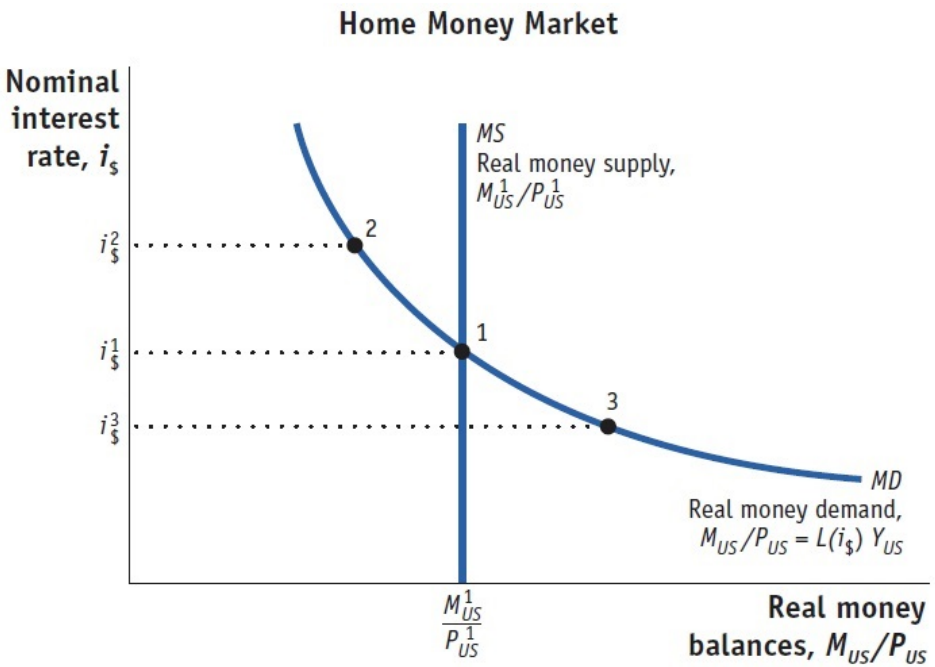


The Measurement of Money This figure shows the major kinds of monetary aggregates (currency, M0, M1, and M2) for the United States from 2004 to 2010. Normally, bank reserves are very close to zero, so M0 and currency are virtually identical, but reserves spiked up during the financial crisis in 2008, as private banks sold securities to the Fed and stored up the cash proceeds in their Fed reserve accounts as a precautionary hoard of liquidity.

Source: Federal Reserve Economic Data (FRED).

The Equilibrium of Money Market

$$\frac{M}{P} = L(i)Y$$



- In the short run, the aggregate price is fixed. $P = \bar{P}$
- In the long run, the aggregate price P is flexible.

A Simple Monetary Model of the Exchange Rate ($L = \bar{L}$)

- Suppose $L = \bar{L}$, the money market equilibrium is ($\mu = \frac{\Delta M}{M}, g = \frac{\Delta Y}{Y}$):

$$\frac{M}{P} = \bar{L}Y \Leftrightarrow \pi = \mu - g$$

- The absolute PPP and relative PPP conditions are:

$$E = \frac{P}{P^*} \Leftrightarrow \frac{\Delta E}{E} = \pi - \pi^*$$

Combine the above conditions, there is:

$$E = \frac{M}{\bar{L}Y}\frac{\bar{L}^*Y^*}{M^*}, \quad \frac{\Delta E}{E} = (\mu - \mu^*) - (g - g^*)$$

Implication of the Simple Model

$$E = \frac{M}{\bar{L}Y}\frac{\bar{L}^*Y^*}{M^*}, \quad \frac{\Delta E}{E} = (\mu - \mu^*) - (g - g^*)$$

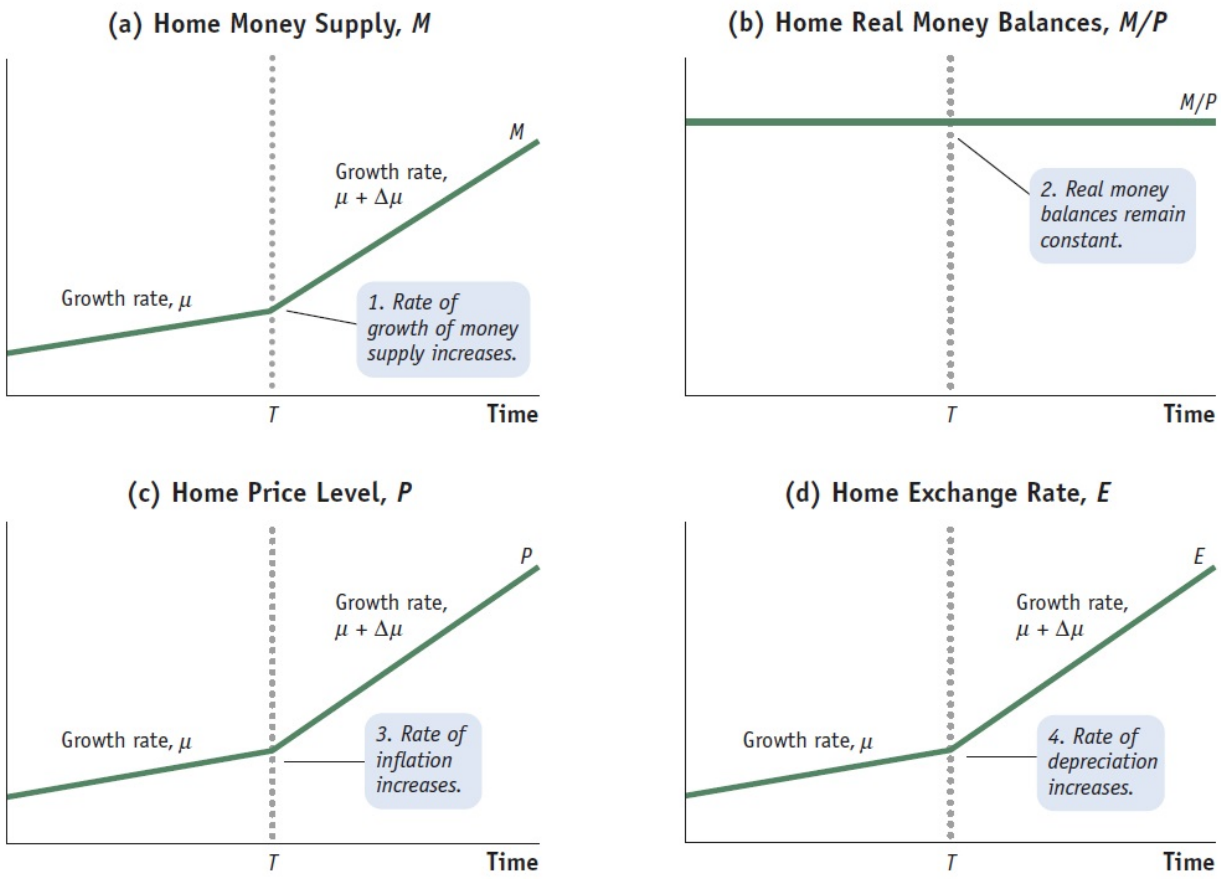


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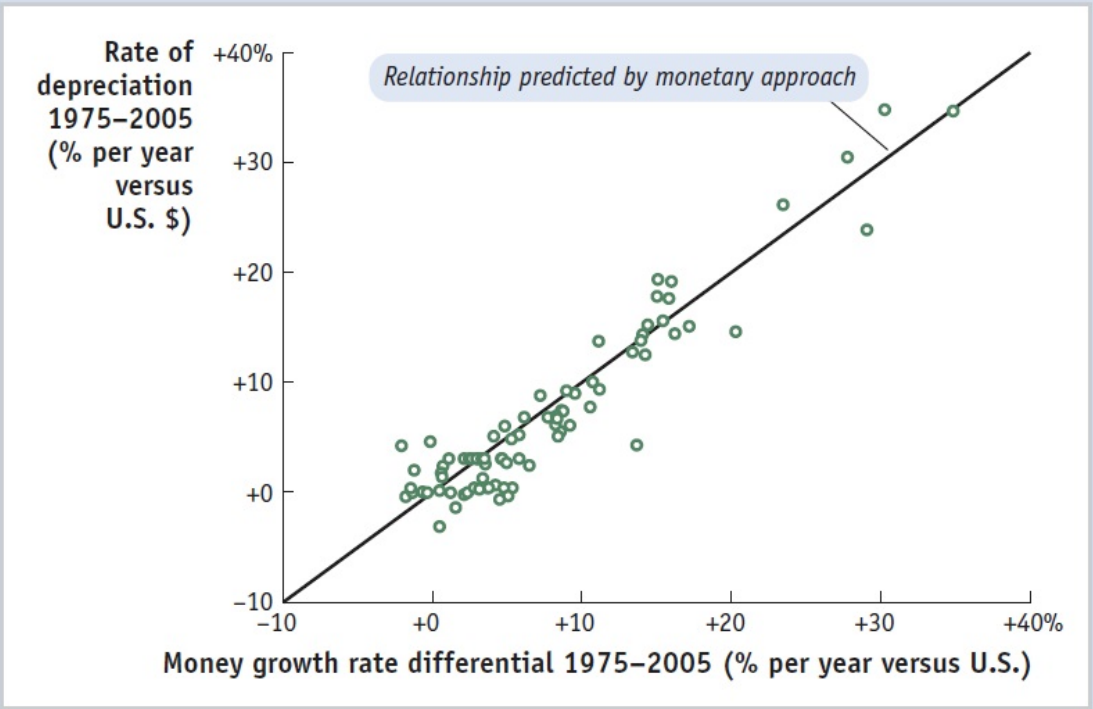
FIGURE 3-8

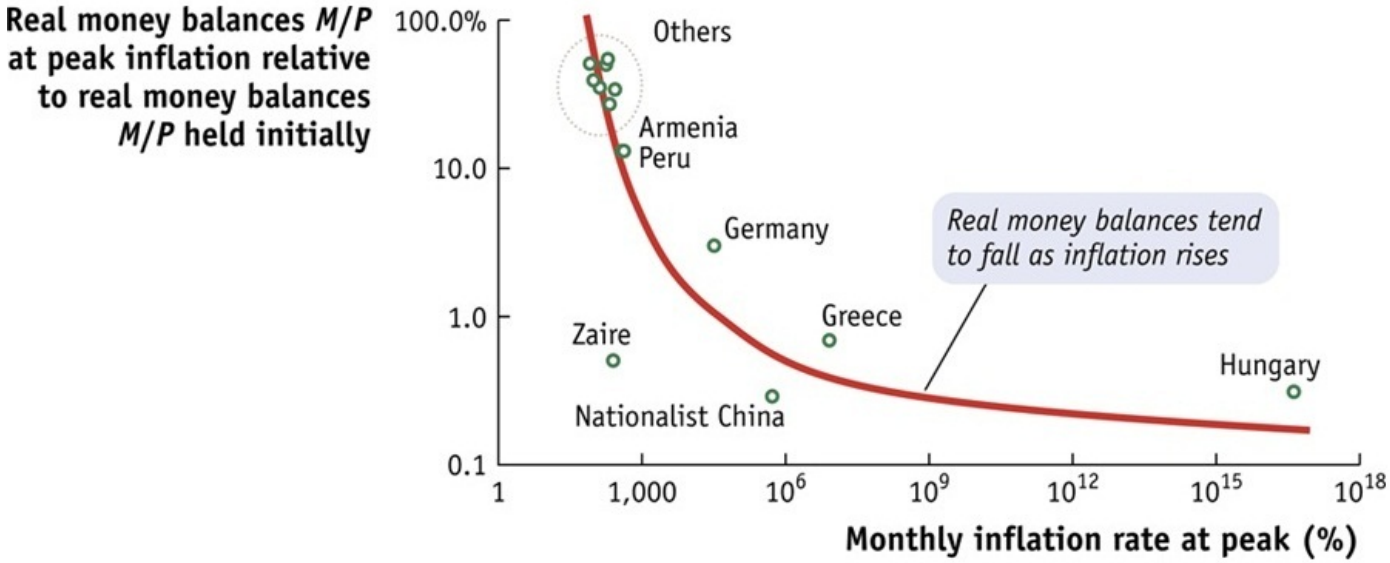


Money Growth Rates and the Exchange Rate, 1975–2005 This scatterplot shows the relationship between the rate of exchange rate depreciation against the U.S. dollar and the money growth rate differential versus the United States over the long run, based on data for a sample of 82 countries. The data show 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.

Source: IMF, International Financial Statistics.

Limitation of the Simple Model

- In the previous simple model, we assumed that the money demand multiplier L is constant, but in fact L will change with interest rate and inflation rate:



- The above figure shows that real money demand will fall as the inflation rate rises, so we need to expand the simple model.

Fisher effect and Real Interest rate Parity

- The Fisher effect: All else equal, a rise in the expected inflation rate in a country will lead to an equal rise in its nominal interest rate.

$$i = r + \pi^e$$

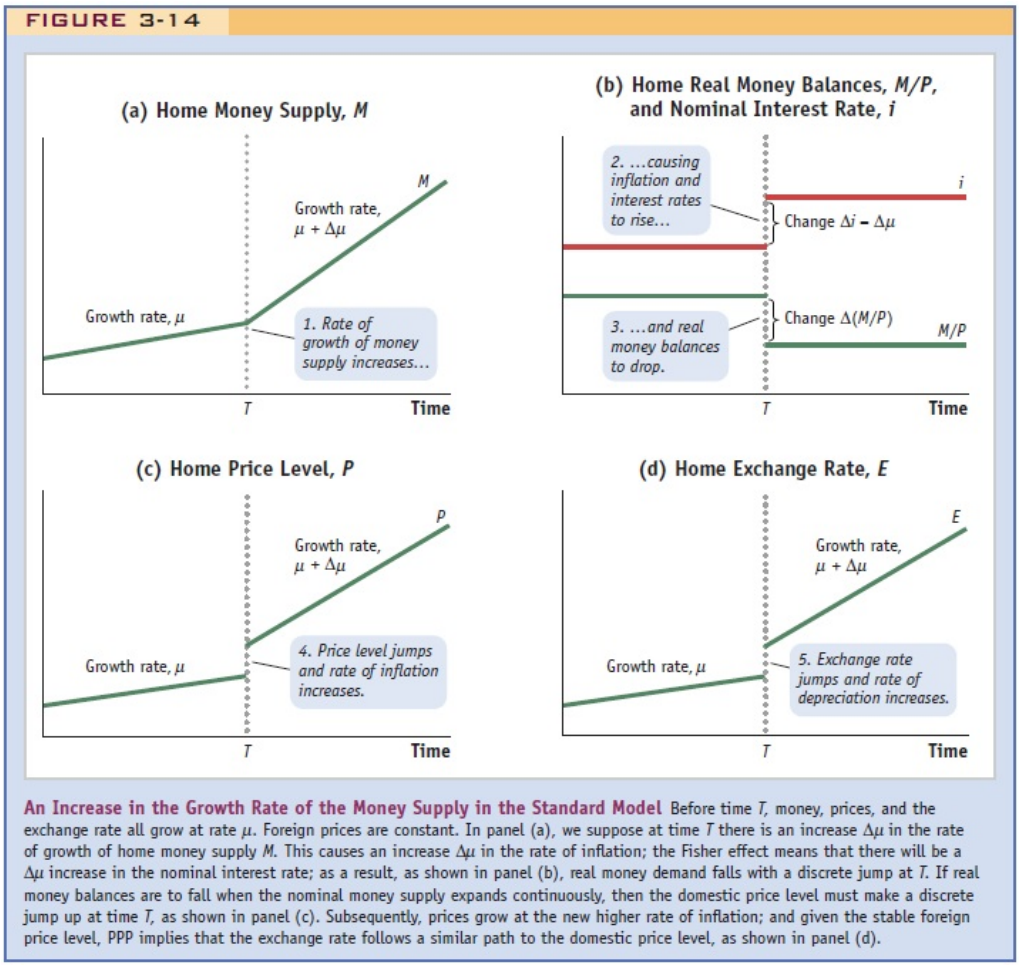
- The Real Interest rate Parity(RIP): The expected real interest rates are equalized across countries.

$$r = r^* \Leftrightarrow i - i^* = \pi^e - \pi^{e*}$$

- When the central bank increase the money supply growth rate μ, the expected inflation rate π^e will increase. If the Fisher effect and RIP exist, the nominal interest rate i will go up, and the multiplier of money demand $L(i)$ will decrease.

$$\mu \uparrow \Rightarrow \pi^e \uparrow \Rightarrow i \uparrow \Rightarrow L \downarrow$$

Implication of the General Monetary Model



An Increase in the Growth Rate of the Money Supply in the Standard 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. This causes an increase $\Delta\mu$ in the rate of inflation; the Fisher effect means that there will be a $\Delta\mu$ increase in the nominal interest rate; as a result, as shown in panel (b), real money demand falls with a discrete jump at T. If real money balances are to fall when the nominal money supply expands continuously, then the domestic price level must make a discrete jump up at time T, as shown in panel (c). Subsequently, prices grow at the new higher rate of inflation; and given the stable foreign price level, PPP implies that the exchange rate follows a similar path to the domestic price level, as shown in panel (d).

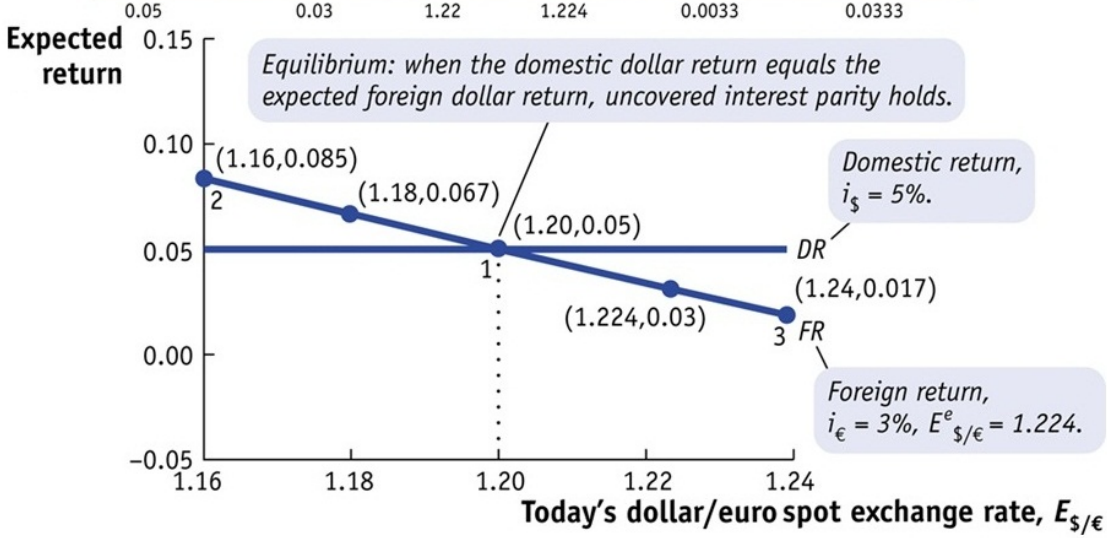
$$E = \frac{M}{LY}\frac{L^*Y^*}{M^*}$$

$$\frac{\Delta E}{E} = (\mu - \mu^*) - (g - g^*)$$

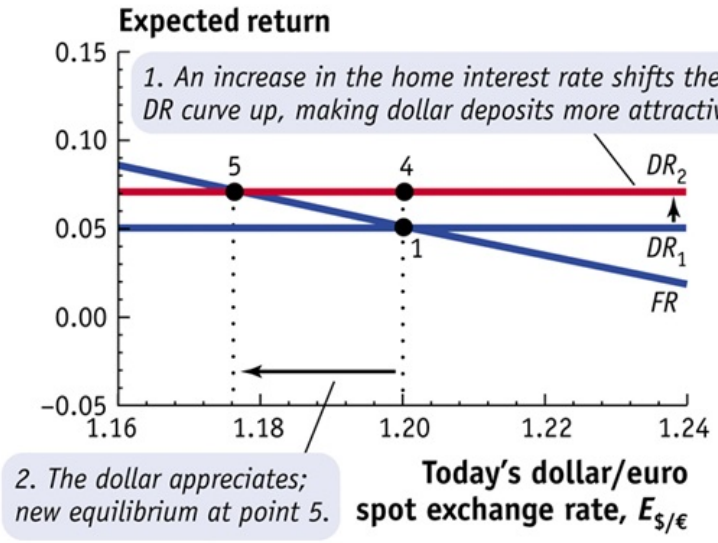
UIP and FX Market Equilibrium

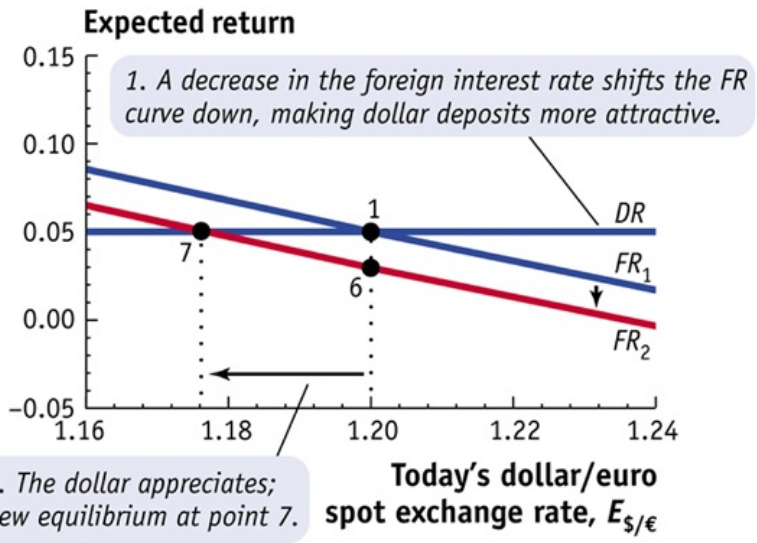
$$\underbrace{i}_{\text{Dollar rate of return on domestic currency}} = \underbrace{i^* + \frac{E^e}{E} - 1}_{\text{Expected dollar rate of return on foreign currency}}$$

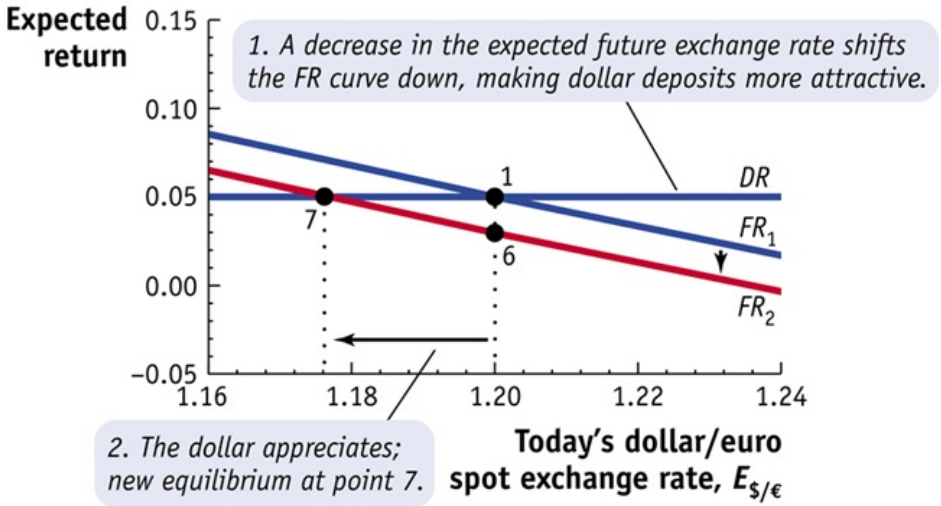
$i_\$$	$i_€$	$E_{\$/€}$	$E^e_{\$/€}$	$\frac{E^e_{\$/€} - E_{\$/€}}{E_{\$/€}}$	$i_€ + \frac{E^e_{\$/€} - E_{\$/€}}{E_{\$/€}}$
0.05	0.03	1.16	1.224	0.0552	0.0852
0.05	0.03	1.20	1.224	0.02	0.05
0.05	0.03	1.22	1.224	0.0033	0.0333



Changes of FX Market Equilibrium, $E(\underset{-}{i}; \underset{+}{E^e}, \underset{+}{i^*})$

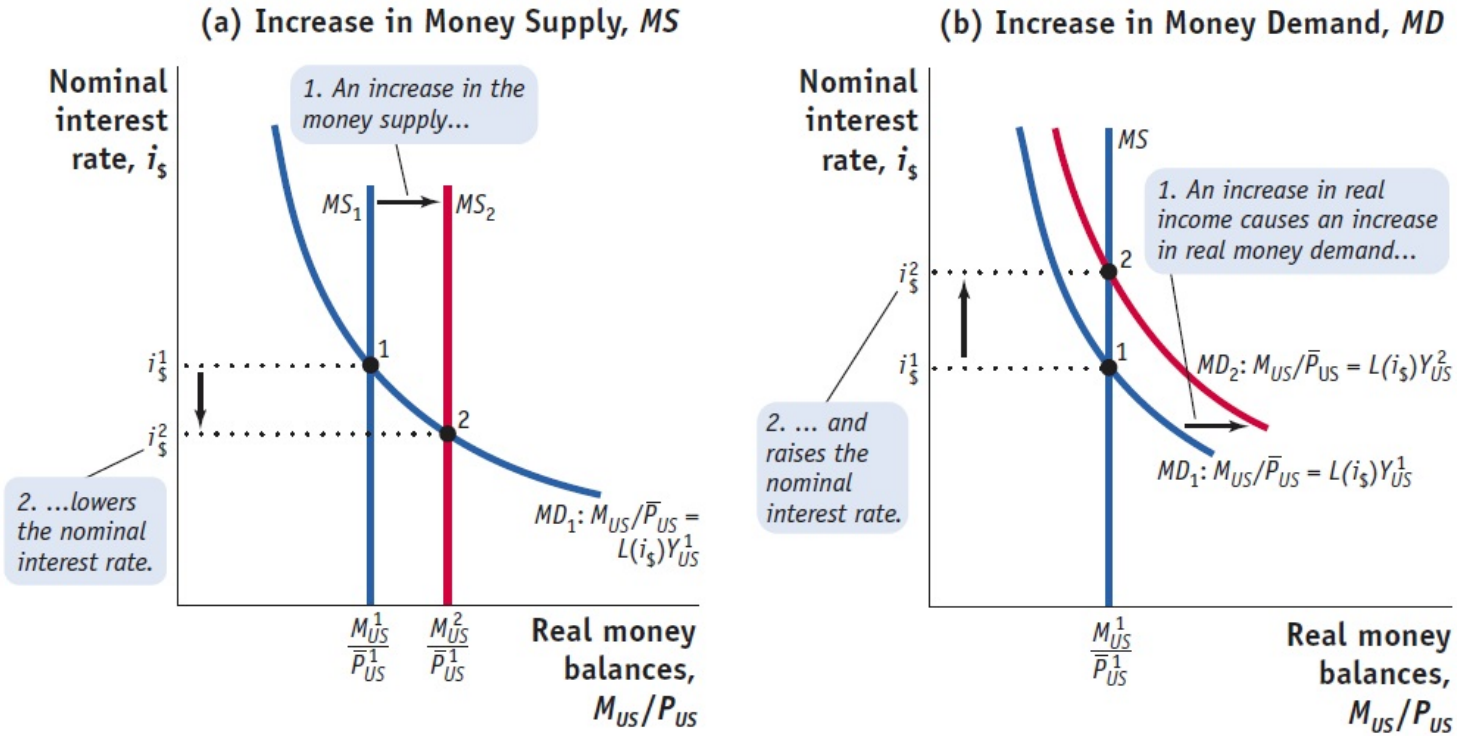






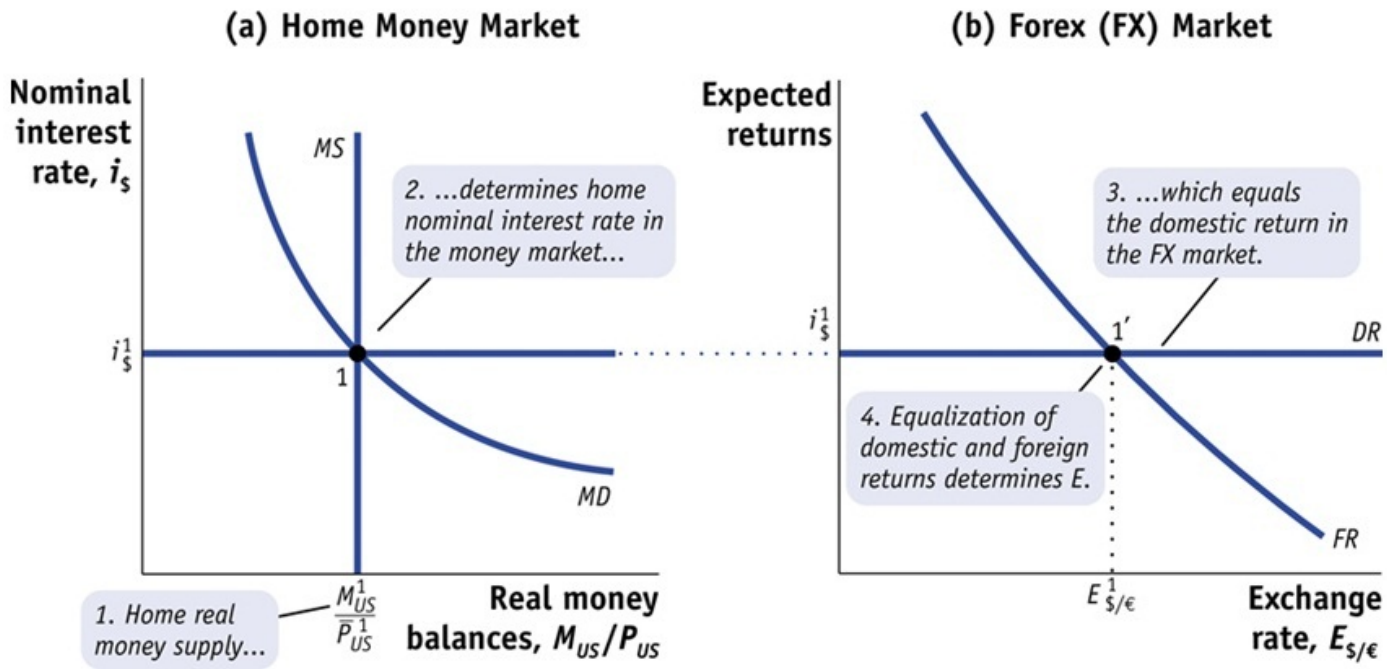
Money Market Equilibrium

$$\frac{M}{P} = L(i)\,Y \Rightarrow i\left(\underset{-}{M};\underset{+}{Y}\right)$$



The Asset Approach to Exchange Rates

$$\begin{aligned} i &= i^* + \frac{E^e}{E} - 1 \\ \frac{M}{P} &= L(i)\,Y \end{aligned} \Rightarrow E = E\left(\underset{-}{i}; \underset{+}{E^e}, \underset{+}{M}, \underset{-}{Y}, \underset{+}{i^*}\right)$$



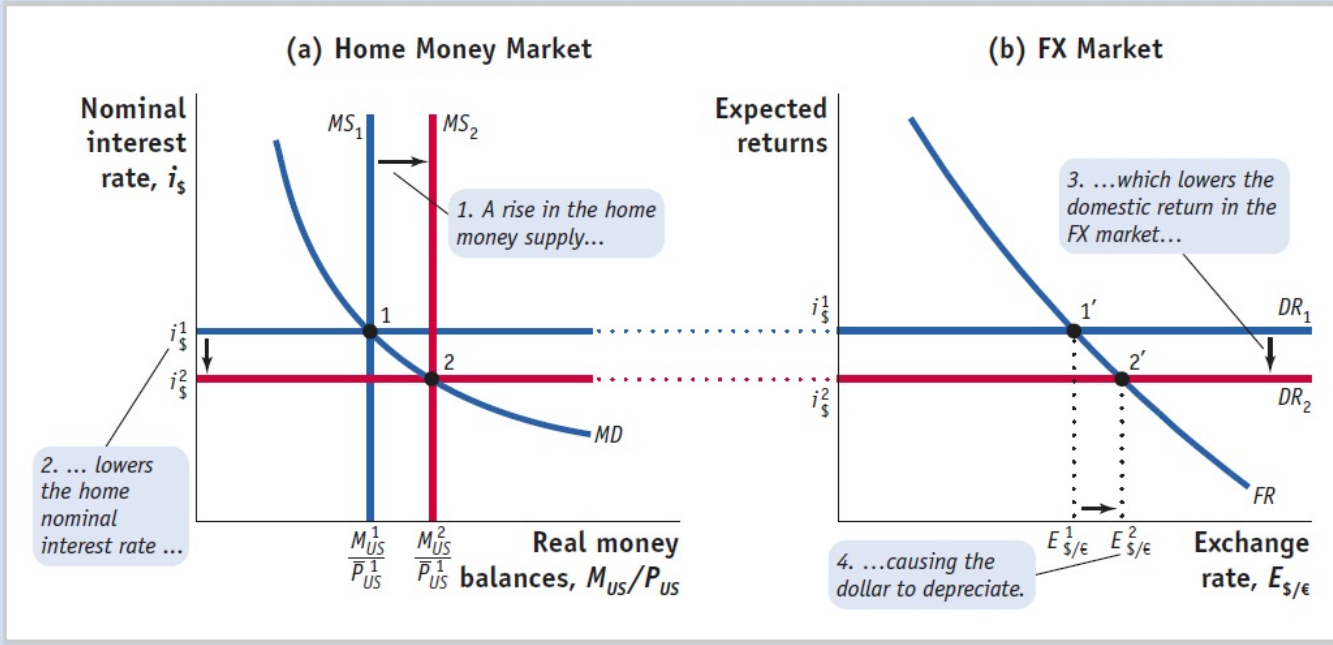
Important Terms for Policy Analysis

- Temporary vs. Permanent Policies: A temporary policy will change the prices today but not the expectations, while a permanent change of the monetary policy will change the prices and the expectations for future.
- Short-term vs. Long-term in Macroeconomics: We assume the price level is fixed in the short run, and will change in the long run.

A Temporary Increase of M

$$i \downarrow, \quad E \uparrow$$

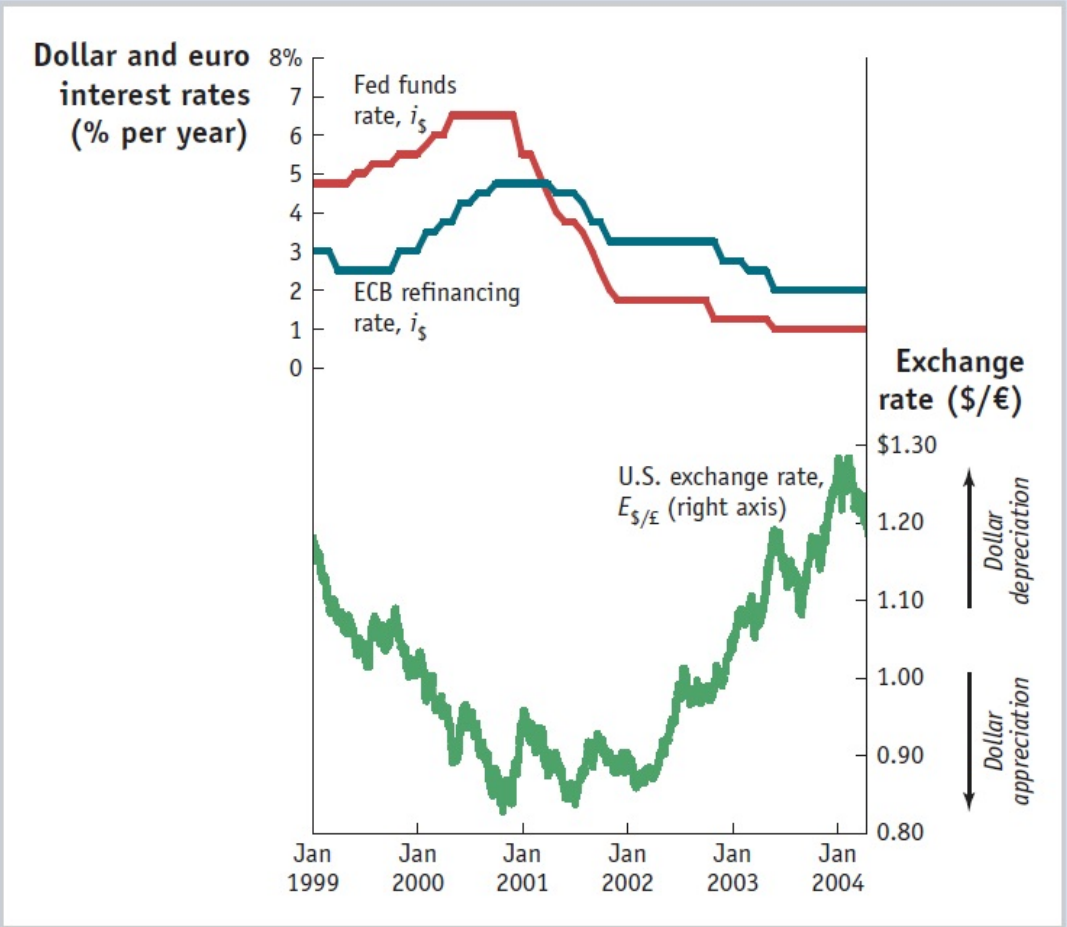
FIGURE 4-8



Temporary Expansion of the Home Money Supply In panel (a), in the home money market, an increase in home money supply from M^1_{US} to M^2_{US} causes an increase in real money supply from $M^1_{US}/\overline{P}^1_{US}$ to $M^2_{US}/\overline{P}^1_{US}$. To keep real money demand equal to real money supply, the interest rate falls from $i^1_\$$ to $i^2_\$$, and the new money market equilibrium is at point 2. In panel (b), in the FX market, to maintain the equality of domestic and foreign expected returns, the exchange rate rises (the dollar depreciates) from $E^1_{\$/€}$ to $E^2_{\$/€}$, and the new FX market equilibrium is at point 2′.

Evidence of Temporary Monetary Shock

FIGURE 4-10

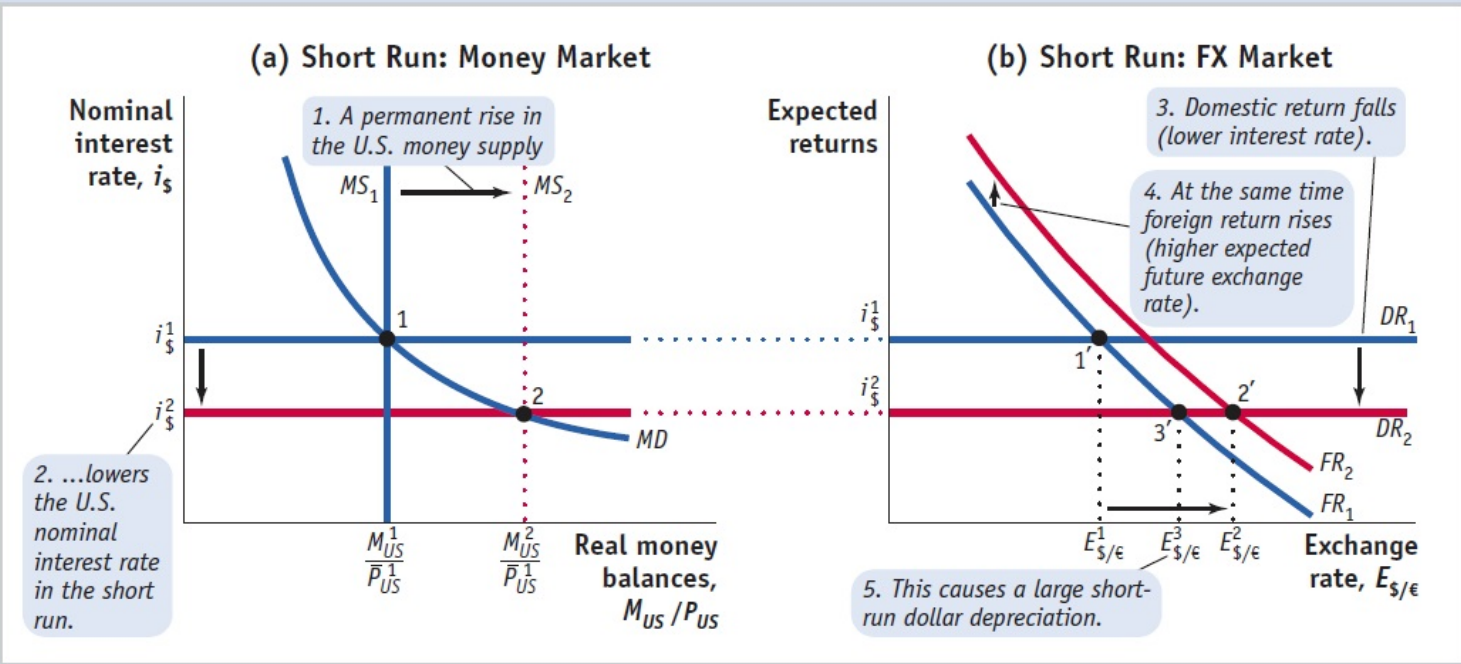


U.S.–Eurozone Interest Rates and Exchange Rates, 1999–2004 From the euro's birth in 1999 until 2001, the dollar steadily appreciated against the euro, as interest rates in the United States were raised well above those in Europe. In early 2001, however, the Federal Reserve began a long series of interest rate reductions. By 2002 the Fed Funds rate was well below the ECB's refinancing rate. Theory predicts a dollar appreciation (1999–2001) when U.S. interest rates were relatively high, followed by a dollar depreciation (2001–2004) when U.S. interest rates were relatively low. Looking at the figure, you will see that this is what occurred.

Sources: Websites of central banks; oanda.com

A Permanent Increase of M: Short Run

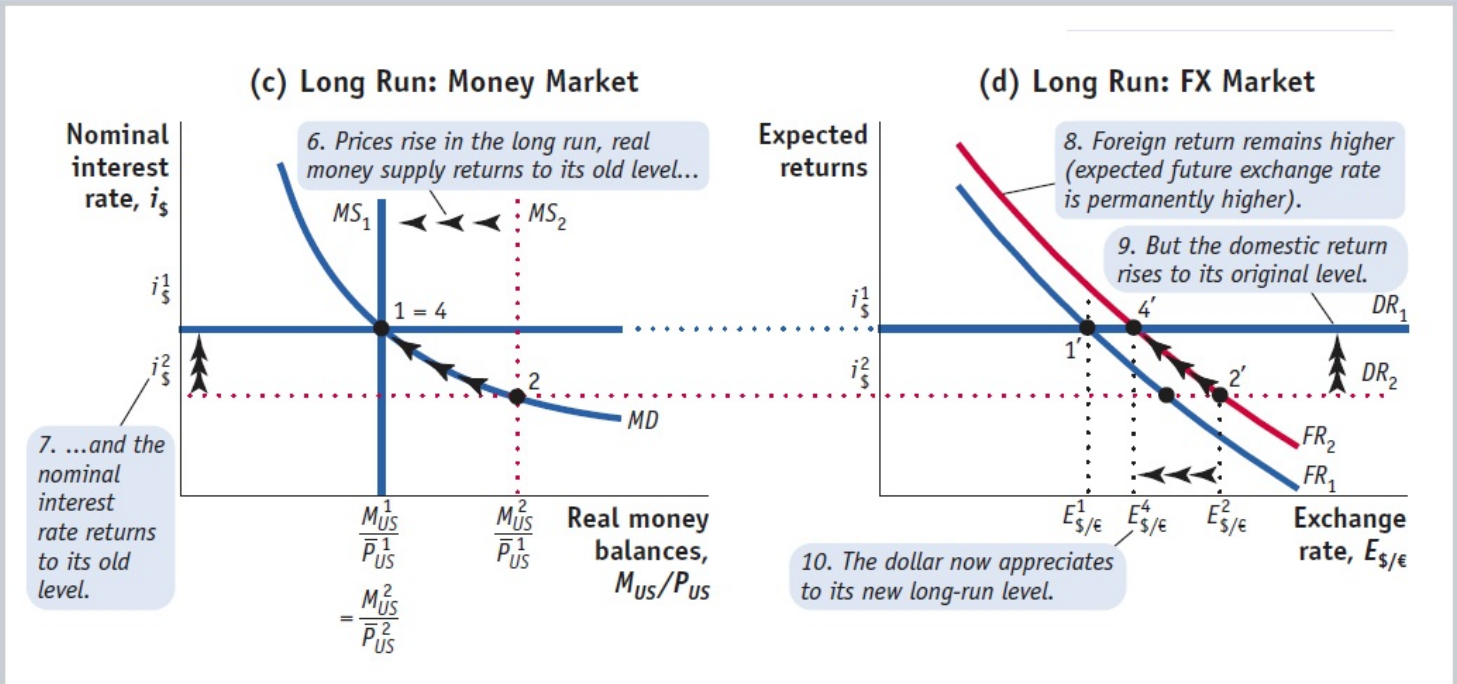
$$i \downarrow, \quad E^e \uparrow, \quad E \uparrow\uparrow$$



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. 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).

A Permanent Increase of M: Long Run

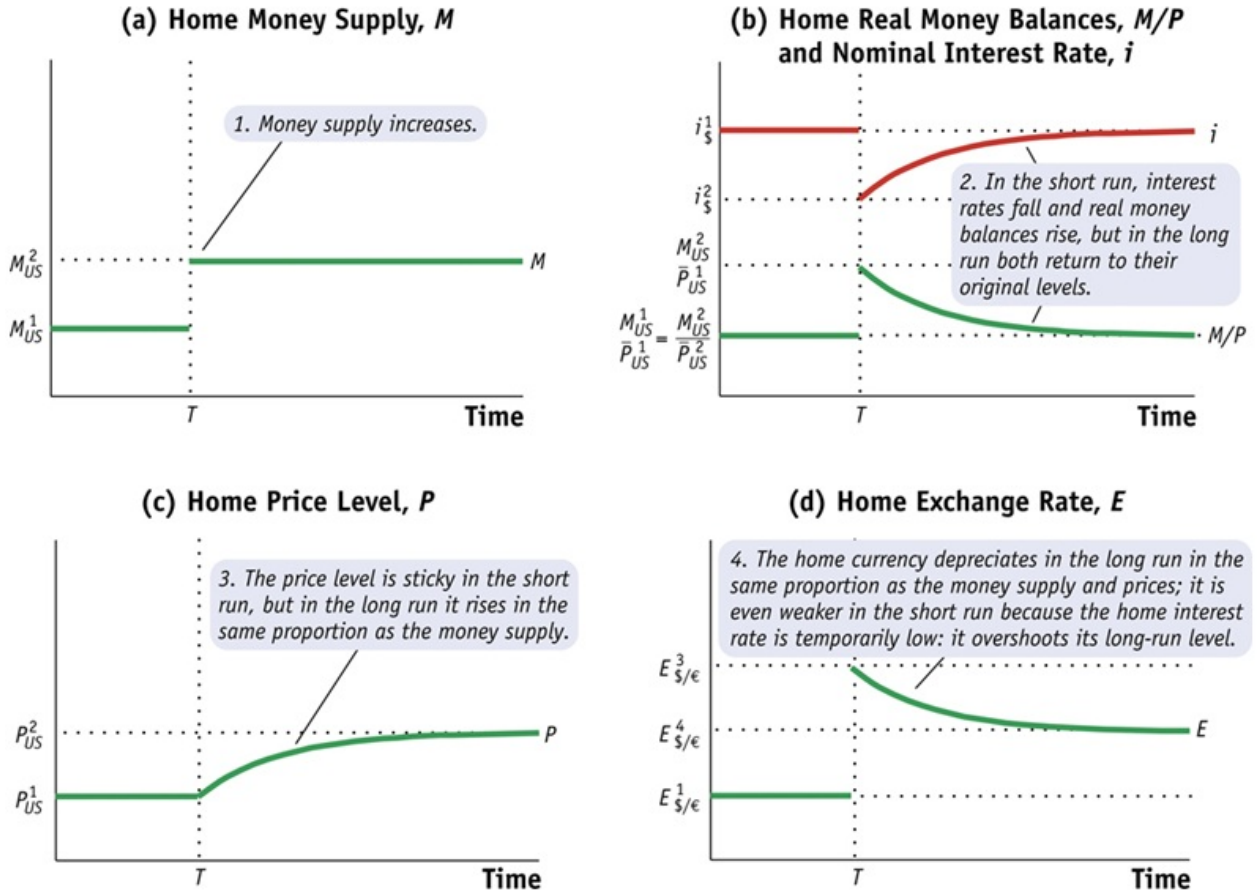
$$P \uparrow, \quad i \uparrow, \quad E \downarrow$$



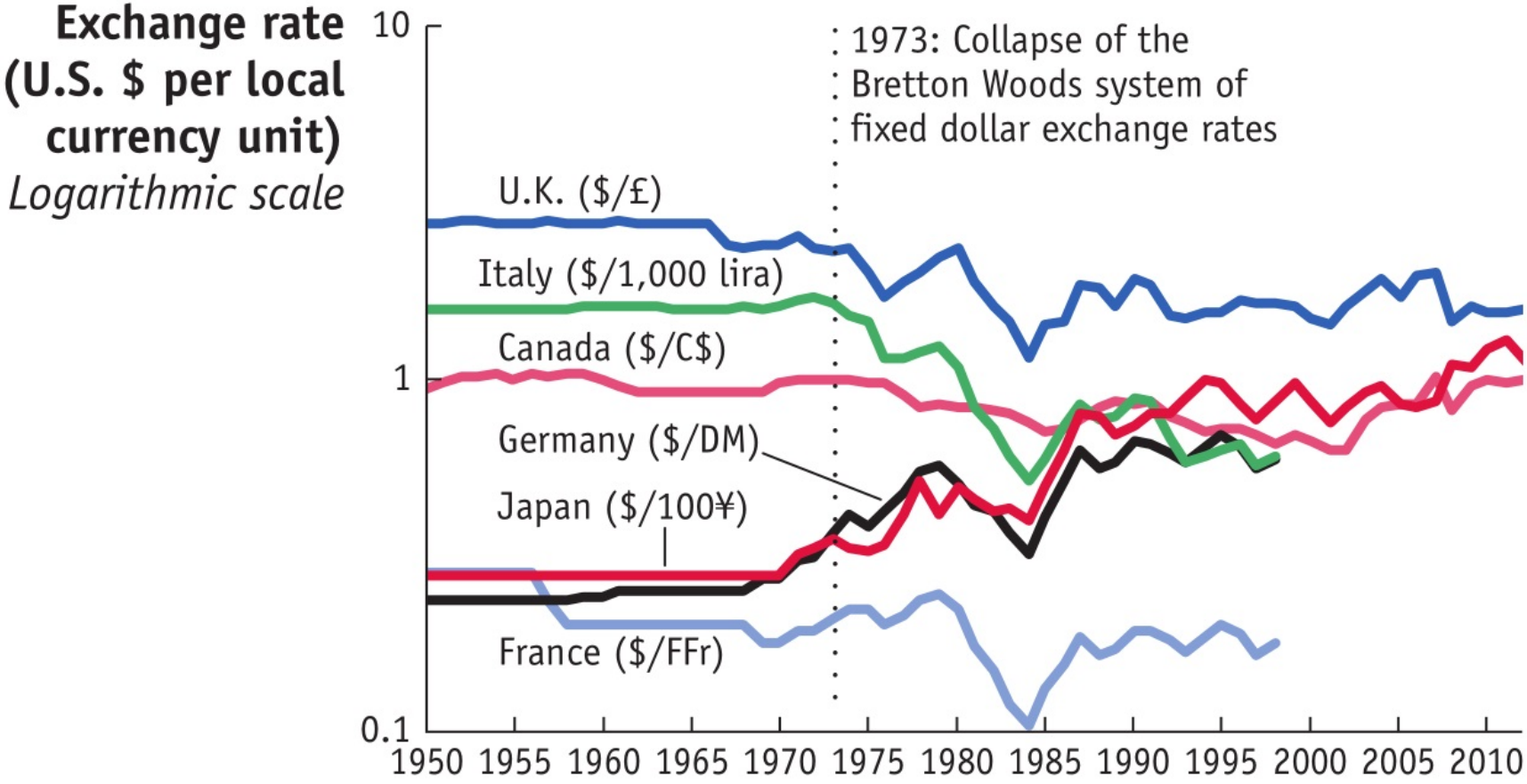
Long-Run Adjustment: In panel (c), in the long run, prices are flexible, so the home price level and the exchange rate both rise in proportion with the money supply. Prices rise to P^2_{US}, and real money supply returns to its original level M^1_{US}/P^1_{US}. The money market gradually shifts back to equilibrium at point 4 (the same as point 1). 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.

Overshooting of FX Market

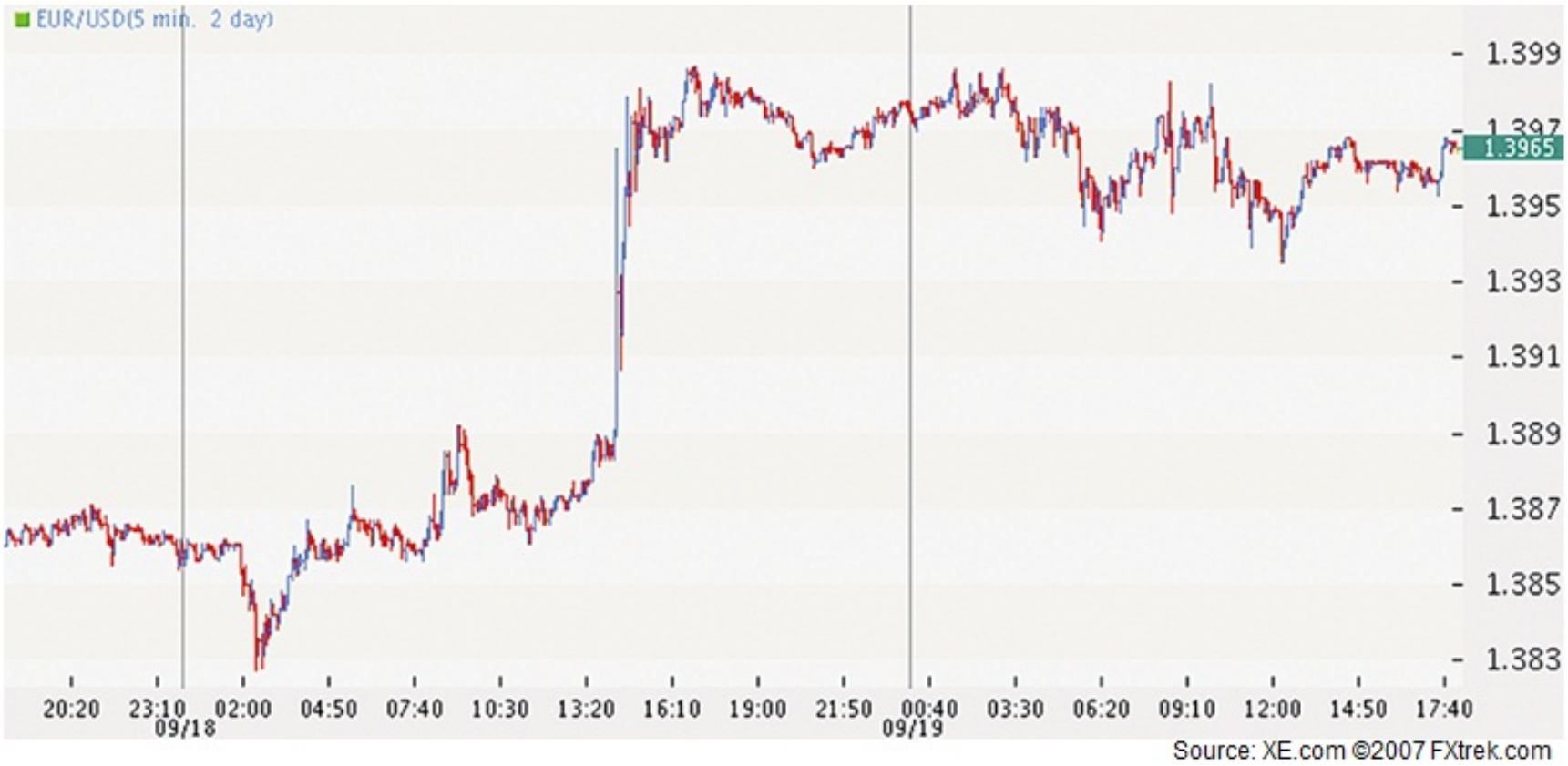
Overshooting refers to the phenomena that compared with the temporary expansion of money supply, the permanent shock has a much greater impact on the exchange rate in the short run.



Evidence of Overshooting: FX after Breton Woods System



Evidence of Overshooting: Influence of Brexit on Euro



Source: Wind Database.

Test IP

Pick up ONE currency you are interested in from Data.xlsx and finish the following exercise:

1. Calculate the monthly appreciation/depreciation rate:

$$g_m = \frac{E_{t+1} - E_t}{E_t} \times 100\%$$

2. Calculate the monthly difference of policy interest rates:

$$\Delta i_m = \frac{i_t - i_t^{USA}}{12}$$

3. Draw pictures of $Profit_m = g_m - \Delta i_m$ and explain your result.

Test PPP

1. Calculate the annually appreciation/depreciation rate:

$$g_t = \frac{E_{t+1} - E_t}{E_t} \times 100\%$$

2. Calculate the difference of inflation rates:

$$\Delta\pi_t = \pi_t - \pi_t^{USA}$$

3. Draw pictures of $\Delta\pi_t$ in x-axis, g_t in y-axis, and explain your result.