ECONOMETRIC TESTING OF PURCHASING POWER PARITY IN LESS DEVELOPED COUNTRIES: FIXED AND FLEXIBLE EXCHANGE RATE REGIME EXPERIENCES

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ABSTRACT

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The aim of this thesis is to investigate the purchasing power parity (PPP) hypothesis for sixteen developing countries during their fixed and flexible exchange rate experiences over the period 1957:01–1999:12. The main contribution of this thesis to the empirical literature on PPP is that our study is the first one considering PPP hypothesis on alternative exchange rate regimes for LDCs from all over the world. The bilateral exchange rates of 16 less developed countries (LDC) and the US, and their respective price levels are considered. Consumer Price Index (CPI) is used as to represent the price level. Three different methodologies have been employed to test PPP hypothesis. These are unit root tests (Dickey and Fuller (1979), DF; Augmented Dickey Fuller (1981), ADF; Phillips and Perron (1988), PP), Engle-Granger (1987) cointegration technique and Johansen multivariate VAR methodology (1988). As a consequently, we can not conclude from our study that PPP hypothesis work well under fixed or flexible regime periods, because we could find just a little and nearly equal number of evidences under these alternative regimes.

Key Words: Purchasing Power Parity, Less developed countries, fixed and flexible exchange rate regimes, unit root and cointegration techniques.

ÖZET

SATIN ALMA GÜCÜ PARİTESİNİN GELİŞMEKTE OLAN ÜLKELERDE EKONOMETRİK OLARAK İNCELENMESİ: SABİT VE DEĞİŞKEN DÖVİZ KURU REJİMİ DENEYİMLERİ

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Bu tezde satın alma gücü paritesi (SGP) on altı gelişmekte olan ülke için test edilmiştir.1957:01-1999:12 periyodu incelenmiş ve sabit ve değişken döviz kuru rejim uygulamaları dönemleri ayrı ayrı kontrol edilmiştir. Bu çalışmanın şimdiye kadar yapılanlarla farkı ilk kez gelişmekte olan ülkeler için SGP'nın farklı döviz kuru rejimlerinin altında kontrol edilmesidir.Tüketici fiyat endeksi ve bu on altı ülkenin Amerikan Dolarına karşı değerini gösteren bilateral döviz kurları SGP yi test ederken kullanılmıştır. Üç ayrı teknik uygulanmıştır. Bunlar birim kök testleri (Dickey ve Fuller (1979), DF; Augmented Dickey Fuller (1981), ADF; Phillips ve Perron (1988), PP), Engle-Granger (1987) ve Johansen (1988) koentegrasyon teknikleridir. Bu testlerin sonuçları bize sabit veya değişken kur uygulamalarının SGP' nin geçerliği üzerinde etkisi olmadığını göstermiştir.

Anathar Sözcükler: Satın alma Gücü Paritesi (SGP), gelişmekte olan ülkeler, sabit ve değişken döviz kuru rejimleri, birim kök testleri, koentegrasyon teknikleri.

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I dedicate this thesis to my family; they were always there when I need. Thanks for your support, encouragements and thanks for your endless love… You are the perfect family everyone wants to have… I love you my DEAREST MOTHER, FATHER AND BROTHERS DERVİŞ AND MEHMED…

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SECTION 1: INTRODUCTION

The purchasing power parity (PPP) is an important theoretical concept in international economics and the basic building block in other models of exchange rate determination. The PPP theory establishes a long run relationship between the nominal exchange rate and the ratio of the domestic to foreign price levels.[1] There are many versions of PPP, however, absolute PPP and relative PPP are most commonly considered versions. The absolute PPP implies that the nominal exchange rate should be equal to the ratio of domestic to foreign price levels. However, in the relative version of PPP the nominal exchange rate can differ from the price ratio by a multiplicative constant.

The PPP theory is an important concept because of two main reasons. First of all, flexible price monetary theory of exchange rate determination assume that PPP holds, so PPP forms the base of exchange rate determination. Secondly, it is the one of the simplest theory that measures the long run equilibrium exchange rate. Hence, these reasons make the testing of long run validity of PPP crucial. Early studies of PPP using the data of the early years of post-Bretton Woods system do not find support for this theory such as Frenkel (1981), Adler and Lehman (1983), Meese and Rogoff (1983). The lack of proper econometric methods limited the analysis of the PPP. Fortunately, with the development of cointegration technique by Engle and Granger (1987), the PPP literature has been growing steadily (e.g. Baillie and

[1] PPP is discredited as a tool to estimate the behavior of the nominal exchange rate both in the short and medium run. Empirical evidence (Frenkel, 1981; Krugman, 1988) rejects PPP in the short run. However, as a long run equilibrium relationship PPP is a meaningful measure, so this has been the objective of the most recent studies.

Selover, 1987; Corbae and Ouliaris, 1988; Enders, 1988; Taylor, 1988, 1990; Ahking, 1990; Kim, 1990; McNown and Wallace, 1990; Patel, 1990; Flynn and Boucher, 1993; Sarantis and Stewart, 1993). This has led to a greater acceptance of PPP as a long run relationship. Johansen at 1988 developed more sophisticated technique of cointegration, which is called Johansen multivariate VAR technique. Johansen and Juselius (1992) support the PPP theory for the United Kingdom, when interest rate parity is included into the system.

If the PPP holds then inter-country commodity arbitrage works as an error correction mechanism, because of that, deviations from the linear combination of the nominal exchange rate and the domestic-foreign price levels should be stationary i.e. the real exchange rate should be a stationary process. Huge number of studies of PPP as a long run theorem have inspected the stochastic behavior of the real exchange rate by implementing unit root tests (Dickey and Fuller (1979), (DF); Augmented Dickey Fuller (1981), (ADF); Phillips and Perron (1988), (PP)) or by applying cointegration tests to a linear combination of the nominal exchange rate and the domestic-foreign price level differentials.

While the countries have changed their exchange rate regimes from fixed rate system to more flexible ones, the nominal exchange rates have exhibited greater volatility. Therefore to understand the pattern of exchange rate movements during the flexible

exchange rate period has become the fundamental object for the financial decision-making (see, Gibson *et al.* 1996). The developed countries have directly adopted the flexible exchange rate system after the collapse of Bretton Woods system in 1973, where all countries were required to sustain some type of currency peg. Therefore, there is an enormous literature on the validity of the PPP theory in industrialized countries. However, the developing countries have maintained the fixed exchange rate regime after the collapse of Bretton Woods system, this situation made the less meaningful to compute the PPP based equilibrium exchange rate. Nonetheless, starting from the late 1970s less developed countries (LDCs) exchange rate regimes have shifted steadily from fixed toward the more flexible regimes because of the movements towards a market oriented approach in their economic policies. This situation can be easily observed from Table 2; there is a gradual decline in the percentage of LDCs whose exchange rate regime are fixed, on the contrary there is a steady increase in the percentage of LDCs having more flexible regimes over the period 1976 to 1996.[2] Hence, the literature on PPP in LDCs has begun to grow in the late 1980s (see, Conejo and Shields (1993), Edwards and Savastano (1999)).

[insert Table 2]

In this study our aim is to test PPP for a group of LDCs and compare the results during fixed and flexible exchange rate periods. There was no priori study employing PPP for alternative regime periods in LDCs Hence, our main contribution to literature on PPP is to fill this gap in LDCs case.

[2] See Table 1 for the IMF's classifications of exchange rate regimes.

Sixteen LDCs are examined from different regions of the world (East Asia and Pacific Region; Latin America and Caribbean Region; Sub-Saharan Africa Region; Central Asia Region; and lastly from South Asia Region). As a proxy for the world economy, the US economy variables are taken into account. The bilateral exchange rates of 16 LDCs and the US, and their respective price levels are considered. Consumer Price Index (CPI) is used as to represent the price level. The absolute version of PPP is tested by employing three alternative methodologies for both fixed and flexible exchange rate regime periods. Firstly, unit root tests are applied to the real exchange rate.[3] Then, Engle-Granger (1987) cointegration approach and Johansen (1988) multivariate cointegration approach are implemented. Symmetry and proportionality conditions are directly imposed to unit root test; however, these conditions are checked out under the cointegration framework.[4]

This thesis is organized as follows: Section 2 explains the PPP theory. Section 3 presents the literature on PPP; how the PPP theory is become popular as an empirical tool, the brief empirical discussion of the literature on the developed countries and the detailed consideration of LDCs cases are pointed out. In Section 4, data set is introduced and how the separation of the fixed and flexible exchange rate regime periods made is explained. Section 5 explains the econometric theory of the unit root tests (DF (1979); ADF (1981); PP (1988) tests), Engle-Granger (1987) cointegration technique and Johansen (1988) multivariate cointegration technique. The results of

[3] In fact all DF, ADF and PP tests are applied to the whole sample's real exchange rates but except this case for the periods of fixed and flexible exchange rate regimes just the ADF test is applied.
[4] As stated in Kai Li's (1999) article 'There are two propositions (symmetry and proportionality) derived from the absolute PPP proposition: (1) Symmetry between the domestic and foreign countries implies that the coefficients of the logarithms of domestic price level and foreign price level should have the same magnitude. (2) Proportionality between the logarithm of exchange rate and prices implies that the values of these two coefficients should be (1, -1) respectively."

the empirical tests applied to PPP theory are presented in Section 6. As a consequently, in Section 7 the conclusions of the empirical results are discussed. The tables are presented in Appendix.

SECTION 2: THEORETICAL FRAMEWORK

(PURCHASING POWER PARITY)

The PPP theory concerns the equilibrium relationship between the exchange rate and prices of two countries. It focuses on the role of prices of goods and services to determine the exchange rate movements. There are two version of PPP theory: absolute (strong) PPP and relative (weak) PPP.

The absolute PPP is based on the law of one price (LOP). The law of one price states that identical commodities or goods should have the same price in all markets. If we formulate the LOP for any good i:

$$P_i = E.P^*_i \quad (1)$$

where P_i, P^*_i are the commodity i' s price level in domestic currency and foreign currency respectively, and E is the nominal exchange rate defined as the domestic currency price of a unit of foreign currency.

The LOP holds under strict assumptions. First of all, the financial markets should be perfect. There should not be barriers like quotas, tariffs to international trade. The goods markets also should be perfectly competitive, the goods have to be homogenous otherwise there can be price differences because of the quality differences of commodities. Furthermore, the prices of goods have to be known by the individual agents of the countries, i.e. there must be perfect information in

markets. Moreover, the international delivery of commodities should be take place freely, instantaneously and costless i.e. there should not be any transportation costs. In the case that the LOP does not hold than arbitrage occurs. Arbitrage is that when the prices of the identical goods are not the same at different countries markets, than the arbitrageurs (profit seeking entrepreneurs) import from the market having lower prices and sell at the expensive market. Because of increasing supply, the prices will decrease in the expensive market while rising in cheaper market because of increased demand. This process will go on until the prices of the commodity are equalized in both markets.

The LOP refers to one good only. However, if the general price level indices of any two countries are constituted by taking the same basket of goods and giving the equal weight to each goods, then we can derive the following relationship:

$$P = E.P^{*} \quad (2)$$

where P, P^{*} are the general price indices respectively in domestic and foreign countries. E is the nominal exchange rate (the domestic currency price of a unit of foreign currency). Then, we can derive the absolute PPP based on LOP as follows:

$$E = P / P^{*} \quad (3)$$

As a consequence, the absolute PPP states that the nominal exchange rate between two currencies is equal to the ratio of the general price levels between two countries. Also it can be interpreted as, the general level of prices will be the same in each country, when it is converted to a common currency i.e. P/SP* =1 whatever the real and monetary disturbances in the economy.

There are many reasons that may cause the divergences from the parity condition. One of the main problem is that, there is no such a special general price index in countries which compose of internationally standardized basket of goods and have the equal weights for the each commodities. Furthermore, the equilibrium price of any given good may not be the same in different locations because of imperfections of competition, productivity differentials in the production of traded goods, transport costs and the other trade obstacles in international trade such as quotas, tariffs.

The less restrictive version of the theory is the relative PPP. The relative PPP points out that the exchange rate should tolerate a constant proportionate relationship to the ratio of national price levels.

$$E = k.P / P^* \quad (4)$$

where k is a constant proxy for the trade obstacles such as transportation cots, tariffs etc. The relative PPP states that in comparison to a period when exchange rates were in equilibrium, changes in the ratio of domestic to foreign general price levels imply the appropriate compensation in the exchange rate. The relative PPP can also be represented as follows with the condition of constancy of k:

$$dE/E = dP/P - dP^*/P^* \quad (5)$$

From equation 5 we can say that the relative PPP implies that the rate of change of the nominal exchange rate is equal to the domestic rate of inflation minus the foreign rate of inflation.

The theory of PPP asserts that the real exchange rate (RER) should be stationary. To demonstrate this claim let us consider the equation (3), the absolute version of PPP. If we consider the all series in their logarithm forms then equation (3) become:

$$e = p - p^* \quad (6)$$

where p, p* and e represent the natural logarithm of P, P* and E series respectively. Since the real exchange rate is a price adjusted nominal exchange rate we can formulate the logarithm of RER in algebraic form by:

$$r = e - (p - p^*) \quad (7)$$

Considering the definition of RER, we can state that if the absolute PPP holds then the real exchange rate series should be stationary.

Now let us think about the relative version of PPP. If we consider the logarithm of the equation 4 the following representation is achieved:

$$e = k + p - p^* \quad (8)$$

$$r = e - (p - p^*) + k \quad (9)$$

The relative version of PPP the nominal exchange rate can differ from the price ratio by a constant term 'k', however the RER still should be stationary. (See, Rivera-Batiz *et al.* 1985; Conejo and Shields, 1993; Gibson *et al* 1996; Filho, 1999)

Hence, empirically the PPP theorem can be tested by examining the stochastic behavior of the real exchange rate by implementing unit root tests or by performing cointegration tests to a linear combination of the nominal exchange rate and the domestic-foreign price level differentials. If the PPP holds then inter-country commodity arbitrage acts as an error correction mechanism, therefore, divergence

from the linear combination of the nominal exchange rate and the domestic-foreign price levels should be stationary, that is, the real exchange rate should be stationary.

In this section, we have emphasized and explained the PPP theorem in detailed by considering absolute and relative versions. In next section, we will emphasize on the empirical literature of PPP theory for both developed and LDCs.

SECTION 3: LITERATURE SURVEY

Empirical literature on PPP is explained in this section. How the PPP theory has become popular as an empirical tool, the brief empirical discussion of the literature on the developed countries and the detailed consideration of LDCs cases are pointed out.

3.1 Popularization of PPP as an Empirical Tool

PPP is one of the oldest model of exchange rate determination. It is originated in 1802 by Francis Horner. Although it was popular during eighteenth and nineteenth centuries as a theory, it gains its popularity as an empirical tool with the Swedish economist Gustav Cassel (1918), who was the first one used the term *"purchasing power parity"* for the parity of the general price levels of two countries and firstly employed PPP as an empirical tool of exchange rate determination (Gibson *et al.* 1996).

The exchange rate determination became as a serious problem after World War I. Before the war, the gold standard was adhered by countries. In gold standard, the currencies were converted into gold at fixed parities; therefore, the exchange between two countries was just the ratio of these parities. However, after the World War I, as pointed out Rogoff (1996) "…speculators become justifiably concerned that countries would devalue their currencies in an effort to gain seignorage

revenues". Hence, countries could not sustain the gold standards. So, what should be the criteria to determine the exchange rate became the main problem of financial decision-makers. Therefore, studies of Cassel and PPP have become the center of the studies on exchange rate determination (see Rogoff, 1996).

3.2 Empirical Literature on Purchasing Power Parity Hypothesis for Developed Countries

There is enormous number of studies on PPP for developed countries (DCs). Fortunately, we can reach some common results for them. Firstly, the hypothesis that long run equilibrium relationship between nominal exchange rate and ratio of domestic to foreign price series are generally accepted. However to impose symmetry and proportionality restrictions can cause the rejection of the hypothesis. Secondly, real exchange rate follows a random walk hypothesis is rejected if the test computed for at least 6 or 7 decades. Moreover, it is observed that the real exchange rate series exhibit strong but slow mean reversion properties, mean reversion properties implies that the real exchange rate series turns to equilibrium PPP after any deviation. Studies show that the half-life of deviation from PPP is generally between 3 to 5 years. Lastly, we can say that the Ballassa-Samuelson effect[5] does not find support among all industrialized countries except Japan (see Rogoff (1996) and Edwards and Savastano (1999)).

[5] The first and crucial model of long run deviations from PPP is Ballassa (1964) and Samuelson (1964). Ballassa (1964) claims that "international productivity differences are greater in the production of traded goods than in the production on nontraded goods" that leads to higher prices of services in rich countries, and this situation causes the systematic deviations from PPP exchange rate.

In our study, we will consider the PPP on LDCs under both fixed and flexible exchange rate regime periods by employing various techniques, unit root tests, Engle-Granger methodology and Johansen methodology. Therefore, we examine the results of DCs studies according to the exchange rate regime periods employed and the technique used.

[insert Table 3]

In Table 3 the studies that we concern are explained in detailed. The early studies using OLS framework could not find much support in favor of PPP. Frenkel (1981) considers the flexible exchange rate periods of the 1920s and post Bretton Woods system period in the 1970s. He finds out that PPP did not work well in the 1970s although it works in the 1920s, because of real shocks instead of monetary shocks. Adler-Lehman (1983) study investigates PPP hypothesis during both fixed and flexible (early years of post Bretton Woods system) regime periods by employing the Martingale model on RER series. Also, he could not find support for PPP under both alternative regimes.

When we consider the unit root tests on real exchange rate studies, it is observed that Enders (1988), Flynn and Boucher (1993) could not find evidence for PPP under both fixed and flexible regime periods. However, Maeso-Fernandez (1998) study finds support in favor of PPP without separating the data into fixed and flexible regime periods.

Moreover, Enders (1988) and Flynn and Boucher (1993) also employ Engle-Granger cointegration approach again for both fixed and flexible regime periods. Although Enders (1988) finds support in favor of PPP in both regime periods, Flynn and Boucher (1993) could not find support either fixed or flexible regime. Moreover, Corbae and Ouliaris (1983) and Kim (1990) studies have reached different results by employing Engle-Granger technique. Although Corbae and Ouliaris (1983) do not find support in favor of PPP for flexible regime periods, Kim find support on PPP without separating data fixed or flexible periods.

Furthermore, by employing another cointegration technique, Johansen VAR approach, Johansen and Juselius (1992) and Ramires and Khann (1999) find support PPP under flexible regime periods.

Hence, we can conclude that the studies on DCs are computed generally by considering the flexible regime period. Since, after the collapse of the Bretton Woods system during 1973, the developed countries have directly adopted to the flexible exchange rate systems. Nonetheless, with the adaptation of flexible regimes the nominal exchange rates have demonstrated greater volatility. Hence, the literature on the validity of the PPP for industrialized countries has enormously grown to understand the pattern of exchange rate movements during the flexible exchange rate period (see Conejo and Shields (1993), Edwards and Savastano (1999)).

Moreover, if we consider the studies that consider both fixed and flexible regime periods, their findings do not change according to the type of regime period under

interest; so the price index used, version of PPP concerned and the technique employed get greater importance.

3.3 Empirical Literature on Purchasing Power Parity Hypothesis for Less Developed Countries

The literature on PPP for LCDs is thin when we compare that of developed countries, its priori reason the late adaptation of LDCs to flexible exchange rate regimes after the collapse of Bretton Woods system. Nonetheless, LDCs have steadily adopted to more flexible regimes starting from the late 1970s as a result of the movements towards market oriented approach in their economic policies. During the late 1980s, the percentage of LDCs having flexible regimes has reached 33, according to the IMF 1997 report. (See Table 2) As a consequence, the literature surveys have grown on PPP for LDCs in the late 1980s.

[insert Table 2]

Recently there are huge numbers of studies concerning PPP theory for LDCs. Here, we will emphasize on nine of them to give an idea about studies and their results.

[insert Table 4]

The following nine studies are considered in Table 4: Conejo and Shields, 1993; Seabra, 1995; Bahmani-Oskooee, 1995; Calvo, Reinhart and Vegh, 1995; Devereux and Connolly, 1996; Soofi, 1998; Filho, 1999; Razzaghipour, Fleming and Heaney, 2000; Holmes, 2000. The period and type of data, region of countries, type of price

index and exchange rate series, exchange rate regime periods, specific version of PPP and econometric techniques are summarized in Table 4.

As seen from Table 4, there are more studies on Latin America region rather than the other developing economies over the world. Five of the nine studies are considers Latin America economies (Conejo and Shields, 1993; Seabra, 1995; Calvo, Reinhart and Vegh, 1995; Devereux and Connolly, 1996; Filho, 1999), one of them (Soofi, 1998) concerns group of OPEC countries, one of them (Holmes, 2000) concerns Africa region, the other (Razzaghipour, Fleming and Heaney, 2000) concerns South East Asia region and one of them (Bahmani-Oskooee, 1995) tests PPP on different regions of the world.

Moreover, it is seen that all the studies cover 25 years or less, except Conejo and Shield (1993) that covers 41 years and uses annual data, and Filho (1999) that employs 135 years more than a century of data. Therefore, mostly quarterly and in one case (Soofi, 1998) monthly data are used to improve the power of the tests.

Furthermore, six of the nine studies apply CPI index other than Seabra (1995) and Devereux and Connolly (1996) who employ the mixed price ratio of both CPI and WPI. For comparison reason, Conejo and Shields (1993) considers also WPI series. However, Filho (1999) just uses the real exchange rate data of Brazil and he does not give information on the price index and nominal exchange rate data.

In addition, nearly half of the studies five out of six consider bilateral exchange rate vis-à-vis the US dollar, and the four of them use multilateral "trade weighted" exchange rate series.

It is seen that, all of the studies concern the absolute version of PPP except three cases. Conejo and Shields (1993), Seabra (1995) and Holmes (2000) employ relative version of PPP.

Moreover, we should point out that none of the studies considers separately fixed or flexible exchange rate regime periods. They just employ the whole data span without dividing data according to alternative regimes. However, Holmes (2000) considers both 1974-1997 and 1960-1973 periods, nonetheless, his aim is not to make comparison between fixed or flexible regime, his is aim to see the effect of pre and post Bretton Woods system experience.

Lastly, we observe from Table 4 that five of the studies apply unit root tests: Bahmani-Oskooee, 1995; Calvo, Reinhart and Vegh, 1995; Devereux and Connolly, 1996; Filho 1999 and Razzaghipour, Fleming and Heaney, 2000. Three studies consider just cointegration framework Conejo and Shields, 1993; Seabra, 1995; Soofi, 1998. Moreover, the study of Razzaghipour, Fleming and Heaney (2000) also employs the cointegration techniques. Holmes (2000) represents the application of panel data technique on LDCs.

When we consider the results of unit root tests; it is observed that RER series are not stationary for most of the cases, this implies PPP condition does not hold in long run for most cases. Only Bahmani-Oskooee (1995) studies find support in favor of PPP, however, it is a little support just in eight country case out of twenty-two. We should indicate that unit root tests employed in studies are just the well-known DF, ADF, PP tests. However, Calvo, Reinhart and Vegh (1995) use the variance ratio test. If we explain the difference of variance ratio test from others; although DF, ADF and PP tests examine stationarity or nonstationarity of real exchange rate series without considering the importance of nonstationary component of real exchange rate series, the variance ratio test analyses the contribution of the nonstationary component to the variance of the series (see Maeso-Fernandez, 1998). However, also by applying this technique, the study of Calvo, Reinhart and Vegh (1995) cannot find support in favor of PPP. Moreover, the study that Filho (1999) do not sustain PPP theory by employing the newest unit root tests proposed by Hasan and Koenker (1997). The importance of Hasan–Koenker test is that "it is robust to fat tailed distributions". This paper finding is remarkable, because, although there are more than a century of data, the inability to reject the unit root hypothesis, bring serious question about hypothesis that PPP holds in the long run.[6]

However, the strongest evidences in favor of the PPP theory are found by the cointegration tests. Conejo and Shield (1993) find support for 2 out of 5 cases by employing just Engle-Granger methodology. The study of Seabra (1995) sustains PPP theory for 4 out of 11 cases with Engle-Granger methodology and again 4 cases

[6] He also employs DF, ADF, PP and KPSS (proposed by Kwiatkowski(1992)) tests. These tests also cannot reject the nonstationarity of real exchange rate series at its level.

out of 11 countries by applying Johansen methodology. Moreover, Razzaghipour, Fleming and Heaney (2000) find support for all five countries by applying Johansen technique, although he could not find evidence in favor of PPP with unit root test. Soofi (1998) considers a different cointegration technique, which is fractional cointegration. "In order to consider the fact that a class of long-memory stochastic processes with a fractionally cointegrating properly also have mean-reverting characteristics, the fractional cointegration method is applied." By employing the Geweke and Porter-Hudak (1983) test, it is found that 4 out of 9 countries are fractionally cointegrated, although according to usual cointegration technique there was no evidence of cointegration relation for all countries.

Lastly, we will consider one of the most recent panel data study by Holmes (2000). He uses a new panel data unit root test, supported by Im *et al.* 1997, which "allows one to test for unit roots in heterogeneous panel data sets". Hence by applying this panel data procedure, the null hypothesis of non-stationarity is rejected for all countries, so PPP holds for all cases.

Moreover, the symmetry and proportionality conditions are directly imposed instead of testing nearly for all of the studies. However, Conejo and Shields (1993) and Seabra (1995) studies test and find evidence in favor of proportionality condition. Although Razzaghipour, Fleming And Heaney (2000) test both symmetry and proportionality, they could not find any support.

Finally, we summarize the characteristics of PPP studies on LDCs. Firstly, we observe that most of the studies concerns the countries from Latin America, this makes hard to reach general results for overall LDCs like industrialized countries cases on PPP. Moreover, all studies suffer from the lack of enough data and therefore high frequency data are employed to increase the number of observations. This also automatically restricts the studies to reach conclusion on the long run properties of real exchange rates. Furthermore, the studies do not examine PPP on fixed and flexible exchange rate separately. Generally CPI is employed as a price index. However, there is no dominant choice in exchange rate series, nearly half of the studies use bilateral exchange rate vis-à-vis the US dollar, whereas the other half multilateral "trade weighted" exchange rate series. Moreover, it should be indicated that studies mostly concern the absolute version of PPP. For majority of the studies, the symmetry and proportionality conditions are imposed, not tested. When we consider the results of the tests, it is observed that unit root tests do not provide the stationarity of real exchange rate series as expected because of data restrictions. However, Filho (1999) study is remarkable, because, although there is more than a century of data, he rejects the stationarity of real exchange rate series for Brazil. The inability to reject the unit root hypothesis, bring serious question about hypothesis that PPP holds in the long run at least for LDCs case. However, when we consider the studies using cointegration and panel data methodologies the long run relationship between exchange rate and the ratio of prices find support.

SECTION 4: DATA

The PPP theory concerns a long run relationship between the nominal exchange rate and the ratio of the domestic to foreign price levels. Therefore to test the theory we need the countries price levels and the nominal exchange rate series. In this study as a proxy for the world economy, the US economy variables are taken into account. Hence, bilateral exchange rates of 16 less developed countries (LDC) and the US, and their respective price levels will be considered. This section introduces the countries included into the study. The frequency of data, data sources, the details of the price level and exchange rate series is discussed. Lastly, the periods of fixed and flexible exchange rate regimes will be explained in detail.

A sample of sixteen emerging economies is considered in this study: five of them are from East Asia and Pacific Region (Thailand, Philippines, Indonesia, Korea, Malaysia), seven of them are from Latin America and Caribbean Region (Mexico, Brazil, Argentina, Colombia, Chile, Venezuela, Peru), one of them is from Sub-Saharan Africa Region (Kenya), one is from Central Asia Region (Turkey) and lastly two of them are from South Asia Region (India, Pakistan). As it is seen, by considering the LDCs in different location, we have a chance to check out PPP theory overall the world.

The monthly data are used in the study. By applying high frequency monthly data instead of annually or quarterly, we can increase the number of observations, which will improve the power of the tests. Data sets of prices and exchange rates for all countries are taken from *International Financial Statistic*, IMF over the period 1957:01–1999:12; there are variations in sample periods for the countries according to the availability of data.

There are two price series mostly considered in PPP studies: the consumer price index (CPI) and the wholesale price index (WPI). WPI includes greater proportion of traded goods than CPI. In this study, the consumer price index (CPI) is chosen to represent the price level like most of the studies concerning PPP for LDCs. However, since the CPI includes the nontraded goods prices, it may cause divergences from PPP. Price differences of nontraded goods do not directly convert into changes in international trade flows; consequently, they do not affect the exchange rates. Ballassa (1964) points out that the services, which are nontradable, have higher prices in rich countries that lead to "systematic deviations" from PPP exchange rate. If we consider for example the McDonald's 'Big Mac' hamburgers prices in Dollars in different countries, the wide range from $5.20 to $1.05 is observed. This situation occurs because; although the ingredients of the hamburger like the frozen beef patty are highly traded, the restaurant place, local labor inputs are nontraded and differ in each country (see Rogoff, 1996).

[insert Table 5]

However, we should not ignore the impact of the price of nontraded goods to traded. The changes in the prices of nontraded goods affect the price of traded goods indirectly through their influence on wage demands and cost of living (see Gibson *et al.* 1996). Therefore, using CPI makes sense in this aspect. For the price levels of countries, CPI (series 64) are taken from IFS.

The exchange rates series coded as (rf) in IFS are used. (rf) refers to period averages of market exchange rates for countries quoting rates in units of national currency per US dollar.

In our study we will examine PPP hypothesis under fixed and flexible exchange rate regime periods separately. Table 6 represents these regime periods for our 16 LDCs.

[insert Table 6]

Up to the collapse of Bretton Woods system (1944-1973), all countries either developed or developing were required to sustain some type of currency peg. Therefore, we just consider our 16 LDCs regimes as fixed during 1957-1972 periods. Calvo and Reinhart (2000) and Ghosh, Gulde, Ostry and Wolf (1997) articles are the main two sources for regime classifications for developing countries for the 1973-1999 period, these are presented in Table 6.a and Table 6.b respectively.

[insert Table 6.a and Table 6.b]

The exchange rate regimes from Calvo and Reinhart (2000) article and from Ghosh, Gulde, Ostry and Wolf (1997) article are represented together in Table 6.c. In Ghosh,

Gulde, Ostry and Wolf (1997) the exchange rate regimes represented as single currency peg, SDR peg, other official basket peg, secret basket peg and their variations are just considered as fixed in this study. Also, cooperative arrangement (EMS or predecessor), more flexible exchange rate regime and their variations are considered just as limited flexibility exchange rate regime.

[insert Table 6.c]

The exchange rate regime periods that we employ are reported in Table 6. It is constructed by grouping the exchange rate regimes in Table 6.c into two categories: the fixed and flexible regimes. Therefore, regime periods of managed floating and floating in Table 6.c are combined and called as flexible. Moreover the limited flexible regime periods of Mexico, Brazil and Turkey are included in their flexible regime period. However for Malaysia, Colombia, Chile and Peru the limited flexibility periods, indicated in parenthesis, omitted. In addition, we also omit 1994-year from data for Mexico and Brazil, because of the Balance of Payment Crises in 1994 in Mexico, which may cause deviation from PPP.

Furthermore, Case 1 and Case 2 represent two different time periods without any intersection for Malaysia, Argentina and Chile in fixed regime period, for Venezuela and Peru in both fixed and flexible periods.

In the thesis, our aim is to test PPP as a long run relationship therefore we omit the periods that have 7 and less years.[7] Hence, Venezuela's and Peru's Case 2 periods

[7] The PPP studies on LDCs contain at least 9 years data, see, Soofi (1998).

omitted in their both fixed and flexible regime. Fixed regime period of Chile Case 2 including 4 years is omitted. Moreover flexible regime periods of Thailand including 2 years, Malaysia and Kenya including 6 years are omitted. Hence, after these adjustments we have reached the Table 6.

We have introduced the data and data sources for our 16 LDCs. Moreover, how the time periods of data grouped into fixed and flexible exchange rate regime have been explained. The econometric theories will be introduced in next section.

SECTION 5: ECONOMETRIC FRAMEWORK

The huge number of studies on PPP as a long run theorem have inspected the stochastic behavior of the real exchange rate by implementing unit root tests such as Dickey and Fuller (1979), (DF); Augmented Dickey Fuller (1981), (ADF); Phillips and Perron (1988), (PP) or by applying cointegration tests to a linear combination of the nominal exchange rate and the domestic-foreign price level differentials. In this thesis we will consider the both methods for testing PPP theory. Therefore the econometric framework of unit root tests and the cointegration tests of Engle–Granger (1987) and Johansen (1988) methodologies are explained in this section.

5.1 Stationarity

Time series is weakly stationary if its mean and all autocovariances are unaffected by a change of time origin. Weakly stationary process is also referred to as a covariance stationary. If a series must be difference d times to make stationary, it is said to be "*integrated of order d* " denoted as $y_t \sim I(d)$. (see, Diebold *et al.* 1998)

Although the properties of a sample correlogram are useful tools for detecting the possible presence of unit roots, the method is necessarily imprecise. The process that may appear as a unit root to one observer may appear as a stationary process to another. Moreover, when the underlying data generating process is a unit root process the ordinary least square approach will yield a bias estimate of the parameters, t-test is inappropriate under the null of a unit root. Fortunately, Dickey

and Fuller (1979,1981) devised a procedure to formally test the presence of a unit root.

5.2 Unit Root Tests

5.2.1 Dickey – Fuller Tests

Dickey-Fuller (1979) consider three different regression equations that can be used to test the presence of a unit root:

$\Delta y_t = \beta y_{t-1} + \epsilon_t$

$\Delta y_t = c_0 + \beta y_{t-1} + \epsilon_t$

$\Delta y_t = c_0 + \beta y_{t-1} + c_1 t + \epsilon_t$

The difference between the three regressions concerns the presence of the deterministic elements c_0, $c_1 t$. The first is a pure random walk model, the second adds an intercept, and the third includes both intercept and linear time trend.

The idea of Dickey –Fuller test is that since the t-test becomes inappropriate if the process is nonstationary, srarting from $y_t = k.y_{t-1} + \epsilon_t$ and by subtracting y_{t-1} from each side of the equation one can obtain the $\Delta y_t = \beta y_{t-1} + \epsilon_t$ model. So, instead of testing whether k equals to 1 or not becomes equivalent to testing whether β equals to 0 or not. Hence, the parameter of interest in all regression equations is β, and if $\beta=0$ the y_t series contain a unit root. The test involves estimating one or more of the equations above using OLS in order to obtain the estimated value of β and associated

standard error. The associated t-statistic for the test of null $\beta=0$ is obtained by dividing the estimate of β by its standard error. To reject the null hypothesis the absolute value of the t-statistic should exceed the critical value. The critical values depend on the form of the regression and the sample size in Dickey Fuller (1979) test.

5.2.2 Augmented Dickey- Fuller Test

Not all time series processes can be well represented by the first order autoregressive process $\Delta y_t = c_0 + \beta y_{t-1} + c_1 t + \in_t$ .It is possible to use the Dickey –Fuller tests in high order equations such as:

$$\Delta y_t = \beta y_{t-1} + \Sigma \alpha_i \Delta y_{t-i+1} + \in_t$$

$$\Delta y_t = c_0 + \beta y_{t-1} + \Sigma \alpha_i \Delta y_{t-i+1} + \in_t$$

$$\Delta y_t = c_0 + \beta y_{t-1} + c_1 t + \Sigma \alpha_i \Delta y_{t-i+1} + \in_t$$

Here i is the number of lag introduced into the model to make the residuals $\in_t$ white noise process. The coefficient of interest is β, if $\beta = 0$ the equation is entirely in first differences and so has a unit root. Again the appropriate statistic to use depends on the deterministic components included in the regression equation.

At both DF and ADF tests in order to reject the null hypothesis of nonstationarity the absolute value of the t-statistic should be greater than the critical value. Also; it should be negative otherwise we can immediately say that the series is nonstationary. In this study for compute the DF and ADF tests the *e-views* packet program is used

and it uses the MacKinnon Critical values because 'MacKinnon (1991) has implemented a much larger set of replications than those underlying the Dickey – Fuller tables '.[8]

5.2.3 Phillips – Perron Tests

The distribution theory supporting the Dickey –Fuller tests assumes that the errors are statistically independent and have a constant variance. Phillips and Perron (1988) developed a generalization of the Dickey- Fuller procedure that allows for fairly mild assumptions concerning the distribution of the errors.

To briefly explain the procedure, consider the following regression equations:

$y_t = \gamma_0 + \gamma_1 y_{t-1} + \mu_t$

$y_t = \lambda_0 + \lambda_1 y_{t-1} + \lambda_2(t- T/ 2) + \mu_t$

here, T represents the number of observations and the disturbance term μ_t is such that $E\mu_t = 0$, but there is no requirement that the disturbance term is serially uncorrelated or homogeneous. Instead of the Dickey –Fuller assumptions of independence and homogeneity the Phillips–Perron (PP) test allows the disturbances to be weakly dependent and heterogeneously distributed.

Phillips–Perron characterize the distributions and derive test statistics that can be used to test hypotheses about the coefficients γ_i and λ_i under the null hypothesis that the data are generated by $y_t = y_{t-1} + \mu_t$. The Phillips–Perron test statistics are

[8] Since the data are monthly, 12 lags are considered in ADF test .If the highest lag's t-statistic is insignificant, it is dropped and this procedure is repeated until a significant lag is obtained.

modifications of the Dickey –Fuller t-statistics that take into account the less restrictive nature of the error process. For PP test, the lagged difference terms are not considered; instead, the equation is estimated by ordinary least squares and then the t statistic of the coefficient is corrected for serial correlation in t. 'Newey –West ' procedure is used in order to adjust the standard errors in e-views packet program.

5.3 Cointegration Framework

5.3.1 Engle And Granger Technique

An alternative methodology to test the long run PPP is Engle and Granger (1987) approach. According to this methodology long run PPP holds if there is cointegrated relationship between nonstationary variables.

Engle and Granger (1987) approach compose of two steps. First of all the integration order of variables should be checked. According to cointegration theory, they should have the same order of integration if not we can immediately say that there are not cointegrated. Second step is to fit equation of long run relationship. ε_t represents the estimated residual of the long run relationship, so if the ε_t series is I(0) process i.e. the deviations from long run relation are stationary than we can say that there is cointegrated relationship between varibales which implies that the long run PPP holds.

5.3.2 Johansen Methodology

A vector autoregressive (VAR) model :

$$\Delta x_t = \Gamma_1 \Delta x_{t-1} + \Gamma_2 \Delta x_{t-2} + ... + \Gamma_{k-1} \Delta x_{t-k+1} + \pi x_{t-k} + \mu c_t + \psi D_t + \varepsilon_t \quad (1)$$

where Δ is the first difference operat or, x_t is an nx1 vector of veriables, π is an n x n matrix of rank r < n, c_t is the intercept, D_t are the centered seasonal dummies and ε_t is an n x 1 vector of residuals with zero mean and variance matrix Ω. Then

$$\pi = \alpha\beta` \quad (2)$$

is the matrix of long-run responses where α,β are n x r matrix for n variables and r cointegrating vectors. The rank of π determines the dimensionality of the cointegrating space. α matrix is called the loading matrix and gives the weight attached to each cointegrating vector in every equation. β is the matrix of cointegrating vectors which can be estimated as the eigenvectors associated with the r largest, statically significant eigenvalues found by calculating:

$$| \lambda S_{kk} - S_{k0} S_{00}^{-1} - S_{0k} | = 0 \quad (3)$$

In the above equality S_{00} is the residual moment matrix from the least squares regression of Δx_t on Δx_{t-1} , ... Δx_{t-k+1} and S_{kk} is the residual moment matrix from a least square regression of x_{t-k} on Δx_{t-k+1}. S_{ok} is the cross product moment matrix. Using these eigenvalues one can test the hypothesis that there are at most r cointegrating vectors by using the eigenvalues and calculating the likelihood test statistics:

$$(-2)\ln(Q) = -T \Sigma_{i=r+1} 1n (1-\lambda_i) \quad (4)$$

where λ_{r+1} .... λ_n are the n-r smallest eigenvalues, and this is called the Trace test. There is also a likelihood ratio test called the maximal eigenvalue test (λ Max) which the null hypothesis of r cointegrating vectors is tested against the alternative of r + 1 cointegrating vectors.

SECTION 6: EMPIRICAL RESULTS

In this section PPP hypothesis tested for a group of LDCs including both of their fixed and flexible exchange rate experience. The empirical results of the unit root tests and cointegration tests are explained.

6.1 Application of Unit Root Tests to PPP Theory and Results

The absolute version of PPP, which states that the nominal exchange rate between two currencies is equal to the ratio of the general price levels between two countries, can be formulated as:

$$e_t = p_t - p^*_t \quad (1)$$

where p_t, p^*_t denote the logarithm forms of the LDC and US price levels at time t respectively, and e_t denotes the logarithm of domestic currency price of a unit of foreign currency at time t.

As we have explained in detail in section 2, the real exchange rate (RER) is a price adjusted nominal exchange rate and can be formulated as:

$$rt = et - (pt - p^*t) \quad (2)$$

Therefore, we can test the PPP hypothesis by testing the time series properties of {rt} series. Hence, if {rt} series is stationary, then PPP holds; however, if {rt} series is nonstationary i.e. if RER series has unit root then PPP does not hold.

There are two specifications of RER series, namely bivariate and trivariate specifications. The RER series in equation (2) is the trivariate specification, since pt, p*t, et are represented separately. However, in the bivariate specification instead of considering pt and p*t separately just the logarithm of ratio of the LDC's and US price levels is considered. Therefore in bivariate specification we deal with two variables log(Pt / P*t) and log(Et). In the thesis, we have considered the bivariate specification of RER. All the DF, ADF, PP unit root tests are applied on RER.

There are two properties, symmetry and proportionality, are required in the absolute PPP proposition. If we consider the nominal exchange rate in following algebraic from:

$e_t = \lambda_1 . p_t - \lambda_2 p^*_t + d_t$

where d_t represents the deviation from PPP in period t.

i- Symmetry between the domestic and foreign countries implies that the coefficients of the domestic price level and foreign price level should have the same magnitude that is $\lambda_1 = \lambda_2$.

ii- Proportionality between the exchange rate and prices implies that the values of these two coefficients should be (1, -1) respectively that is $\lambda_1 = \lambda_2 = 1$.(see Kai Li, 1999 and Razzaghipour, Fleming and Heaney, 2000) These symmetry and proportionality conditions are directly imposed with construction of RER series as explained above.

Initially we check for all 16 countries (Thailand, Philippines, Indonesia, Korea, Malaysia, Mexico, Brazil, Argentina, Colombia, Chile, Venezuela, Peru, Kenya

Turkey India, Pakistan) using DF, ADF and PP tests whether stationarity of RER is found regardless of their exchange rate regime. In next step we differentiate between fixed and flexible regimes and test PPP or the stationarity of RER on each exchange rate regime for LDCs.[9]

The unit root test results for whole sample period are reported in Table7.a.[10] The number in parenthesis in ADF test column represents the highest order of lag for which the t-statistic in the regression is significant.[11] As we have explained in econometric theory section, no lags are introduced in DF tests and PP.[12] Since the PPP theory does not allow for a deterministic time trend, trend component is not introduced to regression of DF, ADF and PP tests, only constant term is considered. All DF, ADF and PP tests results have come up with the conclusion that for a majority of the countries, 12 out of 16 countries, the real exchange rate series are nonstationary and become stationary when they are defined in their first differences. These countries are namely Thailand, Indonesia, Korea, Malaysia, Brazil, Chile, Venezuela, Peru, Kenya, Turkey, India, and Pakistan. As we have explained the

[9] Mexico fixed regime period (1957-1975) have enough length including 18 years. However during this period, its exchange rate series is constant, this leads to near singular matrix in all applications, therefore we have to omit Mexico's fixed regime period for all applications, unit root tests and cointegration tests. Moreover, Brazil has no fixed regime experience during its whole sample 1979:12-1999:12. Hence we consider except Mexico and Brazil, 14 LDCs at fixed regime tests.
For flexible exchange rate regime period just 13 countries out of 16 are considered. Because of the lack of sufficient data in Thailand, Malaysia and Kenya, they are not considered at all (for detailed discussion see data section of the study).

[10] The tests are executed by employing e-view packet program.

[11] Since the data are monthly, 12 lags are introduced initially, after that, the highest order lag is examined for which the t-statistic in the regression is significant .

[12] For PP test, we should specify the truncation lag, that is, the number of periods of serial correlation to include for the Newey-West correction which e-view employs. The truncation lag number is not investigated in our study, just the number offered by the Newey and West's suggestion based only on the number of observations is employed for all LDCs. The Newey and West's offer for truncation lag was 5 for all LDCs except Brazil, for it the truncation lag is 4.

nonstationarity of RER series implies the invalidity of PPP. Hence PPP does not hold for nearly all of the LDCs at whole sample period.

[insert Table 7.a]

However there are 4 exceptions, namely Philippines, Mexico, Argentina and Colombia. The hypothesis of a unit root in RER series can be rejected at 5 percent significance level for Mexico and Colombia and at 10 percent significance level for Philippines and Argentina. Therefore the RER series of these four countries are stationary at their level. The stationarity of RER series implies the validity of PPP theory. Therefore PPP find a little support from LDCs, just 4 out of 16 countries at whole sample period.

To test the unit root on RER series for fixed and flexible regime periods, only the ADF test is used. Again, only the constant term is considered since the PPP theory does not allow for a deterministic time trend. The number in parenthesis presents the highest order of lag for which the t-statistic in the regression is significant.[13]

The results for fixed regime period are presented in Table 7.b. It was found that for all of the countries the RER series are nonstationary, and become stationary when RER series are defined in their first differences, except Argentina at Case 1 and Colombia. The hypothesis of a unit root in RER series can be rejected at 1 percent significance level for Colombia and at 10 percent significance level for Argentina in Case 1. Therefore the RER series of these two countries are stationary at their levels.

[13]Although for the whole sample period 12 lags were introduced into the model, for fixed and flexible regime periods we consider just 6 lags because of the decrease in the number of observations.

As we know, if RER series is stationary, then PPP holds; if not then PPP does not hold. Therefore, PPP find no support from LDCs, except two countries (Argentina at Case 1 and Colombia) during fixed regime period.

[insert Table 7.b]

The results for flexible regime period are shown in Table 7.c. The hypothesis of a unit root in RER series can be rejected at 5 percent significance level for Philippines and Turkey and at 10 percent significance level for Mexico. Other than these three cases there is no evidence in favor of PPP. For the rest of the countries, RER series are nonstationary that implies the invalidity of PPP. Hence, PPP find a little support during flexible exchange rate regime, from just 3 out of 13 LDCs.

[insert Table 7.c]

Hence if we combine and interpret the results of univariate tests for whole sample and fixed, flexible regime sample periods, we can conclude that the stationarity of RER does not receive much support from these studies, thus PPP condition does not hold in long run for most cases.

Now we will consider the tests results of cointegration framework. In these studies PPP theory is tested for fixed and flexible regime periods, however the whole period is not investigated.

6.2 Cointegration Frameworks

6.2.1 Engle-Granger Two Step Approach

The existence of a long run relationship among a set of nonstationarity variables can be tested by Engle-Granger (1987) cointegration approach. Therefore we will employ Engle-Granger (1987) methodology to understand the long-run relationship between nominal exchange rate and the ratio of price levels.

As we have indicated that the absolute version of PPP implies that:

$$Et = Pt / P^*t \quad (1)$$

$$Log(Et) = Log(Pt / P^*t) \quad (2)$$

where Pt, P*t denote the LDC and US price levels at time t respectively, and Et denotes the domestic currency price of a unit of foreign currency at time t, Log represents the natural logarithm function.

Since, cointegration requires that the variables of interest should be integrated of the same order, the order of integration of (Log(Et)) and (Log(Pt / P*t)) series should be determined. After that if the both variables are integrated of the same order, the long run equilibrium relationship should be estimated. Our long run equilibrium relationship, as formulated in (2), is estimated by regressing the exchange rate series on the ratio of price series.

$$Log(Et) = \theta_0 + \theta_1 Log(Pt / P^*t) + u_t$$

Here u_t denotes the residual term at time t. Absolute PPP implies that $\theta_0=0$ and $\theta_1=1$. However, if not there are forcing reasons to omit the constant term, to include it in long run equilibrium regression is advised (see Enders *et al.* 1995).

After estimated the long run relationship equation, the next step is to check the stationarity of the residual term of the regression. Hence, if the residuals are stationary then we can say that nominal exchange rate and the ratio of price series are cointegrated which implies the long run relationship between the nominal exchange rate and the ratio of price levels.

The Engle-Granger methodology is applied to data during both fixed and flexible exchange rate regime periods. Initially, the fixed regime period is considered. After taking the natural logarithms of exchange rate and the price ratio series, the ADF unit root tests are conducted on both level and first difference of series.[14] The results are reported in Table 8.a. Although there are exceptions for a greater part of the countries the exchange rate and the ratio of prices series have a unit root i.e. they are nonstationary, and become stationary when variables are defined in their first differences. One exception to this is the exchange rate series of Indonesia, it is possible to reject the hypothesis that variable is nonstationary at 1 percent significance level. There are three more exceptions: Venezuela, Turkey and Argentina in Case1. Although their exchange rate series are I(1) process, the price ratio series are nonstationary at their first difference and become as stationary when they are defined in their second difference at 1 percent significance level. With these

[14] If stationary is not established after also first differencing, the ADF test for the second difference of the series is also employed.

exceptions in mind, it is possible to conclude that nearly all of the (Log(Et)) and Log(Pt / P*t) series are integrated of order one, I(1).

[insert Table 8.a]

The long run equations are estimated by OLS and results are summarized in Table 8.b. If we check out the restrictions of absolute PPP, it is observed that the constant θ_0 is significantly greater than 0 for all countries except Argentina in both cases. Moreover, nearly all of the cases θ_1 is far different than 1 except Chile, India and Kenya.[15] Hence, we can conclude that the requirements of absolute PPP do not satisfied for all cases.

[insert Table 8.b]

The stationarity of the residuals of the estimated equation are tested by ADF. The results are reported also in Table8.b.[16] The cointegrating relationship is found for nearly half of the fourteen countries. These are Indonesia, Argentina in both cases, Colombia, Chile, Turkey and Pakistan. The hypothesis of a unit root in residual series can be rejected at 1 percent significance level for Colombia, at 5 percent significance level for Chile and Pakistan, and at 10 percent significance level for Indonesia, Argentina in both cases and Turkey. Other than these six cases, LDCs residual series are nonstationary, and become stationary when they are defined in their first differences. Although the PPP restrictions does not find much support, for

[15] However we should point out that if the variables are cointegrated, an OLS regression yields a "super consistent" estimator of the cointegrating parameters θ_0 and θ_1 however if the variables are not the consistency of coeffients fails. (see , Diebold *et al.*). Thererfore if the cointegrationing relationship does not hold our , interpretations fail.

[16] Maccinnon critical values are used to interpret .

nearly half of the LDCs the long run relationship between exchange rate and the ratio of price series holds.

For the flexible exchange rate regime, the ADF tests results for the natural logarithms of exchange rate and the price ratio series are reported in Table 8.c. It was observed that generally the exchange rate and the ratio of prices series of countries are nonstationary, and become stationary when variables are defined in their first differences. One exception to this is the exchange rate series of Pakistan, which exhibits a borderline case since it is possible to reject the hypothesis that variable is nonstationary at a 10 percent significance level. Moreover, for the exchange rate series of Peru, it is possible to reject the hypothesis of nonstationarity at a 1 percent significance level. Brazil's exchange rate series and Venezuela's both exchange rate and price ratio series become stationary at their second difference. With these exceptions in mind, it is possible to conclude that nearly all of the (Log(Et)) and (Log(Pt / P*t)) series are integrated of order one, I(1).

[insert Table 8.c]

The long run equations are estimated by OLS and results are summarized in Table8.d. In these equations it is observed that the constant θ_0 is significantly greater than 0 for all cases except Brazil. However, the θ_1 is close to unity for 8 out of 13 countries.

[insert Table 8.d]

The results of the unit root tests on estimated equation residuals are reported also in Table 8.d.[17] It was found that for a majority of the countries, the series of residual are nonstationary, and they become stationary in their first differences, except Philippines, Indonesia, Turkey and Pakistan. The hypothesis of a unit root in residual series can be rejected at 5 percent significance level for all of them. Hence, Engle-Granger studies find just a little evidence in favor of cointegrated relationship between exchange rate and the price ratio series in flexible periods, only 4 cases.

Hence, applying Engle-Granger technique we have found more support in fixed regime than flexible. The long run relationship between the nominal exchange rate and the price series are accepted in 6 cases for fixed regime and in just 4 under flexible.

6.2.2 Johansen Cointegration Test Results

In application of the Johansen procedure to the analysis of PPP relation, a VAR model is constructed where x_t is defined as (p, p*, e) to obtain a long run relationship among these stochastic variables, where p, p* denote the logarithm forms of the LDC and US price levels respectively, and e denotes the logarithm of domestic currency price of a unit of foreign currency.

Unlike the unit root tests and Engle-Granger methodologies, in Johansen VAR methodology we used the trivariate specification, since p, p*, e are represented separately. Therefore, we should also check the order of integration for each p series.

[17] Maccinnon critical values are used to interpret .

The same order of integration with Log(P/P*) series reached for p=(Log(P)) series under both fixed and flexible regimes (see Table 8.a and 8.c).

Since the cointegration results are sensitive to the lag length of VAR, first the optimum lag length of the cointegration is found by considering Schwarz criteria. We consider the VAR(1), VAR(6) and VAR(12) models. Since, our data are monthly maximum length is chosen as 12, however, because of a reduction in the number of data on alternative regimes, also 6 and 1 lag lengths are examined. The models are estimated with including a constant and 12 seasonal dummies. The minimum of Schwarz Criteria for each gives the optimum lag length for the VAR models. The Schwarz test values for all models under fixed and flexible exchange rate regimes are represented in Table 9.a and Table 9.b respectively. For fixed regime, generally 12 lag length provides optimum for LDCs. However, there is not such a generalization under flexible regime. VAR(1) models were not optimum in any cases.

Table 10.a reports the maximum eigenvalue test results on the existence of the number of cointegrating vectors in a system of unrestricted VAR constructed under fixed regime. According to maximum eigenvalue statistic, we can find for a majority of the countries at least one cointegrated vector and in countries such as Malaysia at case 1, Argentina at case 2, and Kenya there are two cointegrating vectors. Finding the cointegration relationship indicates that "there is an adjustment toward a stationary relationship between exchange rate and the domestic and foreign price". However, the cointegrated relationship is not found for countries such as Philippines, Colombia, and Peru case1. This implies that there is no an adjustment toward a

stationary relationship between exchange rate and the domestic and foreign price for Philippines, Colombia, and Peru case1.

The PPP hypothesis holds if there is a cointegrating vector with the coefficients of the (p, p*, e) equal to (1,-1, –1) respectively, that is, the following equality should be hold :

p- p*- e=0

[insert Table 10.b]

The cointegrating vectors normalized with respect to the coefficient of p reported in Table 10.b. It is observed that regarding the sign of the parameters of the cointegrating vectors, Korea, Malaysia case1 (second vector), Argentina case 2, Chile, Venezuela, Kenya, India and Pakistan are close to the PPP relationship. However, most of the cointegraing vectors do not satisfy the PPP restriction on the size of the parameters. The cointegrating vector of Pakistan is closest to a PPP relationship with coefficients (1, -0.88, -0.75). Hence we can conclude that although the cointegrated relation is found for a greater part of the countries, PPP constraints are not satisfied.

The results of multivariate cointegrating analysis under flexible regime are reported in Table 11.a. Similar conclusions are derived for the PPP relationship. According to maximum eigenvalue statistic, we can find for a majority of the countries at least one cointegrated vector and in countries such as Peru have two cointegrating vectors and Colombia, Venezuela, and Mexico have 3 cointegrated vectors. However, the

cointegrated relationship is not found for countries such as Indonesia, Brazil, and India. The results indicate that there is an adjustment toward a stationary relationship between exchange rate and the domestic and foreign price of each country, except these three countries.

[insert table 11.a]

Moreover, we consider the cointegrating vectors normalized with respect to the coefficient of p. The results reported in Table 11.b. show that for Philippines, Korea, Mexico (2nd vector), Argentina, Venezuela (in all three vectors), and Turkey, their cointegrating vector are close to the PPP relationship as regards the sign of the parameters. However, most of the cointegraing vectors do not satisfy the PPP restriction on the size of the parameters. The cointegrating vector of Philippines and Venezuela's second vectors are the closest to a PPP relationship with coefficients (1, -0.88, -0.75), (1, -0.882, -1.388) respectively.

Hence, the Johansen VAR methodology finds evidence of the cointegration relationship for a majority of countries unlike the Engle-Granger approach except three cases Philippines, Colombia, and Peru case1 in fixed exchange rate regime and again except three cases Indonesia, Brazil, and India in flexible regime. The cointegrating relation indicates that there is an adjustment toward a stationary relationship between exchange rate and the domestic and foreign price levels. However, these cointegarating vectors do not support the PPP restriction of coefficients vector (1, -1, -1) for (p, p*, e).

SECTION 7: CONCLUSION

The aim of this thesis is to investigate the PPP hypothesis for a group of developing countries during their fixed and flexible exchange rate experiences over the period 1957:01–1999:12. In this study we have examined whether PPP holds in 16 developing countries from various regions of the world. The US economy variables are taken into account as a proxy for the world economy. The bilateral exchange rates of 16 less developed countries (LDC) and the US, and their respective price levels are considered. Consumer Price Index (CPI) is used as to represent the price level.

Three different methodologies have been employed to test PPP hypothesis. These are unit root tests, Engle-Granger (1987) cointegration technique and Johansen multivariate VAR methodology (1988). Firstly, unit root tests which are DF (1979), ADF (1981), PP (1988) applied to understand the stochastic properties of real exchange rate series. The results show that, regardless of the time period, the nonstationarity of real exchange rate could not been rejected for most of the cases, which implies that PPP do not hold for most of the LDCs. However, if we consider the exceptions for which PPP hypothesis hold: four of them from whole sample period Philippines, Mexico, Argentina and Colombia; two of them from fixed sample period, Argentina at Case 1 and Colombia and lastly, three exceptions from flexible

period Philippines, Turkey and Mexico. Their interesting feature is that, they are generally from Latin America Region.

Secondly, the Engle –Granger technique employed just on fixed and flexible regime periods data. Hence, applying Engle-Granger technique we have found more support in favor of PPP in fixed regime than flexible. The long run relationship between the nominal exchange rate and the price series are accepted in 6 cases for fixed regime and in just 4 under flexible. For Colombia, Chile, Pakistan, Indonesia, Argentina in both cases and Turkey, the long run relationship between the nominal exchange rate and the price series are accepted in their fixed regime. For Philippines, Indonesia, Turkey and Pakistan, also this relationship accepted in their flexible periods. As it is seen these countries are not concentrate in one region of the world, indeed they are from different regions. Although, the long run relationship of nominal exchange rate and the price series find support from Engle-Granger approach, the absolute PPP restrictions are not satisfied under both fixed and flexible regime periods.

Lastly, the Johansen VAR methodology is employed on data during both fixed and flexible regime periods. The cointegration relationship have found for a majority of the countries, which indicates that there is an adjustment toward a stationary relationship between exchange rate and the domestic and foreign price. For Philippines, Colombia, and Peru case1 during fixed exchange rate regime, and for Indonesia, Brazil, and India during flexible exchange rate the cointegrated relationship could not find. Other than these countries, at least one cointegrated vector is found for each LDCs. However, although the cointegration relationship

exist the cointegrating vectors do not support the PPP hypothesis target relationship i.e. the coefficients of the cointegrated vector of (p, p*, e) does not equal to (1,-1, -1).

Hence one more time the importance of the technique appears. Although, we have employed three methodologies, we have find the strongest evidence in favor of long run relationship between the nominal exchange rate and the price series with Johansen VAR approach, which is the newest one among them.

Moreover, we can not conclude from our study that PPP hypothesis work well under fixed or flexible regime periods, because we could find nearly equal number of evidences under these alternative regimes.

We have mentioned the previous studies findings on PPP in Literature review section. Our results are just same that of unit root tests findings, not provide the stationarity of real exchange rate series and openly not support PPP. However, when we consider the studies using cointegration the long run relationship between exchange rate and the ratio of prices find support in most of the cases of previous studies just like our findings.

However, we should point out that this thesis is one of the first considering PPP hypothesis on alternative exchange rate regimes for LDCs. This is the main distinction of our studies and previous ones.

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APPENDIX

Table 1. Definitions of Exchange Rate Regimes (From Fixed Towards Flexible)

Exchange Arrangements With No Separate Legal Tender

The currency of another country circulates as the sole tender or the member belongs to a monetary or currency union in which the same legal tender is shared by the members of the union. Adopting such regimes is a form of ultimate sacrifice for surrendering monetary authorities to conduct independent monetary policies.

Currency Board Arrangements

A monetary regime based on an explicit legislative commitment to exchange domestic currency for a specified foreign currency at a fixed exchange, combined with restrictions on the issuing authority to ensure the fulfillment of its legal obligation. This implies that domestic currency be issued only against foreign exchange and that it remain fully backed by foreign assets, eliminating traditional central bank functions such as monetary control and the lender of last resort and leaving little scope for discretionary monetary policy; some flexibility may still be afforded depending on how strict the rules of the boards are established.

Other Conventional Fixed Peg Arrangements

The country pegs its currency at a fixed rate to a major currency or a basket of currencies, where the exchange rate fluctuates within a narrow margin of at most Ā1 percent around a central trading or financial partners and currency weights reflect the geographical distribution of trade, services, or capital flows. The currency composites can also be standardized, such as those of SDR and the ecu. The monetary authority stands ready to maintain the fixed parity through intervention, limiting the degree of monetary policy discretion; the degree of flexibility of monetary policy, however, is greater relative to currency board arrangements or currency unions, in that traditional central banking functions are, although limited, still possible, and the monetary authority can adjust the level of the exchange rate, though infrequently.

Pegged Exchange Rates Within Horizontal Bands

The value of the currency is maintained within margins of fluctuation around a formal or de facto fixed peg that are wider than Ã1 percent around a central rate. It also includes the arrangements of the countries in the exchange rate mechanism (ERM) of the European Monetary System (EMS)-replaced with ERM-II on January1, 1999. There is some limited degree of monetary policy discretion, with the degree of discretion depending on the band width.

Crawling Pegs

The currency is adjusted periodically in small amounts at a fixed, preannounced rate in response to changes in selective quantitative indicators (past inflation differentials vis-à-vis major trading partners, differentials between the target inflation and expected inflation in major trading partners, etc.). The rate of crawl can be set to generate inflation adjusted changes in the currency's value ("backward looking"), or at a preannounced fixed rate below the projected inflation differentials ("forward looking"). Maintaining a credible crawling peg imposes constraints on monetary policy in a similar manner as a fixed peg system.

Exchange Rates Within Crawling Bands

The currency is maintained within certain fluctuation margins around a central rate that is adjusted periodically at a fixed preannounced rate or in response to changes in selective quantitative indicators. The degree of flexibility of the exchange rate is a function of the width of the band, with bands chosen to be either symmetric around a crawling central parity or to widen gradually with an asymmetric choice of the crawl of upper and lower bands (in the latter case, there is no preannouncement of a central rate). The commitment to maintain the exchange rate within the band continues to impose constraints on monetary policy, with the degree of policy independence being a function of the band width.

Managed Floating With No Preannounced Path For The Exchange Rate

The monetary authority influences the movements of the exchange rate through active intervention in the foreign exchange market without specifying, or precommitting to, a preannounced path for the exchange rate. Indicators for managing the rate are broadly judgmental, including, for example, the balance of payments position, international reserves, and parallel market developments, and the adjustments may not be automatic.

Independent Floating

The exchange rate is market determined, with any foreign exchange intervention aimed at moderating the rate of change and preventing undue fluctuations in the exchange rate, rather than at establishing a level for it. In these regimes, monetary policy is in principle independent of exchange rate policy.

Source: IMF, Annual Report, 2000.

Table 2. Developing Countries: Officially Reported Exchange Rate Arrangements

(In percent of total)

	1976	1981	1986	1991	1996
Pegged	86	75	67	57	45
US dollar	42	32	25	19	15
French franc	13	12	11	11	11
Other	7	4	4	3	4
SDR	12	13	8	5	2
Composite	12	14	18	20	14
Limited flexibility	3	10	5	4	3
Single	3	10	5	4	3
Cooperative	-	-	-	-	-
More flexible	11	15	28	39	52
Set to indicators	6	3	4	4	2
Managed floating	4	9	13	16	21
Independently floating	1	4	11	19	29
Number of countries	100	113	119	123	123

Source: IMF, 1997.

Table 3. Literature Survey on Purchasing Power Parity for Developed Counties (DCs)

Study	**Frenkel 1981**	**Adler and Lehmann (1983)**
Data	1921:02-1925:08 (monthly)	1964:01-1981:05(monthly data) 1900-1972 (annual data)
Countries	3 DCs vs US	25 LDCs, 18 DCs vs US
Price Index	WPI, cost of living index	CPI,WPI
Version of PPP	Absolute and relative versions	Efficient market version
Exchange Rate Regime	Flexible regimes	Both fixed and flexible regimes
Aim	This study tests whether PPP still hold after collapse of Bretton Woods.	The aim of the study to test whether or not the real exchange rates (RER) come from a martingale process. "Martingale model involves the serial correlation properties of the innovations to the real exchange rate."
Technique	OLS	OLS (F-tests are checked out to test the serial correlation coefficients are jointly zero or not.)
Conclusion	PPP did not work well in the 1970s although it works in the 1920s, because of real shocks instead of monetary shocks	This paper finds that RER follow a martingale process, that is, PPP does not hold, under fixed and flexible periods for monthly and annual data in most of the LDCs and developed countries (DCs). The paper also suggests that the model relies on financial arbitrage in bonds instead of international commodity arbitrage will predict the martingale behavior of RER.

Study	**Enders (1988)**	**Corbae and Ouliaris (1988)**
Data	1960:01-1971:04 1973:01-1986:11 (monthly data)	1973:07-1986:09 (monthly data)
Countries	3 DCs vs US	6 DCs vs US
Price Index	WPI	CPI
Version of PPP	Relative PPP	Absolute PPP
Exchange Rate Regime	Both fixed and flexible regimes	Flexible regime
Aim	This paper considers the importance and persistence of the observed deviations from PPP under alternative exchange rate regimes.	The aim of the paper to examine whether the absolute version of PPP holds or not.
Technique	Arima model and Engle-Granger (1987) cointegration approach with ECM	Engle-Granger (1987) cointegration approach
Conclusion	The Arima tests result in a conclusion that PPP performed poorly in both fixed and flexible periods. The cointegraion tests indicate that there is cointegrating relationship between US and one of the DC's price levels during fixed period, and also there is a support for cointegration US and another DC's price levels during flexible period. Therefore this study does not support the hypothesis of Frenkel (1981) that PPP collapse during 1970s in floating regime.	The long run absolute version of PPP is rejected for all countries.

Table 3 (continue). Literature Survey on Purchasing Power Parity for Developed Counties (DCs)

Study	Kim (1990)	Johansen and Juselius (1992)
Data	1901-1987 (annual)	1972:01-1987:02 (quarterly)
Countries	5 DCs vs US	UK vs US
Price Index	CPI, WPI	WPI
Version of PPP	Absolute PPP	Absolute PPP
Exchange Rate Regime	Whole sample without separating as fixed and flexible.	Flexible regime period
Aim	This study investigates the long run PPP hypothesis and the symmetry and proportionality conditions. Moreover it tests, the real exchange rate follow random walk or not.	This paper develops "new tests for structural hypothesis in the framework of a multivariate error correction with Gaussian errors."
Technique	Engle-Granger (1987) methodology.	Johansen cointegration approach
Conclusion	He finds the cointegration relationship between nominal exchange rate and the price series. Moreover PPP constraints (symmetry and proportionality) holds except one case. Moreover, he finds out that the real exchange rate series do not follow random walk.	Johansen and Juselius (1992) support the PPP theory for the United Kingdom, when interest rate parity is included into the system.

Study	Flynn and Boucher (1993)	Maeso-Frenandez (1998)
Data	1957:01-1972:11 1974:01-1987:11 (monthly data)	1974:01-1994:12 (monthly data) 1948-1994 (annual data)
Countries	2 DCs vs US	19 DCs vs US
Price Index	CPI	CPI, WPI
Version of PPP	Absolute PPP	Relative PPP and efficient version of PPP
Exchange Rate Regime	Both fixed and flexible regimes	Flexible regime
Aim	The paper's aim is to consider the possibility of a structural break over the sample period under investigation.	The aim of the this study is to check PPP in both short and long run, by using different versions and data frequencies.
Technique	Dickey Fuller (1981) and Perron (1989) unit root tests. Engle-Granger (1987) cointegration approach; ADF, Durbin Watson test for cointegration (CRDW) and Peron (1989) tests are applied to test the stationarity of cointegrating regression residual.	Variance Ratio Test. "Although DF, ADF and PP tests examine stationarity or nonstationarity of real exchange rate series without considering the importance of nonstationary component of real exchange rate series, the variance ratio test analyses the contribution of the nonstationary component to the variance of the series."
Conclusion	Regardless of the procedure employed, PPP does not hold as a long run concept for both DCs during either fixed or flexible exchange rate regime. The paper findings substantiate those more recent studies that rely on unit root procedures but have ignored the bias to their finding caused by structural break.	Maeso-Fernandez (1998) study finds support in favor of PPP. He finds more supportive results to relative PPP with annual data and WPI, however, PPP not hold in short run.

Table 3 (concluded). Literature Survey on Purchasing Power Parity for Developed Counties (DCs)

Study	**Ramirez and Khan (1999)**
Data	1973:01-1996:12 (monthly, quarterly and annually data are considered.)
Countries	5 DCs vs US
Price Index	CPI
Version of PPP	Absolute PPP
Exchange Rate Regime	Flexible regime
Aim	This paper investigates the PPP hypothesis for DCs for both short and long run.
Technique	Johansen (1988) and Johansen (1990) cointegration approach, ECM.
Conclusion	The results differ from those of prior studies, although Corbae and Ouliaris (1988) do not find any evidence of cointegration just for the same countries, this study have found the cointegrating relationship for each of five DCs. However PPP hypothesis does not hold for short run. ECM are computed for each of monthly, quarterly and annually data set. It is found that monthly data models are better forecaster for exchange rates.

Table 4. Literature Survey on Purchasing Power Parity for Less Developed Counties (LDCs)

Study	*Conejo And Shields (1993)*	*Seabra (1995)*	*Bahmani-Oskooee (1995)*	*Calvo, Reinhart And Vegh (1995)*	*Devereux And Connolly (1996)*
Data					
Frequency	Annual	Quarterly	Quarterly	Quarterly	Quarterly
Period covered	1949-1990	1970-1989	1971-1990	1978-1992	1973-1990
Countries					
In number	5	11	22	3	18
Region	Latin America	Latin America	Various Regions	Latin America	Latin America
Price Index					
CPI	X		X	X	
WPI	X				
Mixed		X			X
Exchange Rate					
Bilateral US	X	X			
Multilateral			X	X	X
Exchange Rate Regime (fixed or flexible)	No Specific Seperation	No Specific Seperation	No Specific Seperation	No Specific Seperation	No Specific Seperation
Techniques:					
Unit root tech.:			**X**	**X**	**X**
DF, ADF			X	X	X
PP			X	X	X
Variance ratios				X	
Other					
Cointegration tech.:	**X**	**X**			
Engle-Granger	X	X			
DF, ADF	X	X			
PP					
Johansen tech.		X			
Fractional cointegration tech.					
Error correct. model	**X**				
Panel Data tech.					
Version of PPP	Relative	Relative	Absolute	Absolute	Absolute
Conclusions:					
Stationarity of Real exchange rate		Not Tested	Accept in 8 Cases (PP Test)	Not Found	Rejected (Found As I(1))
Cointegration relationship between exchange rate and prices	Accepted in 2 Cases	Accepted in 4 Cases(Engle-Granger tech.) Accepted in 4 Cases(Johansen tech.)			
Symmetry	Imposed	Imposed	Imposed	Imposed	Imposed
Proportionality	Hold in 3 Cases	Hold in 4 Cases	Imposed	Imposed	Imposed

Table 4 (continue). Literature Survey on Purchasing Power Parity for Less Developed Counties (LDCs)

Study	*Soofi (1998)*	*Filho (1999)*	*Razzaghipour, Fleming And Heaney (2000)*	*Holmes (2000)*
Data Frequency Period covered	 Monthly 1957-1989	 Annual 1855-1990	 Quarterly 1971-1997	 Quarterly 1974-1997 1960-1973
Countries In number Region	 9 OPEC countries	 1(Brazil) Latin America	 5 South East Asia	 27 Africa
Price Index CPI WPI Mixed*	 X	 No Precise Explanation	 X	 X
Exchange Rate Bilateral US Multilateral	 X	 No Precise Explanation	 X	 X
Exchange Rate Regime(fixed-flexible)	No Specific Seperation	No Specific Seperation	No Specific Seperation	
Techniques:				
Unit root tech.: DF, ADF PP Variance ratios Other	 	**X** X X X	**X** X 	**X** X
Cointegration tech.: Engle-Granger DF, ADF PP Johansen tech. Fractional cointegration	**X** X X X	 	**X** X 	
Error correct. Model			**X**	
Panel Data tech.				**X**
Version of PPP	Absolute	Absolute	Absolute	Relative
Conclusions:				
Stationarity of Real exchange rate Cointegration relationship between exchange rate and prices	 Not Found(Engle-Granger Methodology) Accepted in 4 Cases(Fractional Cointegration)	Not Found With All Tests	Not Found Accepted in 5 Cases	Not Found (in Unit root Test) Found (in Panel Data Unit Root Test)
Symmetry	Imposed	Imposed	Imposed (in Unit Root Test) not found in johansen	imposed
Proportionality	Imposed	Imposed	Imposed (in Unit Root Test) not found in johansen	imposed

Table 5. Relative Prices of Big Macs Across Selected Countries

Country	Price of Big Mac (in Dollars)
Switzerland	5.20
Denmark	4.92
Japan	4.65
Belgium	3.84
Germany	3.48
United States	2.32
Canada	1.99
Russia	1.62
Hong Kong	1.23
China	1.05

Source: Rogoff, 1996.

Table 6. Exchange Rate Regimes of the 16 LDCs:

	WHOLE SAMPLE	FIXED	FLEXIBLE
Thailand	1965:01-1999:12	1965:01-1997:06	
Philippines	1957:01-1999:12	1957:01-1972:12	1973:01-1999:12
Indonesia	1968:01-1999:12	1968:01-1977:12	1978:11-1999:12
Korea	1970:01-1999:12	1970:01-1979:12	1980:03-1999:12
Malaysia	1957:01-1999:12	**Case1**1957:01-1972:12 **Case2**1975:01-1992:12 (omit 1973-1974)	
Mexico	1957:01-1999:12	1957:01-1975:12	1976:01-1999:12 (omit 1994)
Brazil	1979:12-1999:12		1979:12-1999:12 (omit 1994)
Argentina	1959:01-1999:12	**Case1**1959:01-1977:12 **Case2**1991:03-1999:12	1978:01-1990:12
Colombia	1957:01-1999:12	1957:01-1972:12	1979:01-1999:12
Chile	1957:01-1999:12	1957:01-1977:12	1982:10-1999:12
Venezuela	1957:01-1999:12	1957:01-1988:12	1989:04-1994:06
Peru	1960:01-1999:12	1960:01-1976:12	1990:08-1999:12
Kenya	1968:01-1999:12	1968:01-1993:09	
Turkey	1969:01-1999:12	1969:01-1979:12	1980:01-1999:12
India	1957:01-1999:12	1957:01-1978:12	1979:02-1999:12
Pakistan	1957:01-1999:12	1957:01-1981:12	1982:01-1999:12

Table 6 is constituted by combining the information set in Table 6.a and Table 6.b. How Table 6 is created is explained in detail at the end of the Table 6.c.

Table 6.a Exchange Rate Regimes of the 16 LDCs:

	FIXED	LIMITED FLEXIBILITY
Thailand	1970:01-1997:06	
Philippines		
Indonesia		
Korea		
Malaysia	1990:03-1992:11	1986:01-1990:02
Mexico		
Brazil		
Argentina	1991:03-1999:04	
Colombia		
Chile		
Venezuela	1994:06-1996:03	
Peru		
Kenya	1970:01-1993:09	
Turkey		
India		
Pakistan		
United States		

	MANAGED FLOATING	FLOATING
Thailand		1997:07-1999:04
Philippines		1988:01-1999:04
Indonesia	1978:11-1997:06	1997:07-1999:04
Korea	1980:03-1997:10	1997:11-1999:04
Malaysia	1992:12-1998:09	
Mexico	1989:01-1994:11	1994:11-1999:04
Brazil	1994:07-1998:12	
Argentina		
Colombia	1979:01-1999:04	
Chile	1982:10-1999:04	
Venezuela	1996:04-1999:04	1989:03-1994:06
Peru		1990:08-1999:04
Kenya	1998:01-1999:04	1993:10-1997:11
Turkey	1980:01-1999:04	
India	1979:02-1993:02	1993:03-1999:04
Pakistan	1982:01-1999:04	
United States		1973:02-1999:04

Source: Guillermo A. Calvo & Carmen Reinhart, 2000.

Table 6.b Exchange Rate Regimes of the 16 LDCs:

	Thailand	Philippines	Indonesia	Korea
	THA 1/	PHL	IDN 1/	KOR 1/
Single currency peg	1973:01-1977:12		1973:01-1977:12	1973:01-1979:12
Currency board				
No changes in parity				
Infrequent adjustments				
Frequent adjustments				
SDR peg				
No changes in parity				
Infrequent adjustments				
Frequent adjustments				
Other official basket peg	1978:01-1981:12			
No changes in parity				
Infrequent adjustments				
Frequent adjustments				
Secret basket peg	1984:01-1995:12			
No changes in parity				
Infrequent adjustments				
Frequent adjustments				
Cooperative arrangement (EMS or predecessor)				
More flexible	1982:01-1983:12		1978:01-1982:12	
Rule based				
Crawling peg				
Target zone				
Managed floating			1983:01-1995:12	1980:01-1995:12
With heavy intervention		1983:01-1983:12		
With light intervention		1973:01-1978:12		
Independent float		1979:01-1982:12 1984:01-1995:12		

Source: Ghosh, Gulde, Ostry and Wolf, 1997.

More information on subcategories available:

1/ denotes: Reference currency US dollar.

Table 6.b (continue). Exchange Rate Regimes of the 16 LDCs:

	Malaysia	Mexico	Brazil	Argentina
	MYS	MEX 1/	BRA	ARG 2/
Single currency peg		1973:01-1975:12	1974:01-1974:12 1994:01-1994:12	
Currency board				1991:01-1996:12
No changes in parity				1973:01-1973:12
Infrequent adjustments				1974:01-1974:12
Frequent adjustments			1975:01-1977:12	1975:01-1977:12
SDR peg				
No changes in parity				
Infrequent adjustments				
Frequent adjustments				
Other official basket peg				
No changes in parity				
Infrequent adjustments				
Frequent adjustments				
Secret basket peg	1975:01-1992:12			
No changes in parity				
Infrequent adjustments				
Frequent adjustments				
Cooperative arrangement (EMS or predecessor)				
More flexible	1973:01-1974:12	1976:01-1982:12	1973:01-1973:12 1978:01-1989:12	
Rule based				
Crawling peg				
Target zone				1979:01-1981:12 1986:01-1986:12
Managed floating	1993:01-1995:12	1983:01-1993:12	1991:01-1991:12 1995:01-1995:12	
With heavy intervention				1978:01-1978:12 1982:01-1985:12 1987:01-1990:12
With light intervention			1990:01-1990:12	
Independent float		1994:01-1995:12	1992:01-1993:12	

More information on subcategories available:

1/ denotes: Reference currency US dollar.

2/ denotes: Pegged or crawling in reference to US dollar.

Table 6.b (continue) Exchange Rate Regimes of the 16 LDCs:

	Colombia*	Chile	Venezuela	Peru
	COL	CHL 1/	VEN 1/	PER 1/
Single currency peg		1974:01-1974:12 1979:01-1982:12	1994:01-1995:12	
Currency board				
No changes in parity			1973:01-1975:12 1977:01-1982:12	1973:01-1974:12 1986:01-1986:12
Infrequent adjustments			1976:01-1976:12	1975:01-1975:12 1985:01-1985:12
Frequent adjustments		1975:01-1977:12	1983:01-1988:12	1976:01-1976:12 1987:01-1989:12
SDR peg				
No changes in parity				
Infrequent adjustments				
Frequent adjustments				
Other official basket peg				
No changes in parity				
Infrequent adjustments				
Frequent adjustments				
Secret basket peg				
No changes in parity				
Infrequent adjustments				
Frequent adjustments				
Cooperative arrangement (EMS or predecessor)				
More flexible		1973:01-1973:12 1978:01-1978:12		
Rule based	1975:01-1993:12			
Crawling peg		1983:01-1995:12		
Target zone				1977:01-1978:12 1980:01-1982:12 1984:01-1984:12
Managed floating	1994:01-1995:12		1993:01-1993:12	
With heavy intervention				1979:01-1979:12
With light intervention				1983:01-1983:12
Independent float			1989:01-1992:12	1990:01-1995:12

* Data set between 1973-1974 is not available in Colombia.

More information on subcategories available:

1/ denotes: Reference currency US dollar.

Table 6.b (concluded) Exchange Rate Regimes of the 16 LDCs:

	Kenya	Turkey	India	Pakistan*
	KEN 1/	TUR 1/	IND 3/	PAK 1/
Single currency peg	1973:01-1974:12		1973:01-1974:12	1973:01-1981:12
Currency board				
No changes in parity		1973:01-1974:12		
Infrequent adjustments				
Frequent adjustments				
SDR peg	1975:01-1986:12			
No changes in parity				
Infrequent adjustments				
Frequent adjustments				
Other official basket peg			1975:01-1978:12	
No changes in parity				
Infrequent adjustments				
Frequent adjustments				
Secret basket peg	1987:01-1992:12			
No changes in parity				
Infrequent adjustments				
Frequent adjustments				
Cooperative arrangement (EMS or predecessor)				
More flexible			1979:01-1982:12	
Rule based				
Crawling peg				
Target zone				
Managed floating		1991:01-1995:12	1983:01-1992:12	1991:01-1995:12
With heavy intervention		1975:01-1987:12		
With light intervention		1988:01-1990:12		
Independent float	1993:01-1995:12		1993:01-1995:12	

*Data set between 1982-1990 is not available in Pakistan.

More information on subcategories available:

1/ denotes: Reference currency US dollar.

3/ denotes: Pegged to Pound Sterling.

Table 6.c Exchange Rate Regimes of the 16 LDCs:

	FIXED	LIMITED FLEXIBILITY	MANAGED FLOATING	FLOATING
Thailand	**1970:01-1997:06** *1973:01-1981:12* *1984:01-1995:12*	*1982:01-1983:12*		**1997:07-1999:04**
Philippines			*1973:01-1978:12* *1983:01-1983:12*	**1988:01-1999:04** *1979:01-1982:12* *1984:01-1995:12*
Indonesia	*1973:01-1977:12*	*1978:01-1982:12*	**1978:11-1997:06** *1983:01-1995:12*	**1997:07-1999:04**
Korea	*1973:01-1979:12*		**1980:03-1997:10** *1980:01-1995:12*	**1997:11-1999:04**
Malaysia	**1990:03-1992:11** *1975:01-1992:12*	**1986:01-1990:02** *1973:01-1974:12*	**1992:12-1998:09** *1993:01-1995:12*	
Mexico	*1973:01-1975:12*	*1976:01-1982:12*	**1989:01-1994:11** *1983:01-1993:12*	**1994:11-1999:04** *1994:01-1995:12*
Brazil	*1974:01-1977:12* *1994:01-1994:12*	*1973:01-1973:12* *1978:01-1989:12*	**1994:07-1998:12** *1990:01-1991:12* *1995:01-1995:12*	*1992:01-1993:12*
Argentina	**1991:03-1999:04** *1973:01-1977:12* *1991:01-1996:12*		*1978:01-1990:12*	
Colombia		*1973:01-1974:12*(NA) *1975:01-1993:12*	**1979:01-1999:04** *1994:01-1995:12*	
Chile	*1974:01-1977:12* *1979:01-1982:12*	*1973:01-1973:12* *1978:01-1978:12* *1983:01-1995:12*	**1982:10-1999:04**	
Venezuela	**1994:06-1996:03** *1973:01-1988:12* *1994:01-1995:12*		**1996:04-1999:04** *1993:01-1993:12*	**1989:03-1994:06** *1989:01-1992:12*
Peru	*1973:01-1976:12* *1985:01-1989:12*	*1977:01-1982:12* *1984:01-1984:12*	*1983:01-1983:12*	**1990:08-1999:04** *1990:01-1995:12*
Kenya	**1970:01-1993:09** *1973:01-1992:12*		**1998:01-1999:04**	**1993:10-1997:11** *1993:01-1995:12*
Turkey	*1973:01-1974:12*	*1975:01-1995:12*	**1980:01-1999:04**	
India	*1973:01-1978:12*	*1979:01-1982:12*	**1979:02-1993:02** *1983:01-1992:12*	**1993:03-1999:04** *1993:01-1995:12*
Pakistan	*1973:01-1981:12*		**1982:01-1999:04** *1982:01-1990:12*(NA) *1991:01-1995:12*	
United States				**1973:02-1999:04**

NA: NOT AVAILABLE

The exchange rate regimes from Calvo and Reinhart (2000) article and from Ghosh, Gulde, Ostry and Wolf (1997) article are represented together in Table 6.c. Years of exchange rate arrangements taken from Calvo and Reinhart (2000) article are written in bold numbers.

In Ghosh article the exchange rate regimes represented as single currency peg, SDR peg, other official basket peg, secret basket peg and their variations are just considered as fixed in this study. Also, cooperative arrangement (EMS or

predecessor), more flexible exchange rate regime and their variations are considered just as limited flexibility exchange rate regime.

Construction of Table 6

Table 6 is constructed by separating the exchange rate regimes into two categories: the fixed and flexible regimes. Therefore, regime periods of managed floating and floating in Table 6.c are combined and called as flexible. However, we cannot classify limited flexibility regime directly as fixed or flexible. Therefore, we consider two cases: first of all, limited flexibility period is included in flexible regime period and secondly; it is ignored.

Ghosh, Gulde, Ostry and Wolf (1997) examine the exchange rate regimes period annually between 1973-1996. Since, we study with monthly data, we consider this period as 1973:01-1996:12. Although Calvo & Reinhart (2000) study the regimes up to 1999:04, by controlling from IMF Annual Report (2000) we expand this date up to 1999:12.

Also, as stated in Section 4 of this study, during the collapse of Bretton Woods system (1944-1973), all countries either developed or developing were required to sustain some type of currency peg. Therefore, we just consider our 16 LDCs regimes as fixed during 1957-1972 period.

Before explaining Table 6, let's *study 1* represents Calvo & Reinhart (2000) article and *study 2* represents Ghosh, Gulde, Ostry and Wolf (1997) article.

For Thailand, study 1's periods are used. That is, Thailand regime between 1970:01-1997:06 fixed and between 1997:07-1999:04 flexible. However, Thailand's whole data lie between1965:01-1999:12. Since 1965:01-1969:12 period is in the Bretton Woods system, we directly include this period in fixed period. Hence, we have showed Thailand regime between 1965:01-1997:06 as fixed and between 1997:07-1999:12 as flexible.

For Philippines, both study 1 and study 2 are used. Since, its whole period lies in 1957:01-1999:12, 1957:01-1972:12 period is directly considered as fixed regime period. From study1 we see that regime is flexible during 1988:01-1999:04 and from study 2, it is observed that 1973-1995 is flexible regime period. Hence, by combining these informations we have stated that 1973:01-1999:12 is flexible period.

For Indonesia, both study 1 and study 2 are used. Since, its whole period lies in 1968:01-1999:12, 1968:01-1972:12 period is directly considered as fixed regime period. From study 2 1973-1977 is observed as fixed. Hence, by combining these informations, it have been concluded that 1968:01-1977:12 is fixed period. From study1, we see that 1978:11-1999:04 is flexible regime period. After controlling from IMF Annual Report 2000, we conclude that 1978:11-1999:12 is flexible regime period.

For Korea, both study 1 and study 2 are used. Since, its whole period lies in 1970:01-1999:12, 1970:01-1972:12 period is directly considered as fixed regime period. From study 2, 1973-1979 is observed as fixed. Hence, by combining these informations, it have been concluded that 1970:01-1979:12 is fixed period. From study1, we see that 1980:03-1999:04 is flexible regime period. After controlling from IMF Annual Report 2000, we conclude that 1980:03-1999:12 is flexible regime period.

For Malaysia, both study 1 and study 2 are used. Since, its whole period lies in 1957:01-1999:12, 1957:01-1972:12 period is directly considered as fixed regime period. From study 2, 1975-1992 is observed as fixed. From study 2, we see that 1993:01-1995:12 is flexible regime period. Also from study 1, 1992:11-1998:09 is flexible period. By combining these informations 1993:01-1998:12 is taken as flexible regime period. Since 1973-1974 period is limited flexible, we ignore this period.

For Mexico, both study 1 and study 2 are used. Since, its whole period lies in 1957:01-1999:12, 1957:01-1972:12 period is directly considered as fixed regime period. From study 2, 1973-1975 is observed as fixed. Hence, by combining these informations, it have been concluded that 1957:01-1975:12 is fixed period. From study 2, we see that 1983:01-1995:12 is flexible regime period. From study 1, 1989:01-1999:04 is observed as flexible. Hence, by combining this information, it have been concluded that 1983:01-1999:12 is flexible period. Moreover, in study 2, 1976:01-1982:12 period that stated as limited flexible, therefore it is included in flexible regime.1994 is omitted because of crises.

For Brazil, both study 1 and study 2 are used. Since, its whole period lies in 1979:01-1999:12 the previous periods exchange rate regime did not stated in Table 5. From study 2, 1990:01-1993:12 is observed as flexible. From study 1, we see that 1994:07-1998:12 is also flexible regime period. Hence, by combining these information and IMF annual report 2000 result, it has been concluded that 1990:01-1999:12 is flexible period. Moreover, in study 2, 1979:01-1989:12 period that stated as limited flexible, therefore it is included in flexible regime. 1994 is omitted because of crises.

For Argentina, both study 1 and study 2 are used. Since, its whole period lies in 1959:01-1999:12, 1959:01-1972:12 period is directly considered as fixed regime period. From study 2, 1973:01-1977:12 and 1991:01-1996:12 is observed as fixed. From study 1, we see that 1991:03-1999:04 is fixed regime period. Hence, by combining these information and IMF report result, it have been concluded that 1959:01-1977:12 and 1991:01-1999:12 are fixed period. Moreover, from study 2, 1978:01-1990:12 period that stated as flexible.

For Colombia, both study 1 and study 2 are used. Since, its whole period lies in 1957:01-1999:12, 1957:01-1972:12 period is directly considered as fixed regime period. From study 1, we see that 1979:01-1999:04 is flexible regime period. Hence, by combining this information and IMF report result, it has been concluded that 1979:01-1999:12 is flexible period.

For Chile, both study 1 and study 2 are used. Since, its whole period lies in 1957:01-1999:12, 1957:01-1972:12 period is directly considered as fixed regime period. From study 2, 1974-1977 and 1979-1982 are observed as fixed. Hence, by combining these information, it have been concluded that 1957:01-1977:12 and 1979:01-1982:09 are fixed periods. Moreover, in study 2, 1982:10-1999:04 period that stated flexible.

For Venezuela, both study 1 and study 2 are used. Since, its whole period lies in 1957:01-1999:12, 1957:01-1972:12 period is directly considered as fixed regime period. From study 2, 1973:01-1988:12 is observed as fixed. Hence, by combining these information, it have been concluded that 1957:01-1988:12 is fixed period. The rest of the periods are directly taken from study 1.

For Peru, both study 1 and study 2 are used. Since, its whole period lies in 1960:01-1999:12, 1960:01-1972:12 period is directly considered as fixed regime period. From study 2, 1973:01-1976:12 and 1985:01-1989:12 are observed as fixed. Hence, by combining these information, it have been concluded that 1960:01-1976:12 and 1985:01-1989:12 are fixed period. From study 2, 1990:08-1999:04 period is considered as flexible, (1983 is omitted because it is the passing from fixed to flexible year). Moreover, since 1977-1982 period shows limited flexibility 1977:01-1983:12 period that stated as flexible in Case 2.

For Kenya, just study 1 is used. Since, its whole period lies in 1968:01-1999:12, 1968:01-1972:12 period is directly considered as fixed regime period. From study 1, 1970:01-1993:09 is observed as fixed. Hence, by combining these information, it has been concluded that 1968:01-1993:09 is fixed. The flexible period is directly taken from study 1.

For Turkey, both study 1 and study 2 are used. Since, its whole period lies in 1969:01-1999:12, 1969:01-1972:12 period is directly considered as fixed regime period. From study 2, 1973:01-1974:12 is observed as fixed. Moreover, 1975-1995 periods are considered as limited flexibility periods. Hence, by combining these information, it have been concluded that 1969:01-1979 is fixed period. From study 2, 1980:01-1999:04 period is considered as flexible.

For India, both study 1 and study 2 are used. Since, its whole period lies in 1957:01-1999:12, 1957:01-1972:12 period is directly considered as fixed regime period. From study 2, 1973-1978 is observed as fixed. Hence, by combining these information, it have been concluded that 1957:01-1978:12 is fixed periods. The flexible period is directly taken from study 1.

For Pakistan, both study 1 and study 2 are used. Since, its whole period lies in 1957:01-1999:12, 1957:01-1972:12 period is directly considered as fixed regime period. From study 2, 1973-1981 is observed as fixed. Hence, by combining these information, it have been concluded that 1957:01-1981:12 is fixed periods. The flexible period is directly taken from study 1.

Table 7.a Unit Root Tests Results For Real Exchange Rates (RER): Whole Sample Period

	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
	DF	**DF**	**ADF**	**ADF**	**PP**	**PP**
Thailand	-0.99	-15.33***	-1.52(7)	-7.82***(6)	-1.67	-15.12***
Philippines	-2.74*	-19.93***	-2.79*	-8.34*(11)	-3.05**	-19.89***
Indonesia	-0.82	-16.497***	-0.75(10)	-6.99***(9)	-1.17	-16.54***
Korea	-1.79	-12.26***	-2.48(9)	-5.94***(9)	-2.15	-11.26***
Malaysia	-0.02	-17.96***	-0.64(8)	-7.71***(7)	-0.69	-18.23***
Mexico	-3.30**	-21.24***	-3.79***(12)	-6.83***(8)	-3.63***	-21.21***
Brazil	-1.16	-10.88***	-1.98(11)	-3.74***(10)	-1.46	-10.32***
Argentina	-2.85*	-23.91***	-2.83*(9)	-6.92***(8)	-2.84*	-23.86***
Colombia	-3.21**	-20.64***	-3.62***(3)	-13.39***(2)	-3.21**	-20.55***
Chile	-1.74	-31.80***	-1.20(7)	-9.87***(6)	-1.30	-32.76***
Venezuela	-2.11	-21.77***	-2.04(2)	-16.97***(1)	-1.97	-21.94***
Peru	-1.74	-20.84***	-1.17(7)	-11.03***(5)	-1.46	-21.34***
Kenya	-1.83	-16.17***	-1.98(11)	-6.57***(10)	-2.25	-16.02***
Turkey	-1.99	-17.56***	-2.05(12)	-11.53***(2)	-1.95	-17.53***
India	-0.11	-21.03***	-0.23(1)	-21.03***(0)	-0.33	-21.16***
Pakistan	-0.43	-15.07***	-0.76(12)	-6.93***(12)	-0.87	-14.55***

NOTES:

1) ***, **, * denote significance at 1%, 5%, 10% levels respectively.
2) ADF regression the lagged differences introduced into the model to make the residuals white noise process. The number in parenthesis denotes the significant lagged differenced terms.
3) In all DF, ADF and PP tests regressions for level and first differences of the series i.e. I(0), I(1) constant term is included, but deterministic trend is not.

Table 7.b Unit Root Tests Results For Real Exchange Rates (RER): Fixed Exchange Rate Regime Period

	I(0)	I(1)
	ADF	ADF
Thailand	-1.81(3)	-9.24***(2)
Philippines	-1.25(2)	-8.81***(1)
Indonesia	0.16(0)	-4.61***(6)
Korea	-0.66(1)	-8.61***(0)
Malaysia		
Case 1	-1.66(1)	-10.46***(0)
Case 2	-1.86(1)	-11.10***(0)
Argentina		
Case 1	-2.74*(5)	
Case 2	-1.29(6)	-3.04**(5)
Colombia	-3.56***(0)	
Chile	-0.33(4)	-8.37***(3)
Venezuela	-2.01(1)	-17.78***(0)
Peru	-2.34(2)	-5.19***(6)
Kenya	-0.89(1)	-14.40***(0)
Turkey	-1.65(0)	-11.63***(0)
India	-2.08(0)	-15.48***(0)
Pakistan	-2.31(3)	-11.51***(1)

Table 7.c Unit Root Tests Results For Real Exchange Rates (RER): Flexible Exchange Rate Regime Period

	I(0)	I(1)
	Adf	Adf
Philippines	-2.94**(0)	
Indonesia	-1.57(5)	-5.86***(4)
Korea	-1.70(6)	-6.87***(5)
Mexico	-2.75*(5)	
Brazil	-1.45(2)	-10.55***(1)
Argentina	-1.90(0)	-13.87***(0)
Colombia	-1.44(5)	-7.24***(4)
Chile	-1.89(5)	-5.15***(4)
Venezuela	-1.77(1)	-2.89**(0)
Peru	4.75(1)	-0.89(5)
Turkey	-2.97**(3)	
India	-0.88(1)	-13.74***(0)
Pakistan	-2.54(1)	-10.85***(0)

NOTES: 1) ***, **, * denote significance at 1%, 5%, 10% levels respectively.
2) ADF regression the lagged differences introduced into the model to make the residuals white noise process. The number in parenthesis denotes the significant lagged differenced terms. **3)** In all ADF test regressions for level and first differences of the series i.e. I(0), I(1) constant term is included, but deterministic trend is not.

Table 8.a Unit Root Tests Results For Log(E) And Log(P/P*), Log(P) Series (Fixed Exchange Rate Regime Period)

	I(0)	I(1)	I(2)
	ADF	ADF	ADF
Thailand			
log(E)	-2.24(3)	-10.36***(4)	
log(P/P*)	-2.39(6)	-5.13***(6)	
log(P)	-1.11(3)	-4.13***(6)	
Philippines			
log(E)	-2.54(3)	-9.41***(0)	
log(P/P*)	-1.81(6)	-10.09***(0)	
log(P)	-1.24(6)	-9.74***(0)	
Indonesia			
log(E)	-5.73***(6)		
log(P/P*)	-1.97(0)	-5.07***(6)	
log(P)	-1.59(0)	-4.62***(6)	
Korea			
log(E)	-1.47(1)	-13.71***(0)	
log(P/P*)	-2.72(1)	-6.11***(2)	
log(P)	0.71(1)	-6.06***(0)	
Malaysia			
Case 1			
log(E)	-1.24(3)	-6.70***(3)	
log(P/P*)	-1.78(1)	-6.03***(5)	
log(P)	-1.57(0)	-6.07***(5)	
Case 2			
log(E)	-2.44(4)	-6.27***(4)	
log(P/P*)	-0.96(6)	-5.22***(5)	
log(P)	-1.54(6)	-4.20***(5)	
Argentina			
Case 1			
log(E)	-0.43(5)	-3.39**(4)	
log(P/P*)	1.31(2)	-2.46(6)	-10.65***(6)
log(P)	1.62(2)	-2.41(6)	-10.73***(6)
Case 2			
log(E)	-1.81(5)	-11.39***(1)	
log(P/P*)	-3.63**(6)	-3.73***(5)	
log(P)	-4.94***(5)	-3.76***(5)	

NOTES: 1) ***, **, * denote significance at 1%, 5%, 10% levels respectively.
2) ADF regression the lagged differences introduced into the model to make the residuals white noise process. The number in parenthesis denotes the significant lagged differenced terms. **3)** In all ADF test regressions for level of the series i.e. I(0), both constant and trend components are included. However in ADF regressions for first and second differenceses of series i.e. I(1), I(2) only constant is included.

Table 8.a (continue). Unit Root Tests Results For Log(E) And Log(P/P*), Log(P) Series (Fixed Exchange Rate Regime Period)

	I(0)	I(1)	I(2)
	ADF	**ADF**	**ADF**
Colombia			
log(E)	-2.86(6)	-13.38***(0)	
log(P/P*)	-1.84(2)	-8.23***(1)	
log(P)	-2.58(5)	-8.26***(1)	
Chile			
log(E)	0.96(3)	-3.80***(5)	
log(P/P*)	0.08(6)	-2.78*(6)	
log(P)	0.75(3)	-2.82*(6)	
Venezuela			
log(E)	-0.81(1)	-17.52***(0)	
log(P/P*)	5.16(5)	-1.68(6)	-10.93***(6)
log(P)	2.67(6)	-1.63(6)	-10.67***(6)
Peru			
log(E)	-1.47(1)	-10.89***(0)	
log(P/P*)	-0.30(1)	-3.23**(5)	
log(P)	1.29(6)	-2.87**(5)	
Kenya			
log(E)	2.43(2)	-5.28***(5)	
log(P/P*)	2.55(6)	-3.76***(5)	
log(P)	0.57(6)	-4.01***(5)	
Turkey			
log(E)	-2.32(0)	-16.47***(0)	
log(P/P*)	1.43(6)	-1.84(5)	-11.76***(4)
log(P)	1.82(6)	-1.44(5)	-11.86***(4)
India			
log(E)	-2.16(0)	-15.54***(0)	
log(P/P*)	-0.99(4)	-7.04***(3)	
log(P)	-2.32(4)	-5.75***(6)	
Pakistan			
log(E)	-2.44(3)	-8.32***(2)	
log(P/P*)	-1.71(1)	-15.03***(0)	
log(P)	-1.16(2)	-9.61***(1)	

NOTES: 1) ***, **, * denote significance at 1%, 5%, 10% levels respectively.
2) ADF regression the lagged differences introduced into the model to make the residuals white noise process. The number in parenthesis denotes the significant lagged differenced terms. **3)** In all ADF test regressions for level of the series i.e. I(0), both constant and trend components are included. However in ADF regressions for first and second differenceses of series i.e. I(1), I(2) only constant is included.

8. b Engle-Granger Test Results

(Fixed Exchange Rate Regime Period)

*Result of Regression $Log(E_t) = \theta_0 + \theta_1 Log(P_t/P_t^*) + u_t$

*Unit Root Tests Results For Error Series (u_t)

	(θ_0)	(θ_1)	R^2	σ	Adf for u_t I(0)	Adf for u_t I(1)
Thailand	3.19	0.79	0.26	0.09	-1.711(3)	-16.25***(0)
Philippines	5.91	2.56	0.84	0.17	-2.25(6)	-6.37***(5)
Indonesia	6.26	0.26	0.47	0.09	-2.67*(1)	
Korea	6.54	0.68	0.84	0.06	-2.11(1)	-8.84***(0)
Malaysia						
Case 1	1.07	0.11	0.23	0.02	-1.61(5)	-6.61***(3)
Case 2	0.93	-0.33	0.25	0.06	-2.15(4)	-6.26***(4)
Argentina						
Case 1	-0.42	0.96	0.96	0.31	-2.73*(5)	
Case 2	0.00	0.07	0.55	0.00	-2.68*(1)	
Colombia	7.87	1.33	0.91	0.16	-3.71***(0)	
Chile	5.99	1.12	0.99	0.13	-2.89**(4)	
Venezuela	6.63	1.57	0.66	0.21	-2.32(1)	-17.75***(0)
Peru	-4.69	0.66	0.82	0.09	-2.31(1)	-9.69***(1)
Kenya	4.20	1.22	0.95	0.12	-1.89(6)	-15.37***(0)
Turkey	8.56	0.77	0.85	0.13	-2.73*(0)	
India	2.76	1.13	0.81	0.11	-2.27(0)	-15.31***(0)
Pakistan	3.18	1.54	0.79	0.16	-2.93**(2)	

NOTES:1) R^2 represents coefficient of determination, σ represents the standard error of regression.
2) ***, **, * denote significance at 1%, 5%, 10% levels respectively.
3) ADF regression the lagged differences introduced into the model to make the residuals white noise process. The number in parenthesis denotes the significant lagged differenced terms.
4) In all ADF tests regressions for level and first differences of the series i.e. I(0), I(1) constant term is included, but deterministic trend is not.

Table 8. c Unit Root Tests Results For Log(E) And Log(P/P*), Log(P) Series (Flexible Exchange Rate Regime Period)

	I(0)	I(1)	I(2)
	ADF	**ADF**	**ADF**
Philippines			
log(E)	-1.99(4)	-8.57***(2)	
log(CPI_{LDC}/CPI_{US})	-2.84(0)	-17.41***(0)	
log(CPI_{LDC})	-1.85(6)	-3.21**(4)	
Indonesia			
log(E)	-2.96(5)	-5.32***(4)	
log(CPI_{LDC}/CPI_{US})	-1.99(5)	-4.47***(6)	
log(CPI_{LDC})	-2.52(5)	-4.55***(6)	
Korea			
log(E)	-1.73(5)	-6.79***(5)	
log(CPI_{LDC}/CPI_{US})	-1.85(1)	-11.11***(0)	
log(CPI_{LDC})	-2.53(6)	-4.61***(5)	
Mexico			
log(E)	-0.86(5)	-4.22***(4)	
log(CPI_{LDC}/CPI_{US})	-1.08(4)	-3.12**(3)	
log(CPI_{LDC})	-0.79(4)	-3.06**(3)	
Brazil			
log(E)	-0.57(3)	-2.39(4)	-8.34***(6)
log(CPI_{LDC}/CPI_{US})	-0.63(2)	-3.16**(1)	
log(CPI_{LDC})	-0.61(2)	-3.14**(1)	
Argentina			
log(E)	-1.74(4)	-3.18**(6)	
log(CPI_{LDC}/CPI_{US})	-0.39(3)	-3.19**(5)	
log(CPI_{LDC})	-1.85(6)	-3.21**(4)	

NOTES:
1) ***, **, * denote significance at 1%, 5%, 10% levels respectively.
2) ADF regression the lagged differences introduced into the model to make the residuals white noise process. The number in parenthesis denotes the significant lagged differenced terms.
3) In all ADF test regressions for level of the series i.e. I(0), both constant and trend components are included. However in ADF regressions for first and second differenceses of series i.e. I(1), I(2) only constant is included.

Table 8.c (continue). Unit Root Tests Results For Log(E) And Log(P/P*), Log(P) Series (Flexible Exchange Rate Regime Period)

	I(0)	I(1)	I(2)
	ADF	ADF	ADF
Colombia			
log(E)	-0.78(4)	-4.43***(6)	
log(CPI_{LDC}/CPI_{US})	-1.77(3)	-8.68***(3)	
log(CPI_{LDC})	0.38(4)	-7.92***(4)	
Chile			
log(E)	-2.24(1)	-4.19***(4)	
log(CPI_{LDC}/CPI_{US})	0.77(5)	-3.18**(6)	
log(CPI_{LDC})	1.12(5)	-2.88**(6)	
Venezuela			
log(E)	2.71(4)	-1.14(0)	-7.83***(0)
log(CPI_{LDC}/CPI_{US})	4.21(6)	0.84(6)	-7.51***(0)
log(CPI_{LDC})	3.69(6)	-0.18(4)	-7.46***(0)
Peru			
log(E)	-4.41***(6)		
log(CPI_{LDC}/CPI_{US})	-1.24(6)	-1.80(2)	-11.08***(1)
log(CPI_{LDC})	-1.29(6)	-1.82(2)	-11.08***(1)
Turkey			
log(E)	-0.86(3)	-8.48***(2)	
log(CPI_{LDC}/CPI_{US})	-2.39(4)	-4.27***(5)	
log(CPI_{LDC})	-1.49(1)	-4.47***(5)	
India			
log(E)	-2.70(3)	-13.64***(0)	
log(CPI_{LDC}/CPI_{US})	-1.99(5)	-8.03***(6)	
log(CPI_{LDC})	-2.98(5)	-9.45***(6)	
Pakistan			
log(E)	-3.31*(1)	-9.83***(0)	
log(CPI_{LDC}/CPI_{US})	-1.68(6)	-13.05***(0)	
log(CPI_{LDC})	-2.11(2)	-13.09***(0)	
US			
log(CPI_{LDC})	-1.51(5)	-2.91**(6)	-12.52***(5)

NOTES: 1) ***, **, * denote significance at 1%, 5%, 10% levels respectively.
2) ADF regression the lagged differences introduced into the model to make the residuals white noise process. The number in parenthesis denotes the significant lagged differenced terms. **3)** In all ADF test regressions for level of the series i.e. I(0), both constant and trend components are included. However in ADF regressions for first and second differenceses of series i.e. I(1), I(2) only constant is included.

8. d Engle-Granger Test Results

(Flexible Exchange Rate Regime Period)

*Result of Regression $Log(E_t) = \theta_0 + \theta_1 Log(P_t/P_t^*) + u_t$

*Unit Root Tests Results For Error Series (u_t)

	(θ_0)	(θ_1)	R^2	σ	Adf for u_t I(0)	Adf for u_t I(1)
Philippines	3.35	1.09	0.94	0.16	-3.55***(0)	
Indonesia	7.86	1.99	0.93	0.19	-3.30**(5)	
Korea	6.82	1.12	0.44	0.14	-1.70(6)	-6.87***(5)
Mexico	1.71	1.02	0.99	0.18	-2.51(2)	-5.86***(6)
Brazil	0.04	1.01	0.99	0.16	-0.63(2)	-4.08***(6)
Argentina	1.16	1.05	0.99	0.36	-1.76(0)	-13.87***(0)
Colombia	6.97	1.12	0.97	0.22	-1.03(5)	-7.428***(4)
Chile	6.09	0.96	0.95	0.13	-2.18(5)	-5.07***(4)
Venezuela	5.29	0.87	0.98	0.05	-1.03(1)	-2.62*(0)
Peru	2.73	0.15	0.58	0.36	-1.26(5)	-1.49(6)
Turkey	10.75	1.00	0.99	0.16	-2.95**(3)	
India	3.46	1.81	0.97	0.09	-2.06(6)	-7.49***(5)
Pakistan	3.53	1.52	0.95	0.09	-3.24**(1)	

NOTES:1) R^2 represents coefficient of determination, σ represents the standard error of regression.
2) ***, **, * denote significance at 1%, 5%, 10% levels respectively.
3) ADF regression the lagged differences introduced into the model to make the residuals white noise process. The number in parenthesis denotes the significant lagged differenced terms.
4) In all DF tests regressions for level and first differences of the series i.e. I(0), I(1) constant term is included, but deterministic trend is not.

Table 9.a SIC for Fixed Exchange Rate Regime Period

	Number of lags: 1	Number of lags: 6	Number of lags: 12
Thailand	-31.33	-31.79+	-31.67
Philippines	-28.13	-28.22+	-28.17
Indonesia	-27.69	-28.34	-28.98+
Korea	-29.19	-29.29	-29.35+
Malaysia			
Case1	-34.03	-34.37	-34.79+
Case2	-31.37	-31.68	-32.02+
Argentina			
Case 1	-23.35	-24.09	-24.43+
Case 2	-37.61	-38.52	-39.64+
Colombia	-26.87	-27.56	-28.28+
Chile1	-24.39	-25.48	-26.10+
Venezuela	-27.16	-27.45+	-27.44
Peru	-27.98	-28.19	-28.35+
Kenya	-27.89	-28.25+	-28.08
Turkey	-25.55	-25.56+	-25.31
India	-27.69	-28.34	-28.98+
Pakistan	-27.26	-27.69+	-27.54

Table 9.b SIC for Flexible Exchange Rate Regime Period

	Number of lags: 1	Number of lags: 6	Number of lags: 12
Philippines	-25.25	-25.42	-25.54+
Indonesia	-26.27	-27.31	-27.39+
Korea	-29.58	-30.44	-30.80+
Mexico	-26.47	-27.74	-28.30+
Brazil	-23.23	-25.55+	-25.38
Argentina	-20.12	-21.64+	-21.57
Colombia	-30.48	-31.05+	-30.86
Chile	-28.97	-29.56+	-29.50
Venezuela	-29.36	-30.38	-37.42+
Peru	-24.58	-26.09	-27.01+
Turkey	-26.42	-27.53+	-27.42
India	-29.86	-30.09+	-30.06
Pakistan	-31.48	-31.99+	-31.79

Notes: 1) VAR Models are constructed with including constant and seasonal dummies, without including trend. **2)** + denotes lowest number of SIC i.e. optimum VAR specification.

Table 10.a Johansen Test Results
Fixed Exchange Rate Regime Period

	Eigenvalue	Likelihood Ratio (λ Max)	5 % Critical Value	1 % Critical Value	Hypothesized No. of Cointegrated vectors	Interpretation of Result of likelihood ratio test
Thailand	0.049	30.17	29.68	35.65	None *	L.R. test indicates 1 cointegrating equation(s) at 5% significance level
	0.02	10.77	15.41	20.04	At most 1	
	0.01	3.85	3.76	6.65	At most 2 *	
Philippines	0.07	23.94	29.68	35.65	None	L.R. rejects any cointegration at 5% significance level
	0.03	9.86	15.41	20.04	At most 1	
	0.02	4.09	3.76	6.65	At most 2 *	
Indonesia	0.20	38.35	29.68	35.65	None **	L.R. test indicates 1 cointegrating equation(s) at 5% significance level
	0.09	14.47	15.41	20.04	At most 1	
	0.04	4.230	3.76	6.65	At most 2 *	
Korea	0.22	40.26	29.68	35.65	None **	L.R. test indicates 1 cointegrating equation(s) at 5% significance level
	0.12	13.83	15.41	20.04	At most 1	
	0.00	0.12	3.76	6.65	At most 2	
Malaysia						L.R. test indicates 2 cointegrating equation(s) at 5% significance level
Case 1	0.09	33.74	29.68	35.65	None *	
	0.09	16.17	15.41	20.04	At most 1 *	
	6.44E-06	0.00	3.76	6.65	At most 2	
Case 2						
	0.09	31.75	29.68	35.65	None *	L.R. test indicates 1 cointegrating equation(s) at 5% significance level
	0.04	11.72	15.41	20.04	At most 1	
	0.02	3.79	3.76	6.65	At most 2 *	
Argentina						L.R. test indicates 1 cointegrating equation(s) at 5% significance level
Case 1	0.13	33.94	29.68	35.65	None *	
	0.06	10.49	15.41	20.04	At most 1	
	1.42E-06	0.00	3.76	6.65	At most 2	
Case 2	0.39	83.98	29.68	35.65	None **	L.R. test indicates 2 cointegrating equation(s) at 5% significance level
	0.33	36.86	15.41	20.04	At most 1 **	
	0.00	0.25	3.76	6.65	At most 2	

*(**) denotes rejection of the hypothesis at 5%(1%) significance level.

Table 10.a (continue) Johansen Test Results
Fixed Exchange Rate Regime Period

	Eigenvalue	Likelihood Ratio (λ Max)	5 % Critical Value	1 % Critical Value	Hypothesized No. of Cointegrated vectors	Interpretation of Result of likelihood ratio test
Colombia	0.09 0.06 0.01	28.96 11.79 1.47	29.68 15.41 3.76	35.65 20.04 6.65	None At most 1 At most 2	L.R. rejects any cointegration at 5% significance level
Chile	0.11 0.05 0.01	37.70 12.80 2.47	29.68 15.41 3.76	35.65 20.04 6.65	None ** At most 1 At most 2	L.R. test indicates 1 cointegrating equation(s) at 5% significance level
Venezuela	0.11 0.02 0.01	57.12 13.99 6.14	29.68 15.41 3.76	35.65 20.04 6.65	None ** At most 1 At most 2 *	L.R. test indicates 1 cointegrating equation(s) at 5% significance level
Peru	0.09 0.04 0.01	28.29 10.17 1.48	29.68 15.41 3.76	35.65 20.04 6.65	None At most 1 At most 2	L.R. rejects any cointegration at 5% significance level
Kenya	0.07 0.05 0.00	39.54 16.76 0.52	29.68 15.41 3.76	35.65 20.04 6.65	None ** At most 1 * At most 2	L.R. test indicates 2 cointegrating equation(s) at 5% significance level
Turkey	0.13 0.07 0.02	29.54 11.74 2.12	29.68 15.41 3.76	35.65 20.04 6.65	None At most 1 At most 2	L.R. rejects any cointegration at 5% significance level
India	0.073 0.05 0.00	32.65 13.63 0.44	29.68 15.41 3.76	35.65 20.04 6.65	None * At most 1 At most 2	L.R. test indicates 1 cointegrating equation(s) at 5% significance level
Pakistan	0.11 0.03 0.01	46.19 12.94 2.57	29.68 15.41 3.76	35.65 20.04 6.65	None ** At most 1 At most 2	L.R. test indicates 1 cointegrating equation(s) at 5% significance level

*(**) denotes rejection of the hypothesis at 5%(1%) significance level.

Table 10.b Normalized Cointegrating with respect to p
Fixed Exchange Rate Regime Period

Normalized Cointegrating Coefficients:	P	p*	e
Thailand	1	-1.40	2.35
Indonesia	1	-2.63	0.75
Korea	1	-1.86	-0.49
Malaysia			
Case 1	1	0.35	-1.50E+10
	1	-0.31	-1.52E+10
Case 2	1	-0.62	0.16
Argentina			
Case 1	1	-25.18	1.57
Case 2	1	-0.05	-11.99
	1	-2.44	-77.21
Chile	1	-2.48	-0.84
Venezuela	1	-0.95	-0.05
Kenya	1	-0.79	-1.56
	1	-1.19	-0.61
India	1	-0.92	-0.14
Pakistan	1	-0.88	-0.75

Table 11.a Johansen Test Results
Flexible Exchange Rate Regime Period

	Eigenvalue	Likelihood Ratio (λ Max)	5 % Critical Value	1 % Critical Value	Hypothesized No. of Cointegrated vectors	Interpretation of Result of likelihood ratio test
Philippines	0.06 0.03 0.02	31.65 13.47 5.38	29.68 15.41 3.76	35.65 20.04 6.65	None * At most 1 At most 2 *	L.R. test indicates 1 cointegrating equation(s) at 5% significance level
Indonesia	0.09 0.02 0.00	28.08 5.82 0.05	29.68 15.41 3.76	35.65 20.04 6.65	None At most 1 At most 2	L.R. rejects any cointegration at 5% significance level
Korea	0.09 0.04 0.02	37.32 13.86 4.57	29.68 15.41 3.76	35.65 20.04 6.65	None ** At most 1 At most 2 *	L.R. test indicates 1 cointegrating equation(s) at 5% significance level
Mexico	0.08 0.06 0.04	47.87 26.69 10.78	29.68 15.41 3.76	35.65 20.04 6.65	None ** At most 1 ** At most 2 **	L.R. test indicates 3 cointegrating equation(s) at 5% significance level
Brazil	0.08 0.03 0.01	27.32 9.87 1.76	29.68 15.41 3.76	35.65 20.04 6.65	None At most 1 At most 2	L.R. rejects any cointegration at 5% significance level
Argentina	0.21 0.08 0.00	48.18 13.09 0.22	29.68 15.41 3.76	35.65 20.04 6.65	None ** At most 1 At most 2	L.R. test indicates 1 cointegrating equation(s) at 5% significance level
Colombia	0.129 0.05 0.02	51.98 17.89 5.87	29.68 15.41 3.76	35.65 20.04 6.65	None ** At most 1 * At most 2 *	L.R. test indicates 3 cointegrating equation(s) at 5% significance level
Chile	0.08 0.06 0.00	30.12 12.45 0.21	29.68 15.41 3.76	35.65 20.04 6.65	None * At most 1 At most 2	L.R. test indicates 1 cointegrating equation(s) at 5% significance level
Venezuela	0.96 0.81 0.11	250.19 89.83 5.94	29.68 15.41 3.76	35.65 20.04 6.65	None ** At most 1 ** At most 2 *	L.R. test indicates 3 cointegrating equation(s) at 5% significance level
Peru	0.26 0.15 0.03	49.49 18.91 3.18	29.68 15.41 3.76	35.65 20.04 6.65	None ** At most 1 * At most 2	L.R. test indicates 2 cointegrating equation(s) at 5% significance level
Turkey	0.21 0.04 4.50E-06	63.56 8.69 0.00	29.68 15.41 3.76	35.65 20.04 6.65	None ** At most 1 At most 2	L.R. test indicates 1 cointegrating equation(s) at 5% significance level
India	0.08 0.02 0.01	28.45 7.59 1.98	29.68 15.41 3.76	35.65 20.04 6.65	None At most 1 At most 2	L.R. rejects any cointegration at 5% significance level
Pakistan	0.12 0.03 0.03	37.99 12.29 5.25	29.68 15.41 3.76	35.65 20.04 6.65	None ** At most 1 At most 2 *	L.R. test indicates 1 cointegrating equation(s) at 5% significance level

*(**) denotes rejection of the hypothesis at 5%(1%) significance level

Table 11.b Normalized Cointegrating with respect to p
Flexible Exchange Rate Regime Period

Normalized Cointegrating Coefficients:	P	P*	e
Philippines	1	-1.06	-0.92
Indonesia	1	2.85	0.84
Korea	1	-1.67	-0.09
Mexico	1	13.88	-2.09
	1	-1.59	-0,91
	1	1.17	-1,34
Argentina	1	-2.99	-0.95
Colombia	1	-7.15	0.12
	1	0.83	-1.12
	1	-22.68	5.57
Chile	1	13.66	-3.44
Venezuela	1	-2.95	-0.42
	1	-0.88	-1.39
	1	-5.23	-0,38
Peru	1	-23.53	4.07
	1	-31.08	2.49
Turkey	1	-4.35	-0.88
Pakistan	1	2.09	-1.84