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Lecture #4: Exchange Rate Determination

1. Interest Parity.

- (a) Uncovered Interest Parity. Recall, from last time, that the domestic (US, say) return, R , on a foreign asset with foreign (German, say) nominal return R_{DM} is:

$$1+R = \frac{(D^{DM} + P^{DM'}) \times E'}{P^{DM} \times E} = (1+R_{DM}) \frac{E'}{E} \approx 1+R_{DM} + \frac{E' - E}{E}.$$

Here, E is the domestic currency price of a unit of the foreign currency (if the US is 'domestic' and German is 'foreign', then this is $E_{\$/DM}$). In practice, E' is not known at the time the asset purchase decision is made, so it makes sense to replace E' by E^e :

$$R = R_{DM} + \frac{E^e - E}{E}.$$

This says that the (expected) return, in domestic currency, on a foreign asset is the foreign denominated return on that asset, plus what you make from holding foreign currency for a while. Thus, if the foreign rate of interest is 5% and the anticipated depreciation of the domestic currency is 10%, then the return, in domestic currency units, of the foreign asset is 15%.

Now, when market participants compare alternative assets, they compare them based on various characteristics, including expected return, risk and liquidity. Let's assume for the moment that only the first mattered. That is, suppose they only focussed on expected return. They would then always go for the asset with the highest expected return. This has the implication that all assets that are actually held have to have the same expected return. In particular, the expected return on assets in different countries has to be the same, when denominated in the same currency:

$$R_s - R_{DM} = \frac{E^e - E}{E}.$$

This is called the uncovered interest parity relation (UIP).

- (b) UIP and Risk. We only expect UIP to hold for assets where our assumptions are reasonably well satisfied. That is, it must be that the two assets do not differ much in their liquidity or risk characteristics. US and German government debt are examples where liquidity differences are not great. Both are quite liquid. However, the risk characteristics of these two types of debt, when the returns are denominated in common units, *are* different. To see this, suppose $R_{\$}$ and R_{DM} are the return on US and German government debt, respectively. If the assets are held until maturity, then their risk when the returns are *denominated in their own currency*, is roughly zero. At the time you buy US government debt that you plan to hold onto until maturity, $R_{\$}$ is known for sure. The same is true for R_{DM} . However, what is not known at the time German government debt is purchased is its *dollar denominated* return. This is not known because the value of the exchange rate when the debt matures is not known. This is what makes German debt riskier than US debt, to an American. Of course, the opposite is true from the perspective of a German. A German will find US government debt riskier than German government debt because the former involves exchange risk, while the latter does not.

These issues of risk are likely to prevent the UIP from holding in practice. Consider the following example. Suppose $E^e/E = 1.05$, so that a 5 percent dollar depreciation is expected. Suppose that $R_{\$} = R_{DM} = 0.05$, i.e., the interest rates in both countries is five percent. Now, the uncovered interest parity relationship says that no one should be holding American denominated assets. Any American holding US government debt should sell it and buy German government debt. Why might an American hold on to US government debt anyway? The American may well agree with the assessment that E^e/E is 1.05. And, if E' turned out to equal E^e , the American would regret not having sold his or her US government debt and bought German government debt instead. But, the fact is that E' is uncertain, and therefore it could end up higher than E^e , or lower. The American may be especially concerned about the latter. For example, he or she may be worried that E'/E might turn out to be 0.95, say, where the US dollar appreciates by 5 percent. In this case, the American would *lose* money by holding German government debt.

Often, people hold government debt without planning to hold it to maturity. For example, you may want to buy 30-year government debt and only plan to hold onto it for one year. Then, even the own currency return on government debt is risky. The value of government debt that is sold before it matures is determined in the market, and is a random variable when you first buy it. Thus, there are at least two sources of risk to consider in comparing rates

of return across countries: one that stems from uncertainty in the local currency denominated return and the other that stems from uncertainty in the exchange rate. Both of these forms of risk, if important enough, could lead to UIP not holding.

In particular, if there were evidence that UIP did not hold in the data, that would not constitute evidence of irrationality on the part of portfolio managers. That's because, in deriving UIP, we abstracted from risk considerations. As it happens, UIP tends *not* to fit the data very well when we consider assets with short-term maturities. It does better on assets with longer term maturities.¹ In developing our theory of exchange rates, we will make heavy use of UIP. This is because it probably does a good job in capturing the primary channel linking changes in interest rates and expected future exchange rates to the current exchange rate. A complete understanding of exchange rates requires also knowing how interest rate and expected exchange rate changes impact on the current exchange rate via their impact on risk. This channel is less well understood, and, in any case, well beyond the scope of this course.

- (c) Covered Interest Parity. This is a relationship which must hold in the data. Let F denote the dollar-market exchange rate in the forward market. This is known for sure at the time you buy German or US government debt. The return on German denominated debt, denominated in dollars, assuming the forward market is used, is

$$\frac{F(1 + R_{DM})}{E} \approx 1 + R_{DM} + \frac{F - E}{E}.$$

The covered interest parity relation implies:

$$R_{\$} = R_{DM} + \frac{F - E}{E}.$$

If this did not hold, then sure profits could be made simply by selling one of the assets and buying the other. In efficient markets, sure profits, or arbitrage opportunities, don't exist. Or, if they do they are quickly exploited until they disappear..

2. Exchange rate determination in the Short Run. The UIP condition gives us a way to think about how the exchange rate is determined in

¹For a recent paper that documents this, see 'Long Horizon Uncovered Interest Rate Parity,' by Guy Meredith and Menzie Chinn. This is a November 1998 working paper available as NBER working paper 6797 at <http://www.nber.org/papers/w6797>. This paper uses simple econometric techniques. It is *not* required reading for the class.

the short run. It can be used to determine the impact on E of a change in R_s , R_{DM} , or E^e .

3. Money demand and money supply. The book explains quite nicely, the following money demand relation:

$$\left(\frac{M}{P}\right)^{demand} = L(R, Y),$$

where L is decreasing in R and increasing in Y . In practice, this expression is sometimes assumed to have the following special form: $L(R, Y) = f(R)Y$, where f is a decreasing function of R . With this specification, the percent increase in the demand for real money balances resulting from a one percent increase in income, Y , (the *income elasticity of money demand*) is unity (i.e., one). We can test this view by looking at data on the velocity of money:

$$\text{Money velocity} = \frac{PY}{M}.$$

According to the money demand relation which imposes unit income elasticity, velocity should have the following relationship to the interest rate:

$$\text{Money velocity} = \frac{1}{f(R)}.$$

That is, as income changes, money velocity should not change, and velocity should move up and down in the same direction as the rate of interest.

To see what velocity actually does, look at the attached figure. The relatively smooth line is velocity (left scale) and the choppier line is the rate of interest (right scale).

There are several things worth noting in the figure. First, consider the velocity - interest relationship. At the low frequency level, they move together. Broadly, velocity moves up until 1980, whereupon it turns around and comes down again. The interest rate follows the same broad pattern. At a higher frequency, the relationship seems to change. In the first half of the sample, velocity does not respond much to the higher frequency movements in the interest rate, and in the second half it does. Second, consider the velocity - income relationship. Note that interest rates in the end of the sample are nearly where they were in the beginning. Yet, velocity is not back to where it was before. Instead, velocity seems to be somewhat higher. That is, as PY has gone up, M has not quite kept up. This suggests that the income elasticity of

demand for money is a little less than unity. That is, a one percent jump in Y induces less than a one percent rise in M^{demand} . Another possibility is that all the technical and legal innovations that have occurred in the past decades (spurred in part by the high interest rates of the 70s and early 80s) have allowed people to economize on cash balances. Now that they are in place (ATM machines, information technology that makes credit card purchases easy, etc.), they will not be reversed and we can expect velocity to stay up for a while.

Money velocity (MZM from St Louis Fed) and Opportunity Cost

