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An Empirical Analysis of the Relationship Between Capital Flows and the Real Exchange Rate in India

V. Raveendra Saradhi
Indian Institute of Foreign Trade

Shashank Goel
Indian Institute of Foreign Trade

This paper analyzes the relationship between the net capital flows (NCFs) and other fundamentals and the real exchange rate (RER) in India consequent to the liberalization of the capital account in 1990s for the period 1996–1997 to 2012–2013 using the Autoregressive Distributed Lag approach to cointegration. Most studies in the literature emphasize the role of a number of real and monetary variables and domestic policies in determination of RER. But there is no consensus on what actually determines the RER. The estimation includes NCFs, government consumption expenditure, terms of trade, trade openness, Gross Domestic Product growth rate, change in foreign exchange reserves, current account balance as explanatory variables for investigating the relationship with the RERs. The empirical results confirm that the NCFs in India have been associated with the RER appreciation and the association is statistically significant. Government consumption expenditure is not found to be significantly associated with real appreciation. Current account balance has a positive and statistically significant association with RERs indicating that the outflows on account of current account deficits have been associated with depreciation of RER or prevention of the appreciation on account of capital flows. The change in foreign exchange reserves has a negative and statistically significant association with RERs indicating that the accumulation of reserves by the Reserve Bank of India in the face of increasing capital flows has prevented the appreciation of RERs and mitigated their adverse consequences on the competitiveness of the Indian economy.

Keywords: *real exchange rate, capital flows, cointegration, foreign exchange reserves, trade openness, terms of trade, government consumption expenditure*

Introduction

India has witnessed a large increasing trend in cross border flows since the introduction of the economic reforms process in the external sector in early 1990s consequent to the balance of payment crisis. Net capital flows (NCFs) to India increased from US$7.1 billion in 1990–1991 to US$8.85 billion in 2000–2001 and further to US$89.30 billion during 2012–2013. Underlying this growing trend in the volume of NCFs has been an even more prominent growth in gross inflows and outflows. Gross volume of capital inflows amounted to US$22.77 billion in 1990–1991 and US$471.70 billion in 2011–2012 against an outflow of US$15.71 billion and US$382.40 billion, respectively. Expressed in percentage of Gross Domestic Product (GDP), the NCFs increased from 2.2% of GDP in 1990–1991 to around 3.63% in 2010–2011 and further to 4.84% in 2012–2013. The upswing in the capital mobility to India and other emerging markets suffered a brief setback in the global financial crisis in 2008.

Please address queries to: V. Raveendra Saradhi, Associate Professor, Indian Institute of Foreign Trade. Email: rsaradhi@iift.ac.in

But after ebbing of the crisis, capital flows to India and other emerging market economies rebounded in late 2009 and 2010.

While the relatively high interest rate differentials between India and rest of the world have played an important role in pushing foreign capital after the opening of financial markets in 1990s, internal pull factors such as the significant institutional, regulatory, and policy changes following the balance of payment crisis in 1991 (such as switch to flexible exchange rate regime, full current account convertibility, dismantling of trade restrictions, consolidation of external debt, liberalization of investment policies relating to foreign direct investment [FDI], portfolio flows, etc.) have been equally important in attracting these flows to India (Mohan, 2008). Domestic macroeconomic conditions and institutional framework factors such as strong macroeconomic fundamentals, a resilient financial sector, sophistication of the domestic equity market, the improved performance of the corporate sector, increase in investment opportunities, and attractive valuations also provided confidence to the foreign investors.

The concept of real exchange rate (RER) has been most widely used to analyze the impact of capital flows on the economies of the developing countries. The RER is an important measure of the competitiveness of an economy as it is associated with export growth.

The main objective of this research is to analyze the relationship between capital flows to India and the RER along with other determinants of RER. NCFs, government consumption expenditure, trade openness, terms of trade, GDP growth rate (GR), which is the proxy for productivity differential, current account balance (CAB), and change in foreign exchange reserves (CFER) are used as explanatory variables and the real effective exchange rate (REER) index as a dependent variable. The estimations are conducted on the quarterly data on Indian economy from 1996–1997 to 2012–2013. The autoregressive distributed lag (ARDL) approach to cointegration is used to examine the relationship between capital flow and other macroeconomic fundamentals and the RER. This estimation procedure has the advantage that it allows for a mixture of explanatory variables which are integrated of different order and at the same time it provides consistent estimates for small samples.

The most significant findings of the research are that NCFs to India have been found to have been associated with the RER appreciation and the association is statistically significant. Government consumption expenditure is not found to be significantly associated with real appreciation thereby limiting the role of fiscal policy in managing capital flows.

The rest of this paper traces the trends of capital flows since the onset of liberalization and attempts a comprehensive review of the theoretical and empirical literature on the impact of capital flows and their volatility on the domestic economy. Subsequently, it describes the research methodology and presents the datasets used for analysis. It then reports the results of the econometric analysis of the relationship between RERs and its determinants, analyzes them, and draws conclusions.

The Trend and Magnitude of Capital Flows to India

Figure 1 indicates the trend pattern of the NCFs to India since 1991. NCFs increased from US$7.1 billion in 1990–1991 to US$8.85 billion in 2000–2001 and further to US$89.30 billion during 2012–2013. Gross volume of capital inflows amounted to US$22.77 billion in 1990–1991 and US$471.70 billion in 2011–2012 against an outflow of US$15.71 billion and US$382.40 billion, respectively.

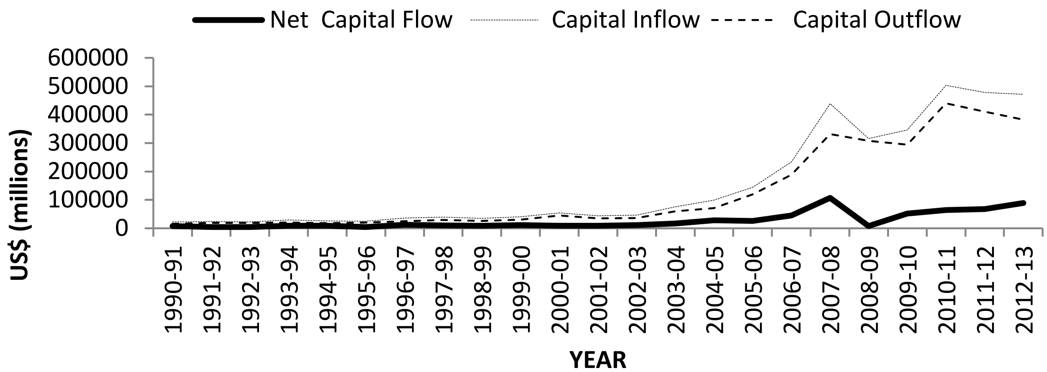

Figure 1: *Net Capital Flows to India (Source of data: Reserve Bank of India* Handbook of Statistics *[RBI, 2014])*

Expressed in percentage of GDP, the NCFs increased from 2.2% of GDP in 1990–1991 to around 3.63% in 2010–2011 and further to 4.84% in 2012–2013. Gross capital flows as a percentage of GDP, which reflect the true magnitude of capital flows into India, have undergone an increase from 7% in 1990–1991 to 29.38% in 2010–2011 and further to 25.60% in 2012–2013. Much of the increase has been offset by corresponding capital outflow largely on account of foreign institutional investors' (FIIs) portfolio investment transactions, India's investment abroad and repayment of external debt. Capital outflow increased from 4.8% of GDP in 1990–1991 to 25.64% of GDP in 2010–2011 and to 20.76% of GDP in 2012–2013. The trend of NCFs indicates stagnation at roughly 2.5% of GDP from the period 1990–1991 to 2000–2001 and large consistent rise to 4.84% of GDP in 2012–2013 from 2002–2003 onward. The trends indicate that due to policy gradualism and the institutional changes that had to be implemented as part of the reform process introduced in the early 1990s, capital account liberalization showed substantial impact from 2002 onward. Strong capital flows to India in the recent period reflect the growing confidence in the Indian economy. The rise in net flows suffered a brief setback in the wake of the global financial crisis in 2008, but resumed thereafter to again level off in 2010 because of global factors.

Theoretical Background and Literature Review

The concept of RER has been most widely used to analyze the impact of capital flows on the (overheating of the) economies of the developing countries. The impact of the capital inflows on the domestic economy which is mainly captured through the appreciation of RER is referred to as the "the transfer problem." The RER is an important measure of the competitiveness of an economy as it is associated with export growth. RER is the relative price of the domestic goods in terms of foreign goods (e.g., U.S. pizza per Indian pizza).

$$\text{RER} = \frac{e \times P}{P^*} \qquad (1)$$

where e = nominal exchange rate, the relative price of domestic currency in terms of foreign currency (e.g., dollar per rupee),

P = overall price level in domestic country, and

P^* = overall price level in foreign country.

The seminal works of Salter (1959), Swan (1960), Corden (1960), and Dornbusch (1974) provide the theoretical framework to draw inferences on the incidence of capital flows on the RER in emerging market economies. The effects of capital inflows on appreciation of RER can be derived from standard open economy models, such as the intertemporal model of consumption and investment in an open economy with capital mobility in the tradition of Irving Fischer (Calvo, Leiderman, & Reinhart, 1996). The theoretical models assume an economy with two goods—traded and nontraded—and a representative consumer who maximizes utility by choosing the consumption of the two goods over time (Mejia, 1999). In these models, a decline in world interest rate induces income and substitution effects in the capital recipient country generating increase in consumption and investment and a decline in savings (which is the converse of higher consumption). Capital inflows generate higher domestic demand of both tradeables and nontradeables in the economy. The rise in demand for tradeables leads to rise in imports and a widening of the trade deficit. The tradeable goods are exogenously priced. The increase in demand of nontradeables, however, leads to an increase in the relative price of nontradeables, which are more limited in supply than the traded goods, so that the domestic resources get diverted to their production. A higher relative price of the nontradeables corresponds to RER appreciation. The extent of real appreciation in the economy will depend largely on the intertemporal elasticity of aggregate demand and the income elasticity of demand and supply elasticity for nontradeable goods. The intertemporal elasticity will determine the extent of consumption smoothing and the distribution of expenditure increase through time. The elasticities for nontradeables will determine the extent to which the surge in capital flows will exercise pressure on the nontradeable prices. The appreciation of the RER is indicative of the "Dutch disease effects" (Corden & Neary, 1982) that illustrates the impact of natural resources booms or increase in capital flows on the competiveness of the export-oriented sectors and the import-competing sectors.

The behavior of RER in response to capital inflows and its components has been examined in several empirical studies. Among the literary works in the early 1990s that examine the relationship between capital flows and RERs, Calvo, Leiderman, and Reinhart (1993) found evidence that with the exception of Brazil, all countries in Latin America experienced real appreciation since January 1991 in the aftermath of the resurgence of capital inflows to Latin America in the early 1990s. Similar inferences were reported by Elbadawi and Soto (1994), who studied the impact of the four disaggregated components—short-term capital flows, long-term capital flows, portfolio investment, and FDI for the case of Chile and found that long-term capital flows and FDI have a significant appreciating effect on the equilibrium and RER, though the short-term capital flows and portfolio investments did not have any affect. Similar findings were reported by Edwards (1998) who found that increases in capital inflows had been associated with the RER appreciation, while decline in inflows were associated with RER depreciation for Argentina, Brazil, Chile, Colombia, Mexico, Peru, and Venezuela for the period 1980 to 1997.

A number of studies in the literature examine the comparative experience of Asian and Latin American countries on the impact of capital flows on RERs. A prominent study on this issue was by Corboand Hernandez (1994), who reviewed and compared the experiences of Latin American Countries (Argentina, Chile, Colombia, and Mexico) and five East Asian Countries (Indonesia, Malaysia, the Philippines, the Republic of Korea, and Thailand) with capital flows and found that generally they would result in appreciation of the RER, a larger nontradeable sector, a smaller tradeable sector and a larger trade deficit. However, a similar study on macroeconomic effects of capital flows by Khan and Reinhart (1995) for the period 1984–1993 indicates that appreciation in real exchange has been less common in Asian countries as compared to Latin American countries. A similar mixed response of the RER behavior to the resurgence of capital inflows in Asian and Latin American countries is reported in the study by Calvo and colleagues (1996). Similar outcomes have also been reported in another comparative analysis of the experiences of the emerging market economies in Asia and Latin America on the nexus of RERs and capital inflows by Athukorala and Rajapatirana (2003). Their study reports that during the period 1985–2000, the degree of appreciation in RER associated with capital inflow is uniformly much higher in Latin American countries as compared to Asian economies, in spite of the fact that the latter experienced far greater foreign capital inflows relative to the size of the economy.

In another recent work, Bakardzhieva, Naceur, and Kamar (2010) reported that an increase in NCFs would lead to appreciation of RER and to the possible loss of competitiveness and that the increase of terms of trade, and productivity would also lead to the appreciation of the RER while the increase of openness and government consumption would tend to depreciate the RER. In another important recent study Combes, Kinda, and Plane (2011) analyzed the impact of capital inflows and exchange rate flexibility on the RER. Their results show that aggregated capital inflows as well as public and private flows are associated with RER appreciation. In a more recent study, Jongwanich and Kohpaiboon (2013) examined the impact of capital flows on RERs in emerging Asian countries for the period 2000–2009 by using a dynamic panel-data model and found evidence that composition of capital flows matters in determining the impact of these flows on RERs. They found that portfolio investments bring in a faster speed of RER appreciation than FDI, though the magnitude of appreciation by different types of capital flows is close to each other. The evidence further indicates that capital outflows bring about a greater degree of exchange rate adjustment than capital inflows.

Among the literatures on the impact of capital flows on RERs in the Indian economy is the work by Kohli (2001), who shows that the RER appreciates in response to capital flows and that during the capital surge in 1992–1995 and 1996–1997, the RER appreciated by 10.7% and 14%, respectively, over its March 1993 level. Another empirical study by Dua and Sen (2006) that examined the relationship between the RER, the level of capital flows, volatility of capital flows, fiscal and monetary policy indicators, and current account surplus of the Indian economy using quarterly data for the period 1993Q2–2004Q1 indicates that the RER is positively related to NCFs and their volatility.

Another recent study for India by Sohrabji (2011) estimated the relationship with RER as dependent variable and terms of trade, openness, investment, capital flows, government spending, and technological progress as explanatory variables using the Johansen cointegration test and error correction model with annual data from 1975 to 2006. The results indicate that increased capital flows are associated with an appreciating RER. In addition, capital flows are found to be an important contributor to RER misalignment, which explains the overvaluation of the rupee associated with increased foreign investment in recent years.

Another study by Biswas and Dasgupta (2012) that examined the impact of capital inflows in India on the RERs using quarterly data for the period 1994–1995Q1 to 2009–2010Q4 using the Johansen multivariate cointegration test arrived at the findings that FDI and workers' remittances affect RER positively. The impulse response analysis results indicated that shocks to FDI has a long-term positive impact on the RERs though it is slightly negative in some of the ending periods. However, a very recent study by Gaiha, Padhi, and Ramanathan (2014) that explored the relationship between capital flows and RERs in India for the period 2005–2012 using ordinary least squares estimation, has reported findings that FDI flows have no significant impact on change in RER. However, portfolio flows and debt flows have a significant appreciation impact on the change in RERs.

The cross-country studies on the effects of capital flows on macroeconomic aggregates present different responses largely due to difference in foreign exchange regimes, internal factors, and policy responses of these countries. The countries that received the largest average capital inflows (as a proportion of GDP) are not those that experienced the greatest exchange rate appreciation. The countries with the greatest capital inflows have experienced either depreciation or low appreciation of their currencies. No comparisons with the effects in India have been brought out in these studies. The studies on the effect of capital flows on RER on India are few and far between. These studies do not provide a comprehensive analysis of the relationship between capital flows along with other determinants (such as government expenditure, terms of trade, trade openness, productivity, etc.) on the RER in India, especially for the more recent period. This calls for further research on the subject.

Research Methodology

The Conceptual Model and the Selection of Model Variables

Capital flow maybe one of the most important, but it is not the only variable contributing to the RER changes. The issue of the factors contributing to determination of RER has been a topic of debate in the literature. A study by Edwards (1987) indicated that both the real and monetary factors are important for explaining the RER variability with structural variables being more important in explaining long-run variability and monetary variables more important in explaining short-run variability. In addition, instability of the exchange rate policy significantly influences the RER. Edwards (1988, 1989) developed an analytical framework for exchange rate determination using both nominal and real factors. As per this analysis, terms of trade, trade restrictions, government expenditure, technology, and capital controls are the fundamental determinants of the equilibrium RER. Later studies by Williamson (1994); Hinkle and Montiel (1999); and Maeso-Fernandez, Osbat, and Schnatz (2004) also provide insights into determinants of the RERs. Carrera and Restout (2008), on survey of the existing literature, arrived at productivity, capital flows, government spending, terms of trade, degree of openness, and defacto nominal exchange rate regime as important determinants of the equilibrium RER. Recent studies (Jongwanich, 2009) indicate that the RER behavior at medium and long horizons is determined by five key fundamental economic variables that in addition to NCFs include government consumption expenditure, trade openness, productivity differentials, and terms of trade. Other variables may be included for some countries where such factors play an important role in determining RER. Some of the variables are correlated with each other and capture similar and overlapping effects. In this study, the following variables are used in order to investigate the relationship between the NCFs and the RER in the Indian economy.

REER

In order to measure the RER, the REER index is included in the baseline model. REER index is the weighted geometric average of the bilateral nominal exchange rates of the home currency (Indian rupee, in this case) in terms of foreign currencies adjusted by the ratio of domestic prices to the foreign prices (RBI, 2005).

$$\text{REER} = \prod_{i=1}^{n}[(\boldsymbol{e}/\boldsymbol{e_i})(\boldsymbol{P}/\boldsymbol{P_i})]^{w_i} \qquad (2)$$

where e = exchange rate of Indian rupee against a numeraire (i.e., the International Monetary Fund's special drawing rights [SDRs]) in indexed form,

e_i = exchange rate of foreign currency i against the numeraire (SDRs; i.e., SDRs per currency i) in indexed form,

w_i = weights attached to foreign currency/country i in the index, $\prod_{i=1}^{n} w_i = 1$,

P = India's wholesale price index,

P_i = consumer price index of country i (CPI_i), and

n = number of countries/currencies in the index other than India.

NCF

NCF is the main explanatory variable in the study and hence included in the model. In order to measure the volume of NCFs relative to the size of the economy, the ratio of the NCFs into the Indian economy in the quarter and the quarterly GDP at market prices (at current prices) is used.

TOT

Terms of trade (TOT) is an important determinant, as it captures the effect of change in relative price of exports on the RER through a combination of income and substitution effects. For the Indian economy, net TOT is calculated as the ratio of the exports general unit value index and the imports general unit value index. The indices indicate the temporal fluctuation in trade (i.e., export or import of the country in terms of unit value). They are a measure of average change in unit value of a group of homogeneous commodities over time. A rise in TOT can be associated with a rise or fall of the RER, depending upon whether the income effect or the substitution effect dominates.

GFCE

Government spending is an important fundamental determinant of RER, as it adds to the aggregate demand and impacts the price levels in the economy; it is, therefore, included in the model. In order to measure the size of public spending relative to the size of the economy, government final consumption expenditure (GFCE) in the quarter as proportion of the quarterly GDP at market prices (at current prices) is used in the analysis. As a sizeable portion of the government expenditure in India is devoted to imports of essential commodities, the association of GFCE with REER is expected to be ambiguous.

TRADE

Trade openness is an important determinant included in the model as it impacts the price levels in the economy. The ratio of sum of exports and imports in the quarter to the quarterly GDP at market prices (at current prices; TRADE) is used as a proxy indicator of the trade openness of the Indian economy. As indicated in the previous chapter trade openness is expected to be associated with depreciation of the RER.

GR

Technological progress and productivity differential is included as an important determinant of RER in the model as it impacts the prices of nontradeables due to increase in wages. Percentage GR of the quarterly GDP at factor cost (at constant prices) over the corresponding quarter in the previous year is used as a proxy for the Balassa–Samuelson effect (Balassa, 1964; Samuelson, 1964) associated with technological progress and productivity differential. Higher GR is expected to be associated with increase in productivity and an appreciation of the RER.

CAB

Net CAB has been included in the analysis as a sizeable portion of capital flows in India is used to finance the current account deficit. Capital flows to the extent of utilization for meeting the financing needs of the country are not expected to cause adverse macroeconomic consequences. It is the surplus capital flows over and above the financing requirements that have an adverse impact on the economy. CAB in the quarter as a proportion of the quarterly GDP at market prices (at current prices) is used in the analysis. A more negative CAB is expected to be associated with deprecation of the RER.

CFER

Reserve Bank of India (RBI) maintains foreign exchange reserves in the form of SDRs, gold, foreign currency assets, and reserve tranche position. CFER in the quarter as a proportion of the quarterly GDP at market prices (at current prices) is used as a proxy for capturing the effect of CFER on the

RER. The CFER is on account of change in rupee value of the components of foreign exchange reserves, that is, SDRs, gold, foreign currency assets, and reserve tranche position held by the RBI, which is different from the increase/decrease in foreign reserves due to overall balance of payments. An increase in foreign exchange reserves, to the extent it is accompanied with prevention of increase in money supply (due to sterilization, etc.), is expected to lead to depreciation of the RER for the Indian economy. On the other hand, an increase in foreign exchange reserves accompanied with an increase in money supply is expected to lead to appreciation of the RER in the economy.

With this choice of variables, the functional relationship between RER and the underlying determinants is represented as follows:

$$REER_t = f\{NCF_t, GFCE_t, TRADE_t, GR_t, TOT_t, CAB_t, CFER_t\} \quad (3)$$

where t refers to time.

To estimate the relationship between the dependent variable (i.e., REER and the NCFs and other explanatory variables), the following log-linear specifications are used:

$$LNREER_t = C + \beta_1 NCF_t + \beta_2 GFCE_t + \beta_3 LNTRADE_t + \beta_4 LNGR_t + \beta_5 LNTOT_t + \beta_6 CAB_t + \beta_7 CFER_t + \epsilon_t \quad (4)$$

Where ϵ_t is a stochastic white noise at time t,

LNREER = natural log (REER),
LNTRADE = natural log(TRADE),
LNGR = natural log (GR), and
LNTOT = natural log (TOT).

Empirical Methodology

Time Series Analysis of Variables

Before estimating the model, the dependent and independent variables are separately subjected to unit roots tests using the Augmented Dickey–Fuller (ADF) test (Dickey &Fuller, 1979) and Philips–Perron (PP) test (Philips & Perron, 1988) for testing the stationarity and order of integration. Usually, all variables are tested with an intercept, with and without a linear trend. The ADF framework does not provide a fully adequate test for the existence of unit roots in cases of uncertainty regarding the dynamic structure of the time series of the variable under study and where the error term may be nonwhite noise. In particular, the power of the ADF test is likely to be low where moving average terms are present or where the disturbances are heterogeneously distributed. In such circumstances, Philips and Perron have proposed further set of statistics using nonparametric adjustments that are modifications of the t statistics employed for the Dickey–Fuller test. The Philips and Perron tests can provide superior results, and the nonparametric adjustments of the PP test are likely to raise the power of the test.

Cointegration Analysis

In the econometric literature, different methodological approaches have been used to empirically analyze the long-run relationships and dynamic interactions between two or more time-series variables. The most widely used methods for estimating the cointegrating vector between a set of time series variables include the Engle and Granger (1987) two-step procedure and the maximum-likelihood approach (Johansen & Juselius, 1990). Both these methods require that all the variables under study are integrated of order one, I(1). This, in turn, requires that the variables are subjected to pretesting for ascertaining their orders of integration before including them in particular cointegrating regressions. This introduces a certain degree of uncertainty into the analysis. Apart from this, some of these test procedures have very low power and do not have good small sample properties. One of the relatively recent developments on univariate cointegration analysis is the ARDL approach to cointegration introduced by Pesaran and Shin (1999) and further extended by Pesaran, Shin, and Smith (2001). The main advantage of the ARDL method over the Johansen and Juselius (1990) approach is that it allows for a mix of I(1) and I(0) variables in the same cointegration equation. Another advantage is that the ARDL test is more efficient, and the estimates derived from it are relatively more robust in small sample sizes as compared to traditional Johansen–Juselius cointegration approach, which typically requires a large sample size for the results to be valid. In addition, the choice of ARDL bounds-testing procedure allows for both dependent and the independent variables to be introduced in the model with lags. This is a highly plausible feature because, conceptually, a change in the economic variables may not necessarily lead to an immediate change in another variable. In some cases, they may respond to the economic developments with a lag, and there is usually no reason to assume that all regressors should have the same lags. Because the ARDL approach draws on the unrestricted error correction model, it is likely to have better statistical properties than the traditional cointegration techniques. The ARDL approach is particularly applicable in the presence of the disequilibrium nature of the time series data stemming from the presence of possible structural breaks as happens with most economic variables. The ARDL analysis also provides estimates of the corresponding error correction model (ECM), which shows how the endogenous variable adjusts to the deviation from the long-run equilibrium.

In view of these considerations, the ARDL approach to cointegration, as suggested by Pesaran and colleagues (2001), is employed in this research in order to analyze the long-run relationship between REER and the ratio of NCFs to GDP (NCF), as well as other explanatory variables. An ARDL (p, q_1, q_2, . . .q_k) model has the following form (Pesaran & Pesaran, 2009):

$$\emptyset(L,p)y_t = \sum_{i=1}^{k} \beta_i(L,q_i)x_{it} + \gamma' z_t + \varepsilon_t$$

$$\emptyset(L,p) = 1 - \emptyset_1 L - \emptyset_2 L^2 - \ldots - \emptyset_p L^p$$

$$\beta_i(L,q_i) = \beta_{i0} + \beta_{i1}L + \ldots + \beta_{iq_i}L^{q_i}, i=1,2,\ldots k \quad (5)$$

where y_t is the dependent variable,

x_{it} , $i = 1, \ldots, k$ are explanatory variables,

L is a lag operator such that $Ly_t = y_{t-1}$, and

z_t is an $s \times 1$ vector of deterministic variables such as the intercept term, time trends, or seasonal dummies, or exogenous variables with fixed lags.

The ARDL procedure involves two stages. In the first stage the existence of the long-run relationship between the variables under investigation is tested by computing the F statistics for testing significance of the lagged levels of the variables in the error correction form of the ARDL model. Once the existence of long-run relationship is established, then in the second stage the long-run coefficients and the error correction model are estimated. Equation 5 is estimated by the ordinary least squares method for all possible values of $p = 0, 1, 2, \ldots, m$ (m is the maximum lag order), $q_i = 0, 1, 2, \ldots, m$, $i = 1, 2, \ldots, k$; namely a total of $(m+1)^{k+1}$ different ARDL models. All the models are estimated for the same sample period, namely $t = m+1, m+2, \ldots, n$. Thereafter, one of the $(m+1)^{k+1}$ estimated models is selected using one of the following four model selection criteria: the R^2 criterion, Akaike Information criterion (AIC), Schwarz Bayesian criterion (SBC), and the Hannan and Quinn criterion. Thereafter, the long-run coefficients and their asymptotic standard errors for the selected ARDL model are computed. The estimates of the ECM that corresponds to the selected ARDL model are also computed.

Data Sources

The dataset comprises the quarterly data for the Indian economy for the period 1996–1997Q1 to 2012–2013Q4. The REER index used in the study is the monthly trade-weighted 36 currency REER indices obtained from the *Handbook of Statistics* published by the RBI (2014). The quarterly REER indices are obtained by averaging the monthly indices for the quarter.

In this study, NCF, GFCE, TRADE (sum of total rupee exports and imports), net CAB, and CFER are measured as ratios of their quarterly values to quarterly estimates of GDP at market prices (at current prices; base year 2004–2005). The CFER is measured as a ratio of the CFER (in rupees) from the end of the previous quarter to the end of the present quarter to the quarterly estimates of GDP at market prices (at current prices; base year 2004–2005). GR, which is a proxy for productivity differential, is measured as the percentage changes in the GDP at factor cost (at constant prices) as compared to the corresponding quarter in the previous year.

The data for NCFs, exports and imports, and foreign exchange reserves is obtained from the *Handbook of Statistics* (RBI, 2014). The data for quarterly GDP at market prices (at current prices), GDP at factor cost (at constant prices), and GFCE base year 2004–2005 are obtained from the National Account Statics of the Central Statistical Office, Ministry of Statistics, and Programme Implementation.

Finally, net TOT is measured as the ratio of general unit value index of exports to the general unit value index of imports. The data for the unit value indices is published by Directorate General of Commercial Intelligence and Statistics, which provides the data with the old series 1978–1979 base year and 1999–2000 as base period and the linking factor for calculating old indices based on new indices.

Estimation Results

Stationary Properties of the Variables

For the quarterly data on variables for the period 1996–1997Q1 to 2012–2013Q4, the results of the ADF test and PP test are presented in the Table 1.

Table 1: *Results of Unit Root Tests*

Series	Order	Exogenous	ADF Test *t* Statistic	ADF Test (*p* Value)	PP Test *t* Statistic	PP Test (*p* Value)
LNREER	Level	Constant	–4.761667	(.0002)	–3.103267	(.0310)
		Constant and linear trend	–4.745895	(.0015)	–3.046587	(.1277)
NCF	Level	Constant	–4.891145	(.0001)	–4.921267	(.0001)
		Constant and linear trend	–5.350538	(.0002)	–5.299399	(.0002)
GFCE	Level	Constant	–1.680792	(.4360)	–10.62818	(.0000)
		Constant and linear trend	–1.880807	(.6529)	–10.65427	(.0000)
	First difference	Constant	–21.29816	(.0001)	–37.03903	(.0001)
		Constant and linear trend	–21.10828	(.0001)	–36.90740	(.0001)
CAB	Level	Constant	–0.593625	(.8642)	–3.620344	(.0078)
		Constant and linear trend	–1.618830	(.7746)	–4.751141	(.0014)
	First difference	Constant	–9.726036	(.0000)	–17.17713	(.0000)
		Constant and linear trend	–9.823498	(.0000)	–19.38159	(.0001)
CFER	Level	Constant	–6.988502	(.0000)	–7.109852	(.0000)
		Constant and linear trend	–6.927756	(.0000)	–7.054127	(.0000)
LNTRADE	Level	Constant	0.063339	(.9603)	–0.914475	(.7778)
		Constant and linear trend	–2.341173	(.4060)	–5.008520	(.0006)
	First difference	Constant	–5.407284	(.0000)	–13.48976	(.0000)
		Constant and linear trend	–5.404503	(.0002)	–13.52306	(.0001)
LNTOT	Level	Constant	–3.833514	(.0042)	–3.667873	(.0068)
		Constant and linear trend	–4.831060	(.0011)	–4.831060	(.0011)
LNGR	Level	Constant	–4.193540	(.0014)	–4.193813	(.0014)
		Constant and linear trend	–4.303771	(.0056)	–4.311876	(.0055)

Note. ADF = Augmented Dickey–Fuller; PP = Philips–Perron; LNREER = natural log of real effective exchange rate; NCF = net capital flows; GFCE = government final consumption expenditure; CAB = current account balance; CFER = change in foreign exchange reserves; LNTRADE = natural log of TRADE (a proxy of trade openness); LNTOT = natural log of terms of trade; LNGR = natural log of growth rate. Source: Author's calculations by EViews 5.

The results of the unit root tests show that the null hypothesis of unit root is rejected for the variables LNREER, NCF, CFER, LNTOT, and LNGR as per the test statistics for both the ADF and PP tests. Hence, these variables are stationary I(0) in the level. For the variables GFCE and CAB, the ADF test statistic fails to reject the null hypothesis for unit root, but the PP test statistic indicates that the null hypothesis of unit root is rejected at even 1% level of significance. Both the ADF and PP tests for the first differences of these series indicate that null hypothesis of unit root is rejected for the first differences and that they are stationary. Both the ADF and PP tests for the variable LNTRADE indicate that the series is nonstationary in the level. However, the first difference of this series is stationary as per both the tests. Hence, the variable LNTRADE is integrated of order one I(1).

Results of Cointegration Analysis

In the first stage, the existence of long-run cointegration relationship for the variables is investigated by computing the F test statistic. Given the few observations available for estimation, the maximum lag order for the various variables in the model is set at two (m =2), and the estimation is carried out for the period 1996Q1–2012Q4. The computed F statistic for testing the joint null hypothesis that there exists no long-run relationship between the variables is F = 3.6476[.003]. The relevant critical value bounds for this test as computed by Pesaran, Shin, and Smith (1996) at the 95% level of is given by [2.365, 3.513]. Because the F statistic exceeds the upper bound of the critical value band, the null hypothesis of no long-run relationship between the variables is rejected. This test result suggests that there exists a long-run relationship between LNREER, GFCE, NCF, LNTRADE, LNTOT, LNGR, CAB, and CFER.

Next, the ARDL model is estimated using the univariate ARDL cointegration test option of Microfit 4.0, with the maximum lag m = 2. Microfit estimates $(2+1)^{7+1}$ = 6,561 models and presents the choice of the selection of the model with optimum number of lags of variables between different selection criteria. The ARDL model specifications selected based on SBC and AIC are the same. The ARDL (1,0,1,1,1,0,1,1) estimates for these models are presented in Table 2.

In the second stage, the estimates of the long-run coefficients of the model are computed. Table 3 presents the estimated long-run coefficients for the model based on the ARDL (1,0,1,1,1,0,1,1) specifications, selected using both the SBC and AIC criterion.

Table 2: *Autoregressive Distributed Lag Estimates of the ARDL (1,0,1,1,1,0,1,1) Model*

Regressor	Coefficient	*SE*	*t* Ratio	(Probability)
LNREER(–1)	0.82533	0.067850	12.1639	(.000)
GFCE	–0.8526E–3	0.0012375	–0.68899	(.494)
NCF	0.83864	0.15507	5.4080	(.000)
NCF(–1)	0.53639	0.17918	2.9936	(.004)
LNTRADE	0.47747	0.024481	1.9504	(.057)
LNTRADE(–1)	–0.045104	0.024377	–1.8502	(.070)
LNTOT	–0.28102	0.016046	–1.7513	(.086)
LNTOT(–1)	0.032279	0.014565	2.2162	(.031)
LNGR	–0.0011571	0.0068497	–0.16892	(.867)
CAB	0.54638	0.18782	2.9090	(.005)
CAB(–1)	0.63911	0.20793	3.0737	(.003)
CFER	–0.67004	0.11699	–5.7273	(.000)
CFER(–1)	–0.41978	0.12370	–3.3935	(.001)
C	0.80129	0.30736	2.6070	(.012)
R^2	0.84748	$\bar{R}^2$	0.80935	
SE of regression	0.018025	*F* statistic *f*(13,52)	22.2261	(.000)
M of dependent variable	4.5956	*SD* of dependent variable	0.041281	
Residual sum of squares	0.016894	Equation log-likelihood	179.2742	
AIC	165.2742	SBC	149.9466	
DW statistic	2.2785	Durbin's *h* statistic	–1.3556	(.175)

Note. Dependent variable is LNREER. *SE* = standard error; LNREER = natural log of real effective exchange rate; GFCE = government final consumption expenditure; NCF = net capital flows; LNTRADE = natural log of TRADE (a proxy of trade openness); LNTOT = natural log of terms of trade; LNGR = natural log of growth rate; CAB = current account balance; CFER = change in foreign exchange reserves; C = constant term; *M* = mean; AIC = Akaike Information criterion; *DW* = Durbin Watson; *SD* = standard deviation; SBC = Schwarz Bayesian criterion. Source: Author's calculations by Microfit (4.0).

Table 3: *Estimated Long-Run Coefficients Using the ARDL (1,0,1,1,1,0,1,1) Model*

Regressor	Coefficient	*SE*	*t* Ratio	(Probability)
GFCE	–0.004813	0.0072162	–0.67643	(.502)
NCF	7.8720	3.2231	2.4424	(.018)
LNTRADE	0.015135	0.82143	0.18425	(.855)
LNTOT	0.23913	0.091567	0.26115	(.795)
LNGR	–0.0066242	0.039296	–0.16857	(.867)
CAB	6.7870	2.9149	2.3284	(.024)
CFER	–6.2392	2.8750	–2.1702	(.035)
C	4.5874	.27324	16.7890	(.000)

Note. Dependent variable is LNREER. *SE* = standard error; LNREER = natural log of real effective exchange rate; GFCE = government final consumption expenditure; NCF = net capital flows; LNTRADE = natural log of TRADE (a proxy of trade openness); LNTOT = natural log of terms of trade; LNGR = natural log of growth rate; CAB = current account balance; CFER = change in foreign exchange reserves; C = constant term. Source: Author's calculations by Microfit (4.0).

The long-run model corresponding to ARDL (1,0,1,1,1,0,1,1) for the natural log of REER can be written as follows:

$$LNREER_t = 4.5874 - 0.0048813 \times GFCE_t + 7.8720 \times NCF_t + 0.015135 \times LNTRADE_t + 0.023913 \times LNTOT_t - 0.0066242 \times LNGR_t + 6.7870 \times CAB_t - 6.2392 \times CFER_t \quad (6)$$

In the next stage, the ECM for the selected ARDL model is estimated. Table 4 presents the results of the estimated ECM using Microfit 4.0. The estimated ECM has two parts: the first part contains the estimated coefficients of short-run dynamics, and the second part consists of the estimates of the error correction term that measures the speed of adjustment whereby short-run dynamics converge to the long-run equilibrium path in the model.

***Table 4**: Error Correction Representation for the Selected ARDL (1,0,1,1,1,0,1,1) Model*

Regressor	Coefficient	*SE*	*t* Ratio	(Probability)
ΔGFCE	–0.856E–3	0.0012375	–0.68899	(.494)
ΔNCF	0.83864	0.15507	5.4080	(.000)
ΔLNTRADE	0.047747	0.024481	1.9504	(.056)
ΔLNTOT	–0.028102	0.016046	–1.7513	(.085)
ΔLNGR	–0.0011571	0.0068497	–0.16892	(.866)
ΔCAB	0.54638	0.18782	2.9090	(.005)
ΔCFER	–0.67004	0.11699	–5.7273	(.000)
ΔC	0.80129	0.30736	2.6070	(.012)
ECM(–1)	–0.17467	0.067850	–2.5744	(.013)
R^2	0.62430	$\bar{R}^2$	0.53038	
SE of regression	0.018025	*F* statistic *f*(8,57)	10.8012	(.000)
M of dependent variable	–0.2288E–3	*SD* of dependent variable	0.26302	
Residual sum of squares	0.016894	Equation log-likelihood	179.2742	
AIC	165.2742	SBC	149.9466	
DW statistic	2.2785			

Note. Dependent variable is ΔLNREER, *SE* = standard error; ΔLNREER = change in natural log of real effective exchange rate; ΔGFCE = change in government final consumption expenditure; ΔNCF = change in net capital flows; ΔLNTRADE = change in natural log of TRADE (a proxy of trade openness); ΔLNTOT = change in natural log of terms of trade; ΔLNGR = change in natural log of growth rate; ΔCAB = change in current account balance; ΔCFER = change in change in foreign exchange reserves; ΔC = change in constant term; *M* = mean; AIC = Akaike Information criterion; *DW* = Durbin Watson; *SD* = standard deviation; SBC = Schwarz Bayesian criterion. Source: Author's calculations by Microfit (4.0).

Interpretation of Results

The ARDL estimates for the long-run coefficients indicate that the relationship between LNREER and NCF is statistically significant and positive. Thus for the estimation period 1996–1997 to 2012–2013, the NCFs to India have been associated with RER appreciation. Similarly, the CAB has a positive and statistically significant association with LNREER, indicating that the outflows on account of current account deficits have been associated with depreciation of RER or limiting the appreciation on account of capital flows. The government spending GFCE has a negative association with LNREER, which could be attributed to focus of this expenditure on imports (capital outflow), but this is not statistically significant. Similarly, LNTRADE has a positive association with LNREER, which is contrary to the expectations as per literature, but this is not statistically significant. LNTOT has a positive association with LNREER, which could be attributed to a rise in demand due to dominance of income effect, but this is not statistically significant. Productivity differential captured by LNGR has a negative association with LNREER, which indicates that this has been associated with a decline in prices of nontradeables, but this is not statistically significant. The coefficient on CFER in the results is statistically significant and negative. This indicates that, to some extent, the accumulation of reserves by RBI in the face of increasing capital flows has prevented appreciation of RERs and, thus, mitigated their adverse consequences on the competitiveness of the Indian economy. The results of the ECM indicate that short-run coefficients for ∆NCF, ∆CAB, and ∆CFER are statistically significant at the 5% level and positive, and the coefficient of error correction term ECM(–1) is negative and highly significant, indicating that in the short-run, changes in NCFs and CAB are associated with RER appreciation, while an increase in foreign exchange reserves is associated with depreciation of RER. The estimated value of the coefficient indicates that about 17.5% of the disequilibrium in RER is offset by the short-run adjustment in the same quarter.

Concluding Remarks

The main contribution of this research lies in comprehensively analyzing the relationship between the NCFs and the RER in India consequent to the liberalization of the capital account in early 1990s. Further other fundamental determinants of RER—such as terms of trade, trade openness, and productivity differential, as suggested in the literature, along with monetary and fiscal variables have been included in the analysis. The most significant finding of the research is that the NCFs in India are positively associated with the RER appreciation, and the association is statistically significant. This evidence indicates that the increasing volume of cross-border flows in India has adverse consequences, such as loss of competiveness of the export sectors, inflationary pressures leading to lowering of profitability of producers, widening of trade deficit, and shock to the real economy.

Government consumption expenditure is not found to be significantly associated with real appreciation, thereby limiting the role of fiscal policy in managing capital flows. The empirical evidence on the positive association between NCFs and the RER and negative association between CFER and RER shows that the accumulation of reserves by RBI in the face of increasing capital flows has prevented the appreciation of RERs and mitigated their adverse consequences on the competitiveness of the Indian economy.

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