Reserve Bank of India Occasional Papers
Vol. 27, No. 3, Winter 2006

The Fundamental Equilibrium Real Exchange Rate in India : An Approach to Estimation and Measurement of Misalignment

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The problem of judging whether the real exchange rate is undervalued or overvalued in relation to its long-run equilibrium path is of potential interest to policy makers responsible for the exchange rate management policy of any country. This paper attempts an estimation of the real equilibrium exchange rate for India for the period in the latter half of the 1990s using fundamental economic variables by decomposing a structural VAR vested with appropriate restrictions consistent with open economy assumptions. The model identifies the permanent impact of three fundamental structural shocks, *viz.*, real demand, supply and nominal shocks, and evaluates their relative contribution to the forecast error variance in the real exchange rate. The empirical results support the finding that the variability in the real exchange rate in India is explained predominantly by permanent real demand shocks followed by nominal and supply shocks, respectively. The significance of real demand shocks underpin the importance of the efforts of the Reserve Bank aimed at sterilizing capital inflows and maintaining stable conditions in the foreign exchange market. Since the aggregate nominal shocks explain just about 30 per cent of the forecast error variance of the real effective exchange rate, it is appropriate that under or overvaluation may not be judged solely on the basis of the relative purchasing power parity (PPP) condition.

JEL Classification : F31, F32

Keywords : Equilibrium exchange rate, structural VAR, forecast error decomposition, Harrod-Balassa-Samuelson (HBS) effect.

Introduction

The exchange rate management policy of a country is very often seized with an important question whether or not the actual real exchange rate is appropriately aligned *vis-à-vis* its long run

* Director, Monetary Policy Department. The views expressed in the paper are strictly personal and not of the Reserve Bank of India. The author is grateful to Dr. M.D Patra, without implicating him for the results drawn in the study, for being a constant source of inspiration and encouragement. The comments received from an anonymous external referee are gratefully acknowledged. Errors and omissions if any are the sole responsibility of the author.

equilibrium path. Notably, "the appropriateness of the exchange rate is determined by the criteria of whether the current level of the exchange rate is appropriate given the level of the exchange rate that is associated with the equilibrium situation, which is defined in terms of the goods and labor market equilibrium and the external balance being sustainable, which on the other hand is determined by the condition of the real economic variables found in equilibrium"(Omerbegivic,2005). Hence a proper assessment of the deviation of the real exchange rate from its equilibrium path can go a long way in helping policy makers to design an exchange rate policy for the purpose of achieving long term sustainability of the balance of payments.

A common method of determining the extent of misalignment of the exchange rate is based on the principle of relative uncovered purchasing power parity (PPP) theory for open economies which assumes that exchange rates adjust to offset the changes in relative prices. The PPP theory considers that the actions of importers and exporters, motivated by cross country price differences, induce changes in the spot exchange rates. In the long run, however, arbitrage ensures that the "law of one price" exists - that is identical goods denominated in a common currency must sell for the same price in two separate markets without transportation costs and differential taxes thus causing, as it were, intra national price convergence. In this process, because the adjustment in exchange rates takes place through the microeconomics of commodity market arbitrage, relative exchange rates based on relative price ratios continue to remain in a state of stable equilibrium, thus reducing the need for deliberate policy directed interventions in nominal exchange rates. In practice, however, it is an empirical question to ask if such automatic market adjustments in exchange rate exist – especially, considering the fact that the presence of non traded goods, for which no international arbitrage exists, can lead to systematic movements in real exchange rates inconsistent with PPP (Balassa,1964; Samuelson, 1964). Besides, even though deviations from the PPP may be considered to provide a meaningful ground for assessing misalignment and,

therefore, for the appropriate management of the exchange rate policy, it is experienced that except in high inflation countries where nominal shocks dominate real shocks or for countries that continued with pegged exchange rates, the PPP condition is observed more in breach than agreement with the empirical record.

The veracity of the PPP condition has been disputed particularly in the case of developing countries for the post Bretton Woods period, suggesting that the influence of other real shocks with permanent effects may be far more significant for the determination of the real exchange rate than relative prices alone. In summarising the results from studies using long-horizon data, Froot and Rogoff (1995) and Rogoff (1996) report the current consensus in the literature that the half-life of a shock (the time it takes for the shock to dissipate by 50 per cent) to the real exchange rate is about three to five years, implying a slow parity reversion rate of between 13 to 20 per cent year. Whereas the slow speed of reversion to purchasing power parity is difficult to reconcile with nominal rigidities, it is also difficult to reconcile with the observed large short-term volatility of real exchange rates (Rogoff, *op cit*). The failure of PPP to account for variations in the real exchange rate has been reported by many other studies using formal statistical tests that failed to reject the null hypothesis of a unit root in the real exchange rate against the alternative of a stationary stochastic process. If the unit root model can characterise real exchange rate behavior, then PPP does not hold because there is no propensity to revert back to any equilibrium level (Cashin *et. al*, 2003). The failure to validate the PPP condition means that empirical models may have to be appropriately redesigned to incorporate other sources of permanent shocks attributed to various economic fundamentals for the determination of the real exchange rate.

Whereas the PPP condition constitutes one of the fundamental but testable theoretical benchmarks against a set of other financial market conditions such as interest rate differentials that become important in a world of dynamic cross border capital flows in the determination of near term exchange rate adjustments, the issue of evaluating the fundamental equilibrium exchange rate must

nonetheless necessarily contend with the working of the fundamental economic factors such as supply, demand and nominal factors which govern the eventual outcomes (deficits/surplus) of the external account of any country. Furthermore, while day to day movements in the nominal exchange rate may be influenced sometimes by financial market conditions (such as those determined by relative/ excess rates on return available in alternative markets in managed exchange rate regimes) that may themselves serve as a source of distortion of the real exchange rate against its fundamental equilibrium level; the importance of finding the equilibrium nonetheless remains at the heart of exchange rate management policy aimed at mitigating the adverse effects of disequilibrium in the exchange rate market in the long term.

The subject matter is also contextual in terms of the recommendations made by the Committee on Fuller Capital Account Convertibility (Chairman: S.S Tarapore) emphasizing on the need to undertake a periodic review of the "neutral" (or equilibrium) REER which could be changed as warranted by fundamentals. The emphasis on the importance of economic fundamentals in the determination of the equilibrium real exchange rate has been fully recognised although much of the discussion in the Indian context has so far been based on *adhoc* generalisations not supported by empirical judgment. This paper, therefore, attempts to fill this void in the empirical work relating to the determination of the fundamental real equilibrium exchange rate in India.

This research, as alluded to above, is focused on the task of evaluating the applicability of PPP in the Indian context, while also positing a broader framework incorporating fundamental economic factors to estimate the equilibrium real exchange rate and to identify factors that could have determined its movements lately during the post reforms years. The empirical method employed here owes to the seminal work of Blanchard and Quah(1989) which offers a methodology for distinguishing temporary and permanent shocks based on a unique characterization of structural VAR. The B-Q estimation procedure can be used to estimate the equilibrium real

exchange rate as also the extent of misalignment of the actual real exchange rate in relation to its equilibrium value. Although the VAR methodology permits a number of analytical insights, the main objective of the present effort is aimed at estimation of the real equilibrium exchange rate to serve as one of the several helpful tools for the purpose of exchange rate management. Furthermore, with a view to supporting appropriate inference making, estimates of forecast error variance decompositions have also been obtained to elicit the components accounted for by innovations in the forecast error variance of individual economic variables specified in the model. The paper is schematised in four Sections. Section I contains a brief survey of literature pertaining to exchange rate determination relevant to the subject. Section II explains the data employed in the study and Section III describes the empirical methodology. Section IV offers the estimate of the real equilibrium exchange rate and other associated empirical evidence for India and, finally, Section V offers concluding observations.

Section I
Review of Literature

The review of literature in the context of the developing countries is related by and large to the empirical body of research devoted to testing the applicability or otherwise of the PPP concept for exchange rate determination. In regard to the conclusions reached by numerous analytical papers related to developing countries, the consensus on PPP is hardly fully supported given the weight of technical shortcomings such as low power of univariate unit root tests highlighted by more recent studies on the subject. Besides even in the case of developed countries where the PPP condition has been validated on the basis of long time series samples or panels of data, evidence in favor of the PPP condition has been acceded only in the case of traded goods. Needless to mention, comprehensive research on the subject, especially, in the case of developing countries is rather scarce, and many studies are limited in their focus on traditional testing of the PPP condition for exchange rate determination(Annexure I). As

alluded to above, because *ex hypothesi* the PPP seeks merely to address the limited question whether or not relative prices determine relative exchange rate positions, it leaves aside the more engrossing issue of identifying fundamental economic factors that could be incorporated in the overall theoretical framework for proper characterization and explanation of exchange rates. The latter approach for determining exchange rate parities is of relatively recent origin and with limited empirical evidence in the context of developing countries.

As mentioned above, in the recent years efforts has been made to incorporate information on real fundamental economic factors for estimating the long-run exchange rate equilibrium and, in that context, suitable measures of misalignment of the actual exchange rate with the equilibrium exchange rate. In fact, the origin of this approach is traced to the large body of the work which emphasized the importance of real shocks in the determination of the underlying the real equilibrium exchange rate. The idea that productivity shocks may affect the equilibrium real exchange rate (Harod-Balassa-Samuelson(HBS) effect) has left an impressive imprint on the history of economic thought, even though evidence based on early empirical work on the subject is somewhat indeterminate. In the more recent work especially, in Taylor and Taylor (2004), the possibility of time varying HBS effect has been tested by allowing for linear and non linear deterministic trends as there may be a tendency for the real equilibrium exchange to shift over time due to inter-temporal variations in relative productivity differentials. The inclusion of linear or non linear deterministic trends offer substantial support in resolving the puzzles about how fast the exchange rate reverts to its mean level. Using data since 1820 for the US, the UK and France, and a nonlinear framework, Lothian and Taylor (2006) found statistically significant HBS effect for sterling-dollar real exchange rate.

The estimation of the fundamental equilibrium exchange rate has been an issue of ongoing interest and a number approaches and explanatory variables have been considered in modeling frameworks. An assortment of relevant macroeconomic and financial indicators, for example, are explicitly included in the behavioral equilibrium exchange

rate (BEER) approach which takes into account factors such as productivity, real interest rate differentials (the interest parity condition), government expenditures and net forex assets in determining the equilibrium exchange rate.

The fundamental equilibrium exchange rate (FEER) of Williamson (1983,1994) is yet another approach that takes into account variables such as unemployment and inflation as determinants of equilibrium exchange rate. On the other hand, in studies particularly in the context of EU member states in transition, the exchange rate misalignment has been evaluated taking into account, *inter alia*, factors such as changes in the quality of goods and services and dismantling of administered price controls.

In another intuitive empirical inquiry, the real exchange rate is determined using fundamental macroeconomic relationships/factors. For example, Vlaar (2002) estimated a portfolio balance model that incorporated an output gap equation, a Phillips curve, a Taylor rule and an equation for the balance of payments. Bjornland (2004) estimated a measure of real equilibrium exchange rate and identified the extent of misalignment of the real exchange rate in Venezuela using a structural VAR between the period 1985 and 1999. Including four structural shocks namely real demand, supply, nominal and oil prices shocks in the model consistent with open economy assumptions of economic fluctuations, the empirical results rejected the PPP hypothesis and instead underscored the relative importance of the permanent real demand shocks in determining the real exchange rate. Bjornland's (*op.cit*) research is distinguished in its approach because of its attempt to identify the significance of the key building blocks/fundamentals of the basic macroeconomic foundation relevant for the determination of the real exchange rate while not merely limiting the objective to the testing the PPP condition.

Ozlale and Yeldan (2002) developed a state space model to estimate the equilibrium exchange rate using exchange rate volatility, short term capital movements, industrial production, inflation, budget balance of public sector, openness and lags of explanatory variables. In efforts made since the mid-1990s, many studies have also been

employing micro founded general equilibrium open economy models for the determination of real exchange rate, although empirical usefulness of these types of models is yet to be fully established given parameter approximations and uncertainties, *viz.*, associated standard errors and the lack of accountability of the structure of stochastic shocks.

Mohsin Khan (2004) investigated the applicability of the Balassa-Samuelson effect on the long-run behavior of real exchange rates in developing countries based on a panel data sample of 16 developing countries. The empirical evidence obtained underscored the significance of the traded-nontraded productivity differential in determining the relative price of nontraded goods, and hence the relative price ratio which in turn exerted a significant effect on the real exchange rate thereby providing a robust verification of Balassa-Samuelson effects for developing countries.

Using fundamental determinants of terms of trade, openness of the economy, relative productivity differentials between home and trading partners, share of investment in total consumption and trade balance, Omerbegovic (2005) developed a cointegrating model for the determinants of the real exchange rate for Bosnia and Herzgovnia.

As far as research in India is concerned, the study by Kohli (2002) appears somewhat broad based than earlier works which were primarily limited to the testing of PPP. Using unit root and cointegration tests, Kohli (2002) found mean reverting tendencies in the real exchange rate series for India constructed using the consumer price index as the deflator, as well as for series constructed using ratio of wholesale and consumer price indices thereby suggesting that monetary policy impulses were the main cause of disturbance in real exchange rate. On the other hand, the evidence of non stationarity of the relative differential of tradable and non tradable goods suggested that real shocks such as permanent changes in productivity or government spending were important for the determination of the real exchange rate movements. The findings are based on statistical data generating properties but do not either explicitly account for or identify various underlying factors contributing to the movements in the real exchange rate series.

The computation of real equilibrium exchange rate is an important feature of the advanced empirical effort undertaken in the recent years. Various approaches for the determination of the equilibrium exchange rate are based on the different types of underlying hypotheses - but all nonetheless in the search of that important model of equilibrium exchange rate determination in different country settings.

Section II
Selection of System Variables

The quarterly data for India and industrial countries for the period 1996:Q1 to 2005:Q4 was collected from IMF's International Financial Statistics(IFS) database. The IFS data base is distinguished by its presentation of different data series/indices with a common base year which helps in making appropriate cross country comparisons. In particular, data series retrieved from IFS database include indices of industrial production and consumer price indices. Data on 36 country bilateral trade weighted real exchange rate (REER, base 1993-94) was taken from various issues of the RBI Bulletin. The data have been transformed into the following system variables for the structural VAR : (i) annual rate of change of 36 country trade weighted REER(base 1993-94=100), (ii) annual growth in the relative indices of industrial production of India and that of industrial countries(composite, 2000=100), (iii) annual growth in the wholesale Price Index (WPI) of India relative to that of the Consumer Price Index (CPI) of industrial countries(composite, 2000=100) and (iv) relative rates of inflation in China and India. The choice of index of industrial production of industrial countries and that of India is taken as representing a relative supply variable as both imports and exports comprise predominantly of both intermediate and final industrial goods that serve to determine a significant portion of trade and thereby have implications for the real exchange rate. Besides, since factor productivities also constitute a part of the overall growth in output, the relative supply variable helps in capturing the impact of HBS effect which avers that the exchange rate of countries with higher

relative productivity tends to appreciate. The relevance of industrial production in industrial countries in relation to the real exchange rate also arises from the fact that the growth and volatility of the output in these countries affects the output of other countries including those of the emerging market economies because of their growing trade and investment relationship with the rest of the world. The nominal shocks in the model are taken as relative inflation indices in India and industrialised countries since inflation differentials (PPP) impact the real exchange rate notwithstanding the presence of market rigidities which slow down adjustments in nominal wages. Finally, the impact of real demand effect on the real exchange rate is captured by factors that generate demand such as money supply and/or fiscal deficit. Notably, all the three factors included in the model that serve as explanatory variables are essential for any meaningful characterization of an economic framework.

Section III
Empirical Methodology

The interpretation of the structural VAR is made in terms of four shocks, namely, real demand(ε_{sup}), supply(ε_{rdem}) and nominal(ε_{nom}) shocks related to system equations for changes in REER, relative industrial output and relative nominal prices. The algebraic form of the VAR model is presented below.

Including stationary variables in the structural VAR, and ordering the vector as z_t = (Δsup, Δrd, Δnom), the model is as follows

$$\Phi(L)z_t = e_t$$

pre-multiplying by its inverse

$$[\Phi(L)^{-1}]\ \Phi(L)\ z_t = [\Phi(L)^{-1}]e_t$$

Let $\Phi(L)^{-1} = K(L)$, then we have

$$[I_n - \Phi(L)L - \ldots.\Phi(L)_pL_p][I_n + K1(L) + \ldots.] = I_n$$

$$z_t = K(L)e_t \qquad (1)$$

where K(L) has finite order and where e_t is the vector of reduced form independent white noise errors corresponding to the individual equations in the structural VAR with a covariance matrix Ω. Assuming that the orthogonal structural shocks (ε_t below) can be written as linear combinations of the structural errors (1) esp., $e_t = R^o \varepsilon_t$ where R^o is a non singular matrix. The moving average (MA) form of system (1) containing the original residuals then can be written in terms of the orthogonal disturbances with each of the ε_t normalized to have unit variance.

$$z_t = R(L)\, \varepsilon_t \qquad (2)$$

where $K(L)R^o = R(L)$ and for positive definite matrix $\Omega = R^o R^{o\prime}$. Equation (2) forms the basis for obtaining Blanchard and Quah decomposition. In particular if R^o is identified then the MA representation can be directly derived from (2). However, since R^o is a three by three matrix, appropriate restrictions are required for identification. Since $\Omega = R^o R^{o\prime}$ and var(ε_t) are normalized to unit variance, matrix R^o requires only three additional restrictions for identification which can be obtained by imposing restrictions on the long run multipliers in the matrix R(L). Each component of the matrix R(L) namely $R_{ij}(1)$ represents the corresponding dynamic long run multiplier which would be need to be subjected to economically meaningful restrictions for identification.

Following Bjornland (2004), the following restrictions needed for the identification of R(L) matrix consistent with the standard open economy assumptions are placed on the long run multipliers to identify the three structural shocks namely real demand, supply and nominal shocks.

(a) There is no long run effect of nominal shocks on the real exchange rate. The short run restriction on nominal shocks is consistent with the most open economy models of short run variability in the exchange rate. This implies that

$$R_{23}(1)=0$$

(b) There is no long run effect of real demand and nominal shocks on supply viz.,

$$R_{12}(1) = R_{13}(1) = 0$$

the restriction that long run real demand shock does not affect supply is according to the widely received wisdom in macroeconomic literature.

(c) Real demand shocks can have a long run effect on itself and can be impacted by supply shocks and as above there is no impact of nominal shocks.

(c) finally, nominal shocks are influenced both by long run real demand and supply shocks.

with these restrictions, it is straightforward to recover R^o as both K(1) and Ω are known. As R(1) is lower triangular, it is also lends itself to Choleski factorization of the long run representation $R(1)\Omega R(1)$.

Forecast error variance decompositions have also been obtained alongside a measure of the real equilibrium exchange rate which is presented in a graph. Measure of misalignment is computed by comparing the actual real exchange rate with the estimated trajectory for the equilibrium real exchange rate obtained from the model.

Section IV
The Empirical Estimate of the Fundamental Real Equilibrium Exchange Rate

As mentioned in Section III since R^o is identified, the MA representation derived there from offers a practical approach for computing the estimate for the equilibrium real exchange rate. However, before the said estimate is obtained, it would be useful to take a look at the forecast error variance decomposition of the real exchange rate variable. The Table below presents the average components, for a forecast horizon of 12 quarters, accounted for by innovations in the individual variables in the forecast error variance or MSE of the real exchange rate variable.

Table 1 : Forecast Error Variance Decomposition of Real Exchange Rate (per cent)

Accounted for by Real Demand factor	Accounted for by Supply factor	Accounted for by Nominal factor
63.12	7.29	30.57

From the results presented in Table 1 on the decomposition of forecast error variance it is obvious that for a country like India with a diversified economic structure, the real exchange rate is determined by a combination of stochastic shocks pertaining to real demand, supply and nominal factors. Notably, the permanent real demand shock accounts for the bulk of explanation (63 percent) followed by nominal and supply shocks. The innovations in the permanent nominal shocks and supply shocks explain about 30 percent and 7.0 percent of the forecast error variance of real exchange rate, respectively. The contributions made by different shocks are expected to change depending on the changing weights of constituent shocks over time and the time sample taken for the empirical analysis. It may be mentioned that the contribution of constituent shocks towards the explanation of the forecast error variance of effective real exchange rate remains by and large unchanged even if the model is augmented with relative price ratio of China and India as an additional explanatory variable.

For the present context, given the fact that factors other than nominal shocks alone are responsible for the determination of the real exchange rate, the multiple indicator approach for conducting monetary/exchange rate policies therefore appears to be an ideal strategy to follow for ensuring long term stabilization of the external account. It may be recalled that from 1950 to 1980, when the Indian economy was growing at a relatively slower speed of 3.6 percent, domestic investment exceeded domestic savings by only a small fraction. During this period, the gap was easily met by foreign borrowing. However, later during the period 1980 to 1990, when the growth rate of GDP accelerated to 5.8 percent, the wedge between savings and investment widened considerably, requiring large foreign

borrowings for capital expenditures on imports of machinery and raw materials, including oil to give a fillip to the increase in aggregate demand. As a consequence, the gross foreign debt shot up from US $ 22.6 billion in 1980 to US $ 83.80 billion in 1991. At the same time the reduction in internal savings rate was accounted mainly by expanding fiscal deficit of the government which rose from an average of 7.72 percent of GDP during the Seventh Five-Year Plan to 7.85 percent by 1990-91. Large fiscal deficits were caused by a number of reasons namely exorbitant expenditures on subsidies of fertilizers, food, exports, power, transport and irrigation. Apart from the current account deficit, mounting capital expenditures by the government and public enterprises were financed through public borrowing. By 1990, internal debt liabilities increased to 49.8 percent of GDP compared with 33.7 percent in 1980. In addition to the aforementioned factors, the sharp rise in import prices of oil and the downgrading of India's credit rating, led to a loss of confidence resulting into drying up of short-term credit and foreign borrowings besides an outflow of non-resident Indian deposits led to the crisis of 1991. Clearly as the experience of the nineties shows, the balance of payments of crisis was caused by a mix of factors esp., high demand and supply mismatches coupled with exogenous oil price shocks that eventually culminated in the institution of a wide ranging macroeconomic, structural and stabilization program encompassing monetary and financial sectors and public finance, trade, industry, foreign investment and exchange rate. The exchange rate regime was itself made increasingly more flexible over time to accommodate appropriate adjustments in keeping with the forces of demand and supply.

As the stability of the real exchange rate hinges on factors indicated above, policies aimed at addressing relevant issues in these areas would serve to foster stability in the external sector. On the demand side, for example, the need for fiscal rectitude and appropriate money supply to enable sustainable growth in a climate of stable inflationary expectations may be considered as ongoing priorities to limit the spillovers from macroeconomic imbalances to the external deficit. On the supply side, facilitating infrastructure

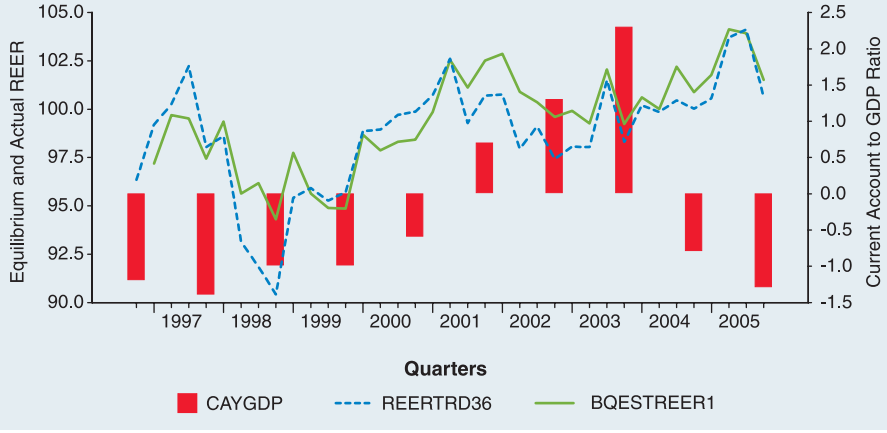
development and improving incentives to encourage increased resource investment, capacity creation and technological absorption in supply constrained sectors may play a key role.

Having captured the contributions of the factors causing the real exchange rate, the real equilibrium exchange rate calculated using real demand shocks(added to the drift) from the MA representation of the VAR is plotted along with the actual real exchange rate.

The comparative positions of the actual REER (REERTRD36 in Chart 1) and equilibrium REER (BQESTREER1 in Graph I) plotted against the current account to GDP (CAYGDP) on the right scale indicate some form of empirical regularity. During the sample period taken for consideration, the actual REER remained above (overvalued) the equilibrium REER until early 1998 where after it was seen as clearly undervalued (except for a few quarters in between 2000 and the first half of 2001) in comparison with the equilibrium REER till early 2003 and then yet again shifted upwards embracing its fundamental level quite closely. From the perspective of the present analysis, the changing magnitudes of the current account to GDP ratio posited against the degree of alignment of the real exchange rate with the corresponding equilibrium (determined by fundamentals) offer some insight into the dynamics of the external account in India.

Chart 1: Equilibrium REER *vs* Actual REER and Current Account to GDP ratio

Current account to GDP ratio on right scale



Illustratively, when the actual REER was perched higher (overvalued) than the equilibrium REER, the current account to GDP ratio was negative between 1996 and 1998 but gradually started improving from 2001 onwards as the actual REER gradually moved below its fundamental equilibrium path until early 2003. Subsequently, as the actual REER increased and began following its fundamental level, this period saw the gradual emergence of current account deficits. While these episodes underline the need for continuous monitoring of the evolution of the fundamental equilibrium REER for managing current account balance, the desirability of having a predefined band around the neutral REER as suggested by Committee on Fuller Capital Account Convertibility (FCAC) also may need to be positively deliberated. There is clearly a need to keep the actual REER anchored closely to its fundamental level which may, perhaps, be relaxed in cases of implied tradeoffs in tandem with the contextual revision in the hierarchy of goals of economic policy and particularly in the face of temporary asymmetric risks to economic outlook.

It may be mentioned that the importance of fundamentals in the context of exchange rate management has been emphasized on many occasions at the policy making level. Dr. Y.V Reddy, in his inaugural address to the XIth National Assembly of Forex Association of India in 1997 underscored that “any currency could come under speculative attack if its exchange rate is out of alignment with fundamentals for a prolonged period of time”. Dr. C. Rangarajan (Chairman, Prime Minister’s Economic Advisory Council) recently noted that “ when and economy becomes more open to capital and financial flows, there is even greater compulsion to ensure that factors relating to macroeconomic stability are not ignored”. Needless to state, the literature on exchange rate management has also been emphasizing the fact that a prolonged deviation of REER from the equilibrium REER in terms of overvaluation could lead to worsening of trade balance, speculative attacks, increased foreign debt, fall in the rate of investment, productivity and thereby overall growth (Gylfason, 2002).

Besides the structural and stabilization program instituted during the nineties, the success in limiting the misalignment of the exchange rate is also significantly attributed to the broad framework of reforms in the external sector in the aftermath of the Gulf crisis which were based on the recommendations of the High Level Committee on Balance of Payment (Chairman: Dr C. Rangarajan, 1991). The Committee advocated compositional shift in capital flows, liberalization of the current account along with introduction of market determined exchange rate regime and emphasized on the need to contain the current account deficit within prudential limits. Needless to mention, the emphasis on containing the current account deficit at prudential levels typically underscored the importance of the impact of aggregate demand effects on the real exchange rate. The implementation of the recommendations of the High Level Committee resulted in market determined exchange rate regime effective March 1, 1993 and thereafter the acceptance of Article VIII of the Articles of Agreement of the IMF in August 1994 brought on full current account convertibility paving way for orderly exchange rate movements in accordance with evolving demand and supply conditions in the foreign exchange market, thereby limiting the extent of exchange rate misalignment The virtues of a flexible exchange rate system are well recognized. Compared to a fixed exchange rate, a flexible exchange rate arrangement, under normal circumstances, leads to quicker convergence towards the equilibrium because of faster self-stabilizing adjustments in the nominal exchange rate in tandem with the changes in fundamentals as compared with slower convergence through changes in relative price ratios which remain sticky because of market rigidities.

Section V
Concluding Observations

Although there are many empirical approaches devoted to the subject, this paper has employed an empirical approach involving economic fundamentals for estimating the equilibrium real exchange rate for India. The assessment of the fundamental equilibrium level

at periodic intervals and its relationship with the actual level of REER can provide useful information and may serve as one of the helpful tools for exchange rate management. According to the empirical illustration, and for the time period under consideration, the real exchange rate in India is found to be predominantly determined by permanent real demand shocks followed by nominal and supply shocks. The upshot of these findings is that the efforts undertaken by the Reserve Bank in sterilizing capital inflows to offset demand pressures would continue to play the pivotal role in exchange rate management policy. On the other hand, the relative PPP condition alone may not be sufficiently significant in judging under or overvaluation of the exchange rate. The dynamically shifting position of the fundamental equilibrium REER in response to evolving fundamentals also implies that it would not be entirely inappropriate to suggest that nominal exchange rate interventions may not be based on any arbitrary "rule of thumb" without appropriate recognition of the contributions made by shocks pertaining to different economic fundamentals. The contribution made by each of the different factors incorporated in the model is subject to change depending on the evolving strength of shocks over time thus requiring continuous monitoring.

For the time sample taken in the study, the empirical regularity, *viz.*, the apparent relationship of the divergences between the actual and fundamental REER and the corresponding developments in the current account ratio underpin the importance of periodically tracking the model based fundamental level of REER. Needless to mention, there is further scope for developing more proximate policy oriented models which can offer policy rules under fast changing conditions in the macroeconomic environment. The flexibility of the real exchange rate is primarily a product of the far reaching reforms in the policies and practices related to exchange rate management during the 1990s, as also due to the remarkable changes in the framework and operating procedures of monetary policy and the general improvement in the macroeconomic environment. From the policy point of view, considering the fact that a variety of factors(viz.,

multiple fundamental indicators) serve to determine the real exchange rate in the Indian context, initiatives aimed at prudent management of demand (*viz.,* fiscal deficits and money supply from the policy perspective) and supply (investments, productivity and technological progress to alleviate supply constraints) coupled with stable inflationary expectations should serve to maintain the stability of the external account on an enduring basis.

Finally, as has been the experience in foreign exchange management in the post reforms year, the policy of maintaining flexibility of the exchange rate in keeping with evolving market forces of demand and supply without undue volatility as adopted by the Reserve Bank has stood the test of time in sustaining the stability of the external account. Needless to mention, the judicious exchange rate management policy of the Reserve Bank supported with sterilisation interventions in the face of heavy capital inflows in the recent years also considerably served to ease the bias in current account besides limiting undue volatility in the exchange rate which is critical for maintaining financial stability.

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Annex I

PPP testing in Developing Countries : A Review

(i) Bleany *et.al* (1999) investigated the applicability of PPP for a sample of high inflation countries esp., Argentina, Brazil, Chile and Israel for the period 1972 to 1993, noting that while in the literature there was particularly striking evidence that the estimated coefficients of cointegrating regressions between exchange rates and relative prices were much closer to PPP predicted value of unity, the alternative empirical evidence obtained by using advanced stochastic unit root models did not support the assumption of a fixed rate of mean reversion of exchange rates, especially under extreme and rapidly changing monetary conditions.

(ii) Nagayasu (1999) studied the long–run purchasing power parity (PPP) concept empirically using the parallel market exchange rates of 17 African countries and using the panel cointegration method. The panel data method was employed to overcome the problem of not having long time–series for African countries. Empirical evidence adduced in the paper supported the weak–form of the long–run PPP hypothesis in Africa, not requiring a homogeneity restriction on prices.

(iii) Wikremsinghe (2001) investigated the applicability of PPP for Sri Lanka using data for the period for the floating exchange rate regime. Using symmetric unit root tests which took into account unknown means and trend and graphical techniques, the empirical evidence overwhelmingly rejected the PPP hypothesis for Sri Lanka. The failure of the symmetric unit root test and therefore of PPP hypothesis pointed towards the existence of market frictions such as transaction costs prevailing in international trade.

(iv) Mohua Paul (2002) tested the validity of PPP hypothesis for six South East Asian countries, including India, employing panel unit root test for multilateral real effective exchange rate based

on dynamic export, import and trade weights. The empirical evidence supported the alternative hypothesis of acceptance of the PPP hypothesis for demeaned data, thus concluding that PPP could be used to assess the levels of exchange rate.

(v) Holmes (2001) conducted test for PPP for a sample of 30 developing countries using a technique that investigates the stationarity of the largest principal component based on deviations from relative PPP against the United States. Using data for the period 1973 to 1997 the empirical results generally confirmed PPP and made out, unlike other studies, that there was no evidence that PPP is confined merely to high-inflation countries as established, *inter-alia*, by McNown and Wallace (1989), Liu (1992) and Mahdavi and Zhou (1994).

(vi) Holmes(2002) tested non-linearities in US $/Latin American real exchange rates and found that non-linearities existed for seven out of thirteen countries in the sample with Columbia and Venezuela showing the sharpest transition between regimes of low and high real exchange rates. Noting that while the vast majority of the work on PPP was based on linear tests for mean reversion of real exchange rate, the authors conclude that the identification of non-linearities should offer some explanation as to why PPP was not confirmed in many cases. In a more recent study Holmes and Wang (2004) investigated the possibility whether the long run purchasing power parity in less developed and developing countries was dependent upon the nature of shocks experienced by them. Using non linear tests of stationarity and cointegration and a sample of ten African economies for the post Bretton Woods era, they found that long run purchasing power held in eight out of ten countries chosen for the sample if an explicit distinction were made between positive and negative shocks.

(vii) Simmons (2005) studied the applicability of PPP hypothesis for Eastern Caribbean Currency Union and found that PPP held for each exchange rate and many real exchange rates are cointegrated and moved in a block in the Eastern Caribbean

region over the 1980s and 1990s. The relationship of the nominal and real exchange rate and purchasing power parity of the Guatemalan peso was investigated by Schweigert (2002) who concluded that the nominal exchange rate was consistent with the PPP hypothesis, and the behaviour of the real exchange rate was consistent with fundamentals. The paper also concludes that improvement of terms of trade and years of good harvest coincided with appreciation while reversal of capital flows led to depreciation.