Chapter 14

Exchange Rates in the Long Run: The Monetary Approach
Chapter 14: Outline

• 14–1 Exchange rates and prices in the long run
  ♦ Law of One Price (LOOP) & **Purchasing Power Parity** (PPP)
    ▪ How home and foreign price levels \( P \) and \( P^* \) predict exchange rates \( E \)
    ▪ Need a long-run theory of the price levels
  ♦ PPP and the real exchange rate
  ♦ PPP and inflation
  ♦ Evidence on PPP

• 14–2 Money, prices and exchange rates
  ♦ Money: a recap
    ▪ Definitions, supply, demand, equilibrium in the money market
  ♦ Theory of the price level: **Quantity Theory**
    ▪ Simple monetary model
    ▪ Real money demand \( M/P \) proportional to real output \( Y \)
    ▪ In levels: PPP shows that how \( M \), \( P \) and \( E \) are related
    ▪ In rates of change: PPP shows how money growth, inflation, and depreciations are related
Chapter 14: Outline

• 14–3 The Monetary Approach
  ❖ Implications and Evidence
    ❖ Forecasting
    ❖ Hyperinflations

• 14–4 Money, interest, and prices
  ❖ A more general model of money demand
    ❖ Now allow nominal interest rates $i$ to affect money demand
    ❖ Need a long-run theory of nominal interest rates
  ❖ Fisher effect and real interest parity
    ❖ Predictions/Evidence

• 14–5 Monetary regimes and exchange rate regimes
  ❖ Policy implications
    ❖ Choice of a nominal anchor

• 14–6 Conclusion
LEARNING OBJECTIVES
14–1 Exchange rates and prices in the long run

- Understand arbitrage in the goods market in the long run
- Understand the law of one price (LOOP) and purchasing power parity (PPP)
- Understand the real exchange rate and its relationship to PPP, plus
  - Real appreciations and real depreciations
  - Overvaluations and undervaluations
- Understand PPP as it relates to both price levels $P$ and rates of change (inflation, $\pi$)
- Understand how and why PPP works in the long run but not in the short run
Example

• Prices of US and Canadian CPI baskets
  - 1970 \( P_{\text{CAN}} = \text{C$ 100} \)  
  - 1970 \( P_{\text{US}} = \text{$100} \)  
  - 1990 \( P_{\text{CAN}} = \text{C$392} \)  
  - 1990 \( P_{\text{US}} = \text{$336} \)

• Exchange rates (C$/$)
  - 1970 \( E_{\text{C$/$}} = 1 \)  
  - 1990 \( E_{\text{C$/$}} = 1.15 \)

• Prices of baskets in C$
  - CAN 1970 100 1990 392 (up 292%)
  - US 1970 100 1990 386 (up 286%)

• The purchasing power of the C$ was the same over the US and Canadian baskets in 1970.
• The purchasing power of the C$ was ALSO virtually the same over US and Canadian baskets in 1990.
• Mere coincidence?
  - An important economic theory says: no
  - The theory of purchasing power parity
Intuition

- Arbitrage principles are applied yet again, this time not to currencies or interest rates, but to goods.
- Assume
  - No transaction costs, no barriers to trade, frictionless markets, identical goods in each location,…
  - Then prices must be equal in all locations for any good when expressed in a common currency
  - (Or else there would be a profit opportunity from buying low and selling high)
- In reality there are transaction costs, trade isn’t frictionless, goods may differ—but some of the same competitive pressures apply.
  - Slight changes in prices can induce people to shift demands to a cheaper location: expenditure switching
  - Example: Back to Canada
In the news

CTV News, November 25, 2003
Strong Loonie Sparking Cross-Border Shopping
The loonie’s strong performance in recent months has sparked a phenomenon not seen in years—cross-border shopping. A flood of Canadians is once again taking advantage of a decent exchange rate and heading south for bargains.

“We’re loving all this wonderful Canadian traffic right now, and we hope it keeps right on going,” said Dan Schenkein, president of the Grand Forks, North Dakota, Chamber of Commerce.

The loonie has been climbing steadily against the U.S. dollar since this summer—$100 Canadian is now worth about $75 US—about $10 Canadian more than last year. Canadian shoppers haven’t seen rates like that since the early ‘90s.
In the news

“I can spend more and I don’t feel so guilty,” cross-border shopper Louise Evans told CTV News.

The surge is good news for Grand Forks, where 25 per cent of the economy is based on Canadian tourism. Located only two hours south of Winnipeg, business owners rely on Canadians to eat in their restaurants, sleep in their hotels and shop in their stores. Retailers in Grand Forks are seeing a 10 per cent increase in the number of Canadian debit and credit cards used in their stores, according to managers.

“We’ve really seen quite an increase in the dollar amount,” said JC Penney [department store] manager Ron Mayer.…. U.S. border towns like Bellingham, Washington, and Niagara Falls, N.Y., are also seeing more Canadians. U.S. customs officials estimate 12 to 15 per cent more Canadian vehicles are crossing the border now than just one year ago.
The Law of One Price

- A microeconomic idea. Consider a single good (g) in two geographically different markets.
- The law of one price (LOOP) states that the price of the good in each market must be the same.
  - For prices to be commensurate they must be expressed in a common currency.
- Relative price ratio for g:
  \[ \frac{q^g_{E/US}}{\text{relative price of good } g \text{ in Europe versus U.S.}} = \frac{(E_{\$/€}P^g_E)}{\text{European price of good } g \text{ expressed in $}} / \frac{P^g_{US}}{\text{U.S. price of good } g \text{ expressed in $}} \]
- If LOOP holds then: \[ E_{\$/€}P^g_E = P^g_{US}, \text{ or } q^g_{E/US} = 1 \]
  - Examples?
Purchasing Power Parity

- Macroeconomic counterpart to LOOP. If LOOP holds for every good in the CPI basket, then the prices of the entire baskets must be the same in each locations.
- The purchasing power parity (PPP) theory states that these overall price levels in each market must be the same.
- Relative price level ratio:

\[
\frac{q_{E/US}}{q_{E/US}} = \left( \frac{E_{$/P_E}}{\epsilon_{P_E}} \right) / \left( \frac{P_{US}}{\epsilon_{P_E}} \right)
\]

- If PPP (Absolute PPP) holds then: \( E_{$/\epsilon_{P_E}} = P_{US} \), or \( q_{E/US} = 1 \).
- The relative price level ratio \( q \) is an important concept. It is called the real exchange rate (RER).
The real exchange rate

- Relative price level ratio \( q \) is an important concept.

\[
\frac{q_{E/US}}{\text{relative price of basket in Europe versus U.S.}} = \frac{\left( E_{$/€}P_E \right)}{\text{European price of basket expressed in $}} / \frac{P_{US}}{\text{U.S. price of basket expressed in $}}
\]

- Called (confusingly?) the real exchange rate (RER)
  - Nominal exchange rate: price of foreign currency in terms of domestic currency
  - Real exchange rate: price of foreign basket in terms of domestic basket

- PPP holds if and only if real exchange rate is 1:

\[
E_{$/€}P_E = P_{US}, \text{ or } q_{E/US} = 1.
\]
The real exchange rate is a new concept, but it has some terminology in common with the nominal exchange rate:

- If the real exchange rate rises (more home goods are needed in exchange for foreign goods), we speak of a **real depreciation**.
- If the real exchange rate falls (fewer home goods are needed in exchange for foreign goods), we speak of a **real appreciation**.

\[
\frac{q_{E/US}}{\frac{E_{\$}/P_E}{P_{US}}} = \frac{\text{European price of basket expressed in $}}{\text{U.S. price of basket expressed in $}}
\]
Overvaluation & undervaluation

- We use PPP-implied level of 1 as a benchmark or reference level for the real exchange rate.
- This leads naturally to more new terminology.
  - If the real exchange rate is above one (by $x$ percent), then foreign (European) goods are relatively expensive, and we speak of the foreign currency (the euro) as being *overvalued* (by $x$ percent).
  - If the real exchange rate is below one (by $x$ percent), then foreign (European) goods are relatively cheap, and we speak of the foreign currency (the euro) as being *undervalued* (by $x$ percent).
PPP as a theory of the exchange rate

• Rearrange the PPP equation:

\[
E_{\$/\€} = \frac{P_{US}}{P_{E}}
\]

exchange rate \hspace{1cm} \text{ratio of price levels}

• One of the most important equations in this course. A clear prediction about exchange rates

• *Purchasing power parity implies that the exchange rate at which two currencies trade is equal to the relative price levels of the two countries.*

  - Example: A basket of goods costs $1000 in the United States, and £800 in the UK. What is the exchange rate ($/£) implied by the PPP theory?
PPP in levels & rates of change

- The PPP equation: \( \frac{E_{\$/\text{\euro}}} = \frac{P_{\text{US}}}{P_{\text{E}}} \)
  - If this is true in levels it is true in rates of change.
    - The rate of change of the LHS is the rate of increase of \( E \).
    - This is the rate of depreciation:
      \[ \frac{\Delta E_{\$/\text{\euro}, t}}{E_{\$/\text{\euro}, t}} = \frac{E_{\$/\text{\euro}, t + 1} - E_{\$/\text{\euro}, t}}{E_{\$/\text{\euro}, t}} \]
      - The rate of change of the RHS is rate of change of home prices minus rate of change of foreign prices (quotient rule).
      - This is the home–foreign inflation differential:
        \[ \frac{\Delta P_{\text{US}, t}}{P_{\text{US}, t}} - \frac{\Delta P_{\text{E}, t}}{P_{\text{E}, t}} = \left( \frac{P_{\text{US}, t + 1} - P_{\text{US}, t}}{P_{\text{US}, t}} \right) - \left( \frac{P_{\text{E}, t + 1} - P_{\text{E}, t}}{P_{\text{E}, t}} \right) \]
        - Rate of inflation in U.S.
        - Rate of inflation in Europe
The PPP equation expressed in rates of change is therefore:

\[
\frac{\Delta E_{\$, /\€, t}}{E_{\$, /\€, t}} = \pi_{US, t} - \pi_{E, t}
\]

This expression is known to as **Relative PPP**.

**Relative PPP implies that the rate of depreciation of the nominal exchange rate equals the inflation differential.**

Example: Refer back to Canada and US from 1970 to 1990.

- Canadian price level went from 100 to 392: inflation was 6.8% pa
- US price level went from 100 to 336: inflation was 6.1% pa
- Can. Exch. rate went from 1 to 1.15: depreciation was 0.7% pa
- This was equal to the inflation differential (6.8 minus 6.1 equals 0.7)
Notes on Absolute & Relative PPP

- Relative PPP is derived from Absolute PPP; i.e., the latter implies the former. *If Absolute PPP holds then Relative PPP must hold also.*
  - But the converse need not be true: one could imagine a case where a basket always costs a fixed amount more, say, 10% in common currency terms in one country than the other—Absolute PPP fails, but Relative PPP holds.

- The PPP theory, whether in absolute or relative form, suggests that price levels in different countries and exchange rates are tightly linked, either in levels or in rates of change.
  - Begs the question: where do price levels come from? (The next task for us.)
  - But first some evidence on PPP.
PPP in the long run: not bad

Relative PPP, ~30 years, annual averages 1972–2000:

45 degree line: relationship predicted by PPP

Annual inflation rate differential (%, versus U.S.)

Annual rate of depreciation of nominal exchange rate (% vs. US$)
PPP in the short run: pretty awful

Absolute PPP, 25 years, US/UK annual data 1975–2000:
Summing up PPP

• The evidence suggests that the theory of purchasing power parity works best in the long run.
• However, the theory does not work perfectly in the long run; and it clearly does not work at all in the short run.
• In theory, if PPP were taken as a strict proposition for the short run, it would require price adjustment via arbitrage to happen fully and instantaneously. In reality, researchers have found that deviations from PPP occur frequently due to economic disturbances.
• These deviations can be large, and quite persistent; typical estimates suggest they may die out at a rate of about 15% per year: after one year 85% of an initial deviation or gap persists; after two years 72% still persists; after four years 52%.
• Such large and persistent disturbances may not be surprising, however, since there are many reasons why the tendency for PPP to hold is relatively weak in the short run.
Why PPP fails in the short run

- **Transaction costs.** Trade is not costless. By some recent estimates, transportation costs may add about 20% to the cost of goods moving internationally, and tariffs (and other policy barriers) may add another 10%, although there is much variation across goods and across countries. Further costs arise due to the time taken to ship goods.

- **Nontraded goods.** Some goods are inherently nontradable; one can think of them as having infinitely high transaction costs. Most goods fall somewhere in between freely tradable and purely nontradable. Consider a cup of coffee bought in a café: it includes certain highly highly-traded components (coffee beans, sugar) and some highly nontraded components (the labor input of the *barista*).
Why PPP fails in the short run

- **Imperfect competition and legal obstacles.** Many goods are differentiated products, often with brand names, copyrights, and legal protection. Firms can engage in price discrimination across countries (pharmaceutical companies charge different prices for drugs in different countries). Firms can use legal threats to foil arbitrage (e.g., if you try to import large quantities of a pharmaceutical, and resell them, you may hear from the firm’s lawyers).

- **Price stickiness.** One of the most common assumptions of macroeconomics is that prices are “sticky” prices in the short run. PPP assumes that arbitrage can force prices to adjust, but adjustment will be slowed down by price stickiness. Nominal exchange rates move up and down in a very dramatic fashion, whereas price levels are much more sluggish in their movements, and hence do not fully match exchange rate changes.
For 20 years *The Economist* newspaper has applied the idea of PPP to evaluate whether currencies are undervalued or overvalued.

- Recall, home currency is $x\%$ overvalued/undervalued when the home basket costs $x\%$ more/less than the foreign basket.

- Actually, it is really a LOOP based test.

- *The Economist* uses a very simple “basket” consisting of just one globally uniform, standardized product.

- The Big Mac
Burgernomics

• Invented in 1986 by economics editor Pam Woodall, based in London.
  - She asks correspondents around the world to visit McDonalds (they don’t have to dine there) and get the prices and she then computes the $ price in each location relative to the US:

    “Big Mac index” = \[ q^{\text{Big Mac}} - 1 = \frac{E_{\$\text{local currency}}}{P_{\text{US}}^{\text{Big Mac}}} - 1 \]

  - The % deviation (+/−) from the US price measures the over/under valuation of the local currency using the burger basket (or is it a styrofoam box?).
Burgernomics

• Invented in 1986 by economics editor Pam Woodall. She asks correspondents around the world to visit McDonalds and get the prices and she then computes the price in each location relative to the US:

\[ q^{\text{Big Mac}} - 1 = \frac{E_{\text{\$/local currency}}}{P_{\text{Big Mac local}}} - 1 \]

- The % deviation (+/-) from the US price measures the over/under valuation of the local currency.

• Updated every year:
Latte parity

- In 2004 *The Economist* tried using a new globally uniform, standardized product.
- The Starbucks tall latte

“Big Mac index” =

\[ q_{\text{Big Mac}} - 1 = \frac{E_{\text{$/local currency}} \cdot P_{\text{local}}^{\text{Big Mac}}}{P_{\text{US}}^{\text{Big Mac}}} - 1 \]

“tall-latte index” =

\[ q_{\text{tall latte}} - 1 = \frac{E_{\text{$/local currency}} \cdot P_{\text{local}}^{\text{tall latte}}}{P_{\text{US}}^{\text{tall latte}}} - 1 \]
Pick your poison

<table>
<thead>
<tr>
<th>Country</th>
<th>Starbucks tall-latte index</th>
<th>McDonald’s Big Mac index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>-4</td>
<td>-17</td>
</tr>
<tr>
<td>Britain</td>
<td>+17</td>
<td>+23</td>
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<tr>
<td>Canada</td>
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<tr>
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<tr>
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<td>-46</td>
</tr>
<tr>
<td>Turkey</td>
<td>+6</td>
<td>+5</td>
</tr>
</tbody>
</table>

Source: The Economist
Recap
PPP as a theory of the exchange rate

• Rearrange the PPP equation:

\[ \frac{E_{\$/\€}}{\text{exchange rate}} = \frac{P_{US}}{P_{E}} / \text{ratio of price levels} \]

• One of the most important equations in this course.

• A clear prediction about exchange rates

• *Purchasing power parity implies that the exchange rate at which two currencies trade is equal to the relative price levels of the two countries.*
  - Begs the question: where do price levels come from?
  - Answer: in the long run, they are determined by monetary forces
Building block

<table>
<thead>
<tr>
<th>Home country</th>
<th>Foreign country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price level</td>
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<td>$P_{US}$</td>
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<td>Exchange rate</td>
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<tr>
<td>$E_{S/E}$</td>
<td></td>
</tr>
<tr>
<td>Price level</td>
<td></td>
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<tr>
<td>$P_{E}$</td>
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</tr>
</tbody>
</table>
Recap

PPP in rates of change

- The PPP equation expressed in rates of change is therefore:

\[
\frac{\Delta E_{\$/\€, t}}{E_{\$/\€, t}} = \pi_{US, t} - \pi_{E, t}
\]

- **Relative PPP.**
- *Relative PPP implies that the rate of depreciation of the nominal exchange rate equals the inflation differential.*
LEARNING OBJECTIVES
14–2 Money, prices and exchange rates

• Recap on money
  ◦ definitions of money, demand and supply, and money market equilibrium

• Understand the monetary approach to exchange rates in the long run
  ◦ How the quantity theory relates money supply M, output Y, and price level P
  ◦ How PPP then explains exchange rate E
  ◦ How the relationship applies to rates of change (linking money growth, inflation, and the rate of deprecation)
Preamble on money

• What is money?
  ✷ It serves 3 functions

• Store of value
  ✷ Money is an asset, but it pays no interest; has value in the future too.

• Unit of account
  ✷ How prices are expressed

• Medium of exchange
  ✷ Has value today and in the future because it is the most liquid form of payment: an asset that is easily converted into goods and services
Measurement of money

- Many definitions of the amount or stock of money in the economy, ranging from narrow to broad
  - M0 currency
  - M1 M0 + demand deposits, traveler’s checks
  - M2 M1 + savings and small time deposits
  - M3 M2 + large time deposits, money market funds, repurchase agreements
- In this course when we refer to money and use the symbol M, we will mean M1
  - Money that is most liquid and earns no interest
Measurement of money

- **$0**
- **$1,000**
- **$2,000**
- **$3,000**
- **$4,000**
- **$5,000**
- **$6,000**
- **$7,000**
- **$8,000**
- **$9,000**
- **$10,000**

**broad money**

- **M3** $8,874 billion
  - Large time deposits, repurchase agreements, money market funds, etc. $2,807 billion

- **M2** $6,067 billion
  - Demand deposits, traveler’s checks, and other highly liquid deposits $625 billion
  - Less liquid deposits, including saving and small time deposits $4,770 billion

- **M1** $1,288 billion
  - Currency $663 billion

- **M0** $663 billion

**narrow money**
Money supply

- We assume that the nominal money supply $M = M_1$ is controlled by the central bank.
  - In fact, the central bank directly controls only part of $M$, namely $M_0$, or currency (notes and coins).
  - However, central banks can indirectly control $M_1$ by using interest rate policies and other tools (such as reserve requirements) to influence the total amount of bank deposits created $M_1 - M_0$.
  - Hence, for simplicity, we assume that the central bank controls $M = M_1$. 
We assume that the demand for nominal money is driven by the need to use money to undertake transactions.

- In the simplest model, the **quantity theory**: the amount of transactions assumed proportional to the dollar value of nominal income $P \times Y$ (where real income is $Y$).
- Hence, money demand is proportional to the dollar value of nominal income, where the proportionality is given by a constant $L$.

\[
\frac{M_d}{\text{demand for money ($)}} = \frac{P \times Y}{\text{nominal income ($)}} \times \frac{L}{\text{a constant}}
\]

- Example (US):
  Nominal income = $12$ trillion, $L=0.1$, $M=\$1.2$ trillion
  - Annually, each $1$ allows economy to transact GDP worth $10$.
  - We say the **velocity** of money ($V$) is $10$ where $V = 1/L$
Money demand, real

- Rearrange to get an expression for the demand for real money balances (the nominal value of money deflated by the price level \( P \)):

\[
\frac{M^d}{P} = \frac{L}{P} \times Y
\]

- The demand for real money is a constant multiple of the real income level \( Y \).
Money market equilibrium
LONG RUN

• If money demand Md equals money supply M then we can replace Md with M in last two equations

• Nominal:

\[ M = \bar{L}PY \]

• Real:

\[ \frac{M}{P} = \bar{L}Y \]

• In the long run, we assume prices P are fully flexible and adjust so this equilibrium is attained.
• So this is also known as the **flexible price model**.
The monetary theory of the price level
LONG RUN

• Now just rearrange and solve for the price level $P$.
• Do this for each economy (e.g. US, euroland)

fundamental equations of the monetary model of the price level

$$P_{US} = \frac{M_{US}}{L_{US}Y_{US}}$$

$$P_{E} = \frac{M_{E}}{L_{E}Y_{E}}$$

• Intuition: These expressions say that the price level $P$ is determined by the ratio of nominal money supplied $M$ to nominal money demanded $L$.
  • Prices rise if there is “more money chasing fewer goods”
Another building block

<table>
<thead>
<tr>
<th>Home country</th>
<th>Foreign country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Money supply $M_{US}$</td>
<td>Money supply $M_{E}$</td>
</tr>
<tr>
<td>Real income $Y_{US}$</td>
<td>Real income $Y_{E}$</td>
</tr>
<tr>
<td>Price level $P_{US}$</td>
<td>Price level $P_{E}$</td>
</tr>
</tbody>
</table>

Exogenous variables:
- Money supply
- Real income

Endogenous variables:
- Price level

Input of the model:
- Known Variables
  - Money supply
  - Real income

Output of the model:
- Price level
The monetary theory of the exchange rate

**LONG RUN**

- Now use another piece of theory that is only suited to the long run, PPP.
- PPP says $E$ equals the ratio of the price levels. So just plug in the price levels:

\[
E_{\text{$/€$}} = \frac{P_{US}}{P_E} \frac{\overline{M}_{US}}{\overline{M}_E} \frac{\overline{L}_{US} Y_{US}}{\overline{L}_E Y_E} = \left( \frac{M_{US}}{M_E} \right) \left( \frac{\overline{L}_{US} Y_{US}}{\overline{L}_E Y_E} \right)
\]

**fundamental equation of the monetary approach to exchange rates**
The monetary theory of the exchange rate
LONG RUN

• The monetary theory can also be expressed in terms of rates of growth.
  ♦ rate of growth of a product = sum of growth rates
  ♦ rate of growth of a quotient = difference of growth rates

• Define
  ♦ growth rate of nominal money supply $M$
  ♦ growth rate of real income $Y$:

\[
\mu_{US,t} = \left(\frac{M_{US,t+1} - M_{US,t}}{M_{US,t}}\right)
\]

rate of money supply growth in U.S.

\[
g_{US,t} = \left(\frac{Y_{US,t+1} - Y_{US,t}}{Y_{US,t}}\right)
\]

rate of real output growth in U.S.

• and similarly for Europe
The monetary theory of the exchange rate
LONG RUN

• The levels equation

\[ P_{US} = \frac{M_{US}}{L_{US} Y_{US}} \]

• The same equation in differences (remember L is a constant)

\[ \pi_{US,t} = \mu_{US,t} - g_{US,t} \]

• Important monetarist result: inflation equals the excess of money growth over real output growth.

• Same for Europe

\[ \pi_{E,t} = \mu_{E,t} - g_{E,t} \]
The monetary theory of the exchange rate

LONG RUN

• Putting it all together in growth rates
  ♦ Use relative PPP rather than absolute PPP

\[
\frac{\Delta E_{$/€,t}}{E_{$/€,t}} = \pi_{US,t} - \pi_{E,t} = (\mu_{US,t} - g_{US,t}) - (\mu_{E,t} - g_{E,t})
\]

- rate of depreciation of the nominal exchange rate
- inflation differential

\[
= (\mu_{US,t} - \mu_{E,t}) - (g_{US,t} - g_{E,t}).
\]

- differential in nominal money supply growth rates
- differential in real output growth rates

• We have a number of important and testable implications
• Let’s have a look at what theory predicts and the evidence
LEARNING OBJECTIVES

14–3 Monetary Approach: Implications and Evidence

- Understand how to put the theory to use and derive implications
  - Policy predictions
- Understand how to evaluate the validity of the theory
  - Evidence
    - Data on money, prices and exchange rates
    - Data from hyperinflations
- Learn about currency deaths and rebirths
Policy predictions

- Both countries
  - Constant money growth rate $\mu$, fixed level of output $Y$
- Foreign
  - Money growth $\mu$ is zero, inflation $\pi$ is zero
- Home
  - Money growth $\mu$ is positive, inflation $\pi$ is positive
- Policy change at time $T$
  - Home increases its rate of money growth $\mu$ by $\Delta\mu$
- What happens to all these variable according to the long run (flexible price) model?
Policy predictions

1. Rate of growth of money supply increases.

2. Real money balances remain constant.

(a) home money supply

(b) home real money balances

growth rate = $\mu + \Delta \mu$

$M$

growth rate = $\mu$

$M/P$

$T$

time
Policy predictions

(c) home price level

1. Rate of growth of money supply increases.

2. Real money balances remain constant.

3. Rate of inflation increases.

(c) home price level

growth rate = $\mu$

growth rate = $\mu + \Delta \mu$

$P$

$T$

time

(d) home exchange rate

4. Rate of depreciation increases.

(d) home exchange rate

growth rate = $\mu$

growth rate = $\mu + \Delta \mu$

$E$

$T$

time

$\mu$

$\Delta \mu$

$\equiv \frac{\text{growth rate}}{1 + \frac{\text{money supply}}{\text{home price level}}}$
Evidence: inflation and money growth

45 degree line: relationship predicted by monetary model
Evidence: exchange rates and money growth

45 degree line: relationship predicted by monetary model

Annual rate of depreciation of nominal exchange rate (% versus US)
Annual money growth rate differential (% versus US)
Evidence: hyperinflations, E and P

Cumulative multiplicative change in price level relative to U.S. price level (start to finish)
Evidence: hyperinflations, $M/P$

<table>
<thead>
<tr>
<th>Monthly inflation rate at peak (%)</th>
<th>Ratio of real money balances $M/P$ held at peak inflation to real money balances $M/P$ held initially</th>
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</thead>
<tbody>
<tr>
<td>1</td>
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<tr>
<td>10</td>
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<td>1,000,000,000,000</td>
</tr>
</tbody>
</table>

Countries: Nationalist China, Hungary, Greece, Zaire, Germany, Armenia, Peru, Others

Graph showing the ratio of real money balances $M/P$ held at peak inflation to real money balances $M/P$ held initially against the monthly inflation rate at peak (%), with data points for specific countries.
FYI
Currency Deaths and Rebirths

• Near-death experiences
  ♦ Cases where a currency is a poor store of value, and exchange rate depreciates rapidly (high inflation or **hyperinflation**)
  ♦ People avoid holding currency (drop in real money demand)
  ♦ **currency substitution:** switch to using a “hard currency” (unofficial money—e.g. $), *de facto* dollarization in the short run
  ♦ Can only be overcome by stabilizing currency—may require a change of units to take off some zeroes.

• Death of currencies
  ♦ If not overcome, dollarization persists, and even become de jure
  ♦ Cases where countries have been or become “dollarized” (includes use of euros, A$, NZ$, £ etc.)
  ♦ Often a result of hyperinflation (in some developing countries)
  ♦ Unilateral adoption of foreign currency
    ▪ No influence over monetary policy
  ♦ Not to be confused with currency unions, e.g. Euro
    ▪ Countries agree to share Monetary Policy powers
## FYI
### Currency Deaths and Rebirths

<table>
<thead>
<tr>
<th>Economy</th>
<th>Currency</th>
<th>Economy</th>
<th>Currency</th>
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<tbody>
<tr>
<td>American Samoa</td>
<td>U.S. $</td>
<td>Montenegro</td>
<td>euro</td>
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<tr>
<td>Andorra</td>
<td>euro*</td>
<td>Monaco</td>
<td>euro</td>
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<tr>
<td>British Virgin Islands</td>
<td>U.S. $</td>
<td>Nauru</td>
<td>Aus. $</td>
</tr>
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<td>Cocos (Keeling) Islands</td>
<td>Aus. $</td>
<td>Niue</td>
<td>N.Z. $</td>
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<tr>
<td>Cook Islands</td>
<td>N.Z. $</td>
<td>Norfolk Island</td>
<td>Aus. $</td>
</tr>
<tr>
<td>Cyprus, Northern</td>
<td>Turkish lira</td>
<td>Northern Mariana Islands</td>
<td>U.S. $</td>
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<td>Palau</td>
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<td>Panama</td>
<td>U.S. $*</td>
</tr>
<tr>
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<td>Dan. krone</td>
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<td>San Marino</td>
<td>euro*</td>
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<tr>
<td>Kiribati</td>
<td>Aus. $*</td>
<td>Tokelau</td>
<td>N.Z. $</td>
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<tr>
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<td>euro</td>
<td>Turks and Caicos Islands</td>
<td>U.S. $</td>
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<tr>
<td>Liechtenstein</td>
<td>Swiss franc</td>
<td>Tuvalu</td>
<td>Aus. $*</td>
</tr>
<tr>
<td>Marshall Islands</td>
<td>U.S. $</td>
<td>U.S. Virgin Islands</td>
<td>U.S. $</td>
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<tr>
<td>Marshall Islands</td>
<td>U.S. $</td>
<td>Vatican City</td>
<td>euro*</td>
</tr>
<tr>
<td>Micronesia</td>
<td>U.S. $</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NB: Only some of these are independent states. * Issues own coins.
FYI
Currency Deaths and Rebirths

Argentina’s Exchange Rate 1980–2004

Dotted line = currency reform
Shaded line = obsolete currency

1 peso argentino = 10,000 pesos
1 austral = 1,000 pesos argentinos
1 convertible peso = 10,000 australes
The peso argentino (a) was replaced by the austral (b) in 1989; in the hurried transition austral denominations were simply overprinted on the old bills; the austral soon disappeared too. A 1923 five billion German mark note (c) was soon just small change. The Hungarian 100 Million B-pengö of 1946 (B denotes the Hungarian billion, or a million million) was a 100,000,000,000,000,000,000 pengö note (d): it is the highest denomination of currency ever issued by any country.
LEARNING OBJECTIVES
14–4 Money, Interest and Prices

- Understand that we need a more general model
  - Money demand is not stable and proportional to real output. Interest rate matters.
  - Develop a more general model of money demand and allow nominal interest rates \( i \) to affect money demand

- Understand that we need a long-run theory of nominal interest rates
  - Understand the Fisher effect
  - Understand real interest parity

- Applications of the general model
  - Policy predictions
  - Evidence
Shortcomings of the simple model

- Quantity theory assumes that $L$ is a constant
  - For a given level of real output $Y$, the level of real money balances $M/P$ is assumed constant
  - Not true in general
    - Clearly not true for hyperinflations!
- Q: Why might people adjust their level of money balances?
- A: The more general theory assumes that $L$ isn’t constant, and depends inversely on the opportunity cost of holding money.
  - What is the opportunity cost of holding money?
Opportunity cost of holding money

- In nominal terms
  - Suppose the bank pays a nominal interest rate $i_{\text{bank}} = i$ on an interest bearing account
  - Cash pays a nominal interest rate of $i_{\text{cash}} = 0$
  - The difference is $i_{\text{bank}} - i_{\text{cash}} = i - 0 = i$

- In real terms
  - Suppose the bank pays a nominal interest rate $i$; the real interest rate is $r_{\text{bank}} = i - \pi$
  - Cash pays a nominal interest rate of 0; the real interest rate on cash is $r_{\text{cash}} = 0 - \pi = -\pi$
  - The difference is $r_{\text{bank}} - r_{\text{cash}} = i - \pi - (-\pi) = i$

- The opportunity cost of holding money is the nominal interest rate $i$. 
The standard model of money demand is motivated by two insights, the first of which carries over from our simple model presented earlier, the quantity theory.

- **Benefits**: As before, the benefit of money is that individuals can transact with it. As in the simple quantity theory, we continue to assume that transactions demand is in proportion to income, all else equal.

- **Costs**: The cost of holding money, instead of other assets, arises because money has a lower rate of return. In particular, the nominal interest rate on money is zero. The expected nominal interest rate on many other assets is positive. By holding money, and not earning this interest, she suffers a cost, the opportunity cost of holding money.
Standard model of money demand

- Moving from the individual or household level up to the aggregate or macroeconomic level, we can infer that the aggregate **money demand** will behave similarly:
  - *All else equal, a rise in national dollar income (nominal income) will cause a proportional increase in transactions and, hence, in aggregate money demand.*
  - *All else equal, a rise in the nominal interest rate will cause the aggregate demand for money to fall.*
Standard model of money demand

• Mathematically:

- **Nominal**
  \[
  \frac{M^d}{P} = \frac{P \times Y}{\text{nominal income ($)}} \times \frac{L(i)}{\text{a decreasing function}}
  \]

- **Real**
  \[
  \frac{M^d}{P} = \frac{L(i)}{\text{a decreasing function}} \times \frac{Y}{\text{real income}}
  \]
A decrease in the nominal interest rate causes an increase in real money demand.
Real money demand function
A CHANGE IN REAL INCOME

An increase in real income causes an increase in real money demand at any level of the nominal interest rate
Long run theory of the interest rate

• Recall: We are building a long run theory
  ✷ Much is unchanged in the standard model
  ✷ We assume price flexibility
  ✷ We assume PPP so that \( E = \frac{P}{P^*} \)
  ✷ We use a monetary model to obtain \( P \) and \( P^* \)

• BUT…
  ✷ The addition of the term \( L(i) \) in the monetary model is only useful if we can come up with a theory of where \( i \) comes from in the long run
  ✷ To do so we invoke the UIP condition and see what UIP implies in the long run
PPP meets UIP…

- **PPP (rates of change)**
  \[
  \frac{\Delta E^e}{E_\$/$\€,t} = \frac{\pi_{US,t}^e - \pi_{E,t}^e}{\text{expected inflation differential}}
  \]

- **UIP (approximation) says that:**
  \[
  \frac{\Delta E^e_{\$/$\€}}{E_{\$/$\€}} = \frac{i_\$ - i_\€}{\text{net dollar interest rate - net euro interest rate}}
  \]

- If the left hand sides are equal, then the right hand sides must be equal too.
And together they imply the Fisher effect

\[ i_s - i_E = \pi^e_{US} - \pi^e_E \]

nominal interest rate differential  
nominal inflation rate differential (expected)

and real interest parity (RIP)

\[ i_s - \pi^e_{US} = i_E - \pi^e_E \]

that is, equalization of ex ante real interest rates

\[ r^e_{US} = r^e_E \]

- A powerful result!
- Only true in the long run given our assumptions
- We have assumed no risk premium, but easily added
Evidence on Fisher Effect
INFLATION AND INTEREST RATES

Annual inflation rate differential (relative to U.S.)

Annual nominal interest rate differential (relative to U.S.)

45 degree line: relationship predicted by Fisher effect
Evidence on RIP
(EX POST) REAL INTEREST RATE DIFFERENTIALS

U.K.–U.S.

Germany–U.S.

France–U.S.
Summing up the standard model

- Same as the basic (quantity theory) model except that the constant L is replaced by the decreasing function L(i):

\[
\frac{E_{\$/\€}}{P_E} = \frac{P_{US}}{P_E} = \left( \frac{M_{US}}{L_{US}(i_S)Y_{US}} \right) = \frac{\left( \frac{M_{US}}{L_{US}(i_S)Y_{US}} \right)}{\left( \frac{M_E}{L_E(i_\€)Y_E} \right)} = \frac{(M_{US} / M_E)}{(L_{US}(i_S)Y_{US} / L_E(i_\€)Y_E)}
\]

- E is still a ratio of price levels (PPP)
- P is ratio of money supply M to real money demand L(i)Y
  - Note: The basic model is “good enough” if interest rates i are stable in the long run.
Policy predictions revisited
NOW USING THE STANDARD MODEL

• Both countries
  ♦ Constant money growth rate $\mu$, fixed level of output $Y$

• Foreign
  ♦ Money growth $\mu$ is zero, inflation $\pi$ is zero

• Home
  ♦ Money growth $\mu$ is +, inflation $\pi$ is +

• Policy change at time $T$
  ♦ Home increases its rate of money growth $\mu$ by $\Delta \mu$

• What happens to all these variable according to the long run (flexible price) model, when we use the standard model and $L = L(i)$
  ♦ Assume inflation is constant before and after the policy change. Verify assumption later as a consistency check.
Policy predictions revisited
NOW USING THE STANDARD MODEL

(a) home money supply

growth rate = $\mu + \Delta \mu$

1. Rate of growth of money supply increases.

(b) home real money balances and nominal interest rate

$\Delta i = \Delta \mu$

2. Expected increase in inflation; interest rate rises.

$\Delta (M/P)$

...causing real money balances to drop.
Policy predictions revisited
NOW USING THE STANDARD MODEL

(c) home price level

1. Rate of growth of money supply increases.
   \[ \text{growth rate} = \mu + \Delta \mu \]

2. Expected increase in inflation; interest rate rises.
   \[ \text{growth rate} = \mu \]

3. Price level jumps and rate of inflation increases.
   \[ \text{growth rate} = \mu + \Delta \mu \]

(d) home exchange rate

4. Exchange rate jumps and rate of depreciation increases.
   \[ \text{growth rate} = \mu + \Delta \mu \]
LEARNING OBJECTIVES
14–5 Monetary regimes and exchange rate regimes

• Understand why policymakers are concerned with inflation

• Understand the idea of a nominal anchor
  ♦ Since M, E and P all move together, ensuring targets for one of these variables, imposes constraints on the other two

• Study three policy regimes
  ♦ M target (money growth rule)
  ♦ E target (fixed exchange rate)
  ♦ P target (inflation target)

• Look at some evidence
Monetary regimes & exchange rate regimes

- Policymakers are greatly concerned with costs of inflation
  - Inflation is unpopular and may have macroeconomic costs (when “large” eg over 10% per annum, and clearly when very large)
- The monetary approach illustrates how policymakers can choose among different nominal anchors to achieve this goal
  - Monetary regime: what are the rules, objectives, policies followed by the central banks
  - Exchange rate regime: part of the monetary regime; is E fixed or floating? (or in between)
Monetary regimes & exchange rate regimes

- Money supply target

\[ \pi_H = \mu_H - g_H \]

- Pro: simple (robots replace central banks).
- Con: can only achieve target rate of inflation if real output growth is known
  - Example. M growth 4%, Y growth 2% means inflation of 2%
  - What if output growth is 1%? 3%?
  - Problem: nobody knows future output growth, not even central bankers (or robots). Cannot rely on autopilot.
  - But is it worse than the alternative(s)?
Monetary regimes & exchange rate regimes

- Exchange rate target (eg fix, crawl)

\[ \pi_H = \frac{\Delta E_{H/F}}{E_{H/F}} + \pi_F \]

- Con: “imported inflation” from base
  - Suppose you peg, so that \( \Delta E/E = 0 \)
  - Relative PPP means your inflation is same as base country
  - Better choose a “hard currency” to peg to
  - Even so, what you get might not be what you want
Monetary regimes & exchange rate regimes

- **Inflation target with interest rate policy**

\[
\pi_H^{e} = i_H - r^*.
\]

- **Anchor variable**

- In **short run** central bank has the freedom to let nominal interest fluctuate, but in **long run promises** to set \( i \) on average at “neutral level” dictated in the above equation by the inflation target and the world real interest rate.

- E.g. (the Fed?) inflation of 1.75% and world r of 2.5% requires interest rate “on average” at neutral rate of 4.25%

- **Con:** Neither simple nor transparent.

- Requires credibility. Something that some central banks don’t have (promises of low inflation often broken)
In the long run, any nominal anchor means the central bank is sacrificing autonomy (to achieve the inflation goal).

In the short run, different nominal anchors are consistent with different exchange rate regimes.

<table>
<thead>
<tr>
<th>Exchange rate regime</th>
<th>Possible exchange rate regime choices for countries using target(s)</th>
<th>Possible exchange rate regime choices for countries with no target</th>
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</thead>
<tbody>
<tr>
<td>Countries without a currency of their own</td>
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<tr>
<td>Pegs/Bands/Crawls</td>
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<tr>
<td>Freely floating</td>
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<td>✓</td>
</tr>
<tr>
<td>Freely falling (rapid depreciation)</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Possible exchange rate regime choices for countries using target(s):
- Exchange rate target
- Money supply target
- Inflation target (plus interest rate policy)
Nominal anchors in practice

- After problems with high inflation around the world in the 1970s, most governments and central banks have adopted some form of nominal anchoring
- Adoption of nominal anchors has been instrumental in bringing down inflation rates globally

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<td>Developing Countries</td>
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</table>
Nominal anchors in practice

- Shift toward use of targets in the 1990s
- Better nominal anchoring in the world?
- In practice, the targets used may be mixed, hybrid, or intermediate, not the pure kind we examined in theory
Chapter 14: Summary

1. Purchasing power parity implies that the exchange rate should equal the relative price level in the two countries, and the real exchange rate should equal 1.

2. Evidence for PPP is weak in the short run, more favorable in the long run. In the short run, deviations are common and changes in the real exchange rate do occur. The failure of PPP in the short run is primarily the result of price stickiness and market frictions and imperfections that limit arbitrage.

3. A simple monetary model (the quantity theory) explains price levels in terms of by money supply levels and real income levels. Since PPP can explain exchange rates in terms of price levels, the two together can be used to develop a monetary approach to the exchange rate.
• 4. We can use the monetary approach to forecast the level of the exchange rate at any time in the future, if we can forecast money supply and income. However, the monetary approach is only valid under the assumption that prices are flexible. This assumption is more likely to hold in the long run, so the short run forecast is not reliable. Evidence for PPP and the monetary approach is more favorable in the long run.

• 5. PPP theory, combined with uncovered interest parity, leads to the strong implications of the Fisher effect (interest differentials between countries should equal inflation differentials). The Fisher effect says that changes in local inflation rates pass through one-for-one into changes in local nominal interest rates. The result implies real interest parity (expected real interest rates should be equalized across countries). Since these results rest on PPP, they should be viewed only as long run results, and the evidence is somewhat favorable.
Chapter 14: Summary

6. We can augment the simple monetary model (quantity theory) to allow for the demand for real money balances to decrease as the nominal interest rate rises. This leads to the standard monetary model. Its predictions are similar to those of the simple model, except that a one-time rise in money growth rates, leads to a one-time rise in inflation, which leads to a one-time drop in real money demand which in turn causes a one-time jump in the price level and the exchange rate.

7. The monetary approach to exchange rate determination in the long run has implications for economic policy. Policymakers and the public generally prefer a low-inflation environment. Various policies based on money growth, exchange rate, or interest rate have been proposed as nominal anchors. Recent decades have seen a worldwide decline in inflation thanks to the explicit recognition of the need for nominal anchors.