Exchange Rates

Christopher J. Neely
Assistant Vice President,
Federal Reserve Bank of St. Louis

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The opinions expressed are my own and not necessarily those of the Federal Reserve Bank of Saint Louis or the Federal Reserve System.
Today’s Topics

- Exchange rates
  - What is an exchange rate?
  - Types of FX Regimes
  - FX determination in financial markets: Uncovered Interest Parity
  - FX determination in goods markets: The Law of One Price and Purchasing Power Parity
  - FX determination: The failure of modeling and forecasting.
  - Exchange rates and international trade.
What is an Exchange Rate?

• An exchange rate is the relative price of monies.

• The price of a peso in terms of dollars or the price of a dollar in terms of pesos.
  – 10 pesos per dollar or 0.1 dollars per peso.
  – There are pricing conventions for exchange rates that determine the usual direction of the quote but these are not economically significant.
What Sorts of Exchange Rate Regimes Are There?

- **Flexible Exchange Rates**
  - The U.S. has flexible exchange rates.
    - Neither the Treasury or the Federal Reserve is obligated to maintain the value of the dollar in terms of some amount of foreign currency.

- **Fixed Exchange Rates**
  - Countries whose international trade is very important to them frequently “fix” their exchange rate to reduce uncertainty in trade.
    - “Fixed” exchange rates are usually fixed within a narrow band that might change over time.
What Sorts of Exchange Rate Regimes Are There?

• Many smaller countries, or countries that trade heavily with each other, have fixed exchange rates.
  – E.g., Mexico, Hong Kong or the EU nations.

• Fixed exchange rates require countries to manage monetary policy to maintain the value of their currency.
  – More money lowers the value of the currency, less money raises it.

• A simple way to “fix” the value of an exchange rate is to simply stand ready to buy (sell) your currency if its price gets much below (above) the fixed value. This becomes your monetary policy.
What Sorts of Exchange Rate Regimes Are There?

- Question(s): Suppose that you are the Governor of the Banco de Mexico and it is your policy to keep the exchange rate within 2% of 12 MXN to 1 USD. (11.76 to 12.24)
  - What do you do if speculators bid the price of the USD above 12.24 MXN/USD?
  - Holding other things equal, will this action increase the number of MXN in the hands of the public or reduce it?
  - Genius bonus question: Suppose that you don’t want to intervene directly in the FX market but would rather take action through the domestic money market. What could you do?
What Sorts of Exchange Rate Regimes Are There?

• Since the U.S. has flexible exchange rates, we will focus on those today.

• The fundamentals of flexible exchange rates are useful to understanding fixed exchange rates.
What Sorts of Exchange Rate Regimes Are There?

• Question: Why do you think that the U.S. chooses to have flexible exchange rates?
  – What is true of U.S. trade/GDP?
  – Is our trade concentrated?

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country</th>
<th>Percent of Total Trade</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Canada</td>
<td>16.4%</td>
</tr>
<tr>
<td>2</td>
<td>China</td>
<td>13.3%</td>
</tr>
<tr>
<td>3</td>
<td>Mexico</td>
<td>12.5%</td>
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<td>4</td>
<td>Japan</td>
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<td>5</td>
<td>Germany</td>
<td>4.0%</td>
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<tr>
<td>6</td>
<td>United Kingdom</td>
<td>2.9%</td>
</tr>
<tr>
<td>7</td>
<td>Korea, South</td>
<td>2.8%</td>
</tr>
</tbody>
</table>
How Are Exchange Rates Determined?

Have you ever wondered how the dollar’s value is determined and why it moves the way it does?
How Are Exchange Rates Determined?

- Uncovered interest parity (UIP)
  - Financial market equilibrium
The Efficient Markets Hypothesis

- The EMH: Traders don’t leave money laying on the table.
  - Abnormal returns imply extra risk.
  - Very attractive idea.
How Are Exchange Rates Determined?

- Uncovered interest parity (UIP)
  - Suppose you had $1000 to invest for a year.
    - In the United States, the return would be the U.S. 1-year interest rate. (Treasury)
    - If you invested in the UK, the return would be the UK 1-year interest rate plus the appreciation of the GBP.
  - If you don’t care about risk, the expected value of these investments must be equal.

\[
i_t^{US} = i_t^{UK} + E(\Delta S_t^{USD/GBP})
\]
How Are Exchange Rates Determined?

- Which interest rates determine expected FX changes, according to UIP?
  - Overnight, 7-day, 1-year, 10-year?
  - Government, high-grade corporate, junk bonds?
- Yes. The differential at N years determines expected changes at N years. (N can = fractions.)
- Interest rates should usually reflect minimal credit risk. (Interbank or corporate rates.)
- Differences in borrowing/lending rates provide some “wiggle room” for UIP.
How Are Exchange Rates Determined?

- Question: Suppose that $\Delta S_t^{USD/GBP}$ is positive. Does that mean that the GBP is appreciating or depreciating versus the USD?
  
  - Hint: Suppose that the price of Microsoft stock is rising, what is happening to USD/MSFT share?
  
  - What is happening to the USD if the GBP is appreciating?
How Are Exchange Rates Determined?

- UIP: If investors are risk-neutral, the expected % change in the exchange rate must approximately equal the interest differential.

\[ E_t (\Delta S_{t+\tau}^{USD/GBP}) = \tau \left( i_t^{US} - i_t^{UK} \right) \]
How Are Exchange Rates Determined?

• Question: Do high interest rate currencies tend to appreciate or depreciate, according to UIP?
  – Hint: Use your intuition. Which would tend to equalize returns?

\[ E_t (\Delta S_{t+\tau}^{USD/GBP}) = \tau (i_t^{US} - i_t^{UK}) \]
How Are Exchange Rates Determined?

- UIP: If investors are risk-neutral, the expected % change in the exchange rate must approximately equal the interest differential.

\[ E_t (\Delta S_{t+\tau}^{USD/GBP}) = \tau (i_t^{US} - i_t^{UK}) \]

- If this were not an equality, people would buy the underpriced investment and sell the other.
- I.e., interest differential should be the best (and only) predictor of exchange rate changes.
How Are Exchange Rates Determined?

- What should the UIP relation look like?

\[ E_t(\Delta S_{t+\tau}^{USD/GBP}) = \tau\left(i_t^{US} - i_t^{UK}\right) \]
How Are Exchange Rates Determined?

• What should the UIP relation look like?

\[ E_t(\Delta S_{t+\tau}^{USD/GBP}) = \tau(\bar{i}_t^{US} - \bar{i}_t^{UK}) \]

This is the same graph as on the previous slide!
How Are Exchange Rates Determined?

• What does the UIP relation look like?

\[ E_t(\Delta S_{t+\tau}^{USD/GBP}) = \tau(i_t^{US} - i_t^{UK}) \]

Starting date is 1985/1/29
Ending date is 2011/3/22

Pretty good?
I am fooling you.
How Are Exchange Rates Determined?

- What does the UIP relation look like?

\[ E_t(\Delta S_{t+T}^{USD/GBP}) = \tau (i_t^{US} - i_t^{UK}) \]
How Are Exchange Rates Determined?

\[ \Delta S_{u/d}^{USD/GBP} = a + b \tau (i_t^{US} - i_t^{UK}) + e_t \quad a \neq 0 \]
\[ b \neq 1 \]

• Why doesn’t UIP work?
  – Risk?
    • Risk premia would have to behave very strangely.
  – Expectations?
    • Expectations in FX markets don’t seem to be completely rational.
How Are Exchange Rates Determined?

- UIP: So why study UIP if it doesn’t work?
  - Still a benchmark for FX models.
  - Does work in some situations:
    - Fixed exchange rates. (UIP forecasts devaluations.)
    - In a few minutes around 5 PM.
    - At very long horizons, i.e., 10 years.
How Are Exchange Rates Determined?

• Covered interest parity (CIP)
  – Consider the price of buy/selling FX at a date in the future (i.e., the forward price).
  – How would this “forward” exchange rate relate to spot FX rates and interest rates?
    • Logic is the same for UIP but this actually works because there is no risk at all.

\[ \left( F_{t+\tau}^{USD/GBP} - S_t^{USD/GBP} \right) / S_t^{USD/GBP} = \tau \left( i_t^{US} - i_t^{UK} \right) \]
How Are Exchange Rates Determined?

- Purchasing Power Parity (PPP)
  - Goods and services market equilibrium
How Are Exchange Rates Determined?

• The Law of One Price (LOOP)
  – The price of a good should be the same when expressed in a common currency.
  – If the price of a barrel of oil is 750 pesos in Mexico City and $75 in Dallas, then the price of a peso in terms of dollars should be $75/750 = $0.1.$

\[
S_t^{USD/NP} = \frac{P_{oil}^{USD}}{P_{oil}^{NP}}
\]
How Are Exchange Rates Determined?

- The Law of One Price (LOOP)
  - What would happen if the exchange rate were not $0.1?
    - Buy low, sell high.
    - If the exchange rate were $0.05, we would buy oil in Mexico City at 750 pesos and sell it in Dallas for 1500 pesos.
    - Buying pesos to purchase oil in Mexico would cause the peso to appreciate until it equaled $0.10.

\[
S_t^{USD/MXN} = P_{oil}^{USD} / P_{oil}^{MXN}
\]
How Are Exchange Rates Determined?

– If the price of oil rises to 1500 pesos in Mexico, what must happen to the exchange rate?
  • Peso depreciates to reflect higher prices in Mexico. The price of a peso (MXN/USD) falls to $0.05.

– This is very important.
How Are Exchange Rates Determined?

• How well does the LOOP hold?
  – The LOOP holds very well for commodities such as oil, corn or gold.
  – Transportation costs, barriers to trade, differentiated goods and other factors will prevent the LOOP from holding for most goods.
How Are Exchange Rates Determined?

• Would you expect to see the LOOP work better for haircuts or hammers?
• Do U.S. and Canadian government bonds obey the LOOP?
  – That is, why don’t they have the same yield?
How Are Exchange Rates Determined?

- If the LOOP held for every price and price indices were constructed with the same weights in each country, then the LOOP would hold for price indices like the CPI.
  - When we aggregate prices into a price index, we have to weight the prices by the importance of the good.

\[
P^\text{US}_t = w^\text{US}_{1,t} p^\text{US}_{1,t} + w^\text{US}_{2,t} p^\text{US}_{2,t}
\]
How Are Exchange Rates Determined?

• The LOOP for a price index implies an idea called *Purchasing Power Parity* or PPP.

\[
S_{t}^{USD/NP} = c \cdot P_{Index,t}^{USD} / P_{Index,t}^{NP}
\]

• PPP implies that exchange rate changes should reflect inflation differentials.
  – If inflation in Mexico exceeds that in the United States, the peso will depreciate to reflect the difference.
  – Why? If Mexican prices rise, people will not buy Mexican goods; the peso will depreciate.

\[
\Delta s_{t}^{USD/NP} = \Delta p_{Index,t}^{USD} - \Delta p_{Index,t}^{NP}
\]
How Are Exchange Rates Determined?

• Another way to state PPP is to say that real exchange rates should be constant.
  – Real exchange rates are those adjusted for price level changes.

• A weaker version of PPP says that they need not be constant but they should be mean-reverting or come back to an average.

$$ S_{t}^{USD/NP} \cdot \frac{P_{Index,t}^{NP}}{P_{Index,t}^{USD}} = c $$
How Are Exchange Rates Determined?

How well does PPP hold?

– Pretty well over long periods, more than 5-10 years.

• Blue line = fitted relation; red line = PPP relation
How Are Exchange Rates Determined?

• Did Sweden have higher inflation or lower inflation than the United States over this sample?

• Did the Japanese yen appreciate or depreciate against the dollar over this sample?

![Graph showing exchange rates and inflation, 1973-2010](image-url)
How Are Exchange Rates Determined?

• Why doesn’t PPP hold perfectly? Or even very well?
  – There are lots of non-traded goods & services, like haircuts.
  – Price index weights differ between countries & over time.
    • Different weights can cause PPP to fail to hold, even if all goods prices rise at the same rate everywhere.

• Countries with lower relative inflation in tradeables will tend to see their real exchange rates appreciate when conventionally measured.
  – Balassa-Samuelson effect
How Are Exchange Rates Determined?

• Real exchange rates tend to appreciate in countries with high productivity growth - like Japan - because productivity growth is concentrated in tradeables.
How Are Exchange Rates Determined?

• If Japanese productivity in manufactured goods rises, the price of manufactured goods (e.g., TVs) will fall compared to other goods (e.g., land) or services.

• Japanese tradeable goods - mostly manufactures - prices will rise more slowly than overall Japanese inflation.

• PPP determines the exchange rate through the prices of tradeable goods only.
How Are Exchange Rates Determined?

- If we try to measure PPP with overall price indices, we will overestimate the inflation in Japanese tradeable goods.
- This will make the Japanese yen look like it is rising “too much” in value.
- If we measured PPP with only tradeable goods prices, this would not happen.
Exchange Rates and Trade
Exchange Rates and Trade

• Exchange rates are *endogenous*, they are determined simultaneously with goods prices and interest rates.

• Real exchange rates are nominal exchange rates adjusted for national price levels.

• If the LOOP held for all goods and price index weights were identical, real exchange rates should be constant.
Exchange Rates and Trade

• If the LOOP held for all goods, we wouldn’t need to worry about FX rates and trade. FX rates would not affect trade.
  – A depreciation of the dollar would be accompanied by higher inflation in the U.S., so real relative prices wouldn’t change internationally.

• PPP says that real exchange rates should tend to come back to some average level over time.
  • Changes in exchange rates or price levels will tend to match over time, eventually leaving real exchange rates unchanged. But this can take a long time.
Exchange Rates and Trade

• Because exchange rates and prices are jointly determined, it isn’t really correct to talk about the effect of an exchange rate change on trade balances.

• But goods markets adjust more slowly than financial markets and real exchange rates have – at the very least – very persistent deviations from long-run averages.
Exchange Rates and Trade

• There are tradeable, differentiated goods.
  – Cars, TVs, foodstuffs, beer, airplanes, etc.

• Domestic goods and services prices are usually considered much “stickier” than exchange rates.

• An exchange rate change can change relative costs and prices for prolonged periods.
  – Boeings can become more or less expensive compared to Airbus.
Exchange Rates and Trade

• So we will talk about the effects of exchange rate changes on trade anyway…

  1. Because the newspapers do it.

  2. And because exchange rates do seem to lack a strong connection to underlying fundamentals.

• When the dollar appreciates in real terms, people do not immediately and fully switch to foreign substitutes because of trade barriers, transactions costs and search costs.
Exchange Rates and Trade

• When the dollar depreciates, American goods look less expensive compared to foreign goods.
  – Suppose that it costs Toyota 2,000,000 yen to make a Camry (including markup), what is the price in dollars?
    • At a rate of 100 JPY/USD, a Camry costs $20,000.
    • At a rate of 90 JPY/USD, a Camry costs $22,222.
    • U.S. cars look relatively cheaper at 90 JPY/USD than at 100 JPY/USD.

• Conversely, when the USD appreciates, American goods look more expensive to consumers here and abroad.
Exchange Rates and Trade

• In fact, most firms price in local currency and “eat” modest exchange rate movements.
  – Toyota doesn’t change the prices of its cars every second as exchange rates change.

• Still, the idea that exchange rate changes affect consumers and producers holds for large movements and for marginal pricing decisions.

• Therefore, the conventional view is that a dollar depreciation is good for U.S. firms and bad for U.S. consumers.
Exchange Rates and Trade

- **Holding other things constant:** A depreciation of the dollar will tend to improve the U.S. trade balance as we export more and import less.

- This effect may not happen right away though. There may be a delay as consumers and firms switch to cheaper American goods.

- Prices might change before quantities, which means that a dollar depreciation might worsen the trade balance in the short run.
Exchange Rates and Trade

- This delay in the improvement in the trade balance is called the “J-curve” effect.

U.S. Trade Balance as Dollar Depreciates
Key Points to Remember

• An exchange rate is the relative price of monies.

• If investors were risk neutral, then exchange rate changes should depend on relative interest rates but they don’t seem to do so.

• Inflation determines the value of the dollar through Purchasing Power Parity (PPP) in the long run.

• Countries with unusually high productivity also tend to see their currencies appreciate.

• A weaker dollar tends to aid U.S. firms and improve the U.S. trade balance but reduce the purchasing power of U.S. consumers.
The End