Module - 17
Exchange Rate Theories: Purchasing Power Parity

Developed by: Dr. Prabina Rajib
Associate Professor (Finance & Accounts)
Vinod Gupta School of Management
IIT Kharagpur, 721 302
Email: prabina@vgsom.iitkgp.ernet.in
Lesson - 17
Exchange Rate Theories: Purchasing Power Parity

Highlight & Motivation:

Certain fundamental macroeconomic factors influence the exchange rates. Factors like inflation rate and interest rate govern how the exchange rate between countries moves with each other. When the actual exchange rate deviates from the rate governed by these fundamental relationships known as parity conditions, arbitrage happens. Hence, this module focuses on understanding these parity conditions and when deviations from these parity conditions occur.

As inflation rate in an economy significantly influences the exchange rate, what is inflation rate and calculation methodology of consumer price index (CPI) and wholesale price index (WPI) have also been discussed briefly.

Learning Objectives:

In this module, the following topics have been discussed:

- Purchasing power parity
- Absolute purchasing power parity & relative purchasing power parity
- Law of One Price (LOOP)
- Calculation of CPI (Consumer Price Index) and WPI (Wholesale Price Index) in India.
17.1. Introduction to Exchange Rate Theories:

Forecasting exchange rate is easier said than done. In the market, there are thousands of trading software known as “forex robots” (described in Session 4.3) are available which help in forecasting forex rates and promise to get rich quick!! However, until now nobody is known to have been amassed great riches by predicting forex rates and making a killing. Interestingly we know of the many traders have companies which have gone kaput on account forex trading going horribly wrong. Irrespective of this fact, all and sundry anything remotely to do with forex rates wants to learn the tools to predict forex rates. Significant research work is also being carried out to find out newer models to predict forex rates and make a killing!

A person interested on forecasting forex would get to hear simpler techniques based one age old basics like “Fibonacci series” and “time series analysis” to complex models based on neural network, artificial intelligence and genetic algorithms etc.

In fact, while browsing through the web, the author comes across an interesting write up. A researcher has claimed to develop a theory, which he is intending to sale/license, and generate revenue from the sale/license. The researcher also mentions that the theory would help users “24 hrs non-stop wealth building”!! The website content goes like this … “The brand new theory towards analyzing and forecasting the forex market and it has come after 700 years of Fibo and 150 years of Elliot waves, the two most popular indicators”. Anybody will be quite intrigued by the phrases like “700 years of Fibo and 150 years of Elliot waves” – how on the earth he got a time series data for 700 years forex quotations!!

As there is no end to the number of theories developed based on mathematical model, let us focus more on understating macroeconomic parameters like interest rate, inflation etc, those that have bearing on forex rate.

There are certain fundamental macroeconomic conditions which influence the exchange rates. One of the fundamental parity conditions is known as “Purchasing Power Parity” and the Law of One Price (LOOP). These aspects are discussed in detail.
17.2: Purchasing Power Parity and Law of One Price:

One of the basic theories on exchange rate relates the price level in a country to the exchange rate. **Purchasing power parity (PPP)** is a theory of exchange rate determination which compares the average costs of goods and services between countries. It proposes that if identical products are services are sold in two different markets at two different prices, the exchange rate would be such that the price of the product/service is still same even if product/service price may be stated in two different currencies. In other words, exchange rate between currency pairs is in equilibrium when purchasing power is same.

PPP indicates that exchange rate between two countries should equal to the ratio of similar goods and services in both countries.

For example, if one kg of Potato costs INR 18 in India and similar quality of potato costs 50 cents in USA, then the PPP exchange rate would be INR 36 per USD. This is the absolute version of theory of purchasing power of parity.

In other words, the exchange rate between two currencies can be represented as

\[
\text{Spot Rate} = \frac{\text{Price}^{INR}}{\text{Price}^{USD}} \quad \text{Eq (17.1)}
\]

The concept of purchasing power parity is quite old. It is believed to have been propounded by the sixteenth-century scholars of the University of Salamanca of Spain. Though lots of empirical research have been undertaken to test whether PP holds or not, the **Big Mac Index** calculated by the Economist is the most well known test on PPP.

The “**Big Mac index**” published by Economist tries to find out what should have been the PPP governed exchange rate. As McDonald burgers offered in many countries are standardized, PPP governed exchange rate is found out by comparing the prices of burgers between two countries and comparing the exchange calculated to the actual exchange rate. The paragraph given in **Box 17.1** succinctly explains the purchasing Power Parity.(source: [http://www.economist.com/markets/bigmac/about.cfm](http://www.economist.com/markets/bigmac/about.cfm))
For example, Price of a Big Mac is USD3.57 in the USA and price of a Big Mac is INR 99 in India. This means that the implied purchasing power parity is INR 27.73 per USD. However the actual exchange rate is INR 48 per USD. This indicates that INR is undervalued by \[ \frac{(27.73- 48)}{48} \times 100 = -42.29\% \]. It indicates that INR should appreciate in near future.

Let us take another example. Suppose a Big Mac costs about $2.99 in USA and costs €2.5 in UK. The prevailing exchange rate is GBPUSD 1.5371 (USD 1.5371 per GBP). As per the Big Mac exchange rate, the GBPUSD rate should be USD 0.8361 per GBP. As per the actual exchange rate, USD is undervalued by 45.6%. USD should appreciate by 45.6%.

**Box 17.1:**

**Burgernomics is based on the theory of purchasing-power parity**

Source: [http://www.economist.com/markets/bigmac/about.cfm](http://www.economist.com/markets/bigmac/about.cfm)

"**Burgernomics** is based on the **theory of purchasing-power parity**, the notion that a dollar should buy the same amount in all countries. Thus in the long run, the exchange rate between two countries should move towards the rate that equalizes the prices of an identical basket of goods and services in each country.

Our "basket" is a McDonald's Big Mac, which is produced in about 120 countries. The **Big Mac PPP is the exchange rate** that would **mean hamburgers cost the same in America as abroad**. Comparing actual exchange rates with PPPs indicates whether a currency is **under or overvalued.**

**Annexure 17.1** details the exchange rate between USD and many other country currency based on the burger price. If a currency is undervalued, it is expected to appreciate and if a currency is overvalued, it is expected to depreciate in future. Hence, by analyzing the Big Mac price prevailing in two countries, we can determine the exchange rate. If the actual exchange rate differs from the Big Mac rate, then either currency will appreciate or depreciate.
However, Big Mac index as a universal product which can be compared across countries has been debatable. Bag Mac is considered as daily consumable staple food in US unlike a luxury product in many countries. Hence in many countries, people do not mind paying a premium to buy a Big Mac. Hence the premium is in-built into Big Mac price itself makes foreign currency undervalued.

**Starbucks Tall Latte index** is also another index which compares the price of Starbucks Latte in different countries, exactly like the Big Max Index. But yet to enjoy the cult status like Big Mac Index.

PPP calculated by comparing price of one good across in different currencies is known as **Absolute PPP**. However the absolute law of one price never holds good when prices of one commodity is compared. (For example, price of one KG of Potato, Price of a similar brand car, price of a mobile phone etc.)

Another form of less stringent PPP stresses on comparing **price index of basket of goods in both countries rather than comparing any one good/service.**

\[
\text{Spot Rate} = \frac{\text{Price Index}^{\text{INR}}}{\text{Price Index}^{\text{USD}}} \quad \text{Eq(17.2)}
\]

It indicates that if a country is experiencing higher inflation (higher price level) compared to another country, its currency will depreciate relative to other currency.

In other words, **the spot rate between two countries can be determined by comparing the price index of a basket of similar goods and services.** It is very important to understand at this point is that price index should comprise of “similar” goods & services” consumed by residents of both countries.

On a given date, suppose a basket of goods & services costs INR 5000 and a similar basket of goods & services costs USD300, the spot exchange rate on that date should be

\[
\text{Spot Rate} = \frac{\text{INR} \times 5000}{\text{USD} \times 300} = \text{INR} \ 16.67/\text{USD}
\]

If the actual spot exchange rate equals the rate calculated by PPP, then PPP holds true. However, it is empirically proved that PPP in **absolute form based on single product or based on a price index does not hold good.**
17.3: Purchasing Power Parity and Law of One Price (LOOP):

PPP is based on the concept of “Law of One Price”. The LOOP indicates that identical good/services should sell for the same price in two separate markets when there are no transportation costs and no differential tax rates exists in the two markets. If there is a price difference, then exchange rate would move in such a manner so that, in both markets the product will sell at same price.

For example, Nokia E75 model mobile phone costs INR 26,000 in India. The same model costs Bangladeshi Taka of 35000. Suppose the exchange rate between BTKINR is INR0.642/BTK. With this exchange rate, mobile handset costs INR 22470 at Bangladesh. So why anybody would buy the handset in India? Indian people would sell INR and buy BTK and purchase the mobile in Bangladesh and sell the handset in India at a price of INR26000. For every handset sold in India, the trader makes a profit of INR3530. This profit is the arbitrage profit i.e buying low and selling high and no risk. So many people would flock to sell INR to buy BTK. Suppose exchange moves to INR0.713/BTK. The mobile handset now costs INR 24967. Still there is possibility of arbitrage opportunity. The exchange rate would keep on adjusting so that the arbitrage opportunity is completely done away with.

Suppose the exchange rate moves to INR 0.746/BTK, then buying in Bangladesh and selling in India becomes a loss making proposition. In this case, the traders would buy the handset in India and start selling Bangladesh. This process will go on till the price of the handset is same in both countries.

In this example, we have ignored, the transaction cost, the import duty, the sales tax and cost associated with conversion of INR to BTK etc. have been ignored. With inclusion of these duties/taxes and levies, the arbitrage opportunity may not exists, Also another inherent assumption in this example is that the Nokia E75 model is demanded in both India and Bangladesh.
The LOOP holds well only if three conditions are satisfied. These three are

- Transportation costs, barriers to trade (import-export levies, customs duty etc) and other transaction costs (currency conversion fee) are insignificant.
- There must be competitive markets for the goods and services in both countries.
- The LOOP applies only to tradable goods. LOOP is not applicable to immobile goods such as houses, and many services that are local.

Many tests have been conducted by researchers to test whether the PPP holds true or not.

### 17.4: Relative Purchasing Power Parity

Relative PPP postulates that the change in inflation rate governs the change in exchange rate.

\[
\frac{S_t}{S_{t-1}} = \frac{P_{for(t)}}{P_{for(t-1)}} \frac{P_{dom(t)}}{P_{dom(t-1)}} \quad (17.3)
\]

Where \(S_t\) is the spot rate of foreign currency/domestic currency and \(P(t)\) is the price level prevailing now and \(P_{(t-1)}\) price level prevailing before one period.

For example, the inflation rate in 2008 is 8.39% in India. Let us assume that Inflation rate in USA during 2008 is 4%. The right hand side of the Eq. (17.3) is \(1.04/1.0839 = 0.96\). This indicates that INR should depreciate by 4%. IF the spot exchange rate was USD0.0217/INR (INR 45 per USD) at \(S_{(t-1)}\) then \(S_t\) should be USD0.0208/INR (INR 47.91 per USD).

With two countries having different inflation rate, the relative prices of goods in the two countries, will change so that the goods and services offered in these countries are priced same.
17.5: Inflation and Measurement of Rate of Inflation:

Inflation rate measures the rate of change of increase in prices of goods and services during a given time period. Normally the prices of goods and services are measured by construction of an index. The index can be Consumer price index (CPI) or Wholesale price index (WPI).

Composition of CPI: The basket of goods and services consumed by different classes of consumers in India varies. Hence based on economic groups, 4 different CPIs are calculated. These 4 indices are CPI for Industrial Workers [CPI(IW)], CPI for Urban Non-Manual Employees [CPI(UNME)], CPI for Agricultural Labourers [CPI(AL)], and CPI for Rural Labourers [CPI(RL)].

Composition of WPI: The WPI for all-India consists of 435 commodities. The 435 items details are given in Table 17.5. Basically it consists of 98 primary articles, 19 articles on fuel, power etc, and 318 items of manufactured products. The base year for calculation of WPI is 1993-94. These three major groups have 22.025%, 14.226% and 63.749% respectively.

| Table 17.5: Composition of Wholesale Price Index in India. |

<table>
<thead>
<tr>
<th>Number of items in the index</th>
<th>Weight in the index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Articles (1+2+3)</td>
<td>98</td>
</tr>
<tr>
<td>(1) Food</td>
<td>22.025</td>
</tr>
<tr>
<td>(2) Non-food</td>
<td>17.386</td>
</tr>
<tr>
<td>(3) Minerals</td>
<td>10.081</td>
</tr>
<tr>
<td>Fuel, power, light and lubricants</td>
<td>19</td>
</tr>
<tr>
<td>Manufactured Products (4+5+6+7+8)</td>
<td>318</td>
</tr>
<tr>
<td>(4) Food Products</td>
<td>14.226</td>
</tr>
<tr>
<td>(5) Beverages, Tobacco &amp; Tobacco Products</td>
<td>10.143</td>
</tr>
<tr>
<td>(6) Textiles</td>
<td>2.149</td>
</tr>
<tr>
<td>(7) Leather &amp; Leather Products</td>
<td>11.545</td>
</tr>
<tr>
<td>(8) Others</td>
<td>32.187</td>
</tr>
</tbody>
</table>

WPI is calculated on weekly basis. The data for these 435 items are collected from both official and unofficial sources—primarily wholesale prices. Data from Directorate of
Economics and Statistics, Ministry of Agriculture etc are taken. Also data from various mandies, trade associations, and manufacturers are taken to calculate the WPI.

**Calculation of WPI:** Suppose price of rice in January 2009 is Rs. 17 per kg. The price of same rice increases to Rs.20 in January 2010. The WPI for Rice in 2010 would be 18% given by \(\frac{(20 - 17)}{17} \times 100 = 18\%\).

Hence WPI for Rice for January 2010 would be 118. Similarly the WPI for all 435 items are calculated. Individual WPI are multiplied with the respective weights given in Table 17.5 to get the WPI for the period ending 2010. This amount is compared with WPI figure in January 2009 to get the inflation rate. For example, if WPI in January 2009 is 112.25 and it is 120.35 in January 2010, the inflation rate would be \(\frac{(120.35 - 112.25)}{112.25} \times 100 = 7.22\%\).

The same process can go on for next week or next month. Suppose by end of February 2010, WPI is 118.75 compared to 120.35 in January 2010. This means Inflation has gone down by 1.33% compared to January 2010.

Government of India changes the composition of all indices from time to time. The change in composition of index is done so as to reflect the changing profile of the consumption pattern of people. Suring September 2010, government of India included items like ice-cream, mineral water, computers, gold, construction machinery and TV sets etc to the WPI.

Besides changing the composition of commodities to be part of the index, government also changes the base year. The WPI composition given in Table 17.5 has the base year of 1994-95. The previous base year was 1981-82.

The changing composition of the WPI index and base year throws some interesting lights on the consumption pattern of a country. As the country develops, people tend to consume more fuel & power, and more manufactured products compared to primary articles. This trend can be observed from the details given in Table 17.6.
**Table 17.6: Comparison of Weights of major commodities group in WPI**

<table>
<thead>
<tr>
<th></th>
<th>Base year 1981-82</th>
<th>Base Year 1994-95</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Article</td>
<td>32.30</td>
<td>22.03</td>
</tr>
<tr>
<td>Fuel, power, light and lubricants</td>
<td>10.66</td>
<td>14.03</td>
</tr>
<tr>
<td>Manufactured Products</td>
<td>57.04</td>
<td>63.75</td>
</tr>
</tbody>
</table>

**Box 17.2: Measurement of Inflation**

*Source: [http://www.epwrf.res.in/upload/MER/mer10703009.pdf](http://www.epwrf.res.in/upload/MER/mer10703009.pdf)*

Inflation rate in India is measured by the **wholesale price index (WPI)**. Currently, WPI (Base year 1993-94 =100) is a combined index of 435 articles/items, comprising 98 ‘primary articles’, 19 items of ‘fuel, power, light and lubricants’ variety and 318 ‘manufactured products’. This index is the most commonly quoted measure of inflation in India mainly because of its availability on a weekly basis and also the absence of a representative retail price index at such regular high frequency.

In India, 4 **consumer price indices** viz., consumer price index for **industrial workers** (CPI-IW), consumer price index for **urban non-manual employees** (CPI-UNME), consumer price index for **agricultural labourers** (CPI-AL) and consumer price index **for rural labourers** (CPI-RL) are compiled officially with reference to four different population groups.

**Figure 17.1** shows the inflation rate (year-on-year) and % change of inflation rate from 1980 to 2009.
Figure 17.1: Inflation (Measured by Consumer Price Index)

Data source for Figure 17.1: International Monetary Fund 2009 World Economic Outlook (Index 2000=100).
Short Questions:

1) Absolute purchasing power parity holds best
   a) when prices are sticky.
   b) in the long run.
   c) when there is no risk premium.
   d) in the absence of capital controls.
   e) All of the above.

2) A Big Mac hamburger in UK costs £1.99 and sells at $2.71 in USA. The actual spot exchange rate is £0.63 per USD. According to ___________ the British pound is________ the US dollar.
   a) purchasing-power parity; undervalued
   b) interest-rate parity; undervalued
   c) purchasing-power parity; overvalued
   d) interest-rate parity; overvalued

3) Relative Purchasing Power Parity is relevant because:
   a) Researchers have found that absolute PPP does not hold true.
   b) Relative PPP compares the price of a bundle of goods and service across countries.
   c) Relative PPP uses CPI while it Absolute PPI uses WPI
   d) None of these.

Short Questions:

1) Why there are 4 CPIs while only one WPI ?
2) Why testing the relative purchasing power parity is a better way of testing the LOOP over the absolute purchasing power parity ?
3) Is it necessary to have a base year for calculation of WPI or CPI? Why or why not?
Reference:

1. The “Big Mac index” Index, [http://www.economist.com/markets/bigmac/about.cfm](http://www.economist.com/markets/bigmac/about.cfm)
3. Burgernomics is based on the theory of purchasing-power parity, Source: [http://www.economist.com/markets/bigmac/about.cfm](http://www.economist.com/markets/bigmac/about.cfm)
7. RBI to revise NEER/REER Indices, Source: [http://www.securities.ru/Public/Public98/RBI/PR/0511040-6@67070.pdf](http://www.securities.ru/Public/Public98/RBI/PR/0511040-6@67070.pdf)
ANNEXURE 17.1

Big Mac Index & Purchasing Power Parity

How much burger do you get for your euro, yuan or Swiss franc?

(Source: Http://www.economist.com)

ITALIANS like their coffee strong and their currencies weak. That, at least, is the conclusion one can draw from their latest round of grumbles about Europe's single currency. But are the Italians right to moan? Is the euro overvalued?

Our annual Big Mac index (see table1) suggests they have a case: the euro is overvalued by 17% against the dollar. How come? The euro is worth about $1.22 on the foreign-exchange markets. A Big Mac costs €2.92, on average, in the euro zone and $3.06 in the United States. The rate needed to equalise the burger's price in the two regions is just $1.05. To patrons of McDonald's, at least, the single currency is overpriced.

The Big Mac index, which we have compiled since 1986, is based on the notion that a currency's price should reflect its purchasing power. According to the late, great economist Rudiger Dornbusch, this idea can be traced back to the Salamanca school in 16th-century Spain. Since then, he wrote, the doctrine of purchasing-power parity (PPP) has been variously seen as a “truism, an empirical regularity or a grossly misleading simplification.”

Economists lost some faith in PPP as a guide to exchange rates in the 1970s, after the world's currencies abandoned their anchors to the dollar. By the end of the decade, exchange rates seemed to be drifting without chart or compass. Later studies showed that a currency's purchasing power does assert itself over the long run. But it might take three to five years for a misaligned exchange rate to move even halfway back into line.

Our index shows that burger prices can certainly fall out of line with each other. If he could keep the burgers fresh, an ingenious arbitrageur could buy Big Macs for the equivalent of $1.27 in China, whose yuan is the most undervalued currency in our table, and sell them for $5.05 in Switzerland, whose franc is the most overvalued currency. The impracticality of such a trade highlights some of the flaws in the PPP idea. Trade barriers, transport costs and differences in taxes drive a wedge between prices in different countries.

More important, the $5.05 charged for a Swiss Big Mac helps to pay for the retail space in which it is served, and for the labour that serves it. Neither of these two crucial ingredients can be easily traded across borders. David Parsley, of Vanderbilt University, and Shang-Jin Wei, of the International Monetary Fund, estimate that non-traded inputs, such as labour, rent and electricity, account for between 55% and 64% of the price of a Big Mac*.

*
The two economists disassemble the Big Mac into its separate ingredients. They find that the parts of the burger that are traded internationally converge towards purchasing-power parity quite quickly. Any disparity in onion prices will be halved in less than nine months, for example. But the non-traded bits converge much more slowly: a wage gap between countries has a “half-life” of almost 29 months.

Seen in this light, our index provides little comfort to Italian critics of the single currency. If the euro buys less burger than it should, perhaps inflexible wages, not a strong currency, are to blame.

Source: The Economist

1 The Big-Mac Table is a copyrighted material. Hence, this is not given here. The readers are requested to visit the Economist Website/tread any standard text book on International finance to get a first hand feel of Big-Mac Index.