UNIT 3
Determinants of the Exchange Rate

What you will learn:
1. Theories of how inflation, economic growth and interest rates affect the exchange rate
2. How trade patterns affect the exchange rate
3. How the monetary sector of the economy affects the exchange rate
4. How investment demands/supplies affect the exchange rate
5. How Central bank activity affects the exchange rate
6. How interest rates reflect future exchange rate values and how to infer the market's forecast of the future exchange rate

• Definition:
  • The exchange rate is the price of one currency in terms of another.
  • Most of the industrial world uses a floating exchange rate system. Under this system, market forces are the primary determinant of the exchange rate. The exchange rate is (for the most part) allowed to vary from day to day.
  • There are a number of economic models which attempt to explain the movement of exchange rates through time. These include (but are not limited to): the Traditional Flow Model, a Money Sector Model and the Asset Model.

• Each of these models examines only one aspect of economic factors which might affect the exchange rate.
  • For each of these models we will examine how:
    - (1) price levels \( P \)
    - (2) real income \( Y \)
    - (3) and interest rates \( i \)
    affect the exchange rate \( e \)

Traditional Flow Model
• (concentrates on the trade accounts)
Assumptions of the Traditional Flow Model
1. Traded goods and services are the ultimate link to the exchange rate.

   Economic factor \(\rightarrow\) Imports or exports \(\rightarrow\) exchange rate

2. No capital flows between countries.

• Like any other "good" the foreign exchange price is determined by the relative supply and demand for each currency.

• If we are talking about the \$/€ exchange rate, this comes from the demand and supply of € relative to the demand and supply of $.

• Where does the demand for € come from?
  - Ans: From the US demand for European goods and services.
Derivation of the Demand for €

- Assume a two good world where the French produce Good X and export this good to the US.

<table>
<thead>
<tr>
<th>Price of good X in €</th>
<th>Exchange Rate $/€</th>
<th>Price of X in $</th>
<th>U.S. demand for X in €</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>0.12</td>
<td>3</td>
<td>17</td>
</tr>
<tr>
<td>25</td>
<td>0.16</td>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td>25</td>
<td>0.20</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>25</td>
<td>0.24</td>
<td>6</td>
<td>4</td>
</tr>
</tbody>
</table>

(1) Given (2) Given (3) = (1) x (2) (4) = Given (5) = (1) x (4)

Underlying the Demand Curve

- US taste for French goods
- US real income (Y)
- US prices ($_{US}$) vs. French Prices ($_{F}$)
- US interest rates

Responses of Demand for €

French Prices Rising Faster than US Prices

As French goods prices increase, French goods become relatively more expensive. Consequently, US citizens buy U.S. goods instead of the French goods (import substitution). With a decreased demand for French goods, there is a decreased demand for €.

US Real Income Growing Faster than French Real Income

As real income increases in the US, US consumers demand more of all goods - including imports - for consumption (recall consumption varies directly with real income). The US consumers must first buy € before they buy French goods. Therefore the demand for € increases.

US Interest Rate Increases

If the interest rate in the US increases, US citizens will save more. If they are saving they are consuming less of all goods, including imports. With a decrease in import demand, there is a decrease in the demand for €.
### Summary of Factors Affecting US Demand for €

<table>
<thead>
<tr>
<th>Factor</th>
<th>US vs. French</th>
<th>US Interest Rate</th>
<th>US Income Growth Rate</th>
<th>Δ Demand for €</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflation Rate</td>
<td>US &gt; French</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td></td>
<td>US &lt; French</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
</tr>
<tr>
<td>Interest Rate</td>
<td>US interest ↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
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<tr>
<td></td>
<td>US interest ↓</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
</tr>
<tr>
<td>Real Income Growth Rate</td>
<td>US income ↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td></td>
<td>US income ↓</td>
<td>↓</td>
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</tbody>
</table>

### Derivation of the Supply of €

- Assume a two good world where the US produces Good Z and exports this good to France.

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### Underlying the Supply Curve

- French taste for US goods
- French real income (Y)
- French Prices ($P_f$) vs. US prices ($P_{us}$)
- French interest rates

### Responses of Supply of €

- French Prices Rising Faster than US Prices

As French goods prices increase, French goods become relatively more expensive. Consequently, French citizens buy US goods instead of the French goods. In order for the French to buy US goods, they must first give up their € for $.

### French Real Income Growing Faster than US Real Income

As real income increases in France, French consumers demand more of all goods - including imports - for consumption (recall consumption varies directly with real income). French consumers must first buy $ before they buy US goods. Therefore the supply for € increases.
If the interest rate in France increases, French citizens will save more. If they are saving more, they are consuming less of all goods, including imports. With a decrease in import demand, there is a decrease in the demand for $, so the supply of € decreases.

### Summary of Factors Affecting the French Supply of €

<table>
<thead>
<tr>
<th>Factor</th>
<th>Effect on Supply of €</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflation Rate</td>
<td>$\downarrow$</td>
</tr>
<tr>
<td>US &gt; French Interest Rate</td>
<td>$\downarrow$</td>
</tr>
<tr>
<td>US &lt; French Interest Rate</td>
<td>$\uparrow$</td>
</tr>
<tr>
<td>Real Income Growth Rate</td>
<td>$\downarrow$</td>
</tr>
<tr>
<td>French Income Growth Rate</td>
<td>$\downarrow$</td>
</tr>
</tbody>
</table>

### Market Equilibrium

The equilibrium exchange rate is determined by the intersection of the supply and demand for foreign exchange. Combining the two graphs, the equilibrium exchange rate is given at point $e_0$. Why can't $e_1$ or $e_2$ be the equilibrium exchange rate? What market forces lead to $e_0$ being the market equilibrium?

**Ans:** At $e_1$ the quantity supplied would be greater than the quantity demanded, i.e., there would be a surplus at this rate. In competitive markets, the exchange rate would fall until it reached $e_0$. At $e_2$, quantity supplied would be less than the quantity demanded, i.e., there would be a shortage. In a competitive market, the exchange rate would be bid up until it reached $e_0$.

### Predictions from the Traditional Flow Model

- **Assume the market starts in equilibrium with $S_0$, $D_0$ and $e_0$. What would happen to the $$/€$ rate under the following circumstance?:**

  1. **US real income rises faster than in France**

    With higher real income in the US, US citizens buy more of all goods including imports. In order to buy more imports, they must first buy €. The Demand for € increases. This causes a temporary shortage of €. The new equilibrium is at $e_1$. Therefore, the $\$ gets weaker.

  2. **US Interest Rates Rise**

    If the interest rate in the US increases, US citizens will save more. If they are saving more, they are consuming less of all goods, including imports. With a decrease in import demand, there is a decrease in the demand for €. This will cause a temporary surplus of €. The exchange rate will fall to the new equilibrium at $e_1$. The $\$ gets stronger.
As real income increases in France, French consumers demand more of all goods - including imports. French consumers must first buy $ before they buy US goods. Therefore the supply for € increases. This creates a temporary surplus and the exchange rate adjusts to e1. The $ gets stronger.

As the price of US goods increases, French citizens find US goods relatively more expensive. They buy fewer US goods, so they have to buy fewer US $. The supply of € decreases. US citizens also find the price of US goods to be relatively more expensive. US citizens therefore buy more French goods. In order to buy French goods they must first buy €. The demand for € therefore increases. The combined effect is a new equilibrium at e1. The $ gets weaker.

Money Sector Model

- (concentrates of relative prices (inflation rates)
- Ultimately based on Purchasing Power Parity (PPP)
- Combines, PPP, the Quantity theory and the Fisher Effect
- Assumes the expected real rate of interest is the same everywhere

Purchasing Power Parity (PPP)

- PPP states that the same currency denomination price of the same good will be the same everywhere.
- Let’s say we have 1 oz. gold trading in New York and London
  - In NY the price is $800 / oz
  - In London the price is 440£/oz
  - Exchange rate is 1.81 $/£

- The $ price in NY is simply $800 / oz
- The $ price in London is
  \[(440£)(1.81 $/£) = 796.40\]
So the common currency price of gold is cheaper in London than in NY
Traders would buy gold in London and sell it in NY
but to buy gold in London, traders would first have to buy £. The pound price would increase until the $ denomination price of the gold was the same in both NY and London.

PPP will hold because of the Law of One Price
- Two forces make Law of One Price hold
  - (1) Final goods arbitrage - prices can deviate by the transaction (including taxes) or transportation costs
  - (2) Input price equalization - if factors of production are free to move, then eventually, final goods prices will equalize. Value additivity says that in competitive markets, the final price of a good will be equal to the sum of the prices of the inputs used to make the goods.
Derivation of PPP

- \( P_{us} \) = US price in $ of the good
- \( P_f \) = Foreign price of good in foreign currency
- \( e_0 \) = exchange rate stated as $/€
- In equilibrium
  - US price in $ of the good = Foreign price in $ of good
  \( P_{us} = e_0 \cdot P_f \)

There are two versions of PPP

- **Absolute PPP**
  \[ P_{us} = e_0 \cdot P_f \]

- **Relative PPP**
  \[ \% \Delta e_0 = \% \Delta P_{us} - \% \Delta P_f \]

Note if \( \% \Delta e_0 \) is positive, then the $ is depreciating.

Defining the Quantity Theory

- **Quantity Theory of Money**
- \( M \cdot V = P \cdot Y \)
- \( M \) = Nominal Money Supply
- \( V \) = velocity of Money
- \( P \) = price level
- \( Y \) = real income / output

- The quantity theory can also be written
  \[ \% \Delta M + \% \Delta V = \% \Delta P + \% \Delta Y \]
  
  - Assume \( \% \Delta V \) is zero because the other variables change so much faster. Then we get
  \[ \% \Delta M = \% \Delta P + \% \Delta Y \]

Notation:

- \( E(\ldots) \) is read “expected…”
- So if \( \% \Delta P \) denotes inflation, then \( E(\% \Delta P) \) denotes expected inflation
Quantity Theory of Money with $\% \Delta V = 0$

$$E(\% \Delta P) = E(\% \Delta M) - E(\% \Delta Y)$$

The expected inflation rate is equal to the expected growth rate in nominal money supply, minus the expected growth in real income.

Inflation is caused when the nominal money supply grows more than the real GNP growth rate.

**The Fisher Equation**

- $i = E(R) + E(\% \Delta P)$

The nominal interest rate, $i$, is equal to the sum of the expected real rate of return, $E(R)$ and the expected inflation rate, $E(\% \Delta P)$

**Predictions for the Money Sector Model**

- Prices rise in the foreign country faster than the US
  - From Equation 1
  1) $E(\% \Delta e) = E(\% \Delta P_{US}) - E(\% \Delta P_f)$ PPP

- Real income in the US rises faster than in the foreign country
- From Equation 2a and 1
  2a) $E(\% \Delta Y_{US}) = E(\% \Delta M_{US}) - E(\% \Delta Y_{US})$ Quantity Theory

- US Nominal interest rates higher than foreign interest rates $i_{US} > i_f$
  - From equations 3a,3b and 1 and our assumption about expected real interest rates
  3a) $i_{US} = E(R_{US}) + E(\% \Delta P_{US})$ Fisher Equation
  3b) $i_f = E(R_f) + E(\% \Delta P_f)$ Fisher Equation

  1) $E(\% \Delta e) = E(\% \Delta P_{US}) - E(\% \Delta P_f)$ PPP

US Nominal interest rates higher than foreign interest rates $i_{US} > i_f$
US nominal money supply increase

- From Equation 2a and 1

2a) \[ E(\% \Delta P_{US}) = E(\% \Delta M_{US}) - E(\% \Delta Y_{US}) \]  

Quantity Theory

1) \[ E(\% \Delta c) = E(\% \Delta P_{US}) \cdot E(\% \Delta Y) \]  

PPP

\[ E(\% \Delta M_{US}) \uparrow \rightarrow E(\% \Delta P_{US}) \uparrow \text{ (by Quantity Theory)} \]

\[ \rightarrow \rightarrow E(\% \Delta c) \uparrow \]  

(by PPP) \[ \rightarrow \rightarrow $ \text{weaker} \]

Asset Model of Exchange Rate Determination

- Based on expected real after-tax risk adjusted interest rates
  - People move their wealth to countries where they believe they can get the highest real, after tax risk adjusted rate of return. In order to invest in a country you must first buy their currency.
  - When a country has a higher real risk adjusted interest rate, their currency gets stronger.

Factors which can make a country's real interest rates higher

(1) Higher growth rate in real income - this increases the demand for funds and drives up the real rates
(2) Government budget deficits that are not expected to be monetized.
(3) Tight monetary policy.

Intuition behind Asset Model

- Anything that you can envision that would make a country a better place to invest will attract capital to that country.
- As the capital flows in, that country's currency will tend to strengthen.

Central Bank Intervention

- Central banks attempt to manipulate the value of their country's currency by creating excess supply of their currency (to weaken it) or excess demand for their currency (to strengthen it).

To strengthen the $ from \( f_0 \) to \( f_1 \) requires that the European Central bank purchase \((Q_1 - Q_0)\) Euros using some of its dollar holdings. Eventually the domestic supply of $ will decline and the domestic supply of $ will increase.
Sterilized vs. Unsterilized Intervention

- In the preceding example, the intervention in the foreign exchange market may have undesired effects on the respective domestic economies.
- US inflation will tend to rise and European inflation will tend to fall.
- In this example, the intervention was unsterilized because no action was taken by the banks to protect the domestic economy from the impact of the intervention.
- The central banks can protect the domestic economy from the impact of the intervention using sterilized intervention.
- Sterilized intervention is when the central banks use open market operations to counteract the effect of a currency intervention.
- In the above example, the European Central bank would purchase European Treasury bonds (thereby increasing the European money supply) and the US Fed. would sell US Treasury bonds (thereby decreasing the US money supply).
- The world is now holding more US debt and less European debt. If the two types of debt are viewed as perfect substitutes, then nothing will happen to exchange rates or interest rates once the sterilization takes place.

Uncovered Interest Parity (UIP)

- $E(\%\Delta e) = i_{US} - i_{f}$ (UIP)
- Derivation of UIP
  1. $E(R_{e}) = E(R_{f})$ Assume the expected real rate of interest is the same across all countries.
  2. $i_{us} + E(\%\Delta P_{us}) = i_{f} + E(\%\Delta P_{f})$ Fisher Effect
  3. $E(\%\Delta P_{us}) = E(\%\Delta P_{f})$ Rearrange 2.
  4. $E(\%\Delta e) = i_{us} - i_{f}$ Use definition of PPP

Implications of UIP

- Rearranging UIP $E(\%\Delta e) = i_{US} - i_{f}$
- $i_{US} = i_{f} + E(\%\Delta e)$
  The US interest rate (in $) is equal to the foreign interest rate (in €) plus an expected adjustment of the exchange rate
  The net effect is that if UIP holds, the dollar return (or cost) is expected to be the same in both countries.

Implications of UIP cont.

- You can think of it as
  - “If I gain on the interest rate, I should expect to lose on the exchange rate”
  - If $i_{US}$ = 4% and $i_{f}$ = 6%, if you decide to invest in the foreign country to gain 2% on the interest rate, then you should expect to bring back € that are 2% weaker so that the net return in dollars is 4%, the same as you would have gotten if you had invested directly in the US.

Implications of UIP cont.

- The big picture is that if (1) capital is free to flow and (2) the assets in the two country are in the same risk class
  - UIP is more likely to hold
  - It won’t matter where you borrow or invest

To get a better return (or cost) from investing (borrowing) overseas, (1) there must be some capital restriction or (2) the risk is not the same.

Market Forecast of the Exchange Rate Change

- If we combine the approximation from CIP $D = i_{US} - i_{f}$
- With UIP $E(\%\Delta e) = i_{US} - i_{f}$
  we get $D = E(\%\Delta e)$
The current observable forward rate is an unbiased forecast of the future spot rate if CIP and UIP hold. For our purposes, this means that if you used the forward rate as your forecast of the future spot rate, then your average error would be zero. Caution: don’t interpret this to mean that the errors would be small. They could be quite large, it’s just that they would average to zero over time.

\[
D = \left( \frac{\Delta f_1 - c_0}{c_0} \right) = E \left( \frac{e_1 - e_0}{e_0} \right)
\]

\[
\left( \frac{\Delta f_1 - c_0}{c_0} \right) = E \left( \frac{e_1 - e_0}{e_0} \right)
\]

\[
(\Delta f_1 - c_0) = E(e_1 - e_0)
\]

\[
\Delta f_1 = E(e_1)
\]