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Lecture #8: Exchange Rates in the Long Run (chapter 15 in KG, cont'd)

1. The Monetary Approach to the Exchange Rate.

To explain the determination of the endogenous variables,  $R_{\$}$ ,  $E$ ,  $P_{US}$ , the Monetary Approach to exchange rates makes use of the following relations:

$$\begin{aligned}\text{UIP} & : R_{\$} = R_{DM} + \frac{E^e - E}{E} \\ \text{Money Market} & : \frac{M}{P_{US}} = L(R_{\$}, Y). \\ \text{PPP} & : \frac{P_G E}{P_{US}} = 1.\end{aligned}$$

Recall, from last time, that *PPP* implies the rate of depreciation (in the long run!) is equal to the excess of the domestic inflation rate (i.e.,  $\pi_{US}$ ) over the foreign inflation rate.

$$\text{(PPP): } \frac{E^e - E}{E} = \pi_{US} - \pi_G.$$

Combining this with UIP, we get:

$$\text{(PPP and UIP): } R_{\$} = R_{DM} + \pi_{US} - \pi_G.$$

This relationship shows that our framework implies the Fisher effect: a rise in  $\pi_{US}$  translates one-for-one into a rise in  $R_{\$}$ , assuming the foreign variables,  $R_{DM}$  and  $\pi_G$ , do not change. Note that these two relations are not independent of our first three. They are derived from those three. Now, we'll do a couple of experiments.

- (a) One time, permanent increase (jump) in  $M$ . The variables to be determined are,  $P_{US}$ ,  $R_{\$}$ ,  $E$ . Note that the money demand equation is satisfied if  $R_{\$}$  stays fixed and  $P_{US}$  jumps enough to leave  $M/P_{US}$  unchanged (this is an equiproportional change in  $P_{US}$ ). Given the jump in  $P_{US}$ , PPP indicates that  $E$  must jump equiproportionally to  $M$  too. Suppose the jump in  $M$  was  $x$  percent, so that the new  $M$  and  $P_{US}$  are  $(1+x)M$  and  $(1+x)P_{US}$ , respectively. Also, the new  $E^e$  and  $E$  are, respectively,  $(1+x)E^e$  and

$(1+x)E$ . With this change in the exchange rate, its rate of change does not change in this experiment (verify this by substituting the new  $E^e$  and  $E$  into the rate of change formula). As a result, the UIP relation can continue to be satisfied at the old  $R_s$ . This establishes the long-run results that we simply assumed in lecture 6. We now see that they follow from the above three relations.

- (b) Increase in money growth. Suppose an unexpected change in the rate of money growth occurs in period  $t_0$ . The money stock follows the path in the curve in Figure 15-1 (a), on page 408 of KG. Its growth rate is assumed to be some (unspecified) number  $\pi$  before the change. At date  $t_0$ , its growth rate becomes  $\pi + \Delta\pi$ , where  $\Delta\pi$  is the notation used to designate the change in the money growth rate.<sup>1</sup> It is important to understand the nature of this experiment, which is very different from the one just discussed, where the money stock took a permanent *jump* at  $t_0$ . Here, the value of the money stock does not suddenly change at any point in time (see Figure (a) again). For example, the event at  $t_0$  is not that  $M$  jumps, only that its growth rate changes. Our objective now is to figure out the impact of this change on the three variables:  $P_{US}$ ,  $R_s$ ,  $E$ . We also want to know how their growth rates are affected.
- i. Inflation jumps from  $\pi_{US}$  to  $\pi_{US} + \Delta\pi$ . Why? We know (this will be confirmed momentarily) that whatever happens to  $R_s$  in the instant,  $t_0$ , it is constant from then on. This means that money demand is constant after instant  $t_0$ . But, if money demand is constant, then the ratio,  $M/P_{US}$  must be constant too. This means that, after  $t_0$ ,  $P_{US}$  must be growing at the same rate as the new growth rate of  $M$ .
  - ii. The interest rate,  $R_s$ , jumps at  $t_0$  because of the Fisher effect.
  - iii. Real money. This drops at  $t_0$  because of the rise in  $R_s$ .
  - iv. The price level. We just showed that the growth rate of  $P_{US}$  (i.e., the inflation rate) jumps at  $t_0$ . But, what does the price *level* do? Does it jump, or does it behave more like the money stock itself, which was assumed not to jump at  $t_0$ ? The answer is that  $P_0$  must jump at  $t_0$ . This is the only way that  $M/P_{US}$  can drop, given that  $M$  does not drop. This explains the price path depicted in Figure 15-1 (c) on page 408.
  - v. The effect of all this on the exchange rate can be determined from PPP. First, since  $P_{US}$  jumps at  $t_0$ , then  $E$  must too, in the same proportion. Second, since the growth rate of  $P_{US}$

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<sup>1</sup>Example: if  $\pi$  is .08 and  $\Delta\pi$  is .01, then the money growth rate goes from 8 percent to 9 percent.

jumps by  $\Delta\pi$ , the growth rate of  $E$  must jump by the same amount, according to *PPP*.

In sum, the increased money growth induces an equal increase in inflation and in the rate of depreciation of the currency. It also induces an immediate jump in the price level and immediate depreciation of the currency. (Note how different these conclusions are from what we found in the short run analysis.)

2. The Facts. An equation at the core of the monetary approach to exchange rates is *PPP*. To evaluate how it works in practice, the attached graphs show  $EP_{foreign}/P_{US}$  for six foreign countries. This object is called the *real exchange rate*. According to *PPP*, it should be equal to one all the time. Note how far from true this is in practice. In the case of all countries except Canada, the real exchange rate has risen significantly since the 1940s. Here,  $P_{foreign}$  is the foreign consumer price index, and  $P_{US}$  is a measure of the price of all US production (the GDP deflator). The graphs indicate that the cost of goods in these other countries have gone up. In some cases, this has happened despite the fact that the US dollar has appreciated. Consider, for example, Italy. The Lira has depreciated substantially since the early 1970s (see the attached Figure with nominal exchange rates). Despite this, the dollar cost of the goods in the Italian consumer basket has risen a lot. This means that inflation in Italy has been stronger than inflation in the US. Britain is another example like this. The US dollar has appreciated relative to the pound. Despite this, the dollar price of British goods has risen more than US goods.

Japan and Germany represent very different examples. The US dollar has depreciated against both these countries. And, the dollar cost of goods in those countries has gone up too. We discussed the Japanese case in the previous lecture. It was argued that the price of non-tradeables in Japan has risen particularly strongly, compared with the price of nontradeables in the US. The standard explanation is that the Japanese nontraded good sector is relatively well protected by government regulations and other such things, and that that has allowed prices to rise there. The idea is that in the US, the nontraded sector is relatively less protected, and that this has acted as a spur to productivity there. A similar story is used to explain why the cost of goods in other developed economies have risen relative to the cost of goods in the US.

You may wonder if these results are sensitive to what measure of US or foreign prices we use. They are not. Overall, different price indexes for a given country behave similarly.

So, the data suggests that *PPP* is not a good approximation, even in the 'long run'.

There is another interesting thing that emerges from the Figures. Note from the nominal exchange rates, that they were less volatile before the 1970s. This is because the world had a system of fixed exchange rates then. When we left that system nominal exchange rates became very volatile. Note that real exchange rates became very volatile at the same time (the exception is Canada, where the nominal and real exchange rates were equally volatile before and after the 1970s.) There are two interpretations of this observation. One is that it supports the notion that prices are sticky. We will discuss this and another interpretation later.

### 3. A More Sophisticated Model of Exchange Rates.

We will modify the PPP and develop a better model of exchange rates, which is more in line with the large variations we see in the real exchange rate. We don't want our modified model to capture *all* of the reasons (i.e., differences in monopoly power, trade restrictions, differences in baskets, etc.) that real exchange rates vary. Such a model would be too huge to be workable. What we need instead, is a model that captures the essence of what drives the real exchange rate around, without getting too involved in details.

The real exchange rate is a measure of the ratio of foreign goods prices to US goods prices. The foreign and domestic goods represented in this ratio are not the same. Many of them are non-traded. We'll think of there being two main forces impacting on this ratio, in the long run.

- (a) Demand. When demand in the world (i.e., by foreigners and/or Americans) shifts towards US goods, then we expect the real exchange rate to fall (i.e., a real appreciation of the US dollar). That is, we expect the shift in demand away from foreign goods to reduce their price,  $EP_{foreign}$ , and raise the price of American goods.

This simple idea encompasses various possibilities:

- i. Suppose there are traded goods and nontraded goods, and the law of one price applies to the traded goods. Suppose Americans increase their demand for American produced non-tradeables. Since, by definition nontraded goods are only produced in the US, the rise in demand for them by Americans is likely to press hard on US productive resources. This is likely to raise the price of tradeables relative to nontradeables:  $P_{US}^{NT}/P_{US}^T$ . Then,

$$\frac{EP_{foreign}}{P_{US}} = E \frac{a_1 P_f^T + a_2 P_f^{NT}}{b_1 P_{US}^T + b_2 P_{US}^{NT}}$$

$$\begin{aligned}
&= E \frac{a_1 \left( P_f^T / P_{US}^T \right) + a_2 \left( P_f^{NT} / P_f^T \right) \left( P_f^T / P_{US}^T \right)}{b_1 + b_2 P_{US}^{NT} / P_{US}^T} \\
&= \frac{a_1 + a_2 \left( P_f^{NT} / P_f^T \right)}{b_1 + b_2 \left( P_{US}^{NT} / P_{US}^T \right)},
\end{aligned}$$

since  $EP_f^T/P_{US}^T = 1$  by the law of one price. From this expression, it is clear that the rise in American demand for US nontradeables will produce a fall in the US real exchange rate.

ii. Suppose the world only has traded goods. Americans make oranges and foreigners make apples. Americans and foreigners consume both apples and oranges. Now suppose the world wants to eat more oranges and fewer apples (this could be because Americans' preferences have shifted, or foreigners' preferences have shifted). Then, we'd expect the dollar price of apples to fall relative to the dollar price of oranges. This is just the real exchange rate.

(b) Supply. Suppose Americans become more efficient at making whatever they make (say, oranges). Then, we'd expect the price of these to fall as their supply rises. This will produce a rise in the real exchange rate (the price of apples relative to oranges), or a real depreciation of the dollar.

Our modified model is composed of the money market equation, UIP and a modified version of PPP:

$$\begin{aligned}
\text{UIP} &: R_s = R_{DM} + \frac{E^e - E}{E}. \\
\text{Money Market} &: \frac{M}{P_{US}} = L(R_s, Y). \\
\text{Real Exchange Rate} &: \frac{P_G E}{P_{US}} = q,
\end{aligned}$$

where  $q$  is the real exchange rate. We assume that it is determined by demand and supply, in the way just discussed.

4. Analysis Using the More Sophisticated Model. In this model, a change in the money stock or its growth rate has the same effect as in the Monetary Approach. That is because we assume monetary factors don't (in the long run) affect the demand and supply conditions which impact on  $q$ . The novelty of this framework is that it can be used to study the impact on  $E$ ,  $P_{US}$  and  $R_s$  of a change in  $q$ .

- (a) Effects of a change in  $q$ . Consider the effect of an increase in world demand for American goods. Suppose it induces a one-time, permanent drop in  $q$ , i.e., induces a real appreciation of the dollar. There is no change in the growth rate in  $q$ . Now, suppose  $R_s$  does not change (we will verify this assumption in a moment). Then, the money market condition says  $P_{US}$  does not change either, since the other variables in that relation,  $M$ ,  $Y$ , do not change by assumption ( $M$  is determined by the Fed, while  $Y$  is determined by the amount of capital and people, etc. in the country). If  $P_{US}$  does not change then the real exchange rate relation indicates that  $E$  has to jump in proportion to the change in  $q$ . That is,  $E$  appreciates instantly. But, since there is no change in the growth rate of  $q$  or  $P_{US}$ , there is no change in  $(E^e - E)/E$  either. UIP then implies that  $R_s$  does not change, verifying our assumption to this effect, made above.

The analysis of a change in the supply which affects  $q$  is the same. The impact on  $E$ ,  $R_s$  and  $P_{US}$ .

- (b) Other Implications of the More Sophisticated Model.
- i. International Interest Rate Differentials. The real exchange rate expression has the following growth rate implication:

$$\frac{E^e - E}{E} = \frac{q^e - q}{q} + \pi_{US} - \pi_{DM}.$$

That is, the rate of depreciation in the nominal exchange rate is the sum of the depreciation in the real exchange rate, plus the excess of US inflation over that of Germany. Under PPP, real exchange rate depreciation is ruled out. However, the data force us to bring it in. Obviously, the data are characterized by long-term, persistent movements in  $q$ . If we substitute this into the interest parity relation, we obtain:

$$R_s - R_{DM} = \frac{q^e - q}{q} + \pi_{US} - \pi_{DM}.$$

So, interest rate differentials reflect not just inflation differentials, but also the trend change in the real exchange rate. The Fisher effect continues to hold, as long as the factor increasing  $\pi_{US}$  does not affect  $(q^e - q)/q$  (or  $R_{DM}$ ,  $\pi_{DM}$ , but we already had to assume that before). In this case, a jump in  $\pi_{US}$  shows up one-for-one in the form of a jump in  $R_s$ .

- ii. There is a different way to write the previous expression for international nominal interest rate differentials. Note that

$R_{\$} - \pi_{US}$  is the real interest rate in the US and  $R_{DM} - \pi_{DM}$  is the real interest rate in Germany.<sup>2</sup> Then, rewriting the last equation, you get:

$$r_{US}^e - r_{DM}^e = \frac{q^e - q}{q},$$

where  $r_{US}^e = R_{\$} - \pi_{US}$  is the real interest rate in the US. Thus, the real interest rate differential between two countries is zero if PPP holds (in which case  $q^e = q$ ), or non-zero if  $q$  is expected to change.

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<sup>2</sup>Remember what a real interest rate is. It's the ratio of the goods value of what you earn on an asset, to the goods value of what it costs. Consider a US asset with a nominal return of  $1 + R_{\$}$ . The cost of one unit of this asset is one US dollar, which corresponds to  $1/P_{US}$  goods. Later, you get back  $1 + R_{\$}$  dollars, which translates into  $(1 + R_{\$})/P_{US}^e$  goods, where  $P_{US}^e$  is the expected price level. Thus, the real rate of return is

$$\frac{(1 + R_{\$})/P_{US}^e}{1/P_{US}} = \frac{1 + R_{\$}}{1 + \pi_{US}} \simeq 1 + R_{\$} - \pi_{US},$$

where,  $\pi_{US} = (P_{US}^e - P_{US})/P_{US}$ .





