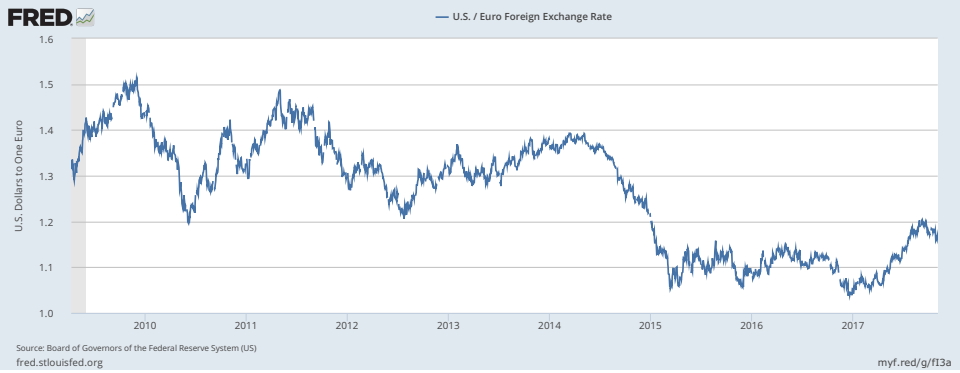
# Exchange Rates[1]

The Federal Reserve's dual mandate does not mention exchange rates. Although the Fed does not consider them directly in conducting monetary policy, exchange rates may affect inflation and the labor market down the road, and they are thus something for policy makers to keep an eye on. These notes will briefly discuss how exchange rates interact with inflation and unemployment and then will discuss how exchange rates are determined.

*Real vs. Nominal Exchange Rates*

We first make the distinction between nominal and real exchange rates. Define $e_t$ as the USD/EUR exchange rate, the number of dollars one must pay to buy one Euro. This is a nominal exchange rate, it is simply the market price. Note that higher values suggest the dollar is depreciating. Exchange rates can always be defined in either direction (*e.g.* the amount of Euros needed to buy one dollar is $\frac{1}{e_t}$).

Figure 1: Nominal USD/EUR Exchange Rate




To convert to real exchange rates, we multiply nominal exchange rates by the ratio of price levels in each country:

$$RER_t = e_t \frac{P^E}{P^{US}} \tag{1}$$

The real exchange rate tries to get at the purchasing power of each unit of currency. If the price level in the Eurozone is twice as high as in the U.S., then the nominal exchange rate would have to be 0.5 in order for the dollar and Euro to have the same purchasing power. There are

[1]These are undergraduate lecture notes. They do not represent academic work. Expect typos, sloppy formatting, and occasional (possibly stupefying) errors.

a lot of complications in calculating price levels. As a result, the real interest rate is harder to measure than you might expect.

The theory of *purchasing power parity* suggests that all real exchange rates should be equal to 1. But the data overwhelmingly reject this theory both in the short and long run. One reason is the importance of non-tradable goods. I cannot buy a haircut in Europe, import it to the U.S., and then re-sell it at a profit.

Suppose that inflation in the U.S. is 2% while it is 0% in the Eurozone. Because the U.S. price level is rising by 2%, the nominal exchange rate must also rise by 2% in order to keep real exchange rates constant. Higher inflation thus typically causes a nominal depreciation of the currency.

*How Exchange Rates Affect Monetary Policy.*

The basic channel by which exchange rates affect monetary policy is straightforward. Suppose that the dollar weakens in real terms. This makes imported goods more expensive, but it also makes exports less expensive to foreign households and firms. We would thus expect net exports to rise, representing a boost in aggregate demand.

In normal times, a Central Bank like the Fed is trying to set interest rate policy to manage aggregate demand. We would thus expect it to ordinarily be more likely to raise interest rates. Likewise, if the dollar becomes stronger, then this should make the Fed more likely to lower interest rates. For the United States, trade is a small enough source of economic activity that these affects are likely to be fairly small. For more open economies, the Central Bank must be more responsive.

The 2008-2015 period was different. Here, Central Banks such as the Fed and ECB were trying to find novel ways to stimulate aggregate demand while interest rates were near zero. Then, a weaker currency would have been welcome and would not have been met with contractionary policy.

*Interest Rate Parity*

We now turn to a theoretical model for pricing currencies. First, some notation. Define $s_t$ as the *spot* exchange rate. This is simply the number of dollars I must pay for 1 Euro on the open market at time $t$.

Suppose that I can also exchange currency in a *futures* market. Here, I agree with a seller to purchase euros at an agreed upon price at some future time. Define $f_{t+1}$ as the price of a Euro (again in dollars) one period in the future. *Covered interest rate parity* then predicts:

$$s_t \frac{1 + i_t^{US}}{1 + i_t^E} = f_{t+1} \tag{2}$$

where $i_t^{US}$ is the one-period risk free, nominal interest rate for the United States.

Suppose I have $\$s_t$. I can save using Euros. To do so, I exchange $\$s_t$ for one euro. I then collect interest at the European rate and am left with $1 + i_t^E$ euros after one period. Alternatively, I can arrange for a futures contract to buy euros in period $t + 1$ and then save in dollars. After one year, my $\$s_t$ becomes $\$s_t(1 + i_t^{US})$. This then converts to $(1 + i_t^{US})\frac{s_t}{f_{t+1}}$. Re-arranging (2) shows that the return under both scenarios is identical.

Uncovered interest rate parity is an arbitrage condition. It says that there cannot be easy, risk-free profits to be made. This theory fits the data extremely well and is not controversial.

A quick example. As of November 2017, one-year interest rates in the U.S. are 2.28% higher than in Germany. Both bonds are almost free of risk. Futures markets thus price in a 2.28% depreciation of the dollar against the Euro through November 2018.

*Uncovered interest rate parity* is more controversial. It replaces the futures market exchange rate with the expected future spot price:

$$s_t \frac{1 + i_t^{US}}{1 + i_t^E} = E_t[s_{t+1}] \tag{3}$$

It is also approximately true that:

$$E_t[\Delta s_{t+1}] = i_t^{US} - i_t^E \tag{4}$$

In words, the expected percentage depreciation of the dollar equals the spread between these two exchange rates. When U.S. rates are higher, we expect the dollar to depreciate (and the Euro to appreciate).

Uncovered interest rate parity has led to an empirical debate known as the *forward premium puzzle*. The theory predicts that the futures market exchange rate should be an unbiased predictor of the future exchange rate itself. But the puzzle emerges because many papers have

found that it is not. Some have argued instead that the country with a higher interest rate actually usually experiences an appreciation instead of a depreciation. A few thoughts:

1. One possibility is that this theory is incomplete. For example, it assumes that agents are risk neutral. Some papers try to show that risk averse agents introduce other factors that affect the expected path of exchange rates.

2. Another possibility is that agents are irrational. This suggests an easy way to make profits, however, if the futures market suggests an appreciation of the Euro, buy dollar denominated assets.

3. Uncovered interest rate parity does seem to work well for large interest rate spreads.

4. Some have argued that the theory works for small spreads too but that the empirical papers that find it does not are misspecified.

5. The 1970s- early 1980s seem to be unusual and may drive a lot of the results showing uncovered interest rate parity does not work well.

*Effects of Monetary Policy on Exchange Rates*

Only unexpected policy changes should affect interest rates. Thus an FOMC meeting where interest rates are raised should have only a small effect if agents expected such an action. A comment from an FOMC member, however, saying that she supports rate hikes, may have important effects.

Suppose that the Fed unexpectedly raises rates or that the Fed suggests more rate hikes are coming relative to expectations. Because U.S. assets now generate a higher return, we expect an immediate appreciation of the dollar, against the Euro but other currencies as well.

From (2), the forward price of the dollar should immediately decline. Equation (3), reflects higher expected depreciation of the dollar. The dollar thus overshoots. It initially rises, but we expect this to be followed by a depreciation that lasts as long as U.S. interest rates remain relatively high. The empirical validity of this prediction remains in question.

Currently, the Fed has begun to shrink its balance sheet, beginning the long process of reversing its quantitative easing program. The European Central Bank has slowed its quantitative easing program down, but is still buying assets. This helps explain why German (the Eurozone member with the lowest default risk) bonds are about 2.5% less than U.S. bonds

for terms of up to five years. Uncovered interest rate parity suggests that the dollar should depreciate at about 2.5% annually during that time. Because these spreads are so large, this is probably a reasonable estimate.