International Economics
Lecture 7
Exchange Rate Determination, Part I

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What "Happened"

US Dollar Behavior During Financial Crisis

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What "Happened"

US Dollar During Financial Crisis

currency market vs. stock market

➔ What to take away?

- Interest parity condition connects interest rates with exchange rates. The currency risk involved originated from the uncertainties in the future, i.e., the uncertainty in $E^e_{\$/\epsilon}$. This is called **currency risk**.

- In reality, currencies also have **liquidity risk** --- you want to hold your assets denominated in a currency so that you can sell it anytime you want, especially in time of crisis. If you can't sell, you are in big trouble.

- During the panic in 2008, US dollar was widely perceived as the "safe haven", or the most liquid currency. So whenever the market was in turmoil, everyone was buying US dollar and selling other currencies, we call this phenomenon, "flight to quality", in currency market.

- Ironically, US economy dragged the world economy down, but the US dollar appreciated most sharply at the peak of the financial crisis.

Today's Plan

- Review of interest parity condition
- Connecting money and interest rates to exchange rates
    - Dornbusch "overshooting model"
- Connecting price levels with exchange rates – ER in the long run
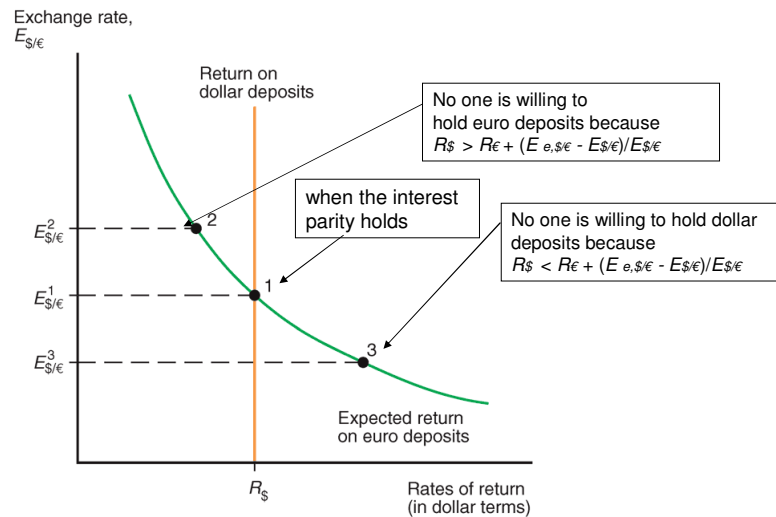
Review of Interest Parity Condition

- The foreign exchange market is in equilibrium when deposits of both currencies offer the same expected rate of return.

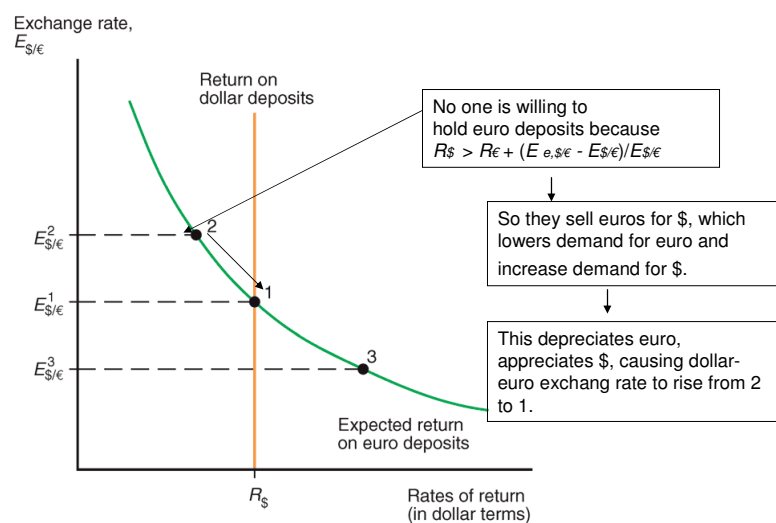$$R_{\$} = R_{\euro} + (E^{e}_{\$/\euro} - E_{\$/\euro}) / E_{\$/\euro}$$

- The above equation is called "uncovered" interest parity condition, or UIP. When it holds, people (e.g. carry traders) have no incentives to move money (in this case, USD and Euro) across national borders.

- In other words, if the parity condition does <u>not hold</u>, there are always arbitrage opportunities for people to make money. <u>And this is often the case in reality.</u>

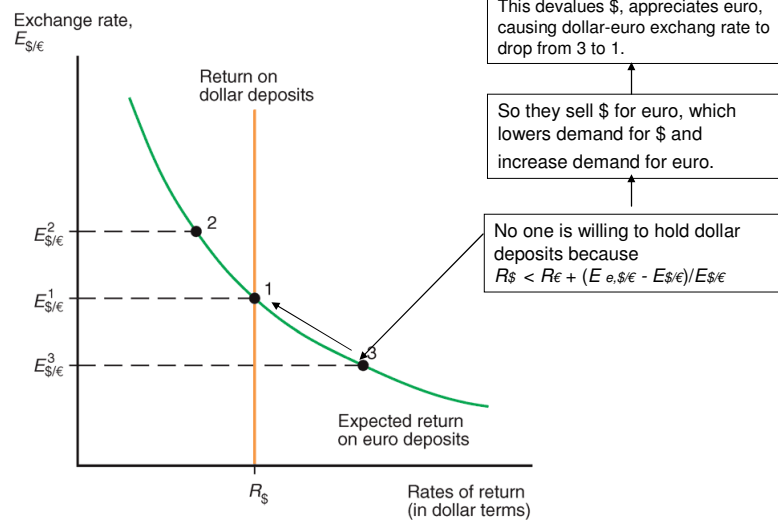- What have made the reality deviate from UIP?
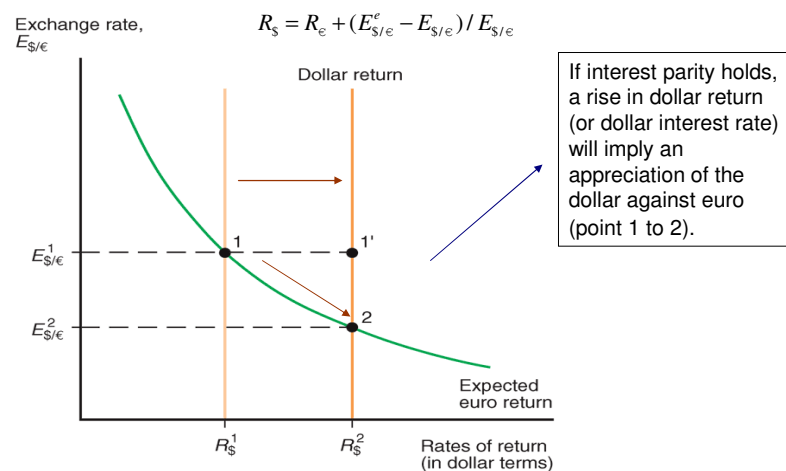
Equilibrium Exchange Rate under UIP

Exchange rate, $E_{\$/\euro}$

Return on dollar deposits

No one is willing to hold euro deposits because $R_\$ > R_\euro + (E_{e,\$/\euro} - E_{\$/\euro})/E_{\$/\euro}$

when the interest parity holds

No one is willing to hold dollar deposits because $R_\$ < R_\euro + (E_{e,\$/\euro} - E_{\$/\euro})/E_{\$/\euro}$

$E_{\$/\euro}^2$ 2

$E_{\$/\euro}^1$ 1

$E_{\$/\euro}^3$ 3

Expected return on euro deposits

$R_\$$ Rates of return (in dollar terms)

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Equilibrium Exchange Rate under UIP

Exchange rate, $E_{\$/\euro}$

Return on dollar deposits

No one is willing to hold euro deposits because $R_\$ > R_\euro + (E_{e,\$/\euro} - E_{\$/\euro})/E_{\$/\euro}$

So they sell euros for $, which lowers demand for euro and increase demand for $.

This depreciates euro, appreciates $, causing dollar-euro exchang rate to rise from 2 to 1.

$E_{\$/\euro}^2$ 2

$E_{\$/\euro}^1$ 1

$E_{\$/\euro}^3$ 3

Expected return on euro deposits

$R_\$$ Rates of return (in dollar terms)

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Equilibrium Exchange Rate under UIP

Exchange rate,
$E_{\$/\epsilon}$

Return on
dollar deposits

This devalues \$, appreciates euro, causing dollar-euro exchang rate to drop from 3 to 1.

So they sell \$ for euro, which lowers demand for \$ and increase demand for euro.

No one is willing to hold dollar deposits because
$R_\$ < R_\epsilon + (E_{e,\$/\epsilon} - E_{\$/\epsilon})/E_{\$/\epsilon}$

$E_{\$/\epsilon}^2$ — 2

$E_{\$/\epsilon}^1$ — 1

$E_{\$/\epsilon}^3$ — 3

Expected return
on euro deposits

$R_\$$

Rates of return
(in dollar terms)

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How exchange rate is determined under UIP?

Exchange rate,
$E_{\$/\epsilon}$

$$R_\$ = R_\epsilon + (E_{\$/\epsilon}^e - E_{\$/\epsilon})/E_{\$/\epsilon}$$

Dollar return

If interest parity holds, a rise in dollar return (or dollar interest rate) will imply an appreciation of the dollar against euro (point 1 to 2).

$E_{\$/\epsilon}^1$ — 1   1'

$E_{\$/\epsilon}^2$ — 2

Expected
euro return

$R_\$^1$ $R_\$^2$

Rates of return
(in dollar terms)

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How exchange rate is determined under UIP?

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

Under interest parity condition, a rise in euro return (or euro interest rate) shifts the euro expected return curve outward, and the new equilibrium moves from point 1 to 2, and it implies an appreciation of the euro or depreciation of the dollar.

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Next…

- We first analyze how interest rates are determined by money demand and supply

- Then, we connect money market and FX market (and exchange rates) through interest rates

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Aggregate Money Demand

The aggregate demand of money can be expressed as:
$$M^d = P \times L(R,Y)$$
where:

P is the price level

Y is real national income

R is a measure of interest rates on non-monetary assets

$L(R,Y)$ is the aggregate demand of real monetary assets

P ↑ → the same transaction requires more money, so money demand increases ↑

R ↑ → money demand falls ↓

Y ↑ → more goods and services, more transactions, money demand rises ↑

Interest Rate and Money Demand

- Everything being equal, a rise in the interest rate causes money demand to fall
  - □ higher interest rate → higher return for non-money assets
  - □ in other words, with higher interest rate, the opportunity cost of holding money increases
  - □ people will choose to hold less money when interest rate increases

Aggregate Money Demand
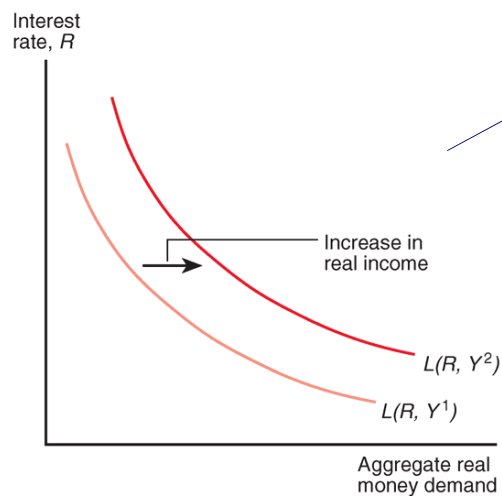
Alternatively, we can write:

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

i.e., the **real** aggregate money demand is a function of output and interest rates.

For a given level of income, real money demand decreases as the interest rate increases.

Aggregate Money Demand

When output increases, real money demand increases at every interest rate, resulting in demand curve shifting outward.

Increase in real income

$L(R, Y^2)$

$L(R, Y^1)$

Aggregate Money Supply

- Money supply is fixed in a sense that it's set by the US Federal Reserve System, or by central banks in other countries.

- The central bank of European Union is called European Central Bank, or ECB for short.

- Note that monetary base (M_b) and money supply (M_s) are different concepts. They are related through the following equation:
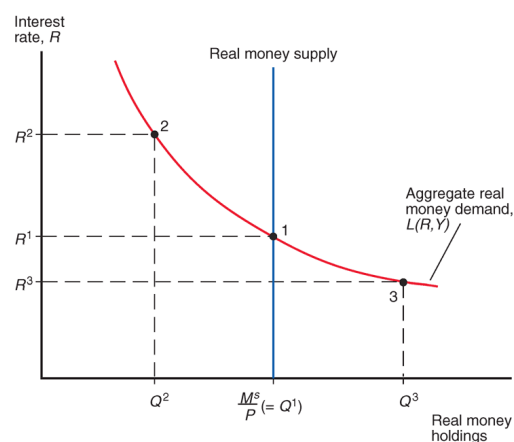
$$M_s = M_b \times V$$

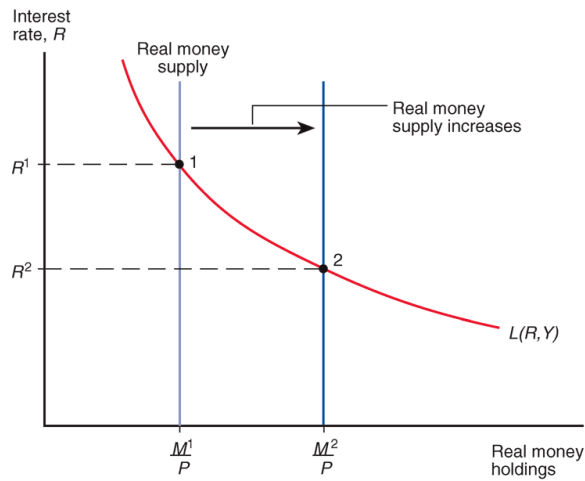   (V is money velocity, sometimes also called money multiplier)

Equilibrium in the Money Market

When money market clears, we have *Ms = Md*

Equilibrium in the Money Market

Interest rate, R

Real money supply

Real money supply increases

R^1 — — — ● 1

R^2 — — — — — — — — ● 2

$L(R,Y)$

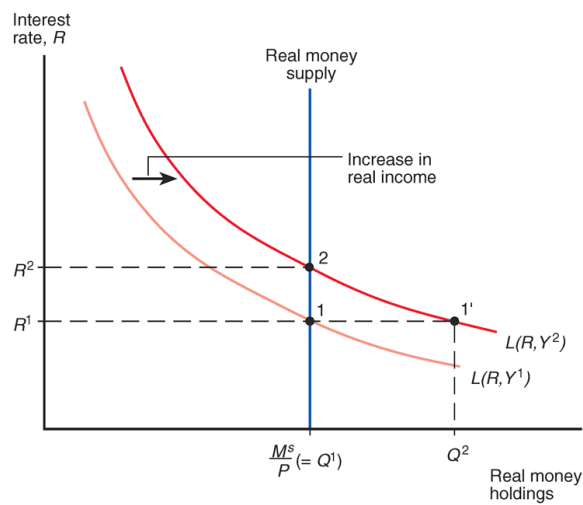$\frac{M^1}{P}$ $\frac{M^2}{P}$ Real money holdings

An increase in the money supply lowers the interest rate for a given price level.

A decrease in the money supply raises the interest rate for a given price level.

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Equilibrium in the Money Market

Interest rate, R

Real money supply

Increase in real income

R^2 — — — — — — — — ● 2

R^1 — — — — — ● 1 — — — — — — — ● 1'

$L(R,Y^2)$

$L(R,Y^1)$

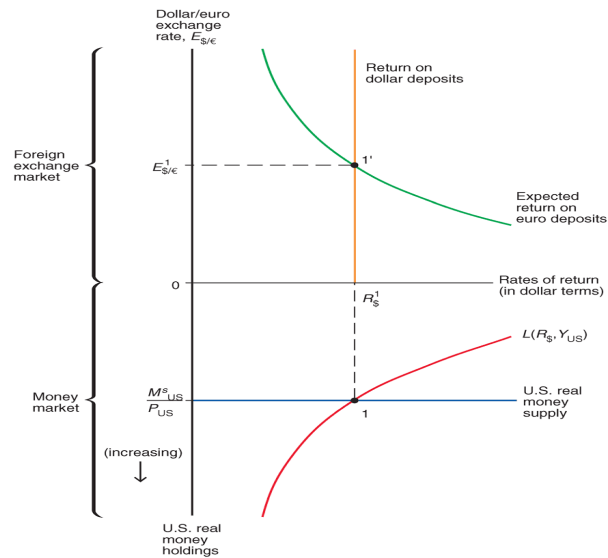$\frac{M^s}{P}(= Q^1)$ Q^2 Real money holdings

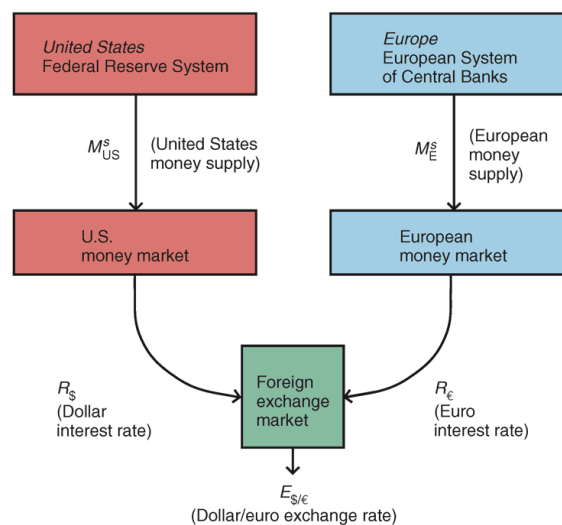An increase in output Y increases equilibrium interest rates for a given price level.
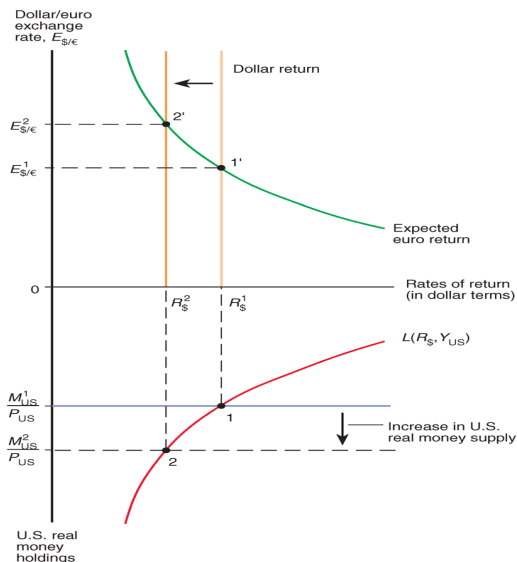
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Money Market - FX Market Linkage

➔ By combining equilibrium under UIP and equilibrium in money market, we establish a link between money and exchange rates.
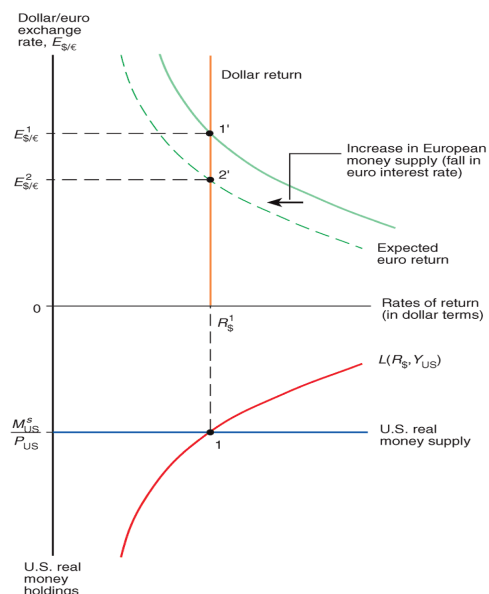

Money - Exchange Rate Linkage

How US Money Supply Affects $E_{\$/€}$

Dollar/euro exchange rate, $E_{\$/€}$

Dollar return

$E_{\$/€}^2$ 2'

$E_{\$/€}^1$ 1'

Expected euro return

0 — Rates of return (in dollar terms)

$R_\$^2$ $R_\$^1$

$L(R_\$, Y_{US})$

$\dfrac{M_{US}^1}{P_{US}}$ 1

Increase in U.S. real money supply

$\dfrac{M_{US}^2}{P_{US}}$ 2

U.S. real money holdings

• Increase of US money supply drives down US interest rate (1→2) and R$1 to R$2 .

• The lower US interest rate corresponds to point 2' in the upper half of the graph. So exchange rate moves from 1'→ 2' , resulting in a depreciation of the US dollar.

•So in short, increase of US money supply corresponds to a depreciation of US dollar.

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How European Money Supply Affects $E_{\$/€}$

Dollar/euro exchange rate, $E_{\$/€}$

Dollar return

$E_{\$/€}^1$ 1'

Increase in European money supply (fall in euro interest rate)

$E_{\$/€}^2$ 2'

Expected euro return

0 — Rates of return (in dollar terms)

$R_\$^1$

$L(R_\$, Y_{US})$

$\dfrac{M_{US}^s}{P_{US}}$ 1 U.S. real money supply

U.S. real money holdings

• Increase of European money supply drives down Euro interest rate.

• Lower euro interest rates means lower expected return for the euro, thus shifting the expected return curve (in green) inward.

• On the graph, this shift results in a move from 1'→2', meaning a depreciation of euro against US dollar (or US dollar appreciation)

• So in short, increase of European money supply corresponds to a depreciation of Euro.

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Change of Money Supply and ER

- We've had:
  - Increase of US money supply → depreciation of US dollar
  - Increase of European money supply → depreciation of Euro

- In general -
  - An <u>increase</u> of a country's money supply <u>depreciates</u> its own currency
  - An <u>decrease</u> of a country's money supply <u>appreciates</u> its own currency
  - Of course, as usual, everything else being equal.
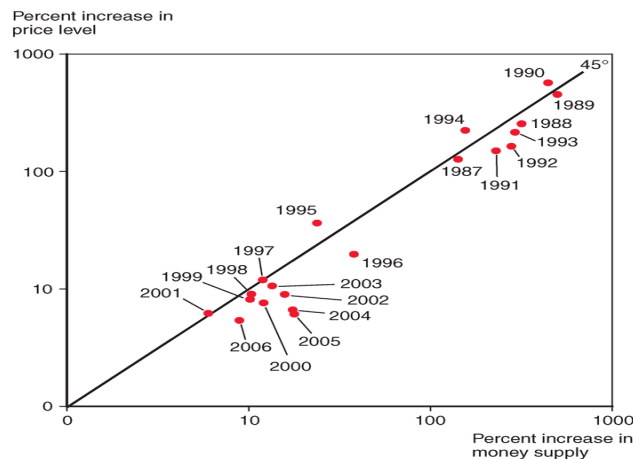 - Note: this is a very important relationship. You should spill this out like 1+1=2.

In the Long Run…

- We previously analyzed the short run effect of money supply, where price does not change, or changes very slowly, the so-called short-run **price stickiness.**

- In the long run, according to the following equation, $M^s = M^d = P \times L(R,Y)$ ➔ $P = M^s/L(R,Y)$. We get:
  - everything being equal, an increase in money supply causes <u>proportional</u> increase in the price level
  - according to equation $M^s/P = L(R,Y)$, in the long run, a change in money supply has no effect on the long run values of interest rate, R or real output Y.

Empirical Evidence on the Long-run Relationship between Money Supply and Price Levels

Percent increase in price level

Percent increase in money supply

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

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Money-Exchange Rate Linkage in the Long Run

- Price levels increase proportionally with increase of money supply in the long run

- Now the domestic money becomes less valuable because it can only buy less of goods and services than before

- So a permanent <u>increase</u> of a country's money supply causes a proportional long-run <u>depreciation</u> of its currency against foreign currencies, and vice versa.

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Dornbusch Overshooting Model

- **Overview**
  - Probably the most important economic model in FX
  - It explains the inflation and exchange rate dynamics ("dynamics" in economics often means it involves different time periods).
  - It also helps to explain why exchange rate is much **more volatile** than the actual price changes.
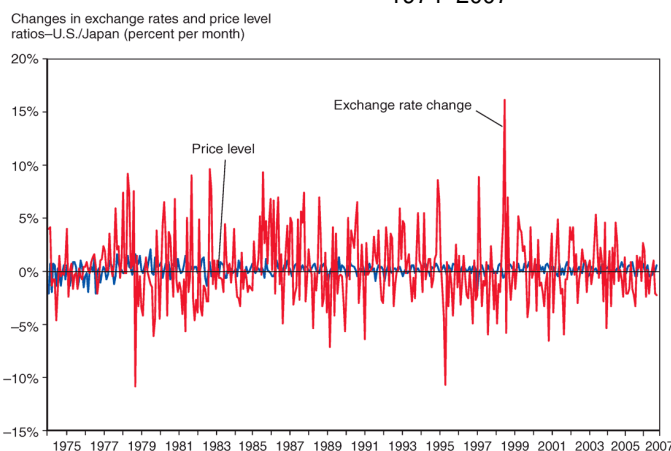
- **Definition**
  - The exchange rate is said to **_overshoot_** when its immediate short-run response to a change, say, money supply, is greater than its long-run response.
  - Overshooting is predicted to occur when monetary policy has an immediate effect on interest rates, but <u>not on prices</u>.
  - Implicitly, we will have two stages in the moves of ER:
    - First stage: overshooting
    - Second stage: adjusting back to normal

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Why exchange rate is so volatile?

Month-to-Month Changes of the Dollar/Yen Exchange Rate
vs. the M-o-M change of the U.S./Japan Price Level Ratio,
1974–2007

Changes in exchange rates and price level ratios–U.S./Japan (percent per month)

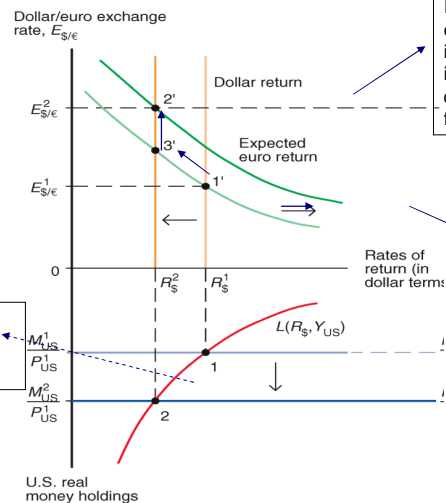➔ the change of ER is much bigger than the change of price levels.

➔ This was the main motivation behind the Dornbusch overshooting model

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Dornbusch Overshooting Model

How does monetary policy affect exchange rate?

Dollar/euro exchange rate, $E_{\$/€}$

Dollar return

$E_{\$/€}^2$ 2'

3'

Expected euro return

$E_{\$/€}^1$ 1'

0

Rates of return (in dollar terms)

$R_\$^2$ $R_\$^1$

If we don't allow expectation of future ER into play, a declining US interest rate will give us deprecation of US dollar from point 1' to 3'.
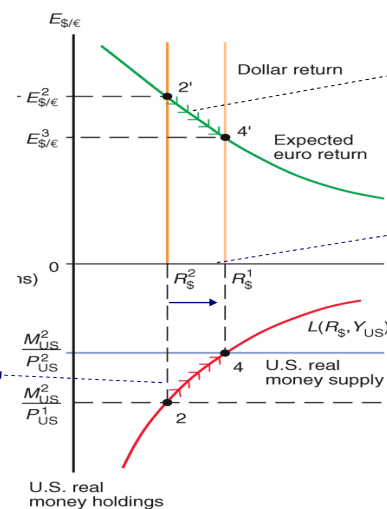
with expectation that an increase of US money supply will bring higher inflation in the long run, so the real expected return on euro increases and the curve shifts outward, resulting in a further depreciation of the US dollar, i.e., dollar overshoots on the downside to point 2'

central bank increasing of money supply drives down US interest rate.

$\frac{M_{US}^1}{P_{US}^1}$

1

$L(R_\$, Y_{US})$

$\frac{M_{US}^2}{P_{US}^1}$

2

U.S. real money holdings

(a) Short-run effects

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Dornbusch Overshooting Model

$E_{\$/€}$

Dollar return

$E_{\$/€}^2$ 2'

$E_{\$/€}^3$ 4'

Expected euro return

Higher US interest rate leads to appreciation of the US dollar, 2' → 4'

0

$R_\$^2$ $R_\$^1$

$L(R_\$, Y_{US})$

The decrease of real money supply increases US interest rate, and increases expected return of US dollar

In the long run, price adjusts: it increases after an increasing money supply. This results a decrease of real money supply.
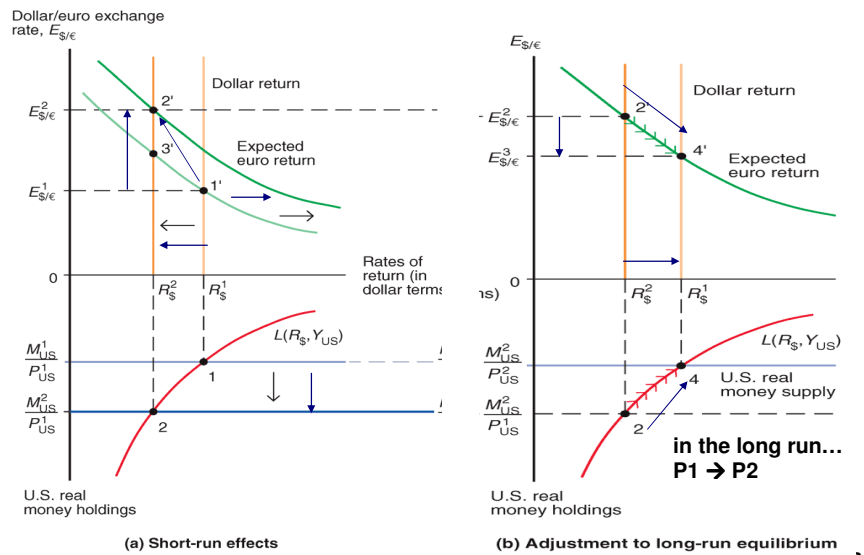
$\frac{M_{US}^2}{P_{US}^2}$

4 U.S. real money supply

$\frac{M_{US}^2}{P_{US}^1}$

2

U.S. real money holdings

(b) Adjustment to long-run equilibrium

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Dornbusch Overshooting Model

Dollar/euro exchange rate, $E_{\$/€}$

$E^2_{\$/€}$ 2'

Dollar return

$E^1_{\$/€}$ 3'

Expected euro return

1'

0

$R^2_\$$ $R^1_\$$

Rates of return (in dollar terms)

$\dfrac{M^1_{US}}{P^1_{US}}$

$L(R_\$, Y_{US})$

1

$\dfrac{M^2_{US}}{P^1_{US}}$

2

U.S. real money holdings

(a) Short-run effects

$E_{\$/€}$

2

Dollar return

$E^2_{\$/€}$

$E^3_{\$/€}$

4'

Expected euro return

0

$R^2_\$$ $R^1_\$$

$\dfrac{M^2_{US}}{P^2_{US}}$

$L(R_\$, Y_{US})$

$\dfrac{M^2_{US}}{P^1_{US}}$

4

U.S. real money supply

2

in the long run…
P1 → P2

U.S. real money holdings

(b) Adjustment to long-run equilibrium

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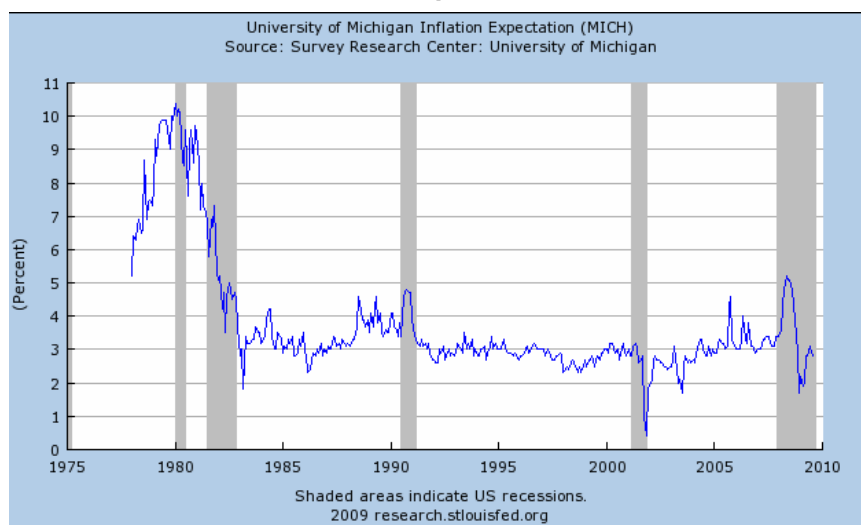# Summary of the Overshooting Model

- Two key points:
  - Inflation Expectation matters
  - The dynamics from short-run price rigidity (or stickiness) to the price flexibility in the long-run

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Case Study: Inflation and Currency Move

- In the overshooting model, **expectation of higher inflation in the future leads to currency depreciation.**

- But **in some cases, higher inflation leads to currency appreciation** (read the case study on p. 375). Why?

- This is because we haven't dealt with the potential reactions of central banks to higher inflation. Currency movement also depends on market's expectation on how central banks will react to a rising inflation.

- In modern economy, different central banks react to inflation quite differently:
  - The Fed of the US
  - ECB of European Union
  - Central Bank of New Zealand
  - Developing countries

- If central bank is perceived as a credible inflation fighter, it will raise interest rate to keep inflation in check. The rise of the country's interest rate will push up the return of its currency, resulting in an appreciation against other currencies.
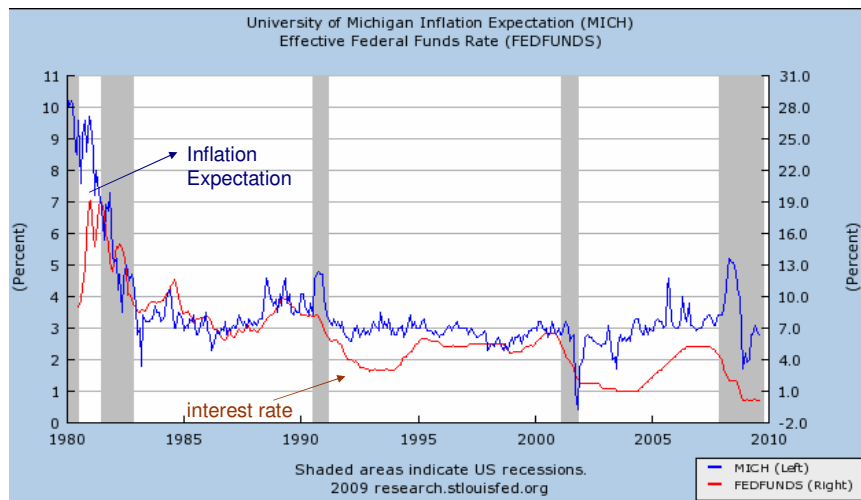
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More on Inflation Expectation

University of Michigan Inflation Expectation (MICH)
Source: Survey Research Center: University of Michigan

Shaded areas indicate US recessions.
2009 research.stlouisfed.org

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Inflation Expectation and Interest Rate

University of Michigan Inflation Expectation (MICH)
Effective Federal Funds Rate (FEDFUNDS)

Shaded areas indicate US recessions.
2009 research.stlouisfed.org

Where to find exchange rate data?

- FRED database
  http://research.stlouisfed.org/fred2/categories/15

- Pacific Exchange Rate Service:
  http://fx.sauder.ubc.ca/