Christiano Econ 362, Winter, 2003 January 20

Lecture #5: Exchange Rates in the Short Run and the Long Run

- 1. Exchange Rates in the Short Run. The Zero Lower Bound on Interest Rates.
 - (a) Why (at least in theory) Can't Market Interest Rates be Negative?
 - i. No one would want to lend. Imagine a lender when R = -0.10 (i.e., the interest rate is minus 10 percent). In this situation, if you lend \$1.00, you get \$0.90 back later. Note that you could make more money simply by sitting on your money. If you just sit on your dollar, you still have the dollar at the end of the period. Clearly, you 'make' more money sitting on money than lending it out when the interest rate is negative.
 - ii. Borrowers would like to borrow and infinite amount with R = -0.10. A person who borrows \$1.00 at R = -0.10 has to pay back only 90 cents, and gets to keep 10 cents for themselves. So, borrowing is free money. Might as well try to borrow an infinite amount!
 - iii. So, with a negative rate of interest, supply would be zero and demand infinite, in the loan market. Markets for foreign exchange cannot clear under these circumstances!
 - (b) Suppose the interest rate is zero and the assumptions justifying UIP are satisfied. The money demand equation must be flat when R = 0, since at this point traders are indifferent between money and bonds.¹ That is, when the central bank conducts an OMO ('open market operation') there is no change in the interest rate. People are indifferent between money and bonds when R = 0, so exchanging money and bonds produces no change in any market price or rate of return. In this way, the key channel by which an increase in M leads to a depreciation in the exchange rate is cut when the interest rate is zero.
 - (c) The result in (b) above many seem strange, so it's worth discussing it some more. Couldn't the central bank depreciate the exchange rate simply by printing up tons of money and exchanging

¹I'm ignoring the possibility that they *wouldn't* be indifferent because money has a greater liquidity value. Implicitly, I'm assuming that taking this into account wouldn't significantly change the basic thrust of the analysis. For the traders with whom the central bank does open market operations, the difference in liquidity between money and government debt is tiny.

it directly for foreign currency? The answer is no, under UIP. As before, I'm assuming the foreign rate of interest stays unchanged. Following is an explanation. For concreteness (and realism) suppose that the country with the zero interest rate is Japan, and that the foreign currency it buys up is US dollars.

i. From the point of view of Americans, UIP implies:

$$R_{\$} = R_Y + \frac{E^e - E}{E},$$

where E is the number of dollars per Japanese yen and R_Y is the nominal rate of interest in Japan. Under UIP, the only way to have $R_{\$} > 0$ and $R_Y = 0$ is for market participants to be anticipating a a depreciation of the dollar. In particular, Americans sitting on zero-interest Japanese financial assets don't mind doing this because they anticipate being able to sell them for more dollars than they paid for them when $(E^e - E)/E > 0$. According to UIP, this extra amount of dollars matches exactly the extra dollars they get from the interest, $R_{\$}$, on US government debt. That is, if the rate of interest on a 1-year US government security is 5%, they must be anticipating that the US dollar will depreciate 5% over one year relative to the yen.

ii. Suppose the Japanese central bank buys 1 US dollar from an American, in exchange for Japanese Yen. From the point of view of the US, it's the same as if the US central bank had just done an open market purchase of an interest bearing US government security. A US government security pays explicit interest, while the 'interest' on yen corresponds to the gains the American can hope to make from the expected appreciation of the ven over time. So, the BOJ's (Bank of Japan) purchase of US dollars would have the same effect as if the Federal Reserve (Fed) had done an open market purchase of 1 US dollar. If that were to happen, then $R_{\$}$ would rise and E would fall...the dollar would appreciate and the Yen would depreciate. But, recall our assumption that the foreign interest rate does not change, that is, that $R_{\$}$ does not change. For the Fed to keep $R_{\$}$ requires an OMO where they buy US government debt in just the right quantity so that the number of US dollars in circulation does not change after the BOJ and Fed actions. (This action by the Fed, neutralizing the impact of the BOJ's OMO on the quantity of US money is called *sterilization*. 'The Fed acts to sterilize the impact of the BOJ's OMO on the quantity of US money.')

- iii. Note what the net effects of the BOJ's and Fed's OMO's are. The quantity of yen in the world increases and the quantity of US government debt decreases. The changes are exactly offsetting, when the two quantities are measured in terms of the market exchange rate. Because Japanese yen and US government securities are perfect substitutes when $R_Y = 0$ and UIP holds, there is no reason for any market price or rate of return to change with these OMO's.
- iv. Message: on its own, the BOJ cannot change the exchange rate when $R_Y = 0$, under UIP. Of course, if the US changed its policy and increased $R_{\$}$, this *would* lead to a depreciation of the Japanese exchange rate. (The analysis above held $R_{\$}$ unchanged.)

At the moment, we have not developed our model far enough to let us think about why the BOJ might *want* to depreciate the value of the yen, and why the Fed might not want to oblige the BOJ. Later, we'll develop a theory which implies that a depreciation in the Japanese exchange rate would, by making Japanese goods cheaper, reorient world demand towards Japan and thereby stimulate the Japanese economy. That theory suggests that non-Japanese governments might not like this policy because, by reorienting world demand away from them, it might cause output in their economies to fall. (Here, I have in mind not just the US economy, but also other economies in Asia.) For now, we cannot discuss these things because we simply assume output, Y, is fixed.

- v. Looking at Japanese data (see the three attached figures, where the first shows data covering 1970s-1990s, the second covers the 1990s, and the third shows what has happened since August 2001), we see how the Japanese central bank has driven the interest rate (this is the central bank's discount rate, the interest rate it charges for loans to Japanese banks) down to zero. When the Japanese interest rate hit zero, the currency appreciated. It did so until mid-September of 2001, and has been depreciating since. Note, UIP does not require that the Japanese exchange rate necessarily appreciate, only people *expect* it to appreciate. Of course, if the Japanese exchange rate continues its recent depreciation pattern for a long time, the notion that people are continually expecting it to appreciate would seem less and less credible. This would be an embarrassment to the UIP.
- 2. The Short and Long-Run Effects of a Permanent Change in the Stock of Money.

- (a) Assumptions about long run A permanent increase in M results, in long run, in proportional increases in P, E^e and no change in Y. Rationale:
 - i. In long run, Y is determined by pace of technical progress, size and quality of the work force, etc., not M.
 - ii. Countries with big increases in M have big increases in P (see Italy in Figure 14-10, and the Latin American countries in the case study on page 377, and attached data on Bolivia, taken from page 380-381 of KO).
 - iii. With respect to E, countries with big rise in M also have big depreciations. Example: Bolivia data on attached figure, taken from page 387 of KO.
 - iv. E is a price (it's the number of dollars it takes to buy one unit of foreign currency), so the notion that, in long run, Erises in proportion to rise in M seems consistent with notion that all the prices summarized in P rise in proportion to Min the long run.
- (b) Assumptions about short run Output and the price level, Y, P, are fixed in the short run.
- (c) Experiment: Permanent increase in US money supply. This results in exchange rate overshooting in the short run. To see why, first do the analysis in our graphical representation of UIP and money demand. Note that the rise in E^e shifts the UIP curve up. For the short-term analysis, increase M holding P fixed. This produces a fall in R, which leads to a rise in E. Note that the rise in E is bigger than what would occur if E^e had remained unchanged. As the short run turns into the long run, the price level starts to rise, driving M/P down. This stops when M/P is where it was before, so that the interest rate in the long run returns to where it was before. As R returns to its original position, E 'rides' the new UIP curve up to its final, higher position.
- (d) Exchange Rate Overshooting. Note that in the previous experiment the exchange rate overshoots its final, higher value. This is the 'exchange rate overshooting' result. The intuition for this is simple. To illustrate it, suppose $R_{\$} = R_{\mathfrak{E}}$ initially, so that $(E^e - E_1)/E_1 = 0$, where E_1 is the exchange rate in the old equilibrium. That is, $E^e = E_1$, so that the exchange rate in the future is expected to coincide with its value in the present. With the permanent rise in M to M_2 , say, the expected future exchange rate jumps equiproportionally:

$$\frac{\ddot{E}^e}{E^e} = \frac{M_2}{M_1}$$

where \tilde{E}^e denotes the new expected future exchange rate.

We know that the jump in M causes R to drop in the short run. While $R_{\$}$ is low, UIP requires there to be an expected appreciation in the exchange rate:

$$\frac{\tilde{E}^e - E}{E} < 0,$$

since $R_{\$} - R_{\mathfrak{E}} < 0$ in the short run. Thus, we need the exchange rate, E, to *fall* towards its new, higher long run value. The only way this can happens is if it overshoots \tilde{E}^e .

- 3. Purchasing Power Parity
 - (a) The Law of One Price. This says that the same good sold in two different places should have the same price. Thus, if P_G^i is the price of some good called *i* in Germany and P_{US}^i is the price of the same good in the US, the law of one price says that the dollar (or, mark) price of the two goods must be the same:

$$P_{US}^i = P_G^i E,$$

where E is the number of dollars per euro. The idea is that if this equality were violated, say because the left exceeds the right, this would trigger a reduction of demand for the US i^{th} good and an increase in demand for the German i^{th} good. This reallocation of demand would result in some combination of a fall in P_{US}^i , a rise in P_G^i and a rise in E.

To understand this 'law', it is interesting to look at the box on page 402-403 of KO. That shows that the dollar price, computed using the above formula, of a McDonald's Big Mac is very different in different countries in the world. One interpretation of the difference is that Big Mac's are really different goods around the world. Each Big Mac represents the services of some poor, unwilling cow, bundled with a lot of locally generated services: transportation, food preparation, beautiful views, etc. Since these are hard to trade, and they are a large part of the price of a Big Mac, there are no really strong forces forcing the price of a Big Mac to be the same everywhere. Of course, the raw hamburger meat *is* likely to be highly tradeable, and the price of this part of the hamburger should vary less across countries. However, in places where there are restrictions on trade, or other factors that hinder transportation, then even the price of hamburger meat would be different. The upshot is that the law of one price should apply internationally only to goods which are easy to ship, i.e., which are highly tradeable.

(b) Purchasing Power Parity. This says that the relationship in the law of one price holds for bundles of goods in different countries. For example, if P_{US} is the consumer price index (CPI) in the US, then P_{US} is the price of a specific bundle of goods in the US. The bundle is composed of the goods that government statisticians determine are bought by the typical family. Suppose P_E is the corresponding price in Europe. According to PPP, $P_{US} = EP_E$. According to a weak version of PPP, EP_E/P_{US} can differ from unity. However, it should always return to the same constant. Thus, if P_E rises more rapidly that P_{US} , eventually E should fall (i.e., the US dollar should appreciate) and return EP_E/P_{US} to its underlying constant value.

Informally, at least, *PPP* is sometimes motivated by the Law of One Price. The following example illustrates this.

(c) The Relationship between PPP and the Law of One Price. The first example shows how the law of one price could hold for each individual good, and Purchasing Power Parity holds too. The second example illustrates the possibility that the law of one price holds for each good, but PPP does not hold. So, PPP and the Law of One Price are different theories.

Example 1 Here is a case in which the Law of One Price holds, and PPP holds too. Suppose $P_{US} = a_1 P_{US}^1 + a_2 P_{US}^2$, where P_{US}^1 is the price of good i = 1 in the US consumption basket and P_{US}^2 is the price of good i = 2. The numbers, a_1 and a_2 , are the fractions of these two goods in the basket. (For the sake of the illustration, I assume there are only two goods in the consumption basket.) Suppose, similarly, that $P_G = a_1 P_G^1 + a_2 P_G^2$. Also, suppose that the law of one price holds with each good. Then, because $P_{US}^i = EP_E^i$, i = 1, 2:

$$\frac{P_{US}}{P_E} = \frac{a_1 P_{US}^1 + a_2 P_{US}^2}{a_1 P_E^1 + a_2 P_E^2} = E \frac{a_1 P_E^1 + a_2 P_E^2}{a_1 P_E^1 + a_2 P_E^2} = E,$$

so that PPP holds too.

Although it is possible that PPP holds when all goods satisfy the law of one price, it is not necessary. If the consumption basket in different countries is different (as seems quite reasonable!), then even if the law of one price applied to each good in the basket, PPP would still not hold. The following example illustrates this: **Example 2** Here is a case where PPP does not hold, even though the Law of One Price holds for each good. Suppose that the basket of goods in Europe assigns different weights to the two goods (not an implausible assumption, since the typical European and American families do not have identical expenditure patterns). Suppose that in Europe the weight on the first good is b_1 and the weight on the second good is b_2 , where either $b_1 \neq a_1$, or $b_2 \neq a_2$, or both. Then, going through the same algebra as in the previous example,

$$\frac{P_{US}}{P_E} = E \frac{a_1 P_E^1 + a_2 P_E^2}{b_1 P_E^1 + b_2 P_E^2} = E \frac{a_1 + a_2 \frac{P_E^2}{P_E^1}}{b_1 + b_2 \frac{P_E^2}{P_E^1}} \neq E$$

Note that if there is a trend over time in P_E^2/P_E^1 , there would be a trend in EP_E/P_{US} , even though the law of one price applies to each good. This example is not surprising. When the weights are different, the baskets of goods being priced by P_{US} and P_E are different. Even if the law of one price applied to each one individually, we'd still not expect the two baskets to have the same price. Two different shopping bags, one with 3 apples and 2 oranges, and the other with 3 oranges and 2 apples, will not have the same price. This is true, even if the oranges and apples in the two bags individually have the same price.

(d) Real Exchange Rates in the Data. An attached figure displays the real exchange rate between the US and six other countries. Note that in the cases of Italy, Japan, France, UK and Germany, there is a trend increase in the real exchange rate: the price of the consumer basket of goods has risen more in those six countries than it has in the US. We can adapt the previous two examples to obtain an explanation for this. We'll look carefully at the Japanese/US exchange rate.

Suppose there are two goods, a traded good and a non-traded good. In the US they have prices P_{US}^T and P_{US}^{NT} , respectively (in practice, each of these 'goods' is really a basket of goods). The corresponding Japanese prices are P_J^T and P_J^{NT} . For simplicity, suppose the weights in the baskets of goods in the two countries are identical. Then,

$$E\frac{P_J}{P_{US}} = E\frac{a_1P_J^T + a_2P_J^{NT}}{a_1P_{US}^T + a_2P_{US}^{NT}}$$
$$= \left(E\frac{P_J^T}{P_{US}^T}\right)\frac{a_1 + a_2\frac{P_J^{NT}}{P_J^T}}{a_1 + a_2\frac{P_{US}^{NT}}{P_{US}^T}}$$

$$= \left(E \frac{P_J^T}{P_{US}^T} \right) q,$$

say. The last figure in these notes shows how the real exchange rate between the US and Japan has depreciated over time. The figure also shows the real exchange rate, when the prices considered are just import prices (IPI, 'import price index').² The idea is that IPI corresponds to the price of traded goods, so that the IPI real exchange rate is a measure of the object in parentheses in the previous expression. Notice how this real exchange rate has essentially no trend. This means (given the decomposition in the previous equation) that the trend in the CPI real exchange rate is coming from a trend in q. This in turn means that the relative price of nontraded goods in Japan (i.e., P_J^{NT}/P_J^{NT}) is rising faster than the corresponding relative price in the US.

KO offer an explanation for this. According to them, the discipline of competition forces technical progress in the traded sector to be about the same everywhere in the world. At the same time, some countries' nontraded sector is sheltered from competition, with the result that the drive to keep up with the latest technology is relatively weak in the nontraded sectors of those countries. In these cases, costs are high in the nontraded sector so that the relative price of nontraded goods is expected to rise faster than it does in a more competitive economy. This may be a good explanation of why the relative price of nontraded goods seems to rise so fast in Japan.

²I am grateful to Ariel Burstein for supplying the IPI data, and for sharing some of the insights he has obtained in an ongoing research project with Eichenbaum and Rebelo.

Japanese Yen Per US Dollar



Years









