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Lecture #8: More on Exchange Rate Determination

1. Some Facts About Exchange Rates. An equation at the core of the simple monetary approach to exchange rates is PPP. Figures displayed in lecture 5 - and reproduced here - show that PPP does not work well in practice. There has been a persistent real depreciation of the US currency against the currencies of all six of the countries in the Figures, with the exception of Canada. It just doesn't make sense to think that the real exchange rate always has a tendency to return to unity (or, any other constant) after it is hit by a shock, as PPP supposes.

It deserves emphasis that PPP pertains to the *real exchange rate*, $EP_{foreign}/P_{US}$. Be sure to distinguish this from the *nominal exchange rate*, E . One corresponds to the relative price of two countries' goods and the other refers to the relative price of the two countries' currencies.

The difference between the real and nominal exchange rates can best be seen by looking at the data for Italy, the UK and France. The US dollar enjoyed a persistent *appreciation* against these currencies in the period since World War II. Despite this, the real value of the dollar fell against these currencies over the same period. The real exchange rate depreciated. Put differently, the dollar cost of the goods in the Italian, UK, and French consumer baskets rose relative to the cost of goods in the US consumer basket. This is true, even though the dollar cost of those currencies rose over the same period (i.e., the dollar appreciated).

2. A More Sophisticated Model of Exchange Rates.

Motivated by the previous observations, we replace PPP by a better model of the real exchange rate, one that is not inconsistent with the trends observed in real exchange rates. The new model is only a little more complicated. 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.

We will think of there being two main forces operating on real exchange rates: demand and supply.

- (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 nontradeables relative to tradeables: P_{US}^{NT}/P_{US}^T . Then,

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

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 primarily consume oranges, but they also consume a few apples. For foreigners it is the reverse: they primarily consume apples, but they also consume a few 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:

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

The first three equations are ‘behavioral equations’, they summarize the assumptions we have made about the way market participants make decisions. The last equation is just the definition of q , the real exchange rate.

3. 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 $R_{\$}$ of a change in q .

- (a) Effects of a Change in Demand for American Goods. 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 $R_{\$}$ 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 drop 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 $R_{\$}$ 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.

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

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

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 the foreign country. 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:

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

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 π_{US} does not affect $(q^e - q)/q$ (or R_{DM} , π_{DM} , but we already had to assume that before). In this case, a jump in π_{US} shows up one-for-one in the form of a jump in $R_{\$}$.

- 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.¹ 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.

4. Back to the Short Run: Making Y Endogenous.

Up to now, we have assumed that Y is exogenous in the short and the long run. We will continue to maintain this assumption for the long

¹Remember 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, $\pi_{US} = (P_{US}^e - P_{US})/P_{US}$.

run. We suppose that in the long run output is determined by the size of the population, the level of education, the amount of physical capital, etc. However, we drop the assumption that Y is exogenous in the short run. We do this because there are reasons to think that Y reacts in the short run to changes in such exogenous variables as M , I , T , etc. For example, the recession in the early 1980s, a transitory slowdown in Y , is often attributed to a tight money policy adopted at the time by the Fed.

- (a) Where we stand. Short run: endogenous variables are R and E . We have two relationships to pin these down - the money market condition and UIP. Long run: endogenous variables are P , R and E . We have three relationships to pin these down - the money market condition, UIP and the condition that the real exchange rate, q is determined rather vaguely by exogenous ‘demand’ and ‘supply’. So far, output, Y , has been held fixed at its long-run level, which is determined by the amount of people, capital, education, etc., in the economy.

We now want to add Y to the list of our model’s variables that are endogenous in the short run. We will stick to our previous assumption that, in the long run, Y is determined by the level of population, education and the quantity of capital. If we are to make Y endogenous in the short run, however, we must add one more relationship, beside just the money market condition and UIP, to our short run model. We will add a goods market relationship. This same relationship will also be used to make precise the relationship we have been using in our long-run model, which relates q to demand and supply.

- (b) Aggregate Demand and Making Output Endogenous in the Short Run. Aggregate demand is the sum of desired (or, planned) spending by households on consumption goods, by business on investment goods, by government, plus net exports:

$$\text{Aggregate Demand: } D = C(Y - T) + I + G + CA\left(\frac{EP^*}{P}, Y - T\right).$$

Here, planned household consumption, C , is an increasing function of disposable income, $Y - T$,² I denotes planned investment and G denotes planned government spending. Also, the planned current account (exports minus imports), CA , is increasing in its first

² $C(Y - T)$ denotes the consumption function. This is not a number, C , times $Y - T$. It is a function saying how much people with disposable income, $Y - T$, consume.

argument and decreasing in its second.³ Equilibrium in the goods market corresponds to the case where planned spending equals output, $Y = D$.

Be careful to distinguish the goods market equilibrium condition from the national income identity, which must hold whether or not the goods market is in equilibrium. The national income identity says that total output must be equal to *actual* consumption, plus actual investment, plus actual government spending, plus the actual current account. We will assume actual and planned coincide for all components of the national income identity, except investment. So, the goods market is in equilibrium if, and only if, planned and actual investment are equal. When the goods market is out of equilibrium, a part of actual investment is unplanned. For example, when aggregate demand is less than output, then actual investment exceeds planned investment. The excess of actual over planned is assumed to be composed of an unplanned accumulation of inventories. This makes sense. When demand is low, we'd expect to see goods pile up on store shelves. When aggregate demand is high, then unplanned investment is negative: inventories are disappearing from store shelves.

Because these observations are so important for the analysis that follows, we dwell on them a little longer. Let C^p , I^p , G^p , CA^p denote planned consumption, investment, government spending and the current account, respectively. Here, $C^p = C(Y - T)$, and $CA^p = CA(q, Y - T)$, where q is the real exchange rate. Let C^a , I^a , G^a , CA^a denote the amount of consumption, investment, government spending, current account that actually occurs. The following is an accounting identity and is always true:

$$Y = C^a + I^a + G^a + CA^a.$$

This is always true, because one way to measure Y is to add up the terms on the right side of the equality. But, $Y = C^p + I^p + G^p + CA^p$ is *only* true when the goods market is in equilibrium. Now, we assume that households always get what they plan, so that $C^p = C^a$. Similarly for government and the current account. We do not assume that business always does the amount of investment they plan. For example, suppose planned spending is less than Y : $Y > C^p + I^p + G^p + CA^p$. We assume that this excess of output over planned spending shows up as unintended inventory

³Again, $CA(\frac{EP^*}{P}, Y - T)$ is a function. The first argument is the real exchange rate and the second is disposable income. We follow the book in referring to the current account and net exports as synonymous. This is not quite right, since the current account also includes net investment income flows.

accumulation, I^u . That is,

$$I^u = Y - (C^p + I^p + G^p + CA^p).$$

Then,

$$I^a = I^u + I^p.$$

It is easy to verify that with this definition of I^a and I^u , the national income identity is satisfied.

Does all this make sense? Of course! For households to realize their plans they just have to go to the store, or restaurant and wilfully make the purchase. The decision is up to no one but the household itself. The same is true for the government and for the export and import decisions that go into determining the current account. This is why it makes sense to posit $C^a = C^p$, $G^a = G^p$ and $CA^a = CA^p$. But, things are different for firms' investment decisions. Certainly, to purchase a new piece of machinery the firm just has to go out and do it. But, part of investment is inventory investment. This component of firms' investment decision is not entirely under the control of firms. If households stop buying things, goods pile up unsold on store shelves. This pile up of goods is counted in the inventory investment of firms. It is included in inventory investment whether firms planned on it or not. It is because the level of inventory investment is not determined by the decisions of firms alone, that it makes sense to think of the possibility that I^a is not equal to I^p .

From here on, we will not use the superscripts, 'a' and 'p'. This should not cause confusion. The distinction only matters for investment. Which superscript we have in mind should be clear from the context.

The goods market equilibrium condition will be used in both our long run and short run analysis. In the short run, when $Y > D$, so that there is unplanned inventory accumulation, Y falls. In the long run, when Y is exogenous, we will suppose that $Y > D$ leads to a fall in the relative price of domestic goods, i.e., to a rise in q .



