Notes on PPP and the Real Exchange Rate (old)

Purchasing Power Parity, Non-traded Goods, and the Real Exchange Rate

1. PPP says that a basket of goods in one country should cost the same as that in another country, when evaluated in a given currency. That is, if we are given CPI price indices in two countries, it should be the case that

\[ P = eP^* \]  \hspace{1cm} (1)

where \( P \) is the home country CPI, \( e \) is the exchange rate, and \( P^* \) is the foreign country CPI. We could of course use PPP with other price indices, such as indices of wage costs or the GDP deflator. Since this version of PPP says that absolute price levels should be equal it is called the Absolute PPP statement.

Where does PPP come from? Fundamentally it is based on the notion that international competition will equalize goods prices for individual commodities. Thus, if we have \( N \) commodities in the price index in each country and

\[ p_i = e p_i^* \quad i = 1, 2, \ldots, N \]

This is the ‘Law of One Price’. It just relies on the assumption that competitive markets equalize the prices of identical goods across locations (in the absence of trade barriers or transport costs). If the law of one price holds for all goods, and consumer price indices are alike across countries, then summing across all goods, we must arrive at (1).

PPP gives a theory of the equilibrium exchange rate. It says that if

\[ e > P/P^* \]  \hspace{1cm} (2)

then there are forces set in motion that will increase prices in the home country and reduce them in the foreign country. Alternatively if

\[ e < P/P^* \]  \hspace{1cm} (3)

then we get forces moving in the other direction. Sometimes people will argue that if (2) holds then the home country currency is ‘undervalued’, while if (3) holds then the currency is ‘overvalued’. This type of reasoning is fraught with difficulty however, as we will see below. Simple PPP based explanations for equilibrium exchange rates are not usually correct. Fundamentally this is because there are many reasons for prices to differ across countries without engendering adjustment in the exchange rate.

The PPP for a country is defined as the exchange rate that satisfies (1). Thus, we say that Canadian PPP vis a vis the US is

\[ e_{PPP} = \frac{P_{Canada}}{P_{US}} \]

where \( P \) represents the price level. One difficulty with this is that typically prices are published as indices, rather than absolute prices. Thus, \( P_{HK} \) is an index that is set to 100 in 1992, for instance, as is \( P_{US} \). Thus, unless we feel sure that PPP held at the initial base year (i.e. that if we actually
had prices, (1) would hold), then the value of $e_{PPP}$ doesn’t really have any meaning. In other words, to construct PPP’s we need data on price levels, not just indices.

2. Nevertheless, there are some data-sets that publish price levels (Penn World Tables for instance). Let’s look at some OECD estimates. See Table 1 gives OECD PPP’s and comparative price levels. The first 5 columns give the PPPs for 93-96. The second 5 columns give comparative price levels, with the OECD as a base. If PPP held, all these would be 100, because, evaluated within a common unit, the price levels would be the same everywhere. But this clearly doesn’t happen, so (absolute) PPP doesn’t hold. Take Korea for instance. The comparative price level in Korea in 1996 was $69/89 = 0.78$ of the price level in the US. That means that $e_{PUS/PKOR}$ was $1/0.78 = 1.29$ using the actual Won-dollar exchange rate. Prices in the US were 30 percent higher than in Korea. By the PPP’s for Korea in 1996, the PPP relative to the US was 631. That is, the value of $P_{KOR}/P_{US}$ was 631. Multiplying this by the ratio of comparative price levels we get a value of $1.29 \times 631 = 814$, which is what the actual exchange rate for the Korean won was in 1996. In other words, using the comparative price levels, we can compute that the actual exchange rate was 29 percent above the PPP exchange rate, so according to the language of over-under-valuation (which we have to beware of, as warned above), the Won was 29 percent under-valued.

3. Why doesn’t absolute PPP work? Because there are all kinds of barriers to trade in goods, services, and factors across countries.

1. Trade barriers exist between almost all countries, even though they have been falling on average in the post-war period. These come in the form of tariffs, quota’s and other restrictions on the free flow of goods and services between countries.

2. There are non-trivial transportation costs for most goods. This means that the prices of goods are not equalized across locations, both within a country and between countries.

3. Many goods are sold by imperfectly competitive firms who may price-discriminate across locations, if they can prevent consumers from reselling the goods. It is much easier to price-discriminate across countries than to price-discriminate within a country. One reason is that domestic laws may prevent price-discrimination within a country, but international law has no such force.

4. Probably the most important reason for goods prices to differ across countries is that a huge fraction of economic output is not traded internationally. This is the case for many types of services, some foodstuffs, and some goods which have very high transportation costs. Because services are such a big fraction of most economies total output, this makes the non-traded sector quite large. Because these goods are not traded internationally (at least in normal times), there is no requirement that their prices be equated across borders. Moreover, many traded goods have a non-traded component in their total price (e.g. reflecting distribution or servicing costs). Again, this can lead to prices differences across countries.

All of these factors make it clear that absolute PPP should not be expected to hold. The failure of PPP is not necessarily an opportunity for profitable arbitrage.

4. The fact that the actual exchange rate does not equal the PPP rate is important in international comparisons of income and standards of living. We recognize that in certain countries, some types
of goods are much cheaper. For instance, it is often observed that in low-income countries, services are much cheaper (we discuss this more fully below). Thus it is much cheaper to hire someone to be a cook in your home in India, relative to the cost of a TV in India, than it is to hire a cook in the US, relative to the cost of a TV in the US. Because TV’s are traded goods, there is some forces which will equate their prices between countries, but not so for domestic services. Imagine if TV prices were exactly equated, due to the law of one price. Then this would mean that the Price level in the US was higher, evaluated in one currency, than in India, since TV's have the same price but services have higher prices in the US. If we were comparing relative GDP’s across countries, we’d have to adjust for this. To do this adjustment, we should use PPP rates rather than market exchange rates. PPP adjustment for poor countries almost always raises their GDP relative to those that come from just using market exchange rates for evaluation. This says that if we let \( I \) represent income, we compare \( I_{us} \) with \( I_{india} \) by multiplying the latter by \( e_{ppp} \). This is equivalent to comparing \( I_{us}/P_{us} \) to \( I_{india}/P_{india} \), as you can easily see. Thus, PPP’s are used in making international comparisons of standards of living.

More generally, this argument implies that richer countries have higher price levels. Using World Bank data on Price Levels, Figure 2 shows that this holds very clearly in the data. Countries that have higher GDP per capita, in US dollar terms, have higher price levels, relative to the US.

Table 3 gives some comparisons of GDP per capita, in dollars, and PPP adjusted. As we’d anticipate, PPP adjusted, Japan’s GDP per capita is much less than its nominal GDP per capita. On the other hand, China’s GDP per capita rises with PPP adjustment.

5. We can conclude then that as a prediction about relative price levels, the absolute version of PPP is felt to have little empirical content. A generalization however is called the relative PPP hypothesis. This is written as

\[
kP = eP^*
\]

or

\[
k = eP^*/P
\]

where \( k \) is a constant (or at least stable over time). This version says that there while the prices of some goods may not be equated across countries, nevertheless we would expect that the differentials across countries in the prices of non-tradeable goods (or transport costs, or price discrimination differentials, or trade barriers) would be stable, so that there would be a relatively constant relationship between national price levels.

We usually call \( k \) the (CPI based) Real Exchange Rate. It is the exchange rate adjusted for national price levels. It is a critical variable in international finance. What it measures is the relative cost of living (based on the CPI) in one country to another country. When \( k \) rises we say that prices in the foreign country have risen relative to prices in the home country, and we have a real depreciation. When \( k \) falls the opposite occurs, and we have a real appreciation. We could also write the real exchange rate based on wage costs i.e.

\[
k_w = eW^*/W
\]

where \( W^* \) is the foreign hourly wage and \( W \) is the home country wage. This would measure the relative competitiveness of the home country to the foreign country, in terms of their wage costs.

3
Relative PPP theory says that the real exchange rate should be stable over time. Why should this be so? One might argue that the relative prices of non-traded to traded goods should be determined by relative national differentials of productivities and demand factors, and that these factors should be quite stable. What this implies is that the exchange rate should be governed by differentials in national inflation rates. Differentiating equation (4) under the hypothesis of relative PPP, we get

\[ \dot{e} = \pi - \pi^* \]

where \( \dot{e} = \frac{de}{e} \) is the rate of change of the exchange rate, and \( \pi \) and \( \pi^* \) are respectively, domestic and foreign rates of inflation.

Relative PPP then says basically that the movement of the exchange rate over time should be such that it reflects national differentials in inflation rates. In this way the real exchange rate will be constant. There is a huge debate about this. We will discuss this at length in the future. At this point we can mention that

1. PPP is clearly and systematically violated in the short run.
2. There is some evidence that PPP applies in the long run.

As a single piece of evidence, that is not meant to apply generally, lets look at the US-Italy nominal and real exchange rate between 1980 and 1996 in Figure 3. During that time, there have been great fluctuations in the exchange rate. In the short run (this is annual data, so the short run here is not so short) real and nominal exchange rate movements match each other closely. But in the long run, we see stronger evidence that the trend in the nominal exchange rate matches the trend movement in price levels.

Although there is some evidence of long run PPP, in many bilateral situations the real exchange rate does have long term trends. A leading example is that Japan has had long term real appreciation relative to the US in the last thirty years. That is, the YEN has appreciated relative to the US dollar without this being reflected in higher US inflation rates than those in Japan.

What explains the long term trends in the real exchange rate? For this we need to look at the fundamental determinants of technology, factor endowments and national preferences that make prices differ across countries. When Japan has a long term real appreciation relative to the US, we are saying that the relative price of Japanese goods is rising vis a vis the US. We need to pin down what factors determine this relative price in the long run.

6. To start, let us assume that the first three factors in the possible set of those responsible for the breakdown of PPP are negligible. That is, assume the the real reason for the movement in the real exchange rate in the long term is due to non-traded goods. This is a realistic assumption. While factors 1, 2, and 3 might be important in causing departures from the law of one price, they are unlikely to vary sufficiently over time to explain long movements in the real exchange rate. With this in mind, let there be two types of goods in the economy; traded, whose price are \( P_T \), and non-traded, whose price are \( P_N \). The home economy CPI is then defined as \( P = P_T^\alpha P_N^{1-\alpha} \). The foreign CPI is \( P^* = P_T^{\alpha^*} P_N^{(1-\alpha^*)} \). The real exchange rate is then given by

\[ k = eP/P^* \]
Now assume that the law of one price holds for traded goods, so that \( P_T = eP_T^* \). What does that mean for \( k \). Using this it is easy to rearrange to show that
\[
k = \left( \frac{P_N^*}{P_T^*} \right)^{1-\alpha^*} \frac{P_N}{P_T^{1-\alpha}}
\]
. The real exchange rate is then determined by the ratio of the relative price of non traded goods in the foreign country to the same relative price for the home country. Again letting \( \hat{x} = dx/x \), we have
\[
\hat{k} = (1 - \alpha^*)\hat{p}_n^* - (1 - \alpha)\hat{p}_n
\]
where \( p_n = P_N/P_T \). This says that the real exchange rate moves in response to the movements in relative prices within individual countries. If the home country has a higher rate of inflation in non-tradeable goods than in tradeable goods, and the foreign country has the same rate of inflation in both goods, then the home country experiences a persistent real appreciation. Note in addition however, that if the consumption shares of traded and non-traded goods are different between countries, then we can get real exchange rate movements even if the relative price changes are the same. For instance if the home country has a higher share of consumption in non-tradeables and \( \hat{p}_n = \hat{p}_n^* > 0 \), it still experiences a real appreciation. This is likely to be a fairly unimportant factor however, the real driving force between real exchange rate movements is the differential inflation rates between traded and non-traded goods.

**7.** We want to develop a model of the determination of the relative price of non-traded goods. Let consumers have preferences for both traded and non-traded goods.

\[
U = \sum_{s=1}^{2} \beta^s - 1 \left[ U(C_{Ts}) + V(C_{Ns}) \right]
\]
where to keep things simple, we assume that preferences are strongly separable between the two types of goods.

Consumers budget constraints are given by
\[
C_{Tt} + pC_{Nt} + B_{t+1} = Y_{Tt} + pY_{Nt}
\]
where \( Y_{Tt} \) represents output of traded goods, \( p \) is the relative price of non-traded goods, in terms of the traded goods numeraire, and \( Y_{Nt} \) is output of the non-traded goods sector. Net foreign assets, \( B_{Tt} \) are denominated in traded goods. \( r \) is the fixed world interest rate.

**Behaviour of Firms**

If factors of production are freely mobile between the two sectors, then we may write a relationship between the relative price of non-traded goods and output of traded and non-traded in the following way.

\[
Y_{Tt} = A_{T1}Y_{Tt}(p) \quad A_{T1}Y_{Tt}'(p) \leq 0
\]
\[
Y_{Nt} = Y_{Nt}(p) \quad Y_{Nt}'(p) \geq 0
\]
Here $A_T$ is a productivity shock in the traded goods sector. How can we derive these relationships? Imagine that there was just one mobile factor of production, labour, which was inelastically supplied. Then we must have

$$A_T F_1(L_T, K_T) = w$$

and

$$p G_1(L_N, K_N) = w$$

where $F$ and $G$ respectively are the CRS production functions for traded and non-traded goods, and $w$ is the wage in terms of traded goods. Imposing labour market clearing

$$\bar{L} = L_T + L_N$$

we get a relationship between between supply and price as described above.

**Behavior of Consumers**

Now let us look at the consumers problem. An optimal consumer plan will have the following aspects, for all $s \geq t$;

$$\frac{V'(C_{Ns})}{U'(C_{Ts})} = p$$  \hspace{1cm} (5)

$$U'(C_{Ts}) = \beta (1 + r) U'(C_{T_{s+1}})$$  \hspace{1cm} (6)

In addition, the consumer must respect the intertemporal budget constraint

$$\sum_{s=1}^{2} \left( \frac{1}{1 + r} \right)^{s-1} (C_{Ts} + p_s C_{Ns}) = \sum_{s=1}^{2} \left( \frac{1}{1 + r} \right)^{s-1} (A_{Ts} Y_{Ts}(p) + p_s Y_{Ns}(p))$$  \hspace{1cm} (7)

How do we define an equilibrium in the open economy with non-traded goods? For a given price $p$, we can use the consumers Euler conditions plus the budget constraint to solve for the sequence of consumption of both types of goods. But in fact, the price is not given now, in an equilibrium. It will be determined by non-traded goods market clearing, given by

$$Y_{Ns}(p_s) = C_{Ns}$$  \hspace{1cm} (8)

Thus, we have an equilibrium in the open economy with a non-traded goods sector as the sequence of consumption levels of traded and non-traded goods that solve (5) and (6), given the budget constraint (7), the supply relationships for each good, and the market clearing condition (8).

**Example**

Let’s construct a fully worked out example. Say that $u(C_T) = \alpha \ln C_T$ and $u(C_N) = (1 - \alpha) \ln C_N$. In this case we can follow a procedure called ‘two stage budgeting’, to separate the atemporal division of expenditure between nontraded and traded goods, and the intertemporal division of consumption across the two time periods. Let the ‘composite consumption’ aggregate $C$ be defined by

$$C = \frac{C_T^\alpha C_N^{1-\alpha}}{\alpha^\alpha (1 - \alpha)^{1-\alpha}}$$
So the utility function is just

\[ U = \ln C_1 + \beta \ln C_2 \]

Then we may show that \( PC' \) is equal to the minimum of \( pC_N + C_T \), subject to \( \frac{C_1^{\alpha} C_N^{1-\alpha}}{\alpha(1-\alpha)} \geq C' \), where \( P = P_N^{\alpha} P_T^{1-\alpha} = p^\alpha \). Thus, the budget constraint over the two periods is

\[ P_1 C_1 + \frac{1}{1+r} P_2 C_2 = pY_{N1} + Y_{T1} + \frac{1}{1+r}(PY_{N2} + Y_{T2}) \]

The first order condition is:

\[ \beta(1+r)P_1 C_1 = P_2 C_2 \]

To derive the conditions for division of consumption between \( N \) and \( T \) at any point in time, note that

\[ C_{N1} = (1-\alpha) \frac{P_1}{p} C_1 \]

How do I derive this? Using Shepherds lemma on the function \( P_1 C_1 \) noting the definition of \( P_1 \). Why is this legitimate? Because \( P_1 E_1 \) is just an expenditure function. It gives the minimum expenditure over two goods \( N \) and \( T \), given current price \( p \), to obtain utility \( C \).

Of course, for the solution to the original problem, you don’t actually need to do the two stage budgeting. Since the problem at hand is so easy, it is hardly worth doing it in fact.

To solve the problem further, assume that \( \beta(1+r) = 1 \). Then the solution for equations (5), (6) and (7), for this example, is:

\[ C_{T1} = \frac{1+r}{2+r} (A_{T1} Y_{T1} + \frac{1}{1+r} A_{T2} Y_{T2}) \]

\[ C_{T2} = C_{T1} \]

\[ p_1 = \frac{1-\alpha}{\alpha} \frac{C_{T1}}{Y_{N1}} \]

\[ p_2 = \frac{1-\alpha}{\alpha} \frac{C_{T2}}{Y_{N2}} \]

In this example, consumption of traded goods is constant across the two periods. Note that we can use the following convenient way to rewrite the budget constraint for the individual. \( pC_N + C_T = p^\alpha C \)

Let’s look at some special cases

A. Assume that \( \beta(1+r) = 1 \), and that the supply schedules are identical in each period (i.e. there are no productivity shocks. Then it is easy to see that the economy will run a current account of zero in every year, and

\[ Y_{Ts}(p_s) = C_{Ts} \]

i.e. the market for traded goods clears in each period.

Another way to think about this case is as if there were zero capital mobility. Then the market for both goods must clear.
This may be illustrated in Figure 1. The Production possibilities curve represents the tradeoff between the production of the two goods. The slope of this curve equals the relative price $p$. When the current account is zero, the country’s indifference curve must be tangent to the PPC, which will jointly determine the relative price $p$ and the output of traded and non-traded goods.

Take now a rise in the productivity of the tradeables sector. In this case, the PPC shifts up but not parallel, rather shifting up in a way biased towards higher production of the tradeable good. The result is that the relative price $p$ rises. If we thought of the comparison of this country with another country, we could conclude that a rise in productivity in the traded goods sector in the home country will lead to an appreciation of the real exchange rate. The logic is that countries that have higher productivity in tradeables will have higher price levels, since prices in traded sectors will be equalized across borders. This gives a rationale for richer countries to have higher prices. This is known as the Balassa-Samuelson hypothesis, and is explored further below.

B. An alternative rationale for the relationship between GDP per capita and price levels is to assume that preferences, unlike those above, are not homothetic, but the income expansion path is biased towards non-traded goods i.e. non-traded goods have income elasticities of demand exceeding unity, and traded goods have income elasticities of demand less than unity. A clear reason for this is that non-traded goods tend to have a large service component in them, and as countries get richer their demand for services tends to rise. Then even balanced sectoral growth will lead to an increasing price of non-traded goods. Thus, faster growing countries would have higher price levels again.

C. Now lets look at the relationship between the current account and the relative price of non-traded goods. Holding conditions in the rest of the world constant, we can thus describe this as the relationship between the current account and the real exchange rate. Note that the definition of the real exchange rate given above includes foreign prices. But in the small open economy we may just take the foreign price level as given, so the real exchange rate is

$$R = \frac{P^*}{P} = \frac{1}{p^\alpha}$$

Note that the current account (in the first period) in this model will be determined by the following

$$B_1 = Y_{T1} - C_{T1}$$

That is, the current account is determined by the excess of traded goods expenditure over non-traded goods expenditure. This is a very important albeit obvious implication of this framework. A country that borrows must repay this debt through trade surpluses. But trade surpluses can only be generated by an excess of traded goods production over traded goods expenditure. This lesson has been learned recently in Thailand and other countries, where it is said that much of the capital inflows went to finance investment in the non-traded sector, such as property and infrastructure.

What is the relationship between the current account and the real exchange rate? This depends on the source of the current account movement.
Take first the case where current consumption of traded goods rises due to a fall in foreign interest rates. Thus, starting from a situation where $\beta(1 + r) = 1$ and consumption of traded goods is constant in all periods, let $r$ fall for period $t + 1$, and then go back to its original level thereafter. This will increase current consumption relative to future consumption, and generate a trade balance deficit. What does it do to the real exchange rate?

From the relationship

$$p_1 = \frac{V'(Y_{N1}(p))}{U'(C_{T1})}$$

we can show that

$$\hat{p}_t = \frac{\sigma_T \hat{C}_{Tt}}{1 + \sigma_N \epsilon}$$

where $\sigma_i \geq 0$ is the coefficient of relative risk aversion for each good ($i = T, N$), and $\epsilon \geq 0$ is the elasticity of supply in non-traded goods. It is clear from this that a rise in traded goods consumption will raise the relative price of non-traded goods. Thus, in this case, a current account deficit will coincide with a real exchange rate appreciation.

Note in this case, a current account deficit leads to an expansion in the non-traded sector and a decline in the traded sector. But this will have to be reversed in the future, as traded goods consumption falls, and the country undergoes a trade surplus to pay off the debt. Then, the real exchange rate must experience depreciation, and the traded goods sector must rise. This may again be seen against the backdrop of the recent experience of Thailand and Malaysia.

However, the current account may change for other reasons. Look at a second case, where a rise in the productivity of traded goods leads to a current account surplus. It is clear that this will also lead to a rise in the consumption of traded goods, and lead to a rise in $p$ and therefore a real appreciation. So the correlation between the current account and the real exchange rate will depend on the source of the disturbance.

8. Now let’s look at a more sophisticated model of the Balassa-Samuelson mechanism. The real exchange rate is driven by differentials between countries in long term productivity growth (or what is almost the same thing, long term growth in output). If one country is growing faster than another, it will have a persistently appreciating real exchange rate relative to the other country. Why? The basic reason, according to the arguments of Samuelson and Balassa, writing in the 1960’s, was that productivity growth is fundamentally driven by growth in the traded goods sector, and thus faster growing countries must have increasing price levels (as seen above).

9 We now develop a slightly different model based on the Balassa-Samuelson hypothesis. First imagine that a small country produced two types of goods, as before traded and non-traded. Say that producers in those countries used the production technologies given by

$$Y_T = \theta_T K_T^{1-\gamma} L_T^\gamma$$

\[ Y_N = \theta_N K_N^{1-\beta} L_N^\beta \]

where \( \theta_i \) represents productivity in sector \( i \), and \( K \) and \( L \) represents labour and capital hiring. Assume all factors are mobile and capital is freely available on world capital markets at rental \( r \). Assume also perfect competition and free entry. Then the cost function for the traded good firm will be

\[ C(w, r, Y_T) = \frac{r^{1-\gamma} w^\gamma Y_T}{\theta_T} \]

A similar cost function clearly applies in the non-traded sector. Then each firm will produce so that price equals unit cost

\[ 1 = \frac{r^{1-\gamma} w^\gamma}{\theta_T} \tag{9} \]

\[ P_N = \frac{r^{1-\beta} w^\beta}{\theta_N} \tag{10} \]

where \( w \) is the competitive wage rate in the country. Again, traded goods are the numeraire. Then from equation (9) we must have

From (9), \( r \) is given, so therefore \( w \) must be determined. But this means that from equation (10) \( P_N \) must be determined exogenously. That is, with perfect physical capital mobility, the relative price of non-tradeables to tradeables in the country is determined purely by the conditions of zeros profits and competitive pricing, and unaffected by aggregate demand considerations.

Note in addition that we can deduce from (9) that

\[ \hat{w} = \frac{1}{\gamma} \hat{\theta}_T \]

and, using this in (10), that

\[ \hat{p}_n = \frac{\beta}{\gamma} \hat{\theta}_T - \hat{\theta}_N \]

In words, the relative price of non-traded goods is determined solely by the differential productivity growth in the non-traded relative to the traded sector. When the productivity growth is highest in the traded goods sector, and the shares of factors are similar in each sector, then the relative price of non-tradeables must be persistently rising. Then, if this country has higher growth than its trading partners, this means that it will have a persistently appreciating real exchange rate. This is the essence of the Balassa Samuelson hypothesis.

This says that relative prices are determined only by supply factors. Demand factors, such as rising income, wealth, or government spending, don’t affect the relative price. How does this happen? It is because when there is free movement of international capital, the supply curve of non-tradeables is perfectly elastic. Demand factors such as those mentioned above can affect the output of the non-tradeable sector but not its relative price. Another way to see it is that the economy has a production possibility frontier between tradeable and non-tradeable goods which is a straight line.

The alternative model developed above, by contrast, implies that both demand and supply factors interact to determine the relative price of non-traded goods. In this model, we should expect
a rise in the scale of government spending (which mostly takes place on non-traded goods) to lead to a rise in the relative price of non-traded goods and therefore a real exchange rate appreciation.

We can close the above model by noting that consumption and output will be determined in the following way. Given that capital may be freely imported from abroad, then the only factor constraint is that of labour.

The labour market clearing constraint is

\[ \bar{L} = \beta \frac{Y_N}{\theta_N} \left( \frac{r}{w} \right)^{1-\beta} + \gamma \frac{Y_T}{\theta_T} \left( \frac{r}{w} \right)^{1-\gamma} \]

where Shepherds Lemma is used to derive the demand for labour in each sector. This gives a relationship between \( Y_N \) and \( Y_T \) that clears the labour market. It gives the PPC for the country in the presence of freely internationally mobile capital, and it is linear. Its slope in Figure 5 is \( \frac{\beta}{\gamma} \).

If the non-traded sector is relatively labour intensive, that means that \( \beta > \gamma \), and the slope of the PPC exceeds \( p \). This is what OR call the GDP line, and it has a slope in excess of \( p \) because as you reduce output of non-traded goods, at given factor prices, you must be shedding relatively more labour to capital than the combination needed in the traded goods sector. This must mean that to increase output the traded goods sector imports capital, and so output of traded goods rises by more than one for one with the fall in the value of non-traded goods (which is \( p \) per unit).

On the other hand, the consumer budget constraint may be written as

\[ C_T + pC_N = w\bar{L} + r(K + B) \]

Assume a steady state where the total financial wealth of the consumer \( Q = K + B \), is constant. This will be the case if the consumer is facing constant interest rates and has \( \beta(1 + r) = 1 \) for instance. This is what OR call the GNP line.

Then we can illustrate this consumption possibility line in Figure 5 as a line with slope \( p \).

For a given \( Q \), the economy’s long run debt pattern will depend upon what point on the GNP line that the consumer chooses to attain. If non-traded consumption is relatively low, then the economy must be a debtor, as it will be producing with imported capital.

10. The paper by De Gregorio, Giovannini and Wolf (“International Evidence on Tradeables and Non-Tradeables Inflation” European Economic Review 1994), presents an analysis of the determinants of the relative price of non-tradeable goods in 14 OECD economies for the 1970-85 period. They basically provide a test of the Balassa-Samuelson hypothesis but add on to this a test of the importance of demand side factors.

Points of the paper.
1. Difficulty of measuring the non-traded sector. They decide to call a sector tradeable if more than 10 percent of its production is exported per year. Services except for Transportation is defined as non-tradeable.
2. Inflation in non-traded goods has been consistently higher than that in traded goods for all 14 OECD economies save for Canada between 70 and 85. The correlation between inflation rates in traded goods sectors is not markedly higher than that between non-traded goods sectors however. This is especially true for the EMS economies.
3. A direct test of the Balassa-Samuelson hypothesis shows that the countries with the highest productivity growth rates in the traded goods sector relative to the non-traded goods sector had faster increases in the relative price of non-tradeable goods.

4. Demand side factors were important however. They run the following regression

\[ \log P = \beta_1 d\theta + \beta_2 g + \beta_3 y \]

where \( P \) is the relative price of non-tradeables, \( d\theta \) is the difference in total factor productivity across sectors, \( g \) is government spending relative to GDP, and \( y \) is per capita income.

They run a panel regression (time series cross country) Their estimates give

\[ \beta_1 = 0.234 \quad (0.018) \quad \beta_2 = 1.974 \quad (0.119) \quad \beta_3 = 0.281 \quad (0.030) \]

Standard errors are in parenthesis. All variables are highly significant and of the right sign. This suggests that demand factors; government spending and income per capita, are also important determinants of the relative price of non-tradeables. The coefficient \( \beta_1 \) says that a 1 percent increase in total factor productivity in the tradeable goods sector will produce a .23 percent increase in the relative price of non-tradeables.

5. We might imagine that demand factors would be important in the short run, but not in the long run. That is, in the long run capital would be mobile between sectors and countries, and the relative price of non-tradeables would be determined fundamentally by the Balassa-Samuelson supply side factors. They test this by regressing the average rates for the variables over the 1970-85 period, (i.e. the average relative price of non-traded goods in each country over the period regressed on the average total factor productivity, the average share of government spending etc.). This gives a measure of the long run importance of each factor. In this average regression only the productivity growth variable is significant. Table 8 documents the importance of the separate factors in the short run and the long run implied by the two types of regressions. It shows that all three factors are important in the short run (with income growth being the most important), but in the long run, only the growth in relative productivity is an important determinant of the relative price of non-tradeables.