MSC Macro Handout - The Basics of Exchange Rate Determination

There are two handouts covering open economy issues. There are in addition two other notes on my home page (http://www.ex.ac.uk/~swrenlew/welcome1) outlining aspects of two particular open economy models: the 1995 paper by Obstfeld and Rogoff (also chapter 10 of their textbook), and a paper by Giovannini, 1988, both on the reading list.

Short run:

Assume perfect capital mobility, and assets denominated in different currencies. In this case Uncovered Interest Parity (UIP) holds. In nominal terms this is given by

$$E_t = RD_t + E^e_{t+1} \tag{1.1}$$

where E is the log of the nominal exchange rate (foreign currency per unit of domestic currency, so an increase is an appreciation), RD is the difference between domestic and overseas interest rates, and we use a superscript e to denote a rational expectation using information at time t. Thus if E is expected to rise (an appreciation), there is an expected capital gain on holding domestic currency, and so RD has to be negative to make agents indifferent between holding domestic or overseas assets. (For those unfamiliar with UIP, a good reference is Krugman and Obstfeld, International Economics, Ch 13 in 5th edition.)

We can use any price measure to turn this into an equation involving real exchange rates: the most commonly used are consumer prices and output prices. The equation then becomes

$$e_t = rd_t + e^e_{t+1} \tag{1.2}$$

where e is the log of the real exchange rate (e=E + log(domestic prices) – log(overseas prices)), and rd is now the real interest rate differential (where r=R-expected inflation). This implies:

$$e_t = rd_t + rd^e_{t+1} + rd^e_{t+2} + \ldots + rd^e_{t+n} + e^e_{t+n+1} \tag{1.3}$$

Take e_{t+n+1} as the long run, equilibrium real exchange rate. Once this is known, the equation above determines the current exchange rate. Note that expectations about future interest rates may depend on many things (political as well as economic), and so exchange rates in the market may react to all kinds of news. This may help explain the high volatility of exchange rates. Note also that the ability of governments to influence the real interest rate may diminish over time (as nominal inertia becomes less important). Note finally that the timing of information is crucial: all expectations are based on the current information set, so what matters is when events enter the information set as much as when they actually happen.

UIP dominates (and counteracts) any short term movement in the trade account. Thus if the current account temporarily moves into surplus, the capital account will move into deficit (agents in the foreign exchange market sell the extra domestic currency demanded by people buying domestically produced goods) - if it did not, the exchange rate would move and UIP would no longer hold.

Note that in steady state equilibrium, the expected=actual real exchange rate will be constant, so UIP implies that rd = 0 i.e. overseas and domestic real interest rates must be the same. This means that the 'small open economy' version of the neo-classical model will differ from the closed economy version, in which real interest rates moved to equate investment and saving. Of course, if domestic inflation is above overseas inflation in this steady state, the nominal exchange rate will depreciate so as to keep the real exchange rate unchanged.

Long run 1. PPP

Whereas trade in financial assets dominates the exchange rate in the short run, in long run equilibrium portfolios are constant, and so there is no trade in financial assets. Trade in goods will therefore determine the long run real exchange rate.

The simplest model of the long run real exchange rate is PPP, which says that it is constant.[1] PPP extends to the aggregate level the *law of one price*, which states that people will be indifferent between buying one particular (identical) good in any country/currency.

The law of one price may not hold because it is costly to trade e.g. because of transport costs or tariffs. However, even if the law of one price holds, PPP may not hold. Here we need to be precise about how we measure the real exchange rate. There are three commonly used measures

1. Nominal exchange rates deflated using consumer prices
2. Nominal exchange rates deflated using output prices
3. The terms of trade: the price of exports divided by the price of imports, measured in the same currency.

If we think about the terms of trade first, it will not be constant if the commodity composition of exports and imports differ, and the relative price of these two aggregates changes. To take one extreme example, imagine a country that only exported a commodity (e.g. oil), but imported a range of manufactured goods. If that country is small (in relation to the total world supply of oil) its terms of trade would be totally governed by the world price of oil relative to manufactures, and therefore beyond its control. If it only produced oil, but bought a representative basket of world output, then its terms of trade would equal its real exchange rate measured using output prices. However, if its consumers were identical to overseas consumers, and there was no home bias (see below), then PPP would hold for the real exchange rate measured in terms of consumer prices (assuming the law of one price held).

Thus, *specialisation of production* will prevent PPP for measures 2 and 3. PPP may also not hold because of non-traded goods, which will enter into measures 1 and 2. A large proportion (probably over 50%) of the consumer basket in most countries is accounted for by non-traded goods: remember that the final price of most imported goods has a large domestic retail element.

Long run 2. The New International Macroeconomics

Most international trade involves differentiated manufacturing goods, rather than commodities like oil. The key distinction is that non-commodities probably face a downward sloping demand curve i.e. they are sold in imperfectly competitive markets. The *new international macroeconomics* (see the paper by Lane on the reading list) typically works in a world where each ‘good’ (or more

[1] Note that if PPP held in the short run as well, then domestic real interest rates would equal world real interest rates at all points in time. From UIP, note that the interest differential can only be non-zero if the exchange rate is changing. Under PPP, the exchange rate is constant, so interest rate differentials must always be zero. However, no one believes short run PPP is realistic.

realistically each variety of good) is produced in just one country, so national output consists of a unique basket of goods.

Suppose that all consumers in all countries were identical (they had identical tastes), and the law of one price holds. As we have already noted, PPP in terms of consumer prices then holds. A typical set up is to assume that the representative consumer maximises

$$U = \sum_{s=t}^{\infty} \beta^{s-t} [\, f(C_s) + ...] \tag{1.4}$$

i.e. discounted utility which involves aggregate consumption and possibly other variables, and where the aggregate consumption bundle C is given by the CES aggregator

$$C = [\int_0^1 c(z)^{(\theta-1)/\theta} dz]^{\theta/(\theta-1)} \tag{1.5}$$

where z is a particular variety of good. The corresponding consumption based price index is then

$$P = [\int_0^1 p(z)^{1-\theta} dz]^{1/(1-\theta)} \tag{1.6}$$

(see, for example, chapter 4 of Obstfeld and Rogoff). This formulation is convenient because it implies a demand for good z of the form

$$c(z) = [\frac{p(z)}{P}]^{-\theta} C \tag{1.7}$$

i.e. θ is the elasticity of demand. We can take this as a demand curve for good z, where C is now total world consumption.

Suppose each country produced just one good for export. If that good was z, then the relative price in (1.7) would be that country's terms of trade (because its consumers imported the basket of goods corresponding to C). Equation (1.7) would then be the demand curve for that country's exports. To see the implications of this, imagine that country only produced to export, and that the supply of output was fixed. Then (1.7) would determine the terms of trade. An increase in domestic supply would require a fall in the term of trade, because the good z would have to become cheaper to sell the additional supply. An increase in world demand would have the opposite effect. Thus the long run real exchange rate, measured using output prices or the terms of trade, would not be constant, but would fluctuate with domestic supply and overseas demand. However, the PPP would still hold for the consumer price real exchange rate. This is the basis of the model used by Obstfeld and Rogoff (1995).

One problem with this approach is that it treats the number of varieties produced in a country as fixed. Thus, we would expect a rapidly growing country to be associated with a depreciating exchange rate, because it has to reduce the price of its goods to generate the demand for its ever-expanding supply. This is not obviously consistent with the facts e.g. Japan in the 1960s and 1970s, which grew very rapidly, and where the real value of the Yen appreciated. We need a way of endogenising the number of varieties produced in a country.

Non traded goods and home bias

In the very simple framework above, shifts in domestic demand do not influence any measure of the real exchange rate in the long run, essentially because consumption is spread evenly across all goods produced in the world. This result, and PPP for the consumer price real exchange rate, are not robust to either of two possible additions to the model.

The first is introducing non-traded goods. The key point about non-traded goods is that their price will tend to reflect the price of traded exports rather than imported goods. This is because the production of exports and non-traded goods require labour, and this labour – if freely mobile within a country – will be paid the same wage in both sectors.

Now take the case of a pure commodity producer. If the world price of oil rises, this will raise wages in the oil extraction industry, and this will in turn raise wages in non-traded goods production. As a result, consumer prices will rise because of its non-traded goods element. So, the real exchange rate measure using consumer prices will also change, although not by as much as the terms of trade.

The same is true for the model based on differentiated manufactured goods. An increase in domestic supply (due, say, to an increase in labour supply) will reduce prices and wages in that sector, with knock-on effects for the price of non-traded goods. Note, also, that if productivity growth in non-traded goods production is less than for traded goods, then the relative price of non-traded goods will tend to rise, and if these productivity differences differ between countries (or the share of non-traded goods is different) then this will produce a trend change in the consumer price real exchange rate – this is the Balassa/Samuelson effect (O&R p210).

For the same reason a shift in consumption demand will influence the terms of trade. Higher consumption, say, will increase the demand for non-traded goods, requiring more production of these goods. This will reduce the supply of labour available for export, and so export prices will rise to choke off some demand. Thus an increase in domestic demand, ceteris paribus, appreciates the real exchange rate.

Another way of capturing similar effects to the introduction of non-traded goods is to allow home-bias in consumption. This splits the consumption bundle into two parts: domestically produced goods and overseas goods. All goods are traded, but consumers have a bias in favour of home produced goods. Thus the aggregate consumption bundle would be given by

$$C = [(1-\alpha)^{1/\eta} C_H^{(\eta-1)/\eta} + \alpha^{1/\eta} C_F^{(\eta-1)/\eta}]^{\eta/(\eta-1)} \qquad (1.8)$$

where C_H and C_F are also CES aggregates. Thus the demand for home goods would be

$$C_H = (1-\alpha)\left(\frac{P_H}{P}\right)^{-\eta} C \qquad (1.9)$$

etc. Note that if $\eta=1$ (Cobb-Douglas rather than CES preferences), then the share of home goods in total consumption is constant. Giovannini (1998) uses this property.

Between the long and the short

It is tempting to regard the long run as equivalent to long run equilibrium, and treat real interest rates as effectively exogenous (set by policy). With UIP, we then have a complete model of the exchange rate. Treating real interest rates as being heavily influenced by the authorities in the short run is not unreasonable for an economy with nominal inertia where these authorities know what they are doing. However the monetary authorities set nominal interest rates, and these influence real interest rates only for as long as nominal inertia is present. This time frame probably does not go beyond 5 years. We know from our simulations of closed economy models that long run equilibrium can take much longer to achieve i.e. decades. So we have important gap, which we can label the medium term.

This has important implications for how we view UIP. In the discussion above, we treated it as an equation determining the exchange rate. But imagine a world with no nominal inertia. In this case a monetary authority would not set real interest rates, and so it would be wrong to treat real interest rates as exogenous. Furthermore, much of our discussion of the determination of long run real exchange rates actually applies to the medium term (or even the short term without nominal inertia). So perhaps these 'long run' factors actually determine the real exchange rate in the medium term, and UIP should be read as an equation giving us the implications for real interest rates of any path for real exchange rates.

However this view may also be misleading, because real interest rates feed back on to demand and supply, which in turn influence trade in goods and the real exchange rate. In most cases, therefore, exchange rates and real interest rates are jointly and simultaneously determined as part of a macroeconomic system. The discussion above can be seen as describing some key parts of that system.