Abstract
In today’s competitive world the structure and the direction of external trade are determined by the exchange rate conducts. In other words nominal exchange rate affects competitive power in external trade. Policy makers can use PPP theory as a guide for the external competitive power of a country. Furthermore numerous empirical workings have been presented that misalignment exchange rate causes currency crises and macroeconomic disequilibrium. PPP provides an indicator for the misalignment.

The purpose of this paper is to test Purchasing Power Parity between India and US using inflation differential and nominal exchange rate data from 1999 to 2011 on the basis of OLS model. The results indicate that PPP does not hold.

Keywords: Purchasing power parity, exchange rate, inflation

Introduction
The post-liberalization period has been characterized by a significant change in international trade and investment and financial markets in India. The major economies throughout the world have removed their controls on the movement of capital. The technical innovation has at the same time made it possible to transfer capital throughout the world at the speed of light. As a result the capital has become more mobile. A more mobile capital will undoubtedly affect the value of different currencies and interest rates.

When the financial markets became more internationalized it led to an increase in the amount of capital trying to take advantage of currency swings. The Bretton Woods system with fixed and pegged exchange rates proved to be insufficient to cope with currency speculation. The international capital flows had made it an unstable monetary system. In 1976 were a new international system agreed on in Jamaica. Currencies were this time allowed to float and the references to the price of gold were abandoned (Solnik 2000, 5-6).

The current international monetary system can be described as a hybrid system, where the basic market mechanisms for establishing exchange rates include the free float, managed float, target-zone arrangement and fixed-rate system. This system has led to rapidly fluctuating exchange rates, creating both problems and opportunities for actors dealing with foreign currencies (Shapiro 1998, 55-56). To protect oneself against these rapid currency changes new instruments were developed on the world capital markets in the 1970s and 1980s, such as options, swaps, futures and warrants.

The trend toward greater exchange rate flexibility is a consequence of rising international capital mobility. The rise of the international capital mobility has made it difficult for many governments to defend their fixed or pegged exchange rates or even pursue independent macroeconomic policies. Defending an exchange rate could turn out to be very costly and even pointless when speculators attack a currency. Governments trying to defend their currencies have been forced to maintain high interest rates to prevent capital outflows. High interest rates that actually hinder the economic growth and further hurting the economy.

Theories aiming to explain and understand the interaction of international monetary variables will become increasingly more important if the deregulation and international integration of financial markets throughout the world continues. One theory linking exchange and inflation rates is the Purchasing power parity. It states that the future spot rate of exchange can be determined from the nominal interest differential. The real interest rates will in turn be equalized across the world through arbitrage. This means that the difference in the observed nominal rates will be stemming from differences in expected inflation rates. The differences in anticipated inflation that are imbedded in the nominal interest rates are expected to affect the future spot rate of exchange. The effect on the exchange rate is also more likely to occur under flexible exchange rate arrangements, where the currencies exchange rates are allowed to fluctuate without the intervention of governments.

Purchasing Power Parity
Purchasing power parity can be divided in to two versions: absolute PPP and relative PPP. The absolute version states that the real price of a good must be the same in all countries. That is, all goods obey the law of one price. The relative PPP is the most commonly used version of PPP. The relative version of PPP states that the exchange rate between any two countries will adjust to reflect changes in the price levels of the same two countries (Solnik 2000, 36-37). For example, if inflation is 5% in India and 1% in the US, the INR value of the USD must fall by about 4% to equalize the INR price of goods in the two countries. The purchasing parity relation can be written as follows:

\[ \frac{St+1}{St} = \frac{R}{1 + \pi_r} \]

History of PPP

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Purchasing power parity has its ebbs and flows over the year. Interest in the doctrine arose whenever existing exchange rates were considered unrealistic and the search began for the elusive concept of equilibrium rates. It was first invoked although in somewhat ambiguous terms in the period of Nepoleonic wars, it received its naming at the hands of Gustav Cassel during world war I and it was resurrected after world war II. It also had its critics, among others Taussing after world war I and Haberler after world war II, but it has managed to survive nevertheless.

Purchasing power parity means different things to different people. As mentioned earlier we are having two versions of purchasing power parity i.e. absolute and relative versions of Purchasing power doctrine.

**Rationale behind PPP**

Purchasing power parity measurements consider the amount of goods and services a person can buy in a country when calculating how much a currency is worth. An individual may earn less money in one country, and have the opportunity to purchase a larger house or more food, because other prices are also cheaper in that country. Purchasing power parity allows an individual to calculate the standard of living available in different countries.

**Effective Exchange Rate**

Purchasing power parity allows an individual to determine the effective exchange rate for foreign currency. If a euro is worth 1.5 dollars, but the price of an item in euros is the same in Germany as it is in dollars in America, the official exchange rate is still 1.5 dollars per euro. The effective exchange rate is $1 per euro, since a person who earns 40,000 euros in Germany can buy the same number of consumer goods as a person who earns $40,000 in America.

**Foreign Military Analysis**

Purchasing power parity also allows analysts to determine the strength of a foreign military. The U.S. has a large military budget, and it also has a stronger currency than other nations. Another country, such as China, may spend less money to hire an individual soldier or purchase an additional tank or airplane. One country may be able to create a stronger military force while having a smaller military budget, because military expenses are lower in that country.

**Local Spending**

Purchasing power parity calculations assume that all income in a currency is spent in the country where the currency is used. The parity calculation assumes that an Indian who receives income in rupees will purchase all necessary items using rupees. Many nations rely on foreign imports to satisfy some consumer needs, requiring an importer to exchange currency for a foreign currency to make the purchase.

**Comparative Wealth**

It is possible for a country to be more wealthy than a neighbor according to per capita income measurements and still have a lower standard of living when using purchasing power parity to calculate income. If a dollar is worth one Swiss franc, but Swiss grocery store prices in Swiss francs are higher than American grocery store prices quoted in U.S. dollars, a Swiss worker can earn more money than an American worker and still have a lower standard of living.

**Employee Cost**

Purchasing power parity affects both education and training costs. An employer can hire a worker in a foreign country and pay a much lower wage, while providing the worker with a comparable standard of living as a worker in the employer’s home country. Additional costs, such as university education for a worker, are also lower because of purchasing power parity.

**Derivation of Purchasing Power Parity**

Purchasing power of a currency is determined by the amount of goods and services that can be purchased with one unit of that currency. If there is more than one currency, it is fair and equitable that the exchange rate between these currencies provides the same purchasing power for each currency. This is referred to as Purchasing power parity. It is ideal if the existing exchange rate is in tune with this cardinal principle of purchasing power parity. On the contrary, if the existing exchange rate is such that purchasing power parity does not exist in economic terms it is a situation of disequilibrium. It is expected that the exchange rate between the two currencies conforms eventually to purchasing power parity. So, according to PPP the exchange rate between the two currencies should be equal to the ratio of these countries’ price level.

For example, for US and India, the price index of a basket of products in US is $P_0$ and the price index of identical basket of products in India is $P_s$ then:

\[
\frac{P_0}{P_s} = S_0
\]

**Equation (i)**

Here $S_0$ is the spot exchange rate at time $t$.

Likewise, according to the version of relative PPP theory there is a link between expected exchange rate$[S_{t+1}]$ and expected inflation rates ($\pi$) in two countries. Since the future price of a commodity is affected by the expected inflation rate, the price levels in India and US are affected by the expected inflation rates. When $P_0$ is the current price level, and $\pi$ is the expected inflation rate, the price levels after a year will be

\[
P_t = P_0(1 + \pi)
\]

In India: $P_{t+1} = P_0(1 + \pi_t)$

In US: $P_{t+1} = P_0(1 + \pi_s)$

The ratio of prices one year later is:

\[
\frac{P_{t+1}}{P_t} = \frac{P_{t+1}}{P_0(1 + \pi)}
\]

This can be written as $S_{t+1} \frac{P_{t+1}}{P_t} = \frac{S_{t+1}}{S_t}$ as $S_{t+1} \frac{P_{t+1}}{P_t}$ is the current spot rate, $S_t$. Thus the expected exchange rate one year later, $S_{t+1}$, is a ratio of the prices one year later.

\[
S_{t+1} = \frac{S_t P_{t+1}}{P_t}
\]

**Equation (ii)**

The above equation can be rearranged as:

\[
\frac{S_{t+1}}{S_t} = \frac{P_{t+1}}{P_t}
\]

The left hand side can be written as $1 + \{S_{t+1} - S_t\}$, where $[S_{t+1} - S_t]$ is nothing but the rate of change in the spot rate. Denoting $[S_{t+1} - S_t]$ by ‘$e$’:

\[
(1 + e) = \frac{P_{t+1}}{P_t}
\]

On simplification $e = (\pi_t - \pi_s) + (1 + \pi_s)$

The denominator on the right hand side $(1 + \pi_s)$ can be ignored for small values of $\pi_s$. Then...
Equation (iii)  
This equation states that ‘e’ is approximately equal to $(\pi_2 - \pi_3)$. Since ‘e’ is nothing but $[S_{t+1} - S_t]$+, the relative version of PPP theory states that the rate of change in the spot rate is approximately equal to the inflation differential in two countries. When this condition holds true, the market is in equilibrium.

Review of Literature
There is evidence that the famous Big Mac index of currencies put forward by the Economist each year holds up well in the long run but not in short run (Daniels & Radebaugh 1998,424). Also Webster (1987) rejected PPP in the short run. Galliott (1971) presents evidence stating the validity of the PPP in the long run. He examined the relationships between the inflation rates in the USA relatively to some of its trading partners and the relatively changes in the exchange rates between the same nations.Galliott came to the conclusion that the price changes are the major determinants of the exchange rate in the long run. Shapiro (1998) presents another evidence of a long run PPP, where he compares the relative inflation rates for 22 countries with the relative change in the exchange rate. He finds that those countries with the highest inflation rates also had the largest depreciation in their currencies. Other studies came to the conclusion that the PPP holds up well for some time periods but does not hold for others (Krugman & Obstfeld 1997, 411). Kasman et al. (2010) tested PPP for potential EMU accession countries. The results reveal that, in these countries, deviations from the parity can be caused by sudden changes in exchange rates, high inflationary pressures, or monetary shocks; do not persist over time; and allow PPP hold in the long run.

Regression Model:
In an efficient market all informations are immediately reflected in the exchange rates. Rational market participants should base their forecasts on all available information. The expected future spot rate at time t+1 given an information set $\Phi_t$, at time t, can be denoted

$$E(S_{t+1}, \Phi_t)$$

Equation (i)

From this follows that the expected future spot rate at time t+1 based on all available information at time t should on average be equal to the future spot rate:

$$S_{t+1} = E(S_{t+1}, \Phi_t)$$

Equation (ii)

We also add an error term, $\mu_{t+1}$, to equation ii. The error term is defined as the difference between the realized future spot rate and the expected future spot rate. If the market participants are rational the error term be uncorrelated with the information available at time t should be reflected in the expectations and deviations from the expected value should only be caused by unpredictable news (solnik 2000,156). If expectations are rational and unbiased, then:

$$S_{t+1} = E(S_{t+1}, \Phi_t) + \mu_{t+1}$$

Equation (iii)

Linking this reasoning to the discussion of Purchasing power parity described in Introduction, one should expect the exchange rate change in relation to inflation differentials. If we add an error term presented earlier in equation iii we get:

$$[S_{t+1} - S_t] + \mu_{t+1} = (\pi_2 - \pi_3)$$

Equation (iv)

That is, the percentage in the expected spot rate of exchange should equal the percentage inflation differential. Thus, the regression model takes the following form:

$$[S_{t+1} - S_t] + \alpha(\pi_2 - \pi_3) + \beta + \mu_{t+1}$$

Equation (v)

Hypothesis
Null hypothesis: $\alpha = 0, \beta = 1$

The t-test will be applied to $\alpha$ and $\beta$, whose hypothesized values are 0 and 1 respectively. The regressions use Ordinary Least Squares estimates of $\alpha$ and $\beta$. Interpreted literally, $\alpha$ shows the value of the exchange rate change when the inflation differential is 0, that is when the inflation differential is 0 the exchange rate should not change and hence, also equal 0. When $\beta$ equals 1 it means that a 1 percent increase in the inflation differential will lead to a 1 percent offsetting change in the exchange rate. That is, if the inflation differential is one percent higher in the India than in the United states, the INR will depreciate by one percent relatively to the USD.

The Data
The data consists of monthly inflation rates for United states and India and currency exchange rate between USD and INR between January, 1999- February, 2012. The exchange rates are taken from Reserve Bank of India website, which is a direct quote. The collected data material has then been revised by calculating the percentage inflation differential and the percentage exchange rate change for different months. The inflation differential has been computed by taking the India’s inflation rate minus US’s inflation rate. The exchange rate change contains the exchange rate change from one month to another where the exchange rate is expressed as home currency per unit of foreign currency. It has been computed by taking the exchange rate at time t+1 minus the exchange rate at time t, divided by the exchange rate at time t. These calculations are continued until we get 157 observations.

Regression results & Analysis
The regression from US-India gave the following results
R-squared = 0.00142
Constant $\alpha = 0.1262$
Variable $\beta = -0.01463$
The acceptance region at 5% level of significance for $\alpha$ is 0.4572 > $\alpha$ > -0.2048
The acceptance region at 5% significant level for $\beta$ is 0.05008 > $\beta$ > -0.07928
R-squared tell us how much of the variation in the dependent variable the explanatory variable can explain. The R-squared for India-US turned out to be very very low .14% of the changes in India US exchange rate can be explained by Inflation differentials.

The null hypothesis $\alpha = 0, \beta = 1$ will be rejected if the hypothetical values of $\alpha$ and $\beta$ lie outside their respective acceptance regions. However, both $\alpha$ and $\beta$ lie within their
acceptance regions at 5% significance and $H_0$ cannot be rejected. This means that we can be 95% confident that the true values of $\alpha$ and $\beta$ lie somewhere inside their respective acceptance regions. The result also illustrates that a 1% increase in the inflation differential on average, lead to approximately 1.46% offsetting change in the INR/USD exchange rate. The $\alpha$ value, in turn, says that if the inflation rates in the US and India are the same, the change in the exchange rate would on average equal 12.62%. This is practically the same as a none-change.

**Conclusion:** The purpose of this paper was to describe the purchasing power parity and test its empirical validity in the long run. Employing regression analysis to inflation differentials and changes in exchange rate made this possible. The R-square turned out very low for the country pair i.e. US and India. So, Inflation differential should not be used to predict changes in future spot rate on a monthly basis. The Low R$^2$ is also indicating the model’s overall performance is low. The hypothetical values of $\alpha$ and $\beta$ lies in the acceptance regions at 5% significance. Therefore, the null hypothesis cannot be rejected. This means that we can say with 95% certainty that the true values of $\alpha$ and $\beta$ lie somewhere in their respective acceptance regions. Though, must be careful in our conclusions due to the low R$^2$, which indicates that the model’s overall performance is low. Therefore, no stable, predictable relationship between changes in the nominal interest differential and exchange rate changes can be assumed.

**References**


