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Reinvestigating Sources of Movements in Real Exchange Rate

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Abstract
In the last decade or so, important developments have taken place in economics of exchange rate, with substantial contributions to both theory and empirical understanding of exchange rate determination. But a number of challenges remain unresolved. With regard to the effect of economic policy on exchange rate, it is clarified that not only current policy actions but also the expectations concerning the future policy affect exchange rate. In this study we investigated the sources of movements in REER (Real Effective Exchange rate). For analysis of REER determination, we pooled the cross sectional information of SAARC (South Asians Association of Regional Cooperation) countries, for the period 1980-2010. By application of Im, Pesaran and Shin unit root test, we confirmed the non-stationarity of pooled time series and cross-section data. After confirming non-stationary of data, we applied Pedroni's panel co-integration test to test whether real exchange rate, in long run, significantly reacts to the changes in real variables or not. We considered terms of trade, government spending, productivity shocks, trade openness and capital inflows as the key determinants of REER. Pooled Least-Square method was applied to estimate the co-integrating coefficient. Our study results indicate REER appreciates in response to changes in terms of trade, productivity and capital flows. For government consumption spending results are mixed. Trade openness explicitly depreciates the REER. All the response parameters are significant. The results are consistent with the view that changes in real variables have a significant influence on variation in real exchange rate.
Key words: Exchange Rate, Terms of Trade, Trade Openness, Financial Openness

1. Introduction

International connection for foreign exchange, goods and capital markets play a key role in determination of exchange rate in this integrated world. Independent domestic polices and equilibrating factors of adjustment are greatly influenced by these linkages.In spite of policy relevance of the issue, surprisingly little is known about the determinants of real exchange rate. Also there is no consensus on what actually determines real effective exchange rate (REER) due to problems involving the lack of long time series data and the low power of time-series unit root tests in small samples. Currently important developments have been taking place in economics of exchange rate, with substantial contributions to both theory and empirical understanding of exchange rate determination. But a number of challenges remain unresolved. Detailed analysis of existing literature on the exchange rate economics suggests that a lot of issues are still unresolved. *Firstly*, there is no consensus about the determinants of real effective exchange rate. *Secondly,* most of previous studies have focused on the bilateral exchange rates. However, any specific bilateral real exchange rate might not be representative of the trade flows of some countries. *Thirdly*, evidence for the long-run determinants of real effective exchange rate for panel data is limited due to novelty of the econometric methodologies.

Present study is an attempt to augment the trivial empirical evidence on the determinants of real effective exchange rate by using different data definitions regarding exchange rate, improved econometric methodology and a micro-founded model of exchange rate dynamics.

Objective of present study is reinvestigating the empirical long run determinants of REER by applying non-stationary panel data techniques and identifying the fundamental determinants of the REER fluctuations.

In order to craft a shape to our objective we will apply panel unit root and co-integration techniques to investigate the long-run determinants of REER. Co-integrating vector will be estimated by Pooled Least-Square method for the SAARC countries for the period of 1980-2010. Pool members are Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka.We did not include Afghanistan due to unavailability of Data.

The study differs from previous studies in a number of ways; *firstly*, panel data techniques allow us to deal with non-stationary data for a heterogeneous pool of selected countries over the period 1980-2010. To the best of our knowledge, slight attention has been paid in empirical studies to the use of these new methods to investigate the main macroeconomic variables influencing the REER in long run. The advantage of panel data unit root and co-integration

techniques is threefold: they permit to by-pass the difficulty related to short spanned time series, these techniques are more powerful than the conventional tests for time series as they rescue a few theoretical predictions that are not empirically validated by time series techniques [see Drine and Rault (2005)], and finally inter-individual information reduces the probability of estimating a spurious regression equation (Banerjee, 1999).*Secondly*, most of previous studies have focused on the bilateral exchange rates. However, any specific bilateral real exchange rate might not be representative of the trade flows of some countries. We, therefore, have chosen trade-weighted REER.

2. Literature Review

The importance of monetary and real factors in explaining real exchange rate variability in developing countries is investigated by Edwards (1987). The study finds that the variability of real exchange rate increased significantly and unevenly among the developing countries over the period Q1:1972 to Q4:1983. The results indicate that the real exchange rate variability has been affected by both real and monetary factors, with structural variables being more important in explaining long run variability (specially terms of trade shocks) and monetary variables more important in explaining the short run variability. In addition, instability of exchange rate policy significantly increases the real exchange rate variability. Hence, it is strongly recommended to adopt a stable nominal exchange rate policy (specifically crawling-peg system) to decrease the variability of the real effective exchange rate.

An inter-temporal optimizing model of a small open economy is presented by Ostry (1988b) in order to analyze how terms of trade changes affect real exchange rate and current account balance. Both temporary and permanent changes in terms of trade are considered. The results show that real exchange rate is an important variable through which a terms-of-trade shock is transmitted to the current account. Response of real exchange rate to a temporary current disturbance in terms of trade depends on the relative magnitude of temporal, inter-temporal, and substitution effects.

Real and nominal sources of fluctuations for the real and nominal exchange rates are empirically distinguished by Lee and Enders (1991), and Lastrap (1992). Authors analyze the dynamic effects and relative importance of real and nominal shocks with regard to exchange rate by imposing a long-run neutrality restriction. Both the studies find that a dominant proportion of nominal and real exchange rate[7] movements have been primarily due to the real socks in all cases and at all horizons over the flexible rate period. These results are consistent with Meese and Rogoff (1988), Hsieh (1992), Yoshikawa (1990), Stein (1990) and the equilibrium models of Stockman (1978, 1980).

An empirical estimation of vector autoregressive (VAR) Model for a set of key real and monetary variables that influence the real exchange rate in Pakistan is done by Chishti and Hasan (1993). The results do not support the purchasing power parity. The study concludes that monetary shocks cause medium-term disturbances while real shocks cause complex and prolonged disturbances in the equilibrium level of real exchange rate. On the basis of these findings, they propose flexible discretionary-managed exchange rate policy for Pakistan rather than rule-governed policy of the exchange rate.

Effects of shocks to monetary policy on nominal and real US exchange rates are investigated by Eichenbaum and Evans (1993). The study provides the strong evidence that the expansionary policy shocks lead to significant and persistent depreciation in the exchange rate, both normal and the real. Furthermore, the results are consistent with the notion that the real changes that affect the relative prices of different goods are at least as important as monetary policy in the process of real exchange rate determination. And hence monetary policy has not been the sole determinant of changes in real exchange rate.

A modified version of Purchasing Power Parity (which hypotheses that real shocks alter the equilibrium relative prices between tradables and non-tradables) is examined by Dibooglu (1996). Co-integration and error correction methods are used on quarterly data from the post Bretton-Wood period for Germany, Italy and Japan Vs United States. The study finds the supportive evidence that the productivity differences between tradables and non-tradables, government spending and the real world oil price might account for the deviations from PPP.

Using Johanson co-integration test, Wang and Dunne (2003) examine long-run relationship between real exchange rate and its fundamentals. Also they analyze the dynamic adjustment of real exchange rate to the real shocks for the six East Asian currencies for the floating period. The time path followed by the real exchange rate in response to real shocks confirms that the real exchange rate may not necessarily be mean reverting. Further they analyze that the

fundamentals explain some, but not all, of the variation of the real exchange rate. Nonetheless, the cross country differences (natural endowments, stage of industrialization, monetary and exchange conditions) explain a substantial portion of exchange rate variations across currencies.

Relationship between the real exchange rate and terms of trade is examined by Dungey (2004). The paper develop the latent factor model that explicitly takes into account the potential for the correlation between domestic and international conditions and the terms of trade index of a particular economy. Real exchange rate changes are modeled as the linear combination of fixed factors, country specific factors, and common world factors. Terms of trade are allowed to vary with the country specific and common world factors. Application of the model to six Asian economies produces contributions of terms of trade volatility to real exchange rate volatility ranging up to 24%. The contributions are higher in East Asian economies and almost negligible in Pakistan and Sri Lanka.

An event-study on the individually documented trade liberalization event in 45 countries is conducted by Li (2004). The objective is to examine the impact of trade liberalization on the real exchange rate movement. The panel data set contains annual data for the period 1970-1995 for 62 countries, with 17 countries having trade barriers throughout the period as control. Results indicate that without controlling country-specific factors, the real exchange rate depreciates 27-48% after countries open their economies to trade. Controlling other factors - relative GDP growth, the terms of trade, the share of government expenditures in GDP, and capital inflows - the real exchange rate depreciates 14.8% annually, with long run effect of liberalization being 17%. Also the partial or transitory trade liberalization resulting from multiple liberalization episodes deter adjustment towards equilibrium rate.

A link between capital flows and real exchange rate is analyzed for 16 sub-Saharan African Countries with special focus on foreign direct investment (FDI) flows that dominate the total private inflows to the region for the period 1980-2000. The objective is to investigate whether capital inflows cause the real exchange rate to appreciate. Real exchange rate model is estimated by specifying official flows and two other categories of private capital flows (FDI and other flows). Using static and dynamic panel data, the study finds that increases in inflows of FDI and official development assistance appreciate real exchange rate (Lartey 2005).

Previous Literature gave us an idea about several factors which had been explored for REER determination. But in our study we incorporated the variables for exchange rate determination which are considered to be the outcome of today's globalized world.

3. Plan of Study

Real exchange rate determinants have been subject to numerous theoretical and empirical works. However, Edwards' model (1988b) provides the most extensively used analytical framework. Edwards (1988b, 1989b) developed a three goods theoretical model of exchange rate determinants that allows for both nominal and real factors to play their roles in the short run. Only real factors influence the equilibrium real exchange rate in the long run. Equilibrium real exchange rate is defined as a rate, which is consistent with simultaneous achievement of internal and external equilibrium. Internal equilibrium is a situation wherein the non-tradable goods market clears, while external equilibrium is achieved when the current account is sustainable. We explore following determinants in our study.

3.1.1 Terms of Trade

External terms of trade are the most significant fundamental of REER. However, the effect of terms of trade is theoretically ambiguous, contingent upon income and substitution effects and also on size of elasticities of demand for exports and imports. An improvement in terms of trade (generated by either fall in price of importable or rise in price of exportable) causes increase in real income (pure spending effect) and, therefore, rise in demand for non-tradable. This in turn raises the price of non-tradable. Hence price of tradable relative to non-tradable decreases, i.e., real exchange rate appreciates.

Substitution effect, on the other hand, shifts the foreign demand away from domestic exportable. Decrease in demand decreases production of exports and factors of production move from tradable to non-tradable sector. Price of non-tradable falls leading to depreciation of real exchange rate. Net effect, however, depends on which effect dominates.

In empirical literature income effect is found to overweight the substitution effect and hence REER appreciates in response to terms of trade improvement [Edwards (1988b); Afridi and Siddique (1994)]. Similarly large elasticities of demand for exports and imports lead to REER appreciation.

3.1.2 Government Consumption as % of GDP

The impact of public spending on REER depends on its level and on its distribution between tradable and non-tradable goods (Edwards 1988b). If state increases its spending on non-traded goods and expenditures are financed by borrowing on domestic and international markets, the demand increase induces a REER appreciation (Substitution effect). Nevertheless, if increase in government spending is financed by increase in non-discretionary taxes, then household's disposable income falls, thereby limiting demand for non-tradable. Decrease in demand reduces prices of non-tradable and results in REER depreciation (Income effect). Thus, the effect of a rise in government spending on REER is a prior indefinite. In most plausible case substitution effect dominates the income effect and hence a rise in public spending induces a REER appreciation (Edwards (1988b).

3.1.3 Technological Progress

Edwards (1988b) showed that the effect of technological progress on REER depends on its nature and its effect on various sectors of the economy. A positive productivity shock in non-tradable sector induces income effect, which entails an increase in demand for non-tradable goods and therefore prices, leading to REER appreciation. Technical progress then shifts resources from tradable to non-tradable sector. Prices decrease in non-tradable sector and REER depreciates. This is known as offer effect.

3.1.4 Trade Openness

Trade openness refers to the trade policy stance of countries. An increase in degree of openness via decrease in import tariff increases imports and decreases domestic price of importable. This further generates inter-temporal and intra-temporal substitution effects because tradables and non-tradables are substitute in demand everywhere. Demolition of tariff wall increases demand for imports and hence volume of trade. On the other hand, demand for non-tradables falls, leading to decreases in price of non-tradable. Given that price of tradable is exogenous to the system, relative price of tradable increases, that is, REER depreciates. An increase in tariffs leads to a higher relative increase in the prices of non-tradable goods, and results in appreciation of equilibrium REER.

3.1.5 Net capital Inflows (Financial Openness)

Increase in capitalflow increases demand for non-tradables goods in the recipient country. Prices of non-tradable increase and hence REER appreciates. Capital inflows entail an increase in domestic spending and a reallocation of resources from tradable to non-tradable sector, hence long-run demand for non-tradable goods increase leading to increase in price of non-tradable and REER appreciation.

3.2 Framework of Analysis

3.2.1 Static Model of REER (Edwards Model)

Edwards (1988b) identified fundamental factors that determine the equilibrium real exchange rate. The fundamental determinants of the equilibrium real exchange rate are terms of trade, trade restrictions, government expenditure, technology and capital controls. The relationship between equilibrium real effective exchange rate (REER) and the fundamentals is expressed as vector of variables:

$$q_t = f(tot_t, g_t, gdp_t, to_t, capf_t)$$

By considering CPI-based (external) REER, system equations for the real exchange rate fundamentals can be represented as:

$$q_{1t} = \beta_0 + \beta_{1i} tot_t + \beta_{2i} g_t + \beta_{3i} gdp_t + \beta_{4i} to_t + \beta_{5i} capf_t + \varepsilon_{it} \qquad \textbf{(2.a1)}$$

q_{1t} = Logarithm of Internal REER in period t

tot_t = Logarithm of internal terms of trade in period t

g_t = Logarithm of public spending as % of GDP in period t

to_t = Logarithm of trade openness in period t

$capf_t$ = Logarithm of capital flows in period t

By considering WPI-based (internal) REER, system equations for the real exchange rate fundamentals can be represented as:

$$q_{2t} = \beta_0 + \beta_{1i} tot_t + \beta_{2i} g_t + \beta_{3i} gdp_t + \beta_{4i} to_t + \beta_{5i} capf_t + \varepsilon_{it} \quad \textbf{(2.a2)}$$

q_{2t} = Logarithm of Internal REER in period t

Remaining definitions remains same as in system (2.a1).

3.3.1 Measures of Financial and Trade Openness

Financial and trade openness are measured by using outcome and policy measures. Regarding trade openness, we considered the ratio of real exports plus imports to real GDP (both expressed in local currency at constant prices) as our outcome measure of openness to international trade of goods and services. On the other hand, our policy measure of trade openness is based on an updated version of the Sachs and Warner (1995) binary variable of trade liberalization (Wacziarg and Welch 2003). This dummy variable takes the value of one whenever the trade regime is such that the country enjoys an open trade policy .Outcome measure of financial openness - openness to international trade of assets - is an equity-based measure of financial integration, $EQIFI_{i,t}$, (Lane and Milesi-Ferreti, 2003):

$$EQIFI_{i,t} = \frac{PEQI_{i,t} + FDIL_{i,t}}{GDP_{i,t}} \quad \textbf{(2.2.1)}$$

Where $PEQI_{i,t}$ and $FDIL_{i,t}$ are the stocks of portfolio equity and foreign direct investment liabilities by the i^{th} cross section in period t. Here we update the figures from Lane and Milesi-Ferreti (2001) for our sample of countries using data from the IMF's *Balance of Payments Statistics*. On the other hand, our policy measure of financial openness is based on the *IMF* binary variable of capital account restrictions. Following Prasad *et al* (2003) our variable takes the value of one in the years when there are no restrictions on capital account transactions and zero otherwise.

3.2.2 Measuring Real Effective Exchange Rate (REER)

The choice of definition, methodology, weights, and indices used in the computation of REER was heavily influenced by data availability and the objective of this study. The multilateral or REER index is used here for considering the major trading partners only.

REER, calculated using the Geometric Mean (GM) method of averaging, can be defined as product of the nominal effective exchange rate and effective relative price indices, following Hinkle and Nsengiyumva (1999). The real effective exchange rate index for country i (home country) with country j (trading partner) at time t is the product of the nominal effective exchange rate (NEER) and the effective relative price indices (in this instance the weighted wholesale/consumer price index of trading partners and the consumer price index for the home country).

The REER is defined in domestic currency-terms as followed:

$$REER_{it} = \frac{NEER_{ijt} . EP_{jt}}{P_{it}}, \quad \textbf{(2.3.1)}$$

where $$NEER_{ijt} = \prod_{j=1}^{k} [(ER_{ijt})^{wij}] \quad \textbf{(2.3.2)}$$

and $$EP_{jt} = \prod_{j=1}^{k} [Pgjt^{wij}] \quad \textbf{(2.3.3)}$$

$NEER_{ijt}$ is the nominal effective exchange rate in domestic-currency terms between the home country i and its trading partners j at time t. This is defined as an index reflecting movements in the bilateral nominal exchange rate between a home country i and trading partners j at time t adjusted by the respective weights of the trading partners. $EPjt$ is the geometric weighted average (or effective) aggregate price index for the home country's trading partners at time t. Π denotes the product of bracketed terms over the k countries. P_{it} is the domestic price index at time t. The trading partner's weights are defined in such a way that weights sum to unity, i.e.

$$\sum_{j=1}^{k} wij = 1;$$

For total trade we have: $$wij = \frac{(X_{ij}^{..} + M_{ij}^{..})}{\sum_{j=1}^{k} (X_{ij}^{..} + M_{ij}^{..})}, \quad \textbf{(2.3.4)}$$

where

wij = Trade share (weight) of country i with its partner j

$M_{ij}^{..}$ = Imports of country i with j

$X_{ij}^{..}$ = Exports of country i with j

k = Number of trading partners of the home country (i).

The weights rely on the average geographic distribution of imports and exports of goods and services during the period 1980-2010, and are fixed throughout the period of estimation. Weights are constructed using data from different issues of *IMF* publication *Direction of Trade*. Using trade weights provide a more general view of the evolution of degree of competitiveness of a country than using import or export weights.

4. Results and Discussions

Im, Pesaran and Shin (1997, 2003) approach has been widely implemented in the empirical research due to its rather simple methodology and alternative hypothesis of heterogeneity. The test assumes cross-sectional independence among pooled units, but allow for heterogeneity of the form of individual deterministic effects (constant and/or linear time trend) and heterogeneous serial correlation structure of the error terms.

Table- 1.1

Im Pesaran and Shin (1997, 2003) Pooled Unit Root Tests Results

H_O: All series are stationary

H_1: At least one series is non-stationary (Unit root hypothesis)

UNIT ROOT TEST RESULT				
	Level		First Difference	
	Constant	Constant and Trend	Constant	Constant and Trend
q1	-1.21	-1.60	-2.05	-2.40
m	0.72	1.05	-7.52	-9.12
tot	-0.20	-0.95	-4.83	-4.10
g	-0.46	1.45	-5.96	-6.25
gdp	-0.75	1.18	-4.48	-5.86
gdppc	-0.42	-1.27	-6.21	-7.60
to	-1.06	-0.70	-5.28	-5.97
fo	-0.37	-0.93	-2.35	-3.81

As this is one sided test, the critical value is -1.65 (at 5 % level) and for unit root to exist calculated statistics must be larger than 1.65 in absolute terms.

Results confirm the hypothesis of non-stationary for all the series in first difference. Therefore we can conclude that the real exchange rate and its potential determinants expressed in levels are all integrated of order 1.

4.1 Pooled Co-Integration Tests

After confirming non-stationarity of all the data series, we tested the existence of long-run relationship between the REER and its potential fundamentals. Table 1.2 in appendix reports the results of pooled data co-integration tests developed by Pedroni (1995, 1997a, 1999). Using the conventional (asymptotic) critical values extracted by Pedroni (1999) from the standard normal distribution under the assumption of cross-section independence, the null hypothesis of no co-integration is rejected. On the basis of panel unit root and co-integration tests, we can fairly conclude that a long-run relationship exists between the real effective exchange rate (REER) and its fundamentals (external terns of trade, government consumption expenditures as % of GDP, productivity in non-traded sector proxied as real GDP, trade openness, and financial openness). This supports the popular view that in long-run real exchange rate is determined by the real or structural factors only. Next, we estimate the co-integrated vector.

4.2 Estimation Results of External REER's Determinants

The results about external REER determinants are reported in Table 1.3 in Appendix. We apply Pooled Least-Square method to estimate REER. Findings confirm the previous empirical literature that in long-run real exchange rate is determined by the real and structural factors.

Estimated coefficient for TOT has expected theoretical sign and is statistically significant. A 1% improvement in TOT induces 0.92% appreciation of our sample countries. All the coefficients are statistically significant at 1% level. Since theoretically the TOT effect is ambiguous but our findings are in line with most plausible empirical evidence that wealth effect usually dominates the substitution and hence a TOT improvement is associated with REER appreciation [Edwards (1989b); Drine and Rault (2005b)]. Also our findings support the viewpoint that when traded and non-traded goods are substitutes, any improvement in TOT appreciates the REER.

Effect of fiscal policy measures such as public spending on external REER is usually depend upon the source of borrowing. For our samples a 1% increase in public spending entails a REER depreciation of 2.06% , which shows if public spending is extensive in tradable goods, an expansionary budget policy entails a tax increase which reduces the private demand for non-tradable goods. This decrease in demand decrease prices of non-tradable and hence external REER depreciates.

The coefficient of GDP is positive and statistically significant for our sample of countries. 1% increase in productivity leads to an appreciation of REER by 0.99%. These results imply that economic growth is accompanied by a REER appreciation. The effect of economic growth on the evolution of REER is higher . This might indicate that countries with initially high level of growth grow at a slower rate than the countries with a relatively low initial level of economic growth.

The coefficient of trade liberalization is negative and statistically significant. Trade liberalization of 1% is accompanied by an equilibrium external REER deprecation of 0.965% .All the results are statistically significant at 1% level. These findings are consistent with theoretical and empirical evidence of Edwards (1989b).

Coefficient of capital flows confirms the theoretical predictions. A 1% increase in inflows of capital flows is associated with a real appreciation. The corresponding appreciation is 0.54% for our sample of SAARC countries. Positive coefficient confirms that capital inflows results in reallocation of factors towards non-traded goods and hence long-run demand for non-traded goods increase leading to increase in price of non-traded and appreciation of external REER.

CONCLUSION

We establish from IPS test the non-stationarity of all the series. Results of co-integration test indicate the existence of a stable long run relationship between REER and real variables regardless the measures of REER. Moreover, REER appreciates in response to changes in terms of trade, productivity and capital flows. Trade openness clearly depreciates the REER. All the response parameters are significant. The results are consistent with the view that changes in real variables have a significant influence on variation in real exchange rate.

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Appendix

Table-1.2 Panel Co-integration Tests

Panel v-Stat (Non-Parametric)	**Panel rho-Stat** (Non-Parametric)	**Panel t-Stat** (Non-Parametric)	**Panel t-Stat** (Parametric)
989.117*	-3198750612.8*	-4.9991*	-10.977*
Group Mean Co-integration Tests			
Group rho-Stat (Non-Parametric)	**Group t-Stat** (Non-Parametric)	**Group t-Stat** (Parametric)	
-454663.015*	-717.9667*	4.450541*	

**Critical value for one tailed test is 1.65 at 5 % level. An asterisk indicates the rejection of null of no co-integration.*

Table-1.3 Parameter Estimates of External Equilibrium REER Equation

Constant	log(tot)	log(g)	log(gdp)	log(to)	log(fo)
10.78	0.924	-2.06	0.994	-0.965	0.541
(0.00)*	(0.00)*	(0.02)**	(0.00)*	(0.00)*	(0.00)*
$R^2 = 0.45$					

*Here tot, g, gdp, to, and fo represent external terms of trade index, government spending, GDP, trade openness and financial openness respectively. *, **, and *** denotes significance at 1%, 5% and 10% respectively.*