

Bhagwati, Jaimini; Barua, Abheek; Khan, M. Shuheb

**Working Paper**

## Is the Rupee over-valued?

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# **Working Paper 304**

## **Is the Rupee Over-valued?**

**Jaimini Bhagwati**

**Abheek Barua**

**M. Shuheb Khan**

**June 2015**



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## Abstract

The paper's objective is to examine whether the Indian Rupee was fairly valued as of end March 2015. First, the movements of the trade weighted real effective exchange rate (REER) of the Rupee are tracked over the last ten years. Next, the underpinnings of the Harrod-Balassa-Samuelson effect, which suggests taking changes in productivity levels into account in arriving at reliable estimates of exchange rates, and associated studies, are assessed. The paper also discusses varying approaches to Behavioural Equilibrium Exchange Rate (BEER) models and uses one to analyse whether the Rupee is fairly valued. The conclusion of the paper that the Rupee is substantially over-valued is based on a comparison of results obtained using differing methodologies.

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**JEL Classification:** E00, E30, F31, F32, F41 C50.

**Keywords:** *Real effective exchange rate, capital inflows, inflation, export growth, Harrod-Balassa-Samuelson, Behavioural Equilibrium Exchange Rate*

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# Is the Rupee Over-valued?<sup>1</sup>

Jaimini Bhagwati<sup>2</sup>, Abheek Barua<sup>3</sup> and M. Shuheb Khan<sup>4</sup>

## SECTION I

### *1.1 Introduction*

Section I of this paper provides an overview of the movements in the rupee's nominal and real effective exchange rates in the context of India's foreign exchange (FX) debt and reserves positions and net FX flows. This section also comments on the considerations involved in maintaining an appropriate level of FX reserves and the RBI's and government's positions on rupee exchange rate management. Section II of this paper details how the rupee real effective exchange rate (REER) has behaved over the last 10 years and it elaborates on why a trade weighted real effective exchange rate (REER) could be deemed to be inaccurate. The underpinnings of the Harrod-Balassa-Samuelson (HBS) effect (which suggests that productivity changes need to be factored into movements in real exchange rates) are analysed in this section. Further, the extent to which REER numbers have to be adjusted if productivity and capital flows are taken into account using Behavioural Equilibrium Exchange Rate (BEER) models are also examined in this section. Section III presents REER and BEER estimates for the rupee exchange rate and discusses the extent of under or over-valuation indicated by these calculations. Section IV, the concluding section, assesses whether any greater accuracy is achieved by using BEER models as compared to: (i) trade-weighted REERs using CPI differentials; or (ii) point estimates incorporating total factor productivity. This paper concludes that the rupee is currently substantially overvalued.

### *1.2 Rupee and Foreign Currency Interest Rates*

Interest rates on short to long-term securities issued by the Indian government provide the benchmarks for the rupee debt market as is the practice for most other currencies. The Indian government issues fixed income securities ranging from 3-month treasury bills to bonds with maturities stretching up to 30 years. Secondary market liquidity is much higher at shorter maturities. The Indian government has not issued sovereign bonds in hard currencies to date. However, most government-owned banks such as the State Bank of India offer hard currency term deposits and the interest rates on such deposits are a higher cost proxy (perhaps around 50 basis points higher at 5-year maturity) for the pricing of Indian sovereign credit in US\$.

Indian private firms with rupee requirements often borrow in hard currencies if their creditworthiness is acceptable to foreign investors. Such borrowings are through bond

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offerings possible only for larger and better known corporates, or through external commercial borrowings (ECBs), foreign currency convertible bonds (FCCBs) and foreign currency exchangeable bonds (FCEBs). The extent of Indian borrowers' appetite for hard currency debt depends on the spread between the higher nominal interest rates on rupee borrowings and the lower cost of corresponding maturity borrowings in foreign currencies.

**Table 1: Treasury Yields (per cent per annum) as of April 27, 2015**

	3-Month	6-Month	12-Month	2-Year	5-Year	10-Year	30-Year
UK	-	-	-	0.49	1.26	1.64	2.39
US	0.02	0.09	0.21	0.52	1.32	1.91	2.61
Germany	-	-	-	-0.27	-0.11	0.14	0.57
Japan	-	-	-	-0.01	0.06	0.29	1.3
India	7.89	7.90	7.89	-	7.78	7.78	-

Source: RBI, Bloomberg & Investing website

If borrowings in foreign currencies are fully hedged against future exchange rate movements, the resulting cost would not be that different from rupee borrowing costs except for occasional arbitrage opportunities. Indian firms, both private and public, tend to borrow in foreign currencies because the cost of borrowing is lower in nominal terms compared to borrowing in rupees and often, a part or even all of the proceeds are left unhedged. This creates a constituency which wants the rupee to remain at the same level or strengthen to keep the ex-post cost in rupees well below their cost of direct rupee borrowings. Concurrently, there are some in Indian decision making circles who mistakenly perceive a strong rupee as a sign of a buoyant economy.

### **1.3 Foreign Investments in Indian Debt and Equity**

The ceilings on foreign portfolio investments in Indian debt are US\$30 billion in government securities and US\$51 billion in corporate debt. As can be seen from Table 1, foreign investors in Indian debt receive a considerably higher nominal return than comparable maturity returns in government or corporate debt issued in developed country currencies. Table 1 lists US, German, Japanese, UK and Indian Treasury yields as of April 27, 2015.

Table 2 provide the volumes of annual external commercial borrowings (ECBs) of Indian firms in foreign currencies. If the proceeds of foreign currency borrowings are converted to Indian rupees, authorised India-based dealers in foreign exchange are allowed to provide the amounts required in foreign currencies for debt service.

**Table 2: External Commercial Borrowings**

	ECBs (\$ billions)
2010	24
2011	37
2012	30
2013	35
2014	31

Source: Thomson Reuters DataStream

The annual net capital inflows, portfolio equity investments, FDI and the total net flows to emerging countries over the last 5 years are provided in Table 3.

**Table 3: Net Capital Inflows (\$ billions)**

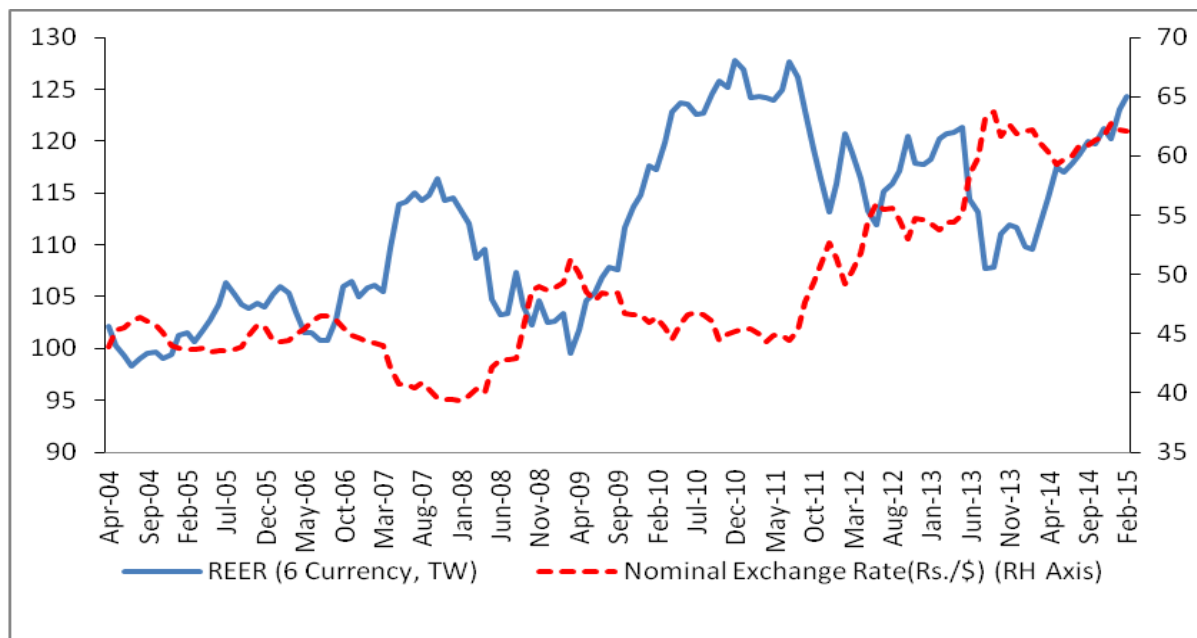
	India	Emerging countries
2010	71	492
2011	60	340
2012	85	315
2013	60	413
2014	71	-62

Source: Thomson Reuters DataStream, Institute of International Finance

#### 1.4 Rupee-US\$ Exchange Rate

The movements of the nominal rupee-\$ exchange rate as also the trade weighted real effective exchange rate (REER) between the rupee and 6 other currencies are shown in Figure 1. The real effective rupee-\$ exchange rate is closely correlated to net capital flows – the positive correlation was about 0.6 between 2004 and 2014. It appears, therefore, that RBI tends to allow net foreign exchange flows to drive the rupee exchange rate.

**Figure 1: Nominal Exchange Rate & REER**



Source: Thomson Reuters DataStream

Foreign investors are taking a currency risk by investing in rupee debt or equity and this is another interest group that would prefer the rupee to remain stable or appreciate for the returns in their numeraire hard currencies to be higher. Since the US\$ is by far the dominant international reserve currency, investment managers track the movements of the Indian rupee



versus the US\$ most closely. Even without conspiracy theories to keep the rupee overvalued, the objective fact is that there are winners and losers if the rupee strays too far from what could be considered a reasonable, fairly-valued level, which factors in inflation, productivity, trade and foreign investment differentials between India and its economic partner countries.

### ***1.5 Foreign Exchange Reserves, Monetary Policy and Exchange Rate Management***

Rupee interest rates are discussed at length in specialised forums and the RBI provides periodic guidance. It was mentioned in the budget speech on February 28, 2015 that the RBI Act would be amended to enable the setting up of a Monetary Policy Committee (MPC). The logic is that this will provide greater clarity in policy making to ensure that inflation remains within low and predictable levels. RBI's role in setting interest rate benchmarks would now be more formally decided by an MPC. Although the details of exactly how such an MPC is to be constituted and its functions are not yet public, it is a move towards greater transparency and accountability in the formulation of monetary policy.

India's trade in goods, invisibles (consisting of services, income from financial assets, labour and property and NRI workers' remittances) and capital account are affected by decisions about the rupee's exchange rate. Effectively, although the rupee is mostly non-convertible for Indians, it is mostly convertible on the capital account for non-Indian residents and foreign investors. It follows that the RBI has to stock an adequate level of FX reserves to prevent a run on the rupee as happened in August 2013.

Capital flight out of long-term debt has to be self-limiting as foreign investment in government debt is capped at \$30 billion and corporate debt at \$51 billion. Therefore, if short-term trade credit and other hard currency debt with residual maturity of 6 months are monitored transparently and accurately, it should be easier for RBI to manage orderly depreciation.

The net stock of FII investment in India, as of April 27, 2015, is \$228.7 billion: \$170.6 billion is in equity while investment in debt securities amounts to \$57.9 billion.<sup>5</sup> Around 10 per cent of FII investment is in the form of participatory notes. Abstracting from developments in India, external considerations could require FIIs to reduce their positions in Indian stocks. Substantial proportions of the floating stock of large cap NIFTY and SENSEX companies are owned by FIIs. If FIIs sell in large volumes, stock prices would fall precipitously and this would be counterproductive for them. Therefore, if FX reserves keep pace with GDP, growth in trade and stock of FII investments, it should provide adequate insurance against precipitous outflows from equity investments. As the economy grows and trade volumes and foreign investments rise, FX reserves need to increase commensurately.

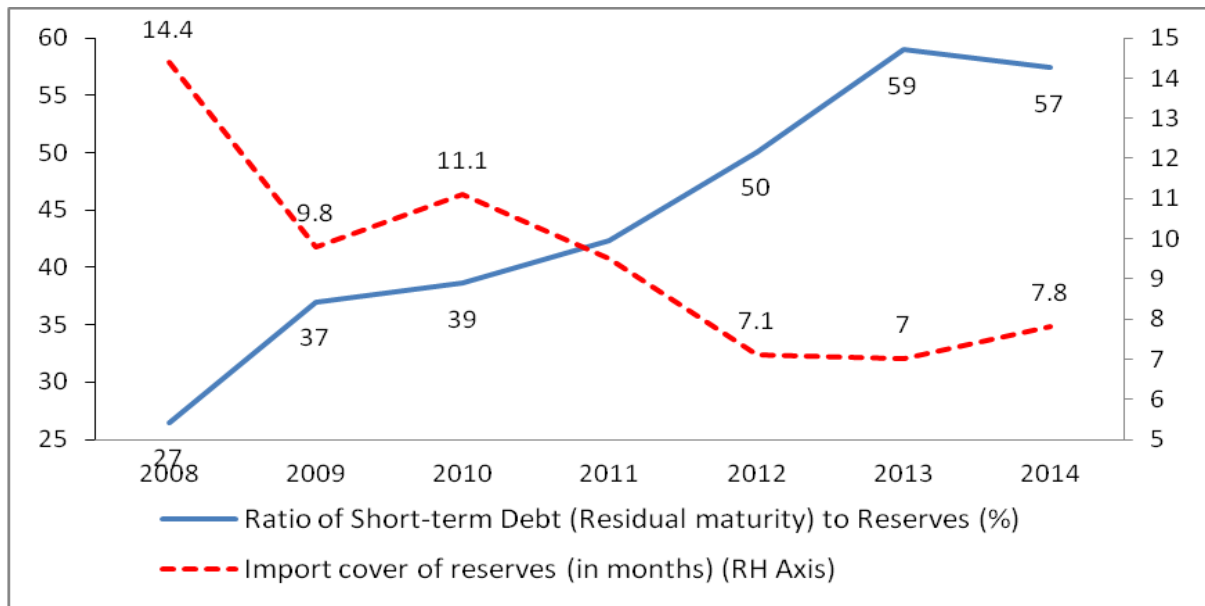
RBI had purchased (net) \$20 billion from January 1, 2015, till end- February 2015 and in various commentaries, the current level of FX reserves have been deemed to be at record levels. This is factually inaccurate in terms of the adequacy of FX reserves against the risk of unanticipated FX outflows. The nominal volume of FX reserves was US\$335.7 billion on

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<sup>5</sup> [www.cdslindia.com](http://www.cdslindia.com)

March 13, 2015. Figure 2 shows that the ratio of short-term debt (with residual maturity of 1 year) to FX reserves has more than doubled from 27 per cent in 2008 to 57 per cent in 2014. Import cover has decreased from 14.4 to 7.8 months over the same period. On these counts, the current level of FX reserves appears to be inadequate. It follows that RBI should continue to use every opportunity to raise the level of India's FX reserves even though there is a substantial cost to be paid for mopping up the resulting rupee liquidity.

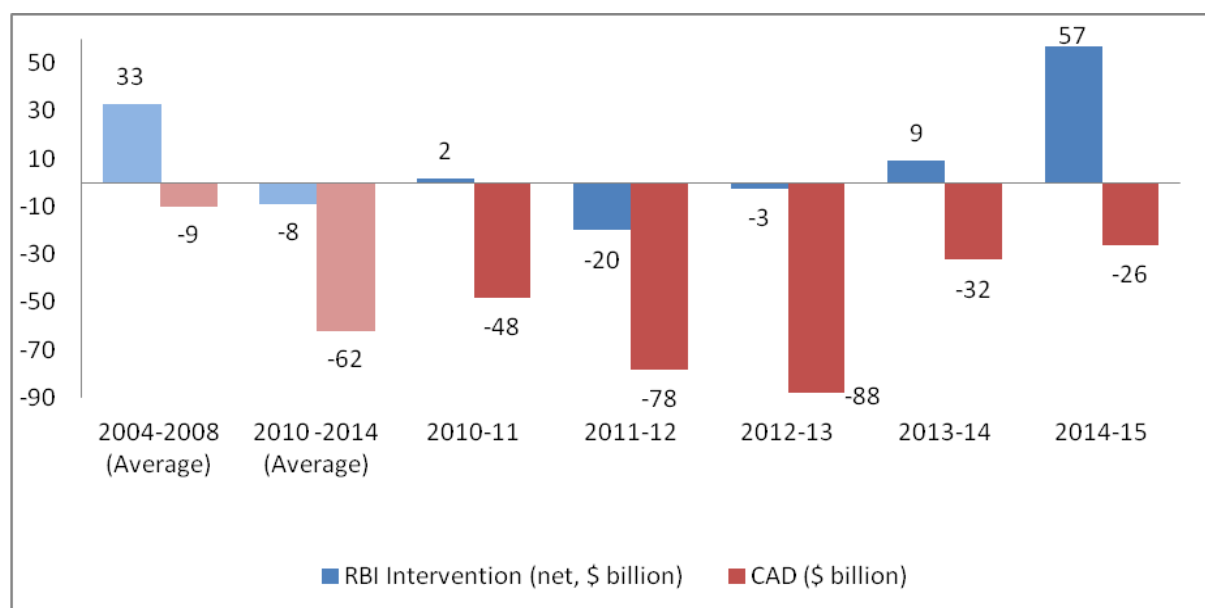
**Figure 2: Adequacy of FX Reserves (end-March)**



Source: RBI

RBI's FX interventions in the last decade are shown in Figure 3 below.

**Figure 3: RBI's FX interventions and CAD (\$ billion) (end-March)**



Source: Thomson Reuters DataStream& CEIC database

Note: CAD 2014-15 data is available till December 2015

In this context, as of March 4, 2015, the RBI Governor's position on the rupee exchange rate management was that the:

“Rupee has remained strong relative to peer countries. While an excessively strong rupee is undesirable, it too creates disinflationary impulses. It bears repeating here that the Reserve Bank does not target a level for the exchange rate, nor does it have an overall target for foreign exchange reserves. It does intervene on occasion, in both directions, to reduce avoidable volatility in the exchange rate. Any reserve build-up is a residual consequence of such actions rather than a direct objective.”

And, on exchange rate policy, RBI's web-site states that it

“focuses on ensuring orderly conditions in the foreign exchange market. For this purpose, it closely monitors the developments in the financial markets at home and abroad. When necessary, it intervenes in the market by buying or selling foreign currencies. The market operations are undertaken either directly or through public sector banks.”

Although these formulations are ambiguous compared to RBI's standards for monetary policy, the suggestion is that the rupee exchange rate is lightly managed and only if there is volatility. There is logic to this position on the downside risk of rupee depreciation since it would be counterproductive to try to defend it by selling FX even though the rupee is not fully convertible on the capital account. As the well-publicised case of George Soros versus the Bank of England and several other episodes have shown, it is a losing battle for a central bank to defend its currency, particularly for a freely convertible currency, if markets have decided that it is overvalued.

As for Government of India, it usually does not take a publicly visible stand on rupee exchange rate management. Ministry of Finance officials comment sporadically about the nominal value of the rupee without providing supporting logic about why the exchange rate is under or over-valued. Information about the extent to which consultations may have taken place in the past across financial sector regulators, government and stake-holders about actions that would be taken in accordance with risk perceptions and/or actual developments is not readily available. For reasons that are surprisingly totally unclear, there appears to be insufficient government oversight of the rupee exchange rate, which affects crucial outcomes such as foreign investment, trade, inflation and level of foreign exchange reserves.

Razin and Colins, 1999; Dollar and Kraay, 2003; Prasad, Ranjan and Subramanian 2006; Gala 2008, have shown that exchange rate overvaluation can have negative effects on long-run economic growth. Further, Rodrik (2008) and Berg and Miao (2010) have shown that undervaluation can benefit growth.

### ***1.6 Exports and Rupee Exchange Rate***

Table 4 shows that there has been a marked decline in India's merchandise export growth in the last few years.

**Table 4: External Sector**

<b>Balance of Payments</b>	2004-2008 (Av.)	2010 - 2014 (Av.)	2010-11	2011-12	2012-13	2013-14
Merchandise Exports (% change)	25.3	12.2	40.4	20.9	-1	3.9
Merchandise Imports (% change)	32.3	9.7	27.6	30.3	0.5	-7.2
Trade Balance/GDP (%)	-5.4	-8.9	-7.5	-10.1	-10.5	-7.9
Invisible Balance/GDP (%)	5.1	5.7	4.6	5.9	5.8	6.1
Current Account Balance/GDP (%)	-0.3	-3.2	-2.8	-4.2	-4.7	-1.7
Net Capital Flows /GDP (%)	4.6	3.7	3.7	3.6	4.8	2.6

Source: RBI

Between 2004 and 2008, annual export growth averaged 25.3 per cent and declined to 12.2 per cent during the years 2010 to 2014. Exports grew by 3.4 per cent in fiscal years 2013-14 and 2014-15. Of course, tepid, fitful and patchy recovery in the global economy is an explanatory factor for sluggish external demand. However, the prolonged overvaluation of rupee has also been blamed by several economists. Their argument is that due to high remittances and net capital inflows, India is suffering from a variety of the ‘Dutch Disease’<sup>6</sup> (Rajwade 2014). An overvalued rupee has resulted in the loss of competitiveness of our export sector (Kumar, 2014)<sup>7</sup>. It follows that close attention needs to be paid by the government, the RBI, interested parties and non-partisans on whether the rupee is fairly valued.

## SECTION II

### 2.1 Purchasing Power Parity Theory

Purchasing power parity (PPP) theory, used to gauge living standards across economies, is an explanatory factor in the determination of exchange rates. At its core, this simple theory states that the exchange rate between two currencies is determined by relative price levels (Dornbusch 1995). The Law of one Price is the basis for PPP, which states that if there are no transportation costs, taxes or tariffs arbitrage would ensure that internationally traded items

<sup>6</sup> “Dutch disease is the negative impact on an economy of any factor which causes a sharp inflow of foreign currency, such as the discovery of large oil reserves. The foreign exchange inflows lead to currency appreciation, making the country’s other products less price competitive internationally. It also leads to higher levels of cheap imports and could lead to deindustrialisation as industries apart from resource exploitation are moved to cheaper locations” (FT 2015)

<sup>7</sup> “Why India needs a weaker rupee” (indiaincorporated.com, 2014)

would have the same price in every country if prices are expressed in a common currency (Pakko & Pollard 2003).

If the price of commodity x in India and the US are  $P^{INR}$  and  $P^{\$}$  respectively, the Law of One Price can be expressed as follows with the exchange rate represented by e.

$$P^{INR} = e * P^{\$} \quad \text{Equation 1}$$

The exchange rate between the two currencies would be determined by the ratio of the price levels in the two countries.

$$e^{INR/\$} = \frac{P^{INR}}{P^{\$}} \quad \text{Equation 2}$$

If prices deviate and relative prices are not equated by the exchange rate, arbitrage opportunities would arise and consequent movements of prices of commodity x would ensure a reversion to an equilibrium PPP exchange rate.

Purchasing power parity can be calculated in absolute or relative terms. Exchange rates as per absolute PPP are calculated by taking the ratios of price indices in the home jurisdiction and foreign countries. A weaker version of PPP requires that the rate of change in the exchange rate offsets the differential between the rate of changes in home and foreign price indices (Rogoff 1996).

Several studies have been done to test this theory with little success in explaining the behaviour of exchange rates. A recent PPP-based exercise claims that the rupee is undervalued by 70 per cent (Persaud 2015). Despite its simplistic appeal, PPP has severe limitations in explaining exchange rates, primarily due to the existence of non-traded goods and services, which are not subject to cross-country arbitrage. Further, transportation costs for traded goods plus differences in taxes, tariffs and non-tariff barriers can make the cost of arbitrage too high and hence ineffective. (Lafrance & Schembri 2002).

## **2.2 Indian Rupee Real Effective Exchange Rates (REERs)**

Sharp movements in nominal exchange rates create uncertainty and raise concerns about market risk in the economy – hence, the universal demand for stable exchange rates. However, stability in nominal exchange rates may be counterproductive in the longer term if other key macroeconomic variables do not move in the desired proportions and directions. Nominal exchange rates, which are adjusted for inflation and other macro-indicators, need to be estimated to gauge the economic impact and implicit risks involved. REER is a summary indicator that captures the movement of the home currency against a basket of trading partner currencies. The movements of the nominal effective exchange rate (NEER) and real effective exchange rate (REER) are indicators of changes in external competitiveness.

NEER is simply the weighted average of nominal exchange rates of the home currency against foreign currencies. Headline exchange rates can be quoted in rupees to the US dollar.

If the dollar appreciates/depreciates by varying amounts against India's major trading partner currencies, movements in just the dollar/rupee exchange rate would not provide an accurate indication of external competitiveness.

$$NEER = \prod_{i=1}^n (e/e_i)^{w_i} \quad \text{Equation 3}$$

NEER = nominal effective exchange rate

e = exchange rate of the Indian rupee against a numeraire currency (SDR)

e<sub>i</sub> = e<sub>i</sub> is exchange rate of a foreign currency 'i' against the numeraire currency (SDR)

w<sub>i</sub> = weights (total trade or export weights)

NEER numbers could indicate a stable exchange rate and it is a better indicator than spot exchange rates. However, it can be a misleading indicator of competitiveness during periods of high inflation.

REER factors in inflation differentials. REER is defined as a weighted average of nominal exchange rates adjusted for price differentials between domestic and foreign jurisdictions and is underscored by the purchasing power parity (PPP) hypothesis. That is, REER is the weighted average of NEER adjusted by the ratio of domestic to foreign prices.

$$REER = \prod_{i=1}^n [(e/e_i)(P/P_i)]^{w_i} \quad \text{Equation 4}$$

REER = Real Effective Exchange Rate

e = exchange rate of the Indian rupee against a numeraire currency (SDR)

e<sub>i</sub> = e<sub>i</sub> is exchange rate of a foreign currency 'i' against the numeraire currency (SDR)

P = price index in the domestic economy

P<sub>i</sub> = price index for trade partner country i

w<sub>i</sub> = weights (total trade or export weights)

The Reserve Bank of India (RBI) has been estimating six-country and thirty six-country NEER and REER indices as part of its communication policy and to aid researchers and analysts (RBI 2014). Before 2014, RBI calculated REERs using the wholesale price index (WPI) for India and the consumer price index (CPI) for trading partners. However, with the availability of the new series of consumer price index-combined (CPI-C), the RBI has moved away from WPI to CPI for REER calculation. The rupee REER index constructed, using CPI for both India and trade partner countries, is aimed at ensuring a higher degree of comparability of the rupee's international competitiveness vis-à-vis trading partner currencies (RBI 2014). The new six-currency indices represent the US, the Eurozone (comprising 19 countries), UK, Japan, China and Hong Kong SAR (the Hong Kong currency is tied to the US dollar). The Eurozone has the highest weight among individual countries, China has the highest trade weight, while US is the largest constituent in the export basket (Table 5).

**Table 5: 6 Currency REER Weights**

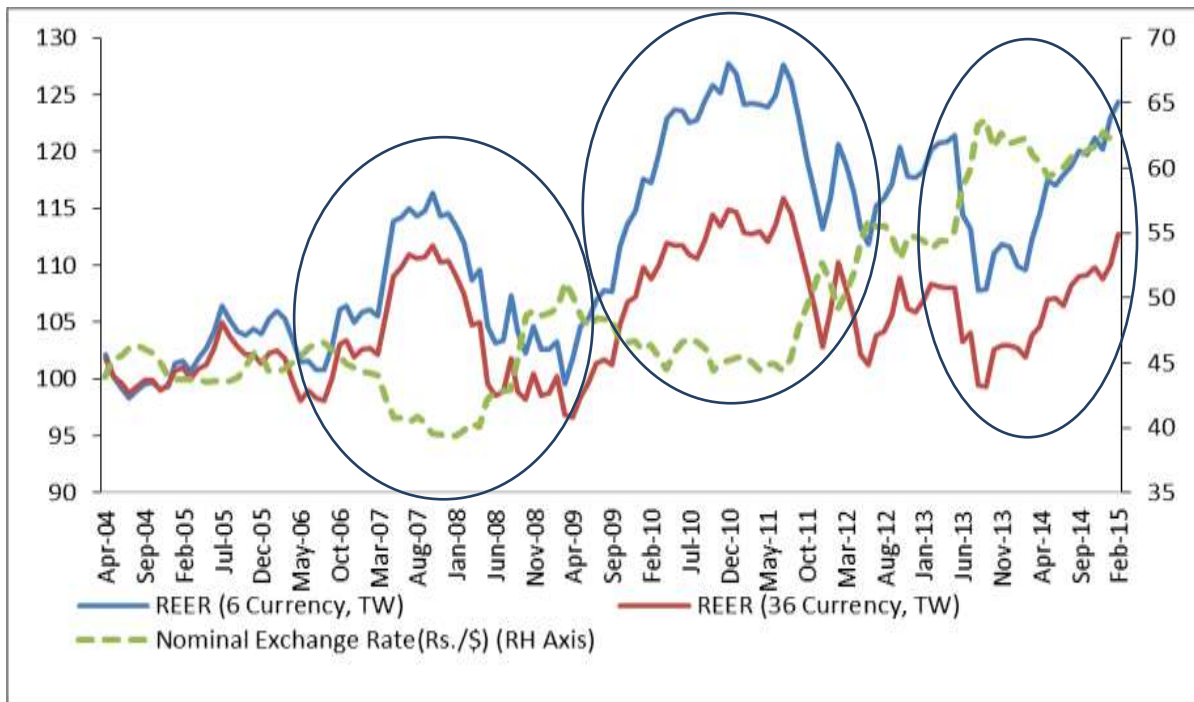
	Trade Weights	Export Weights
China	26.56	14.06
Hong Kong	8.35	10.61
Euro	31.09	34.21
Japan	6.65	5.29
UK	5.79	7.35
USA	21.56	28.48

*Source:* RBI

For the new series, 2004-05 was chosen as the base year (2004-05 = 100). This means that if the REER moves above/below 100, the rupee is deemed to be overvalued/undervalued compared to the base period. This can happen through relative appreciation/depreciation of nominal exchange rates or increase/decrease in price indices.

Figure 4 shows periods when the REER was highly misaligned. These episodes were followed by painful corrections. Driven by high global GDP growth in the pre-financial crisis period before 2008, both merchandise and service exports registered impressive average growth rates of 25 per cent and 35 per cent respectively between 2004 and 2008. Over the same period, India received net capital inflows and private remittances of \$225 billion and \$138 billion respectively. Moderate current account deficits and this surge in capital inflows exerted an upward pressure on the rupee. The RBI tried to contain appreciation through sterilised interventions. However, it was insufficient to stem the upward pressure on the rupee. Both spot and effective exchange rates were overvalued by 2007-08. This exchange rate overvaluation combined with the slowdown in the global economy, which reduced external demand, resulted in a sharp increase in India's current account deficit. Concurrently, risk aversion in international financial markets led to capital outflows from India. These factors resulted in a correction of the rupee exchange rate and the six-currency trade weighted REER declined from a peak of 116.4 in October 2007 to 99.53 in March 2009.

**Figure 4: REER Movements**



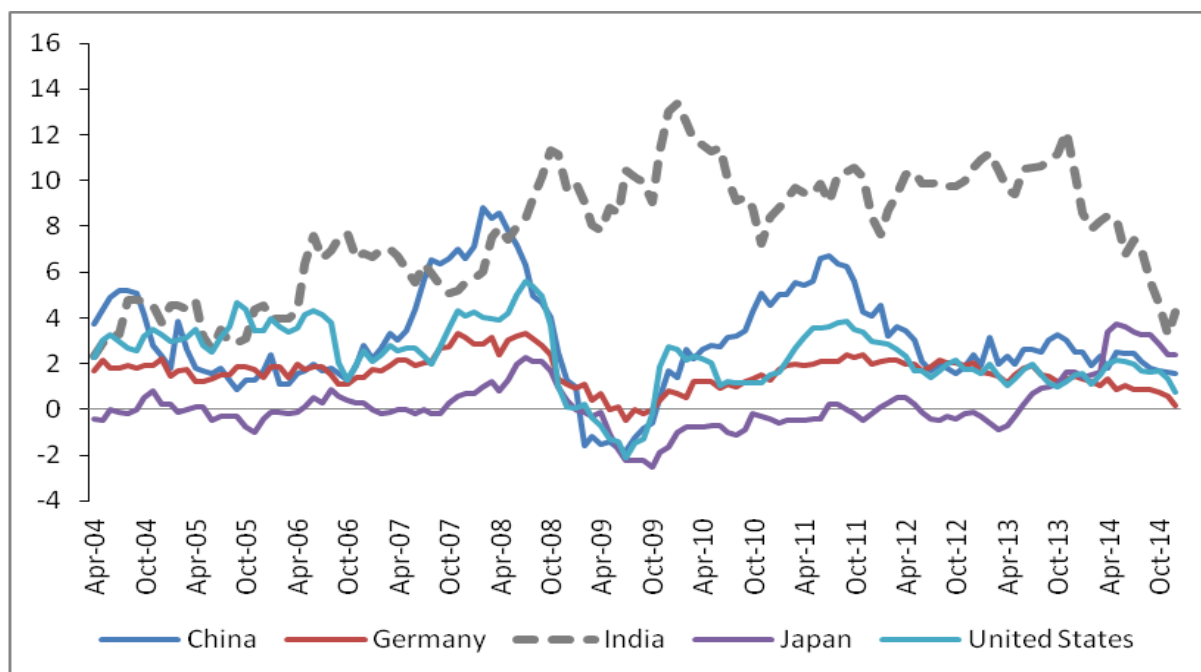
Source: Thomson Reuters DataStream

Post-crisis recovery in the global economy resulted in a pick-up in capital inflows and export growth. The rupee's REER, as valued by RBI, was overvalued by around 25 per cent at the end of 2010. However, the principal factor which caused this appreciation was sustained higher inflation in the Indian economy vis-à-vis its major trading partners. Double digit inflation over this prolonged period resulted in higher input costs, rendering our exports uncompetitive in international markets (Figure 5). A significantly overvalued rupee created expectations of an inevitable correction of the nominal exchange rate. These expectations combined with the Eurozone crisis in periphery countries resulted in a significant reduction in net capital inflows. The government found it difficult to finance its ballooning current account deficits. The RBI tried to stabilise the currency through large interventions when the rupee breached 50 to a US\$. However, falling FX reserves forced it to reduce dollar sales. The rupee depreciated from Rs.44.4 to a dollar in July 2011 to Rs.56 in June 2012. Consequently, the real effective exchange rate declined from 127.6 to 111.9 over the year.

The uncertainty over quantitative easing and a high current account deficit in 2013 forced another bout of correction in the nominal exchange rate. Despite the correction in the nominal exchange rate, persistently higher inflation vis-à-vis its trading partners ensured that the six-currency trade weighted REER remained overvalued by more than 20 per cent.



**Figure 5: Consumer Price inflation (% y-o-y)**



Source: Global Economic Monitor (World Bank)

Figure 4 shows that the gap between the 6-currency REER (trade weighted) and 36-currency REER (trade weighted) is more pronounced in the inflation driven misalignment phases. Inflation differentials between India and the constituents of the six-currency REER have been higher compared to other countries in the 36-currency basket.

Notwithstanding the substantially overvalued REER, a counter-argument has been that the rupee would be found to be fairly valued if estimates using trade-weighted consumer price inflation differentials are adjusted for productivity gains, as suggested by Balassa and Samuelson in the mid-1960s. This proposition seems to be playing an important role in RBI's assessment of the fair value of the rupee.

To estimate a fair value of the rupee, this paper adopts two approaches. One approach is to adjust the rupee's REER for changes in productivity, and these rupee values are called "point-to-point" estimates. A second approach is based on the longer term purchasing power parity concept, which provides a benchmark for estimating equilibrium exchange rates. Such "equilibrium" values of currencies are postulated to be based on underlying factors, such as terms of trade, productivity differentials, openness and net foreign currency flows.<sup>8</sup>

<sup>8</sup> Refer Ades, A., Choksy, H., O'Neill, J., & Stolper, T(2005), MacDonald, Ronald, and Preethike Dias (2007), Iossifov, Plamen K., and Elena Loukoianova (2007) and Didi Nuryadin (2006)

### **2.3 *The Harrod-Balassa-Samuelson ‘theorem’ – the need to adjust exchange rates in accordance with changes in relative productivity***

The Harrod-Balassa-Samuelson (HBS) ‘theorem’ or ‘effect’ draws on work done by economists Roy Harrod (1933), Bela Balassa (1964) and Paul Samuelson (1964). It emphasises the impact of productivity on the measures of competitiveness of a currency, specifically those measures that draw on the purchasing power parity (PPP) principle. HBS claims that in a situation where an economy’s ‘tradables’ (products that are exported or imported) sector witnesses a rise in productivity, some measures like the Real Effective Exchange Rate (REER) could overstate the loss in competitiveness of a currency stemming from a rise in domestic prices if there are compensating gains in productivity.

Harrod, Balassa and Samuelson’s initial work on the productivity exchange rate nexus were largely in the way of broad observations rather than rigorous empirical analysis. More rigorous exposition of their proposition was done in a number of papers written over the sixties and seventies culminating in the work of Kenneth Rogoff (Rogoff, 1992), who provided a comprehensive version of the HBS effect.

The view that competitiveness of a currency should somehow reflect productivity changes in its ‘tradables’ sector appears intuitive but there are subtle assumptions and qualifications underpinning the HBS theorem that need to be recognised before using it to adjust exchange rates. First, the effect really emerges in economies with distinct ‘tradables’ and ‘non-tradables’ sectors. A common tack used by economists is to use the manufacturing and service sectors interchangeably with tradables and non-tradables. However, with countries like India increasingly exporting services, this could be a misleading assumption.

Second, the HBS effect arises when particular types of price indices, which include both tradables and non-tradables such as the Consumer Price Index (CPI) is used to adjust the exchange rate to arrive at the REER. It would not arise if a price index based only the price of tradables is used. Thus, if producer prices or wholesale prices (assuming that they correctly reflect the price levels of tradables) are used to adjust the exchange rate, the HBS effect is unlikely to operate (Dornbusch et al). In the Indian case, the transition in 2014 from using the wholesale price index to the CPI to arrive at official REER indices has raised concerns about the existence of an HBS effect and the need for appropriate productivity adjustments.

A full exposition of the HBS theorem would involve elaborate mathematical derivations involving a number of assumptions. In this paper, we focus on the core analytical reasoning of the HBS proposition and highlight the assumptions which, in our opinion, are important from a ‘policy’ perspective.

#### **2.3.1 *The core reasoning of HBS***

In a two sector economy of non-tradables and tradables, consider the effect of a rise in labour productivity due to say a rise in investment or better ‘skills’. (This could apply to other inputs such as capital as well but for ease of exposition, we restrict ourselves to labour). Let us also

assume that there is either no change in productivity in the non-tradables sector or simply that the increase is less than that in the tradables sector.

A rise in productivity entails a rise in wages in the tradables sector. However, for this sector, the global market for products determines its price (the law of one price) and thus, there is no impact on prices. If as it should, the rise in productivity equals the rise in wages in equilibrium, profitability is also unchanged for the producer. Thus, there is no net impact on the CPI. However, the rise in wages in the tradables sector could lead to a rise in prices in the non-tradables sector. There are several channels through which this could happen but the one that may be more convincing is that the rise in wages in tradables leads to a rise in demand for non-tradables. Here, prices are flexible since they are not governed by global markets. This rise in prices affects the CPI and thus increases the REER. However, since these goods are not traded, there should be no impact on competitiveness. In short, the REER tends to overstate the fall in competitiveness and has to be netted out.

As with most abstract theoretical models in economics, the HBS proposition holds under a set of extremely restrictive assumptions. This does not necessarily take away from the utility of the model but instead compels the researcher to explore possible deviations from 'core' assumptions in the particular setting or context in which the model is used. In the Indian case, for instance, it is quite likely that given the relatively manpower intensive niches in the value chain that Indian IT companies have established themselves in, Indian firms are not price takers. Again, the channel of transmission of wage inflation from the tradables to the non-tradables sector could be weak given that the skill sets needed for tradables and non-tradables are widely divergent. Rising food prices, as we have seen in India, could be the key driver of economy wide wage inflation rather than genuine productivity growth. Alternatively, there could be persistent disequilibrium in the labour market if rising food prices (driven largely by a wage shock through the introduction of a reservation wage indexed to inflation as in the case of MNREGA) and labour shortage in non-rural areas arising from reduced migration (a function of the reservation wage) come together. The challenge then is to take a view on how much of an economy or economic situation deviates from the pristine conditions of the HBS and whether HBS is relevant at all.

Indeed, there is a body of literature that questions the applicability of HBS in different contexts. Lee and Tang of the IMF (2003) find little evidence of the impact of rising productivity on real exchange rates using a sample of 10 OECD economies for a period of three decades. They claim that factors such as market imperfections (that violate the basic HBS assumptions) and strategic pricing decisions instead of plain vanilla 'pricing-taking' that HBS posits are responsible for this. Chinn (1998) examines the productivity-real exchange rate link a la HBS for East Asian economies but finds inconclusive evidence save for three economies. For our analysis, we remain agnostic to whether HBS actually works as a general principle.

To summarise, a rise in productivity in tradables increases the price of non-tradables, which then inflates the REER. This inflation is 'spurious' in the sense that there is no impact on competitiveness. Thus, the REER has to be deflated by some measure of productivity to

arrive at a correct measure of trade competitiveness. We must point out that there is a large body of literature that raises doubts about the very existence of the HBS effect in different economies, depending on their size and stage of development. For the sake of completeness, we examine the extent to which rupee overvaluation may need to be corrected due to productivity changes, assuming the HBS effect is applicable in the Indian context.

#### 2.4 Productivity Adjusted REERs

The proponents of a productivity-adjustment approach argue that an increase in efficiency in tradables offsets REER appreciation in the domestic currency. An extension of this logic would suggest that higher productivity in relation to trade partners could be deemed to offset the loss in competitiveness due to exchange rate appreciation. Comparable cross-country data on productivity growth for tradables is difficult to access.

One of the estimates in this paper for the fair value of the rupee uses the growth in per capita income (at constant prices) as a proxy for productivity gains. Table 6 provides the productivity adjustment of RBI REER<sup>9</sup> (6-currency TW) data while Table 7 shows the adjustment of estimated REER data. The unadjusted REER estimation is based on the trade weights and methodology used by the RBI. This shows a 21 per cent overvaluation of the rupee between 2004 and 2014. Prices and income data are sourced from the International Monetary Fund's World Economic Outlook. The consumer price index (CPI) and income data are rebased to 2004. To incorporate productivity gains, the REER is adjusted by per capita income ratios of trade partner countries and India. A reduction in the ratio ( $Y_i/Y$ ) shows an improvement in productivity, which would reduce the REER in the equation. Persistently higher growth rates in India compared to advanced economies particularly in the Eurozone has pulled down the adjusted REER. According to this methodology, Table 6 indicates a rupee undervaluation of 6 per cent as against an unadjusted REER overvaluation of 16 per cent in 2013 and 17 per cent in 2014.

$$REER = \prod_{i=1}^n [(e/e_i)(P/P_i)(Y_i/Y)]^{w_i} \dots \text{Equation 5}$$

REER = Real Effective Exchange Rate

$e$  = exchange rate of the Indian rupee against a numeraire currency (SDR)

$e_i = e_i$  is the exchange rate of foreign currency 'i' against the numeraire currency (SDR)

$P$  = price level in the economy

$P_i$  = price index for trade partner country i

$Y$  = per capita income in home country

$Y_i$  = per capita income in partner country

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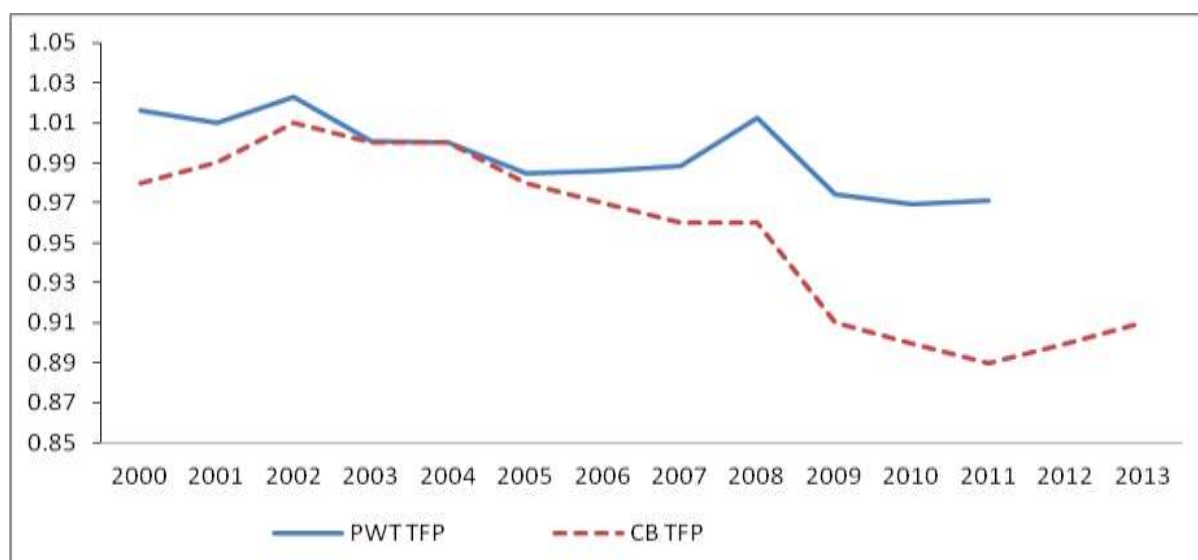
<sup>9</sup> We are using the six-currency REER (trade weighted) data for our analysis as it covers a significant percentage of India trade. Moreover, in the 36-currency REER basket, UAE, Saudi Arab, Qatar and Kuwait have pegged their exchange rates to the US dollar. Some other countries like Iran and Nigeria mainly export oil to India, for which these economies are price takers expressed in US dollars. The aggregate weights of six economies and UAE, Saudi Arab, Qatar, Kuwait, Nigeria and Iran constitute 67 per cent weights in the 36-currency basket.

$w_i$  = trade weights

We would like to highlight that the use of growth in per capita income as a proxy for productivity may be appropriate for economies at similar levels of per capita income. However, it appears inappropriate to use this measure to make adjustments for the currency pair of a high per capita income country such as the United States, typically associated with lower growth rates, with India which is at a lower level of development and per capita income and is, thus, expected to grow faster. The use of per capita income for productivity should invariably lead to an undervaluation bias for the currency of the faster-growing economy.

Total factor productivity (TFP) numbers are probably marginally more suitable for adjusting efficiency gains. Conference Board (CB) and Penn World Table (PWT) provide TFP data for all countries in the RBI's six-currency REER basket except for the Eurozone. For the Eurozone, we have taken the weighted average of the four largest economies, namely France, Germany, Italy and Spain. Figure 6 shows the relative productivity index for India (2004=1). A decrease in the index means India is becoming more productive vis-à-vis the six trading partners. Figure 6 shows significantly higher productivity gains for India with Conference Board data compared to the Penn World Table (PWT). In our analysis, we have used Conference Board TFP data because it is available until 2013 while the Penn World Table data is available only until 2011.

**Figure 6: India's relative productivity (2004=1)**



Source: Estimation based on the Conference Board (CB) and Penn World Table (PWT) data

$$REER = \prod_{i=1}^n [(e/e_i)(P/P_i)(TFP_i/TFP)]^{w_i} \quad \text{Equation 6}$$

REER = Real Effective Exchange Rate

$e$  = exchange rate of the Indian rupee against a numeraire currency (SDR)

$e_i = e_i$  is the exchange rate of foreign currency 'i' against the numeraire currency (SDR)

P = price level in the economy

P<sub>i</sub> = price index for trade partner country i

TFP = total factor productivity in home country

TFP<sub>i</sub> = total factor productivity in partner country

w<sub>i</sub> = trade weights

Adjustment of REER using growth in TFP is similar to using growth in income numbers. TFP and price level are rebased to 2004. A decline in the ratio (TFP<sub>i</sub>/TFP) indicates an improvement in Indian productivity and this would reduce the REER in Equation 6. The estimates in Table 6 show that the REER not adjusted for productivity changes was overvalued by 16 per cent as of 2013. As of the same year, a TFP-adjusted REER was overvalued by 5 per cent.

**Table 6: Productivity adjustment of RBI's six-currency REER data (Annual average)**

	RBI REER (2004 = 100)	Productivity (per capita income) adjusted	Productivity adjusted (CB TFP)	Productivity adjusted (PWT TFP)
2004	100	100	100	100.0
2005	105	102	103	103.1
2006	104	99	101	102.5
2007	107	99	103	105.6
2008	107	99	102	107.8
2009	99	86	91	96.8
2010	114	96	102	110.3
2011	114	95	102	110.6
2012	115	96	103	n/a
2013	116	94	105	n/a
2014	117	94	n/a	n/a

Source: RBI & Estimated by authors

**Table 7: Productivity adjustment of estimated six-currency REER data (Annual average)**

	Estimated REER (2004 = 100)	Productivity (per capita income) adjusted	Productivity adjusted (CB TFP)	Productivity adjusted (PWT TFP)
2004	100	100	100	100
2005	105	102	103	103
2006	106	101	103	104
2007	114	106	110	113
2008	110	102	105	111
2009	110	95	100	107
2010	126	106	113	122
2011	126	105	112	122
2012	120	100	108	n/a
2013	119	97	108	n/a
2014	119	95	n/a	n/a

Source: Estimated by authors

## **SECTION III**

### ***3.1 Alternative Methodologies to Estimate Rupee's Fair Value***

The literature on determination of the fair value of a currency can be grouped into two broad categories. One traditional method is to use trade weighted inflation differentials to arrive at REER values. The other uses the more recent purchasing power parity (PPP) driven behavioural equilibrium exchange rate (BEER) models. The various studies done by academics, multilateral institutions and investment banks employ an array of techniques to model movements in exchange rates and estimate fair values.

In this paper, we adjust REER estimates for changes in productivity, openness, terms of trade and net foreign assets using a variant of the BEER approach and the results are shown in Table 9. An advantage of using the BEER model for the Indian rupee is that it covers both shorter run changes and macroeconomic variables. This approach is implicitly driven by PPP.

The following approach used in this paper is based on that of Clark and MacDonald (1999) and MacDonald and Dias (2007).<sup>10</sup>

$$REER = f(NFA, OPN, PRODCB, TOT_{RBI}) \quad \text{Equation 7}$$

The study uses quarterly time-series data collected from various national and international sources. All the series have been rebased to the same year, i.e., 2004-05.

The definitions of the variables are as follows:

**LNREER** is the log of the rupee real effective exchange rate. We use CPI adjusted REER, weighted against India's trade shares with six major trading partners: the United States, Euro area, China, the United Kingdom, Japan and Hong Kong (even though the HK dollar is pegged to the US\$) since the RBI follows this practice.

**NFA** is net Indian foreign assets as a fraction of GDP. It is included keeping in mind the portfolio-balance theory. NFA has been defined as the difference between India's international assets and liabilities. Quarterly NFA data is available since 2005. We extended the quarterly series by taking capital flows and changes in FX reserves into account. Large capital inflows in the post-liberalisation era have caused an accumulation of foreign liabilities. Inflows exert an upward pressure on the exchange rate. Hence, the sign of NFA is expected to be negative, that is, a decrease in NFA leads to REER appreciation.

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<sup>10</sup> **Clark, Peter B., and Ronald MacDonald.** "Exchange rates and economic fundamentals: a methodological comparison of BEERs and FEERs". Springer Netherlands, 1999.  
**MacDonald, Ronald, and Preethike Dias.** "Behavioural equilibrium exchange rate estimates and implied exchange rate adjustments for ten countries." *Peterson Institute of International Economics Working Paper, February* (2007). [http://www.gla.ac.uk/media/media\\_30667\\_en.pdf](http://www.gla.ac.uk/media/media_30667_en.pdf)

**OPN** is the index that measures India's openness. It is calculated as the aggregate of aggregate exports and imports as a percentage of GDP. The expected sign of openness is ambiguous.

**PRODCB** is defined as relative productivity. PRODCB is expected to have a negative sign if the Balassa-Samuelson effect were to hold. We have taken the total factor productivity (TFP) data for India and the six economies mentioned above from the Conference Board source. The time series numbers for this variable were constructed by taking the ratios of partner country productivity to Indian productivity. Trade weights were used to estimate the aggregate series. Conference Board TFP data is available in annual numbers. To convert the series from annual to a higher frequency, i.e., quarterly, we use the quadratic-match average technique as in EViews.

**TOT\_RBI** is the net terms of trade data from RBI. Commodity prices impact the real exchange rate through changes in terms of trade, making them one of the explanatory variables. Net terms of trade are the unit value index of exports expressed as a percentage of unit value index of imports (RBI 2014). Due to data frequency limitations, we use the quadratic-match average technique as in EViews to convert the series from an annual to quarterly frequency. The expected sign for terms of trade is positive.

Before proceeding further, it is useful to mention that Lee and Tang (LT henceforth), in their IMF working paper,<sup>11</sup> revisit the linkage between productivity and real exchange rates. By decomposing the exchange rate into two components – the real exchange rate based on prices of tradables and international differentials between relative prices across non-tradable and tradable sectors – they try to explore the long-term relationship between productivity and the real exchange rate. As per their analysis, two separate measures of productivity – labour productivity and total factor productivity – are not interchangeable. Using these two measures of productivity, they find contrasting BS effect results. Even though the direction of the change may be in line with the BS effect for labour productivity, the effect works more through tradables based real exchange rate than inter-country differentials in relative prices between tradables and non-tradables. Moreover, total factor productivity seems to support the BS effect less than labour productivity but the channel through which this effect acts seems to be the same as for labour productivity. They use DOLS for their estimation.

The well-known investment bank Goldman Sachs (GS) has estimated equilibrium exchange rates for a number of currencies in a paper titled “Merging GSDEER and GSDEEMER: A Global Approach to Equilibrium Exchange Rate Modelling” dated May 16, 2005.<sup>12</sup>

We now discuss how our paper and the LT and GS approaches to measures of productivity and BEER/PEER estimation differ from each other.

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<sup>11</sup> **Lee Jaewoo and Man-Keung Tang.** “Does Productivity Growth Lead to Appreciation of the Real Exchange Rate?” WP/03/154, International Monetary Fund, July 2003.

<sup>12</sup> **Ades, A., Choksy, H., O'Neill, J., & Stolper, T.** “Merging GSDEER and GSDEEMER: A Global Approach to Equilibrium Exchange Rate Modelling”. Goldman Sachs, 2005.



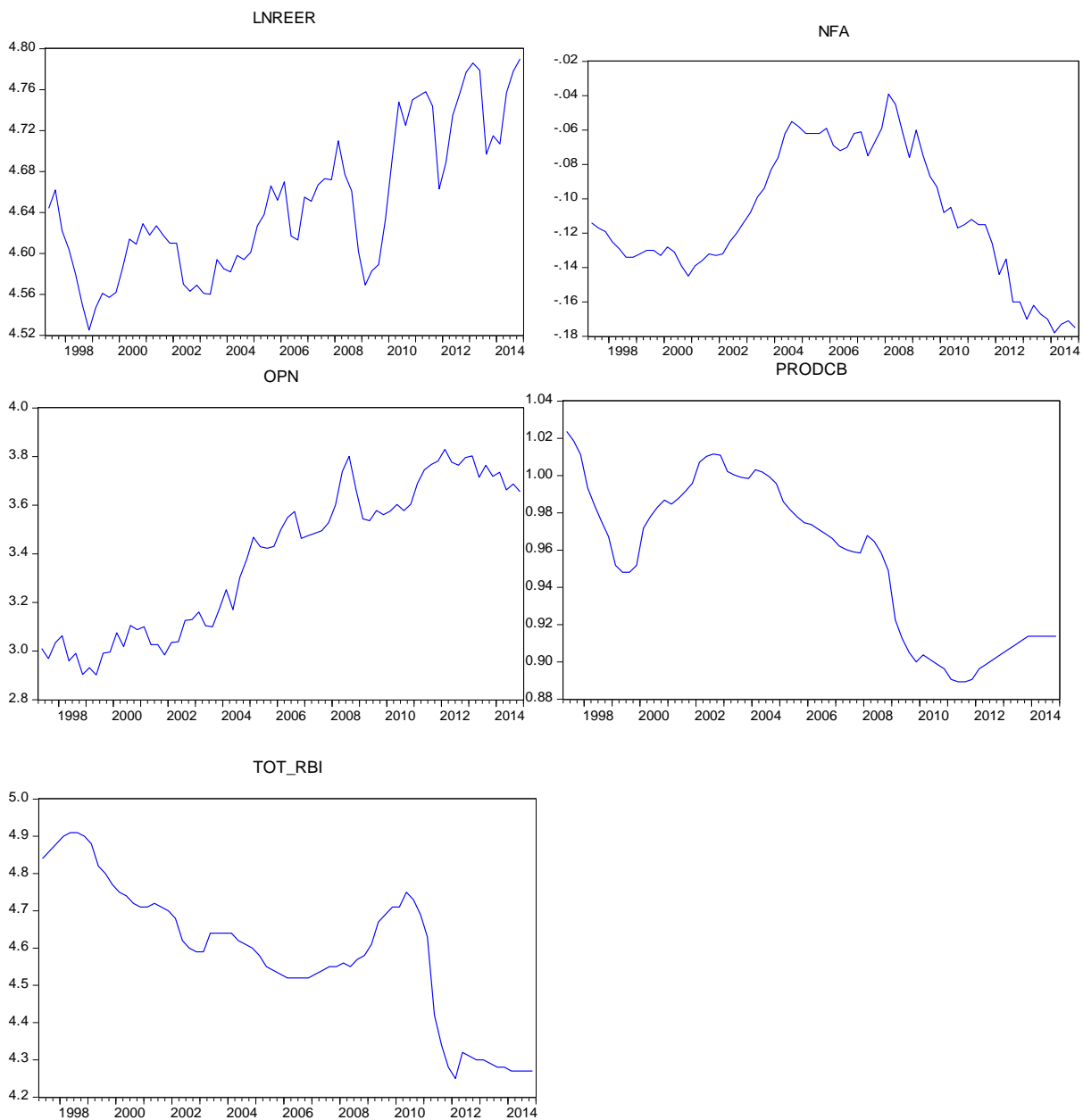
1. For productivity analysis, the LT study focuses mainly on 12 advanced OECD economies such as the USA, the UK, Japan, Italy etc. It is worth noting that these countries have extensive data for TFP, prices, wages, output, employment, capital stocks and gross fixed capital formation at nine 2-digit ISIC industry levels. LT use the ISDB and STAN database from OECD for their study. Given the detailed nature of the data used in LT's study, this kind of analysis is not feasible for India as yet, given data limitations.
2. For various real exchange rate indices, i.e., BEER and PEER calculations, we use the Clarke and Macdonald (1999) model for our analysis, which is also used by GS. However, GS includes only three variables in its study – relative productivity, terms of trade and net international investment position as a percentage of GDP. We also use openness as one of the explanatory variables, as openness has been widely accepted as an important variable in determining real exchange rates in the relevant literature<sup>13</sup> for emerging economies.
3. We have updated the definition of the variables to fit the Indian scenario as closely as possible. For example, GS uses a combination of quarterly data for labour productivity published by the OECD and from country-specific sources. We do not use the same series for Indian productivity. Instead, we have constructed an index. We use total factor productivity (TFP) data for India and its 6 major trading partners from the Conference Board and have constructed an index by taking the ratios of partner country productivity to Indian productivity. Trade weights were used to estimate the aggregate series.
4. GS uses a pooled panel; that is, their sample consists of 35 countries spanning G-10 to various emerging market economies, whereas our study focuses on India. Hence, the two studies are different in nature in terms of countries covered and the data used. GS uses quarterly data from 1973Q4 to 2004Q4 for their study while we use quarterly data from 2001Q1 to 2014Q4 for our study. The sample countries and the time periods differ for the two studies and so does the estimation technique. GS uses DOLS for estimating model in level and ECM for estimating model in difference and forecasting. Instead of following their methodology, we use the Vector Error Correction Model (VECM) to estimate our model in difference and the long run co-integrating relation. DOLS and FMOLS do not perform well on our data sample and yield poor D-W statistics, implying presence of auto-correlation and bias in the estimates. Therefore, we use VECM for our study.

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<sup>13</sup> For example see, **Abbes Hiri** ,The Real Effective Exchange Rate Misalignment: Application of Behavioural Equilibrium Exchange Rate BEER to Algeria 1980-2009, International Journal of Economics, Finance and Management Sciences. Vol. 2, No. 5, 2014, pp. 277-284. doi: 10.11648/j.ijefm.20140205.12

Figure 7 plots the log values of the above mentioned variables except for NFA.

**Figure 7: Time plots of LNREER, NFA, OPN, PRODCB and TOT\_RBI in levels**



Our estimation strategy is as follows:

- Identify a parsimonious VAR specification and all the relevant variables that may contain information which can help address the question at hand.
- Identify the time-series properties of the selected variables so as to decide on the correct model specification, i.e., VAR, SVAR or VECM in level or difference respectively.
- Conduct lag order selection tests, i.e., use the AIC, SIC, LR, HQ and FPE test statistics to decide on the correct lag length that is enough to remove all serial correlation for the estimated model.

- Analyse the VECM results and finally conduct diagnostic tests by conducting tests for heteroscedasticity, no serial correlation and normality on the residuals so that the results can be relied upon.

### 3.2 Empirical Results

We start by investigating the potential non-stationarity of the chosen explanatory variables. The sample is quarterly data from 2001 Q1 to 2014 Q4.<sup>14</sup> The quarters here are for calendar years. For non-stationarity, we use the Augmented Dickey-Fuller (ADF) unit root tests. All the variables are non-stationary in levels (with trend and intercept) but stationary in first difference, i.e., series are stationary. Table 8 lists the result of the ADF tests.

**Table 8: ADF tests statistics**

ADF Unit root test				
Variable	In level	In difference	Critical values	
	ADF	ADF	1%level	5%level
LNREER	-1.062	-7.083	-3.532	-2.906
NFA	-0.116	-7.609	-3.532	-2.906
OPN	-1.038	-8.562	-3.532	-2.906
PRODCB	-1.125	-2.658	-3.532	-2.906
TOT_RBI	-1.109	-2.485	-3.532	-2.906

The lag order selection test suggests a model with one lag.<sup>15</sup>

As all the variables are integrated of order one, i.e.,  $I(1)$ , it would be inaccurate to proceed without checking for any possible co-integrating relation amongst the variables. Hence, the Johansen trace and maximum Eigen value test are conducted. The test results indicate co-integration amongst the series<sup>16</sup> and hence, the presence of long-term relations between them. Thus, we need to use a vector error correction model (VECM) for our analysis. The estimated VECM contains zero lag in difference. The advantage of estimating a VECM is that such models capture both long-run and short-run dynamics and we do not lose any significant information that the data may have to offer.

Hence, our proposed base line model is:

$$\nabla Z_t = \alpha\beta'Z_{t-1} + \Gamma_1\nabla Z_{t-1} + e_t$$

where,

<sup>14</sup> Data for REER, openness and net foreign assets are easily available until 2014Q4. For productivity data, we have assumed the same productivity as that in 2013 Q4 for the quarters of 2014. Similarly, for terms of trade, we have assumed constant values for all the quarters of 2014.

<sup>15</sup> The test statistics used are SIC, AIC, HQ and FPE. For test results, refer to Annex 1.

<sup>16</sup> For detailed results of the Johansen trace and maximum Eigen value tests, refer to Annex 2.

$$Z_t = \begin{bmatrix} LNREER \\ NFA \\ OPN \\ PRODCB \\ TOT\_RBI \end{bmatrix}, \text{ and } e_t = \begin{bmatrix} e_{lnreer} \\ e_{nfa} \\ e_{opn} \\ e_{prodcb} \\ e_{tot\_rbi} \end{bmatrix}. \quad \text{Equation 8}$$

The variables are as defined before.

### 3.2.1 Long-term trend and the long-term “optimal” real exchange rate and current rupee exchange rate misalignment

Normalising the significant co-integrating vector on the real effective exchange rate, we obtain the following long-term relationship:

$$\begin{aligned} LNREER = & -0.866104 * NFA + 0.29469 * TOT\_RBI + \\ & (3.13)^{17} \qquad \qquad \qquad (-3.63) \\ & + 0.83247 * PRODCB + 0.49118 * OPN + 0.73324 \text{ Equation 9} \\ & (-2.05) \qquad \qquad \qquad (-6.19) \end{aligned}$$

In the long run, the real effective exchange rate is determined by net foreign assets, openness, productivity and terms of trade. All the variables enter the equation with correct signs except for PRODCB, which would be expected to have a negative sign if the Balassa-Samuelson effect were to hold.<sup>18</sup> All the coefficients in the equation are significant.<sup>19</sup> The real exchange rate adjusts significantly to exchange rate disequilibrium and the adjustments are transparent. The adjustment coefficients (alpha) are given in Table 9.

**Table 9: Adjustment coefficients**

Adjustment coefficients	
D(LNREER)	-0.131 (-1.75)
D(NFA)	0.0376 (1.69)
D(OPN)	-0.226 (2.40)
D(PRODCB)	0.060 (5.13)
D(TOT_RBI)	0.467 (3.34)

Note: figures in brackets indicates t-statistic

<sup>17</sup> () indicates t-statistic.

<sup>18</sup> Refer to page 12-13, **MacDonald, Ronald, and Preethike Dias**. "Behavioural equilibrium exchange rate estimates and implied exchange rate adjustments for ten countries." *Peterson Institute of International Economics Working Paper, February* (2007). [http://www.gla.ac.uk/media/media\\_30667\\_en.pdf](http://www.gla.ac.uk/media/media_30667_en.pdf) For Canada, all of the coefficients are correctly signed and statistically significant. Although the coefficient on the relative productivity term is wrongly signed in terms of the standard 13 neo-classical (Balassa-Samuelson) framework, it is correctly signed in terms of the more recent theoretical interpretation of the effects of productivity on the exchange rate (see, for example, MacDonald and Ricci (2002)).

<sup>19</sup> For detailed equation, t-stats and standard errors, refer to Annex 3.

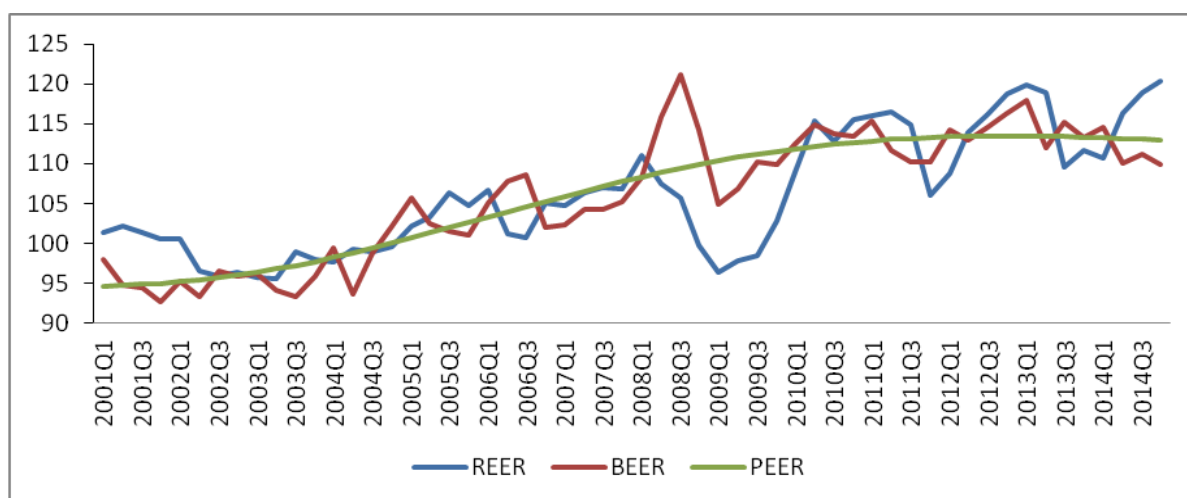
Table 9 indicates that openness has the highest value for speed of adjustment, followed by terms of trade, REER, productivity and net foreign assets respectively. This suggests that if any variable deviates from the long-run equilibrium value, openness adjusts the fastest to restore long run equilibrium followed by terms of trade, REER, productivity and net foreign assets. Hence, one can say that the equilibrium rupee exchange rate is most impacted by changes in openness.

The diagnostic tests indicate that the residuals forms of the model are homoscedastic and there is no serial correlation. However, the residuals are not normal jointly.<sup>20</sup>

### 3.2.2 Exchange Rate Misalignment

Figure 8 provides the plots of actual REER and REER estimated by the model – the BEER and permanent equilibrium exchange rate (PEER). The model has been used to decompose the rupee exchange rate into its more stable, transitory or cyclical components. To obtain the long run values or the BEER numbers, the coefficients from Equation 9 have been used with actual values of macroeconomic fundamentals for the given sample. The values obtained are the long-run BEER exchange rate values. Using the Hodrick-Prescott filter, we smooth the BEER numbers to separate the permanent from the transitory or cyclical components. The smoothed permanent component is the PEER.

**Figure 8: REER compared with BEER and PEER**



Source: Estimated by authors and Thomson Reuters DataStream

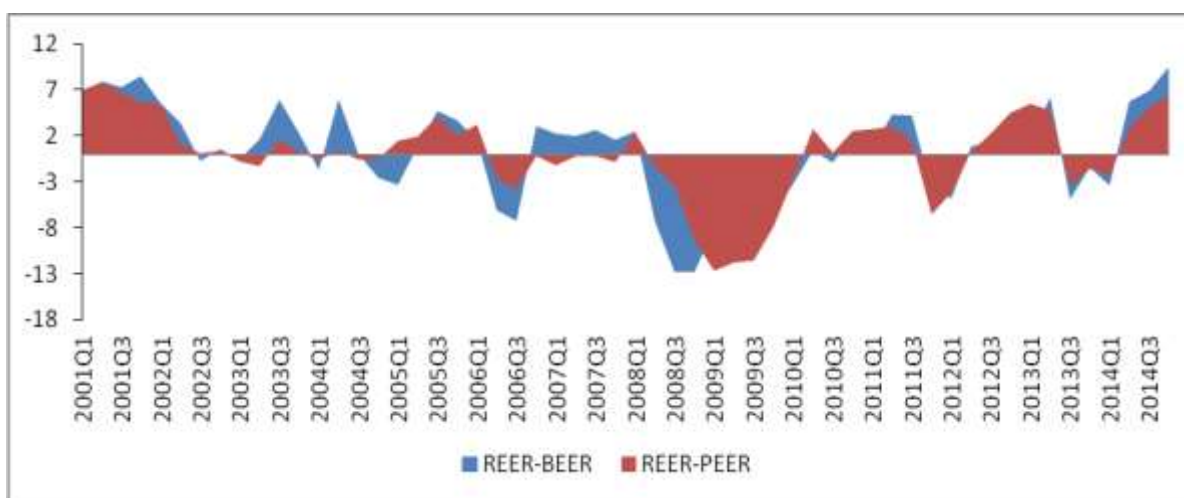
The rupee exchange rate misalignment has been calculated as the difference between the actual REER value from the estimated values of BEER and PEER.

Figure 9 plots the deviation of REER values of the Indian rupee from its behavioural equilibrium values. As evident from the Figure 9 and Table 10, the rupee appears to be overvalued by 10.4 per cent from its behavioural exchange rate value and by 7.4 per cent

<sup>20</sup> For the detailed test statistics of the various diagnostic tests, refer to Annex 4.

from its equilibrium value for 2014 Q4. It is noteworthy that the rupee has been mostly overvalued from its permanent equilibrium value (PEER) since 2010 Q2 except for 2011 Q4-2012 Q1 and 2013 Q3- 2014 Q1. The BEERs for the following quarters are mainly in line with the PEER predictions. Figure 8 indicates the misalignments of the rupee from its BEER and PEER values over the sample. One major episode of rupee depreciation was in 2008-09 around the time of the financial sector meltdown. Otherwise, the Indian rupee has been overvalued for the sample period. Positive values denote overvaluation of the rupee against the US dollar and negative numbers indicate undervaluation.

**Figure 9: Misalignment of REER compared to BEER and PEER**



Source: Estimated by authors

**Table 10: Misalignment of REER**

Time	REER-BEER		REER-PEER	
	Absolute	Percentage	Absolute	Absolute
2012Q3	1.58	1.38	2.67	2.35
2012Q4	2.49	2.14	5.23	4.61
2013Q1	1.89	1.60	6.32	5.57
2013Q2	6.94	6.19	5.52	4.86
2013Q3	-5.61	-4.87	-3.79	-3.34
2013Q4	-1.60	-1.42	-1.72	-1.52
2014Q1	-3.87	-3.38	-2.52	-2.23
2014Q2	6.33	5.75	3.26	2.88
2014Q3	7.66	6.88	5.83	5.16
2014Q4	10.41	9.48	7.37	6.53

Source: Estimated by authors

### 3.3 Scenario Analysis

We ran the model using scenarios in which we assume that each of the four variables is tweaked by 5-10 per cent, one at a time. This is to take into account errors in the estimation of these variables. For instance, we assess what would be the impact if Indian productivity were say 5 or 10 per cent higher than indicated by Conference Board data. The following are results from our scenario analysis.<sup>21</sup>

1. Productivity: If we revise Indian productivity numbers by 5-10 per cent and reconstruct the productivity index (as defined before), we find that this changes the nature of the series. An increase of 5 per cent shows presence of more than one unit root and a 10 per cent increase leads to the disappearance of unit root from the series. In this case, the VECM model breaks down and cannot be used. It also means that one can then question the presence of any long term relationship among the variables in the model and needs to look for alternative techniques for the estimation.
2. Openness: For a 5 per cent increase in the values, the model predicts lower levels of undervaluation, i.e., 2.59 per cent and 4.07 per cent for BEER and PEER respectively. However, the sign of the adjustment coefficient for all the variables are of the same sign except for terms of trade.
3. Net foreign assets: Tweaking the NFA figures by 5-10 per cent does not have any unexpected effect on the results. The nature of the series remains the same, which is to say that the unit root still persists in the series. The model predicts an overvaluation of 9.5 per cent and 6.5 per cent in BEER and PEER respectively for 5 per cent higher NFA numbers.
4. Terms of Trade: Tweaking the TOT figures by 5 or 10 per cent, the nature of the series remains the same, that is to say that the unit root still persists in the series. The model predicts an overvaluation of 9.4 per cent and 6.5 per cent in BEER and PEER respectively. Interestingly, a 10 per cent growth, a 5 per cent decline or 10 per cent decline also predict the same level of overvaluation as for 5 per cent growth.

### 3.4 Sensitivity Analysis for VECM

It is necessary to carry out sensitivity analysis to check the extent to which the results listed in Table 11 vary based on changes in estimation techniques. In this context, we carry out the following sensitivity analysis to assess the robustness of our results.<sup>22</sup>

- I. Changing the estimation technique does alter results. However, the basic predictions of the model in terms of direction of change are the same. The results from the FMOLS<sup>23</sup> estimation are given in Table 11 below. Comparing Tables 10 & 11, one can see that the predictions for under/over valuation are almost the same. However,

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<sup>21</sup> For detailed results and test statistics, refer to Annex 5.

<sup>22</sup> Further details of sensitivity analysis for VECM are explained in Annex 6,

<sup>23</sup> For detailed results for the FMOLS estimation, refer to Annex 6.

the degree of under/overvaluation is sensitive to the technique. FMOLS results predict a lower value of overvaluation of the Indian rupee compared to the VECM results.

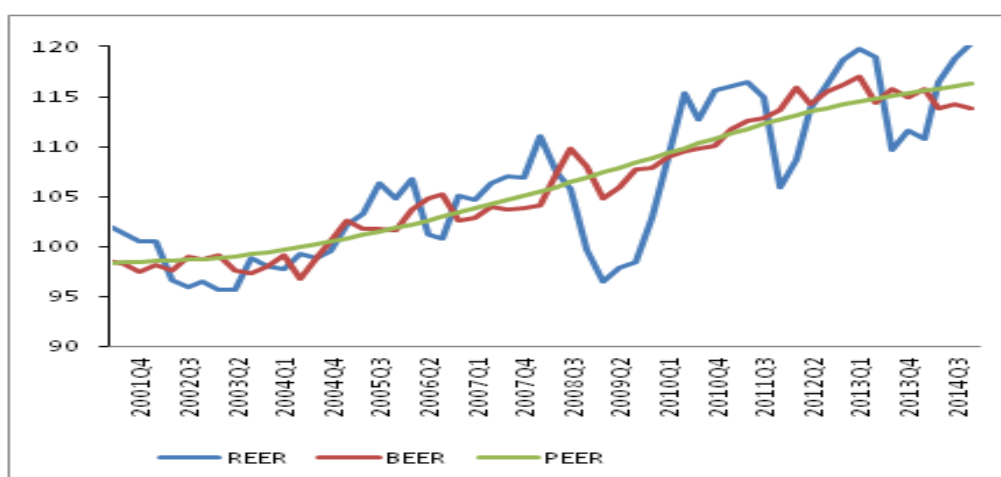
Dynamic Ordinary Least Square (DOLS) was also tried for the estimation. After careful runs, we find that the D-W statistics for the various models using DOLS do not imply absence of auto-correlation among the residuals. Hence, we do not employ this technique.

**Table 11: Misalignments**

Estimation Technique: FMOLS				
	REER-BEER		REER-PEER	
Time	Absolute	Percentage	Absolute	Percentage
2012Q3	0.62	0.54	2.31	2.03
2012Q4	2.56	2.21	4.55	3.99
2013Q1	2.83	2.42	5.31	4.64
2013Q2	4.59	4.01	4.18	3.64
2013Q3	-6.17	-5.33	-5.46	-4.75
2013Q4	-3.33	-2.89	-3.73	-3.24
2014Q1	-5.10	-4.40	-4.87	-4.21
2014Q2	2.55	2.24	0.57	0.49
2014Q3	4.61	4.03	2.80	2.41
2014Q4	6.48	5.69	4.00	3.44

Source: Estimated by authors

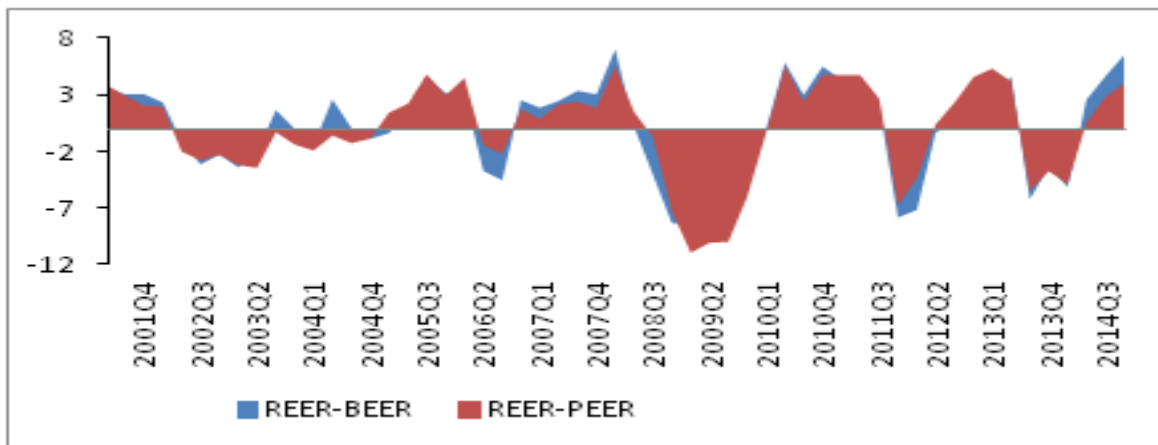
**Figure 10: REER compared with BEER and PEER**



Source: Estimated by authors



**Figure11: Misalignment of REER compared to BEER and PEER (absolute values)**



Source: Estimated by authors

- II. As we have converted the frequency of PRODCB and TOT due to data limitations, we employ other frequency conversion techniques as well to ensure that the results are not sensitive to the technique employed for frequency conversion. Using another frequency conversion technique such as linear match does change our results.<sup>24</sup> As mentioned in Section III, we have used the quadratic match average technique for frequency conversion for our model. To check for robustness, we used the linear match technique for the frequency conversion of the series. The change in technique has significant implications for the co-integration among the series. For example, the trace test and maximum Eigen value test indicates presence of 3 co-integrating relations for the model, which is not as expected in theory.

The above suggests that there is an absence of stable relationships depending on the frequency with which variables are estimated and the model. This instability is demonstrated by the fact that the fair value exchange rate results change substantially or are not reliable with small changes in variables or the technique.

## SECTION IV

### 4.1 Conclusions

This paper attempts to estimate whether the rupee exchange rate with the US\$ is fairly valued using 2004 as the base year. The rupee's trade-weighted real effective exchange rate is 26 per cent overvalued as of March 31, 2015, compared to 2004-05. As mentioned in Section II, India's higher relative productivity growth is cited as a neutralising factor for the rupee's appreciation in real terms.

Estimating productivity has its set of problems, particularly for developing countries such as India, where it is difficult to obtain reliable employment numbers for the large unorganised

<sup>24</sup> For detailed results and graphs for the VECM estimates from the model with linear matching, refer to Annex 7.

sector that employs about 90 per cent of the total labour force. OECD labour productivity data is used in some exchange rate studies. However, comparable numbers are not readily available for India. The Conference Board<sup>25</sup> and the Penn World Table provide numbers for total factor productivity (TFP) for several countries, including India. These TFP estimates may have limitations, particularly for India given the recent revisions in GDP numbers and unreliable employment data. Nevertheless, these are the data sources that provide comparable cross-country TFP data for India and its trading partners. Figure 6 shows the two data sources give different productivity levels; the Conference Board data shows a significantly higher relative productivity for India compared to the Penn World Table.

Adjustment of REER using CB TFP shows that at Rs.58.6/\$ (annual average) in 2013, the real exchange rate was overvalued by 5 per cent. Since then, the nominal exchange rate has depreciated by 6.8 per cent against the dollar (Rs.62.6 /\$ March 2015 average) and Hong Kong dollar,<sup>26</sup> 0.7 per cent against the pound sterling and 6.8 per cent against the Renminbi. However, against the Euro and Japanese Yen, the rupee has appreciated by 13.4 per cent and 13.2 per cent respectively.

Despite the moderation in consumer price inflation in India in the last 12 months, it has been relatively high compared to its trading partners; as a result the RBI REER (6-currency TW) shows overvaluation of 26 per cent at the end of March 2015.

Assuming that TFP of partner countries remains at 2013 levels, and taking the turnaround in India's TFP (which increased by 2 per cent in 2014 and 3 per cent in the first quarter 2015 against -1.21 per cent in 2013), the productivity adjusted REER (last row Table 12) shows an overvaluation of around 10 per cent.

To recapitulate in summary form, Table 12 provides the extent to which the rupee is under or overvalued using 2004 as the base year.

**Table 12: Rupee Under/Over-valuation Point to Point Estimates**

<b>6 county trade weighted REER (CPI based)</b>		
<b>Methodology</b>	<b>Misalignment</b>	<b>Data</b>
Productivity adjusted (productivity based on per capita income)	Under-valued by 6 per cent	2004-2013 (Base: 2004)
	Under-valued by 6 per cent	2004-2014 (Base: 2004)
Productivity adjusted ( CB TFP)	Overvalued by 5 per cent at the end of calendar 2013	2004-2013 (Base: 2004)
Productivity adjusted ( CB TFP): Based on TFP growth assumptions and March end 2015 RBI REER	Overvalued by 10 per cent at the end of March 2015	2004- March 2015 (Base: 2004)

<sup>25</sup> Conference Board data has been used to construct the productivity index for our model because it is available until 2013

<sup>26</sup> The movement is identical, given that the Hong Kong dollar is pegged to the US dollar. However, it begs the question about the inclusion of Hong Kong dollar in RBI's REER estimates.

**Table13: Rupee Under/Overvaluation using Equilibrium Models**

BEER: Behavioural Equilibrium Exchange Rate

PEER: Permanent Equilibrium Exchange Rate

Methodology	Misalignment (as % of predicted value)	Variables	Data
BEER (VECM): Six county trade weighted REER (CPI based)	Overvalued by 9.5 per cent	NFA, TFP, Openness, ToT (RBI)	2001 Q12-2014 Q4
PEER (VECM): Six-county trade weighted REER (CPI based)	Over-valued by 6.5 per cent	NFA, TFP, Openness, ToT (RBI)	2001 Q1-2014 Q4

The theoretical underpinnings of BEER and PEER have been explained in Section III. There are multiple BEER models e.g. the types used by market maker Goldman Sachs or the multilateral IMF. In this paper, we have used the academic, hence, hopefully non-partisan, approach of MacDonald et al.<sup>27</sup> It can be seen in Table 13 that using BEER, the misalignment of the rupee amounts to an overvaluation of 9.5 per cent. If PEER is used (although the use of the word permanent appears to be a contradiction in terms for an exchange rate), the rupee is overvalued by 6.5 per cent.

It is apparent that the sophistication of the models and econometric methodologies used to estimate the equilibrium, fair value of currencies has increased steadily in recent years. The rupee can be shown to be highly overvalued or even undervalued depending on the choice of the measure used for productivity. For instance, we find that the rupee is overvalued if TFP is used and undervalued if changes in per capita income are used as a proxy for productivity. The use of TFP as a measure of productivity instead of labour productivity or separately for productivity in the tradables and non-tradables sectors could be questioned. The availability of TFP data and unavailability of the other measures has driven the use of TFP in this paper. As stated earlier, growth in per capita income across countries, even though the data for this is readily available, as a measure of changes in productivity has not been used since it tilts the balance towards making currencies of all less developed countries undervalued. This is because large developed economies can be expected to grow slowly as compared to countries starting from a relatively much lower base.

<sup>27</sup> **Clark, Peter B., and Ronald MacDonald.** "Exchange rates and economic fundamentals: a methodological comparison of BEERs and FEERs". Springer Netherlands, 1999.

**MacDonald, Ronald, and Preethike Dias.** "Behavioural equilibrium exchange rate estimates and implied exchange rate adjustments for ten countries." *Peterson Institute of International Economics Working Paper, February* (2007).[http://www.gla.ac.uk/media/media\\_30667\\_en.pdf](http://www.gla.ac.uk/media/media_30667_en.pdf)

Empirical evidence on the Balassa-Samuelson effect in various studies is mixed. Gregorio & Wolf (NBER 1994) find evidence of faster productivity growth in tradables relative to the non-tradables sector inducing a real appreciation in OECD countries. Lee and Tang (IMF2003) find differing results for the BS impact if labour is used instead of total factor productivity. They find that higher labour productivity tends to lead to an appreciation of the real exchange rate. The effect is transmitted through the prices of tradables rather than through relative prices between tradables and non-tradables. However, they find that higher total factor productivity leads to depreciation of the real exchange rate.

It can be seen in Annex 8 that the TFP adjusted rupee is currently under or over-valued against the Chinese Renminbi depending on the base year. For instance, if the base year is 1999, the rupee was overvalued by 30 per cent in 2013. However, this overvaluation decreases steadily thereafter, as China allowed the Renminbi to appreciate keeping in mind its trade surpluses and ever higher mountain of foreign exchange reserves. That is, if 2005 is used as the base year the rupee was undervalued by 7 per cent in 2013.

The scenario analysis in Section III indicates that the results of the estimates using a BEER model are sensitive to relatively minor changes in relative gains in productivity. Consequently, it is not evident that for purposes of assessing the fair value of any currency for trade and investment purposes, trade weighted REERs are less reliable than equilibrium exchange rates.

The rupee's value against the US\$ is a key exchange rate even for India's trade with countries other than the US as the \$ is the preferred international reserve currency in which imports/exports are invoiced. Further, it does seem that productivity estimates based on per capita income overstate productivity gains in developing countries. As such, the values for the rupee in Table 12, which all show an overvalued rupee, may be reasonably reliable. Similarly, Table 13 equilibrium values for the rupee also indicate overvaluation but at differing and lower levels. On balance, we feel that as of end March 2015 (one US\$ = 62.6 Rupees) the rupee may be about 10 per cent overvalued against the US\$.

To conclude, one of the budget announcements of February 28, 2015, was that, henceforth, capital controls on FDI would be exclusively in the government's domain. It would be appropriate if on all issues and risks associated with capital account convertibility, the government would consult more openly with the RBI and final accountability would rest with government. This could be the mirror image of RBI's jurisdiction over monetary policy.

## Annex 1

VAR Lag Order Selection Criteria

Endogenous variables: LNREER NFA TOT\_RBI PRODCB OPN

Exogenous variables: C

Sample: 2001Q1 to 2014Q4

Included observations: 56

Lag	LogL	LR	FPE	AIC	SC	HQ
0	411.8402	NA	3.37e-13	-14.53001	-14.34917	-14.45990
1	756.6116	615.6632	3.71e-18	-25.95041	-24.86540*	-25.52976
2	790.7179	54.81370	2.74e-18	-26.27564	-24.28645	-25.50444
3	817.1205	37.71800	2.75e-18	-26.32573	-23.43237	-25.20398
4	851.2448	42.65548	2.22e-18	-26.65160	-22.85407	-25.17931
5	905.1892	57.79752*	9.57e-19*	-27.68533*	-22.98362	-25.86249*

\* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

## Annex 2

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Sample: 2001Q1 to 2014Q4

Included observations: 56

Trend assumption: Linear deterministic trend

Series: LNREER NFA TOT\_RBI PRODCB OPN

Lags interval (in first differences): No lags

Unrestricted Cointegration Rank Test (Maximum Eigen value)

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Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigen value	Statistic	Critical Value	Prob.**
None *	0.590471	49.99384	33.87687	0.0003
At most 1	0.321049	21.68356	27.58434	0.2371
At most 2	0.273643	17.90397	21.13162	0.1335
At most 3	0.188089	11.66839	14.26460	0.1237
At most 4	0.062584	3.619204	3.841466	0.0571

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Max-Eigen value test indicates 1 cointegrating eqn(s) at the 0.05 level

\* denotes rejection of the hypothesis at the 0.05 level

\*\*MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Trace)

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Hypothesized		Trace	0.05	
No. of CE(s)	Eigen value	Statistic	Critical Value	Prob.**
None *	0.590471	104.8690	69.81889	0.0000
At most 1 *	0.321049	54.87513	47.85613	0.0095
At most 2 *	0.273643	33.19157	29.79707	0.0196
At most 3	0.188089	15.28760	15.49471	0.0537
At most 4	0.062584	3.619204	3.841466	0.0571

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Trace test indicates 3 cointegrating eqn(s) at the 0.05 level

\* denotes rejection of the hypothesis at the 0.05 level

\*\*MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalised by  $b'S11*b=I$ ):

LNREER	NFA_NEW_	TOT_RBI	PRODCB01	OPN
-19.27843	-16.69713	5.681182	16.04872	9.469238
6.836298	42.67427	-4.493442	-43.78349	-7.563447
-0.990187	5.343430	0.536729	26.57326	1.702128
-15.77818	14.47840	-9.799301	-41.59651	-7.213263
-4.978042	-12.32420	6.543474	-13.31855	-0.771714

Unrestricted Adjustment Coefficients (alpha):

D(LNREER)	0.006795	0.001079	-0.004055	0.008153	0.004792
D(NFA_NEW_)	-0.001950	-0.002553	0.002973	0.000113	0.001240
D(TOT_RBI)	0.011721	-0.005038	0.007747	0.011460	-0.003522
D(PRODCB01)	-0.003108	-0.000576	-0.001411	0.000948	1.27E-05
D(OPN)	-0.024224	0.026769	0.006267	0.002991	0.000380

1 Cointegrating Equation(s):      Log likelihood      729.1740

Normalised cointegrating coefficients (standard error in parentheses)

LNREER	NFA_NEW_	TOT_RBI	PRODCB01	OPN
1.000000	0.866104	-0.294691	-0.832470	-0.491183
	(0.27630)	(0.08126)	(0.40632)	(0.07935)

Adjustment coefficients (standard error in parentheses)

D(LNREER)	-0.130998
	(0.07494)
D(NFA_NEW_)	0.037584
	(0.02345)
D(TOT_RBI)	-0.225953
	(0.09423)

D(PRODCB01)	0.059915
	(0.01167)
D(OPN)	0.466996
	(0.13962)

2 Cointegrating Equation(s):      Log likelihood      740.0158

Normalised cointegrating coefficients (standard error in parentheses)

LNREER	NFA_NEW_	TOT_RBI	PRODCB01	OPN
1.000000	0.000000	-0.236276	0.065192	-0.392077
		(0.07416)	(0.36733)	(0.07058)
0.000000	1.000000	-0.067445	-1.036436	-0.114427
		(0.04929)	(0.24414)	(0.04691)

Adjustment coefficients (standard error in parentheses)

D(LNREER)	-0.123619	-0.067397
	(0.07946)	(0.17802)
D(NFA_NEW_)	0.020134	-0.076377
	(0.02384)	(0.05341)
D(TOT_RBI)	-0.260394	-0.410686
	(0.09899)	(0.22177)
D(PRODCB01)	0.055980	0.027328
	(0.01228)	(0.02751)
D(OPN)	0.649998	1.546824
	(0.12804)	(0.28684)

3 Cointegrating Equation(s):      Log likelihood      748.9678

Normalised cointegrating coefficients (standard error in parentheses)

LNREER	NFA_NEW_	TOT_RBI	PRODCB01	OPN
1.000000	0.000000	0.000000	11.52909	0.293895
			(3.56804)	(0.58676)
0.000000	1.000000	0.000000	2.235952	0.081385



			(0.99105)	(0.16298)
0.000000	0.000000	1.000000	48.51902	2.903262
			(14.8251)	(2.43799)

Adjustment coefficients (standard error in parentheses)

D(LNREER)	-0.119604	-0.089063	0.031578
	(0.07875)	(0.17740)	(0.02793)
D(NFA_NEW_)	0.017190	-0.060492	0.001990
	(0.02239)	(0.05043)	(0.00794)
D(TOT_RBI)	-0.268065	-0.369288	0.093382
	(0.09673)	(0.21792)	(0.03431)
D(PRODCB01)	0.057377	0.019788	-0.015827
	(0.01165)	(0.02624)	(0.00413)
D(OPN)	0.643793	1.580310	-0.254542
	(0.12699)	(0.28609)	(0.04504)

4 Cointegrating Equation(s):      Log likelihood      754.8020

Normalised cointegrating coefficients (standard error in parentheses)

LNREER	NFA_NEW_	TOT_RBI	PRODCB01	OPN
1.000000	0.000000	0.000000	0.000000	-0.194142
				(0.03140)
0.000000	1.000000	0.000000	0.000000	-0.013265
				(0.03239)
0.000000	0.000000	1.000000	0.000000	0.849407
				(0.12961)
0.000000	0.000000	0.000000	1.000000	0.042331
				(0.02863)

Adjustment coefficients (standard error in parentheses)

D(LNREER)	-0.248251	0.028986	-0.048320	-0.385105
	(0.09518)	(0.17803)	(0.04491)	(0.25001)
D(NFA_NEW_)	0.015413	-0.058862	0.000886	0.154784
	(0.02826)	(0.05285)	(0.01333)	(0.07422)

D(TOT_RBI)	-0.448890	-0.203360	-0.018922	0.137830
	(0.11526)	(0.21559)	(0.05438)	(0.30275)
D(PRODCB01)	0.042414	0.033518	-0.025120	-0.101619
	(0.01432)	(0.02679)	(0.00676)	(0.03761)
D(OPN)	0.596599	1.623615	-0.283852	-1.518700
	(0.15997)	(0.29920)	(0.07548)	(0.42018)

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### Annex3

Vector Error Correction Estimates

Sample: 2001Q1 2014Q4

Included observations: 56

Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1				
LNREER(-1)	1.000000				
NFA_NEW_(-1)	0.866104				
	(0.27630)				
	[ 3.13468]				
TOT_RBI(-1)	-0.294691				
	(0.08126)				
	[-3.62636]				
PRODCB01(-1)	-0.832470				
	(0.40632)				
	[-2.04882]				
OPN(-1)	-0.491183				
	(0.07935)				
	[-6.18992]				
C	-0.733238				
Error Correction:	D(LNREER)	D(NFA_NEW_)	D(TOT_RBI)	D(PRODCB01)	D(OPN)
CointEq1	-0.130998	0.037584	-0.225953	0.059915	0.466996

	(0.07494)	(0.02345)	(0.09423)	(0.01167)	(0.13962)
	[-1.74793]	[ 1.60294]	[-2.39783]	[ 5.13354]	[ 3.34473]
C	0.002875	-0.000536	-0.007857	-0.001306	0.010132
	(0.00389)	(0.00122)	(0.00489)	(0.00061)	(0.00724)
	[ 0.73955]	[-0.44047]	[-1.60745]	[-2.15691]	[ 1.39901]
<hr/>					
R-squared	0.053549	0.045421	0.096228	0.327968	0.171617
Adj. R-squared	0.036022	0.027743	0.079492	0.315522	0.156276
Sum sq. resids	0.045700	0.004473	0.072250	0.001108	0.158614
S.E. equation	0.029091	0.009101	0.036578	0.004530	0.054197
F-statistic	3.055251	2.569421	5.749602	26.35326	11.18722
Log likelihood	119.6474	184.7202	106.8227	223.7862	84.80514
Akaike AIC	-4.201693	-6.525722	-3.743668	-7.920936	-2.957327
Schwarz SC	-4.129359	-6.453388	-3.671334	-7.848602	-2.884993
Mean dependent	0.002875	-0.000536	-0.007857	-0.001306	0.010132
S.D. dependent	0.029630	0.009230	0.038125	0.005476	0.059003
<hr/>					
Determinant resid covariance (dof adj.)		4.04E-18			
Determinant resid covariance		3.37E-18			
Log likelihood		729.1740			
Akaike information criterion		-25.50621			
Schwarz criterion		-24.96371			
<hr/>					

## Annex 4

VEC Residual Serial Correlation LM Tests  
Null Hypothesis: no serial correlation at  
lag order h  
Sample: 2001Q1 to 2014Q4  
Included observations: 56

Lags	LM-Stat	Prob
1	38.22903	0.0439

Probs from chi-square with 25 df.

VEC Residual Portmanteau Tests for Autocorrelations  
Null Hypothesis: no residual autocorrelations up to lag h  
Sample: 2001Q1 to 2014Q4  
Included observations: 56

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	30.32040	0.9540	30.87168	0.9462	45

\*The test is valid only for lags larger than the VAR lag order.  
df is degrees of freedom for (approximate) chi-square distribution

VEC Residual Normality Tests

Orthogonalization: Residual Correlation (Doornik-Hansen)

Null Hypothesis: residuals are multivariate normal

Date: 05/20/15 Time: 13:42

Sample: 2001Q1 2014Q4

Included observations: 56

Component	Skewness	Chi-sq	df	Prob.
1	-1.084554	9.964105	1	0.0016
2	-0.216951	0.527753	1	0.4676
3	-3.172073	39.00685	1	0.0000
4	-0.353559	1.366267	1	0.2425
5	0.037758	0.016238	1	0.8986
Joint		50.88122	5	0.0000

Component	Kurtosis	Chi-sq	df	Prob.
1	4.317387	2.041665	1	0.1530
2	3.512778	2.079572	1	0.1493
3	18.83850	19.56316	1	0.0000
4	4.649051	8.148367	1	0.0043
5	2.287662	0.750965	1	0.3862
Joint		32.58373	5	0.0000

Component	Jarque-Bera	df	Prob.
1	12.00577	2	0.0025
2	2.607325	2	0.2715
3	58.57001	2	0.0000
4	9.514634	2	0.0086
5	0.767204	2	0.6814
Joint	83.46494	10	0.0000

VEC Residual Heteroscedasticity Tests: No Cross Terms (only levels and squares)

Date: 05/20/15 Time: 13:43

Sample: 2001Q1 2014Q4

Included observations: 56

Joint test:

Chi-sq	df	Prob.
47.61653	30	0.0216

Individual components:

Dependent	R-squared	F(2,53)	Prob.	Chi-sq(2)	Prob.
res1*res1	0.165236	5.245497	0.0083	9.253213	0.0098
res2*res2	0.082111	2.370605	0.1033	4.598237	0.1003
res3*res3	0.015018	0.404053	0.6696	0.841024	0.6567
res4*res4	0.214914	7.254246	0.0016	12.03516	0.0024
res5*res5	0.025329	0.688675	0.5067	1.418450	0.4920
res2*res1	0.018393	0.496542	0.6114	1.029996	0.5975
res3*res1	0.005168	0.137652	0.8717	0.289385	0.8653
res3*res2	0.013483	0.362184	0.6979	0.755051	0.6856
res4*res1	0.239563	8.348374	0.0007	13.41552	0.0012
res4*res2	0.184729	6.004530	0.0045	10.34483	0.0057
res4*res3	0.034035	0.933704	0.3995	1.905955	0.3856
res5*res1	0.222850	7.598940	0.0013	12.47959	0.0020
res5*res2	0.142289	4.396191	0.0171	7.968189	0.0186
res5*res3	0.026449	0.719937	0.4915	1.481138	0.4768
res5*res4	0.134308	4.111352	0.0219	7.521252	0.0233

## Annex 5

Null Hypothesis: PROD\_5 has a unit root

Exogenous: Constant

Lag Length: 0 (Automatic - based on SIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.523961	0.1154
Test critical values: 1% level	-3.555023	
5% level	-2.915522	
10% level	-2.595565	

\*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(PROD\_5) has a unit root

Exogenous: Constant

Lag Length: 3 (Automatic - based on SIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-1.226597	0.6561
Test critical values: 1% level	-3.565430	
5% level	-2.919952	
10% level	-2.597905	

\*MacKinnon (1996) one-sided p-values.

Changes in openness

VAR Lag Order Selection Criteria

Endogenous variables: LNREER NFA OPN\_5 PRODCB01 TOT\_RBI

Exogenous variables: C

Sample: 2001Q1 to 2014Q4

Included observations: 56

Lag	LogL	LR	FPE	AIC	SC	HQ
-----	------	----	-----	-----	----	----



0	408.2890	NA	3.82e-13	-14.40318	-14.22235	-14.33307
1	844.9855	779.8151	1.58e-19	-29.10662	-28.02161*	-28.68597
2	878.3165	53.56768	1.20e-19	-29.40416	-27.41498	-28.63296
3	899.6056	30.41302	1.45e-19	-29.27163	-26.37827	-28.14988
4	921.1682	26.95322	1.83e-19	-29.14886	-25.35133	-27.67657
5	990.4855	74.26854*	4.55e-20*	-30.73162	-26.02992	-28.90878*
6	1020.228	26.55568	5.26e-20	-30.90099*	-25.29511	-28.72761

\* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

Sample: 2001Q1 to 2014Q4

Included observations: 56

Trend assumption: Linear deterministic trend

Series: LNREER NFA OPN\_5 PRODCB01 TOT\_RBI

Lags interval (in first differences): No lags

Unrestricted Cointegration Rank Test (Trace)

Hypothesised		Trace	0.05	
No. of CE(s)	Eigen value	Statistic	Critical Value	Prob.**
None *	0.597154	94.98921	69.81889	0.0002
At most 1	0.356531	44.07398	47.85613	0.1084
At most 2	0.160935	19.38464	29.79707	0.4655
At most 3	0.096910	9.558458	15.49471	0.3162
At most 4 *	0.066444	3.850229	3.841466	0.0497

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level

\* denotes rejection of the hypothesis at the 0.05 level

\*\*MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigen value)

Hypothesised		Max-Eigen	0.05	
No. of CE(s)	Eigen value	Statistic	Critical Value	Prob.**
None *	0.597154	50.91523	33.87687	0.0002
At most 1	0.356531	24.68934	27.58434	0.1124
At most 2	0.160935	9.826178	21.13162	0.7608
At most 3	0.096910	5.708229	14.26460	0.6509
At most 4 *	0.066444	3.850229	3.841466	0.0497

Max-Eigen value test indicates 1 cointegrating eqn(s) at the 0.05 level

\* denotes rejection of the hypothesis at the 0.05 level

\*\*MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalised by  $b'S11*b=I$ ):

LNREER	NFA	OPN_5	PRODCB01	TOT_RBI
-15.09199	0.411742	-6.038207	-0.619571	3.442492
14.71918	13.11327	4.557587	-29.57670	-1.518522
14.09374	-2.385306	-5.691552	41.23000	8.765961
4.165692	40.33111	8.287428	-37.02048	-7.905961
4.404324	3.295761	-3.424557	30.07743	-4.217875

Unrestricted Adjustment Coefficients (alpha):

D(LNREER)	0.009960	-0.003782	-0.005428	-0.004507	-0.004183
D(NFA)	-0.002493	-0.003561	0.001479	-0.001522	-0.000122
D(OPN_5)	0.004261	0.003449	0.000947	-0.001374	0.001410
D(PRODCB01)	-0.002481	0.001151	-0.001199	-0.000792	-2.53E-05
D(TOT_RBI)	0.008464	-0.014973	-0.007605	0.000852	0.004552

1 Cointegrating Equation(s):      Log likelihood      822.9485

Normalized cointegrating coefficients (standard error in parentheses)

LNREER	NFA	OPN_5	PRODCB01	TOT_RBI
1.000000	-0.027282	0.400094	0.041053	-0.228101
	(0.30079)	(0.09252)	(0.51439)	(0.09693)

Adjustment coefficients (standard error in parentheses)

D(LNREER)	-0.150309
	(0.05673)
D(NFA)	0.037622
	(0.01808)
D(OPN_5)	-0.064302
	(0.02060)
D(PRODCB01)	0.037447
	(0.00991)
D(TOT_RBI)	-0.127739
	(0.07562)

2 Cointegrating Equation(s):      Log likelihood      835.2932

Normalised cointegrating coefficients (standard error in parentheses)

LNREER	NFA	OPN_5	PRODCB01	TOT_RBI
1.000000	0.000000	0.397406	-0.019873	-0.224388
		(0.06580)	(0.36176)	(0.06743)
0.000000	1.000000	-0.098518	-2.233172	0.136068
		(0.14402)	(0.79182)	(0.14759)

Adjustment coefficients (standard error in parentheses)

D(LNREER)	-0.205972	-0.045489
	(0.07850)	(0.04885)
D(NFA)	-0.014791	-0.047721
	(0.02309)	(0.01437)
D(OPN_5)	-0.013539	0.046979
	(0.02702)	(0.01681)
D(PRODCB01)	0.054393	0.014075

	(0.01345)	(0.00837)
D(TOT_RBI)	-0.348130	-0.192860
	(0.09651)	(0.06006)

3 Cointegrating Equation(s):      Log likelihood      840.2063

Normalised cointegrating coefficients (standard error in parentheses)

LNREER	NFA	OPN_5	PRODCB01	TOT_RBI
1.000000	0.000000	0.000000	1.227533	0.198029
			(0.30468)	(0.08478)
0.000000	1.000000	0.000000	-2.542409	0.031349
			(0.41523)	(0.11555)
0.000000	0.000000	1.000000	-3.138872	-1.062938
			(0.78849)	(0.21941)

Adjustment coefficients (standard error in parentheses)

D(LNREER)	-0.282470	-0.032542	-0.046480
	(0.09255)	(0.04867)	(0.03455)
D(NFA)	0.006050	-0.051248	-0.009593
	(0.02730)	(0.01436)	(0.01019)
D(OPN_5)	-0.000191	0.044720	-0.015399
	(0.03234)	(0.01700)	(0.01207)
D(PRODCB01)	0.037491	0.016936	0.027055
	(0.01564)	(0.00822)	(0.00584)
D(TOT_RBI)	-0.455315	-0.174720	-0.076063
	(0.11309)	(0.05947)	(0.04222)

4 Cointegrating Equation(s):      Log likelihood      843.0604

Normalised cointegrating coefficients (standard error in parentheses)

LNREER	NFA	OPN_5	PRODCB01	TOT_RBI
1.000000	0.000000	0.000000	0.000000	0.214879
				(0.08202)

0.000000	1.000000	0.000000	0.000000	-0.003549 (0.09058)
0.000000	0.000000	1.000000	0.000000	-1.106023 (0.23282)
0.000000	0.000000	0.000000	1.000000	-0.013726 (0.05705)

Adjustment coefficients (standard error in parentheses)

D(LNREER)	-0.301245 (0.09246)	-0.214312 (0.15283)	-0.083831 (0.04527)	0.048740 (0.22599)
D(NFA)	-0.000289 (0.02715)	-0.112620 (0.04488)	-0.022204 (0.01329)	0.224166 (0.06637)
D(OPN_5)	-0.005914 (0.03242)	-0.010689 (0.05358)	-0.026785 (0.01587)	-0.014734 (0.07923)
D(PRODCB01)	0.034190 (0.01560)	-0.015017 (0.02579)	0.020489 (0.00764)	-0.052629 (0.03813)
D(TOT_RBI)	-0.451768 (0.11456)	-0.140372 (0.18937)	-0.069005 (0.05609)	0.092519 (0.28002)

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Vector Error Correction Estimates

Sample: 2001Q1 to 2014Q4

Included observations: 56

Standard errors in ( ) & t-statistics in [ ]

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Cointegrating Eq:	CointEq1
LNREER(-1)	1.000000
NFA(-1)	-0.027282 (0.30079) [-0.09070]
OPN_5(-1)	0.400094 (0.09252) [ 4.32435]

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PRODCB01(-1)      0.041053  
                           (0.51439)  
                           [ 0.07981]

TOT\_RBI(-1)      -0.228101  
                           (0.09693)  
                           [-2.35333]

C                    -4.164807

Error Correction:	D(LNREER)	D(NFA)	D(OPN_5)	D(PRODCB01)	D(TOT_RBI)
CointEq1	-0.150309 (0.05673) [-2.64945]	0.037622 (0.01808) [ 2.08136]	-0.064302 (0.02060) [-3.12164]	0.037447 (0.00991) [ 3.77787]	-0.127739 (0.07562) [-1.68912]
C	0.002875 (0.00376) [ 0.76481]	-0.000536 (0.00120) [-0.44728]	-0.017500 (0.00136) [-12.8216]	-0.001306 (0.00066) [-1.98816]	-0.007857 (0.00501) [-1.56800]
R-squared	0.115038	0.074266	0.152870	0.209050	0.050184
Adj. R-squared	0.098650	0.057122	0.137182	0.194403	0.032595
Sum sq. resids	0.042731	0.004338	0.005633	0.001304	0.075931
S.E. equation	0.028130	0.008963	0.010214	0.004915	0.037498
F-statistic	7.019601	4.332069	9.744636	14.27232	2.853112
Log likelihood	121.5283	185.5793	178.2624	219.2242	105.4313
Akaike AIC	-4.268868	-6.556405	-6.295085	-7.758007	-3.693976
Schwarz SC	-4.196534	-6.484071	-6.222751	-7.685673	-3.621642
Mean dependent	0.002875	-0.000536	-0.017500	-0.001306	-0.007857
S.D. dependent	0.029630	0.009230	0.010996	0.005476	0.038125
Determinant resid covariance (dof adj.)		1.42E-19			
Determinant resid covariance		1.18E-19			
Log likelihood		822.9485			

Akaike information criterion	-28.85530
Schwarz criterion	-28.31280

Changes in NFA:

Sample: 2001Q1 to 2014Q4

Included observations: 56

Trend assumption: Linear deterministic trend

Series: LNREER NFA\_NEW5 OPN PRODCB01 TOT\_RBI

Lags interval (in first differences): No lags

Unrestricted Cointegration Rank Test (Trace)

Hypothesised		Trace	0.05	
No. of CE(s)	Eigen value	Statistic	Critical Value	Prob.**
None *	0.590471	104.8690	69.81889	0.0000
At most 1 *	0.321049	54.87513	47.85613	0.0095
At most 2 *	0.273643	33.19157	29.79707	0.0196
At most 3	0.188089	15.28760	15.49471	0.0537
At most 4	0.062584	3.619204	3.841466	0.0571

Trace test indicates 3 cointegrating eqn(s) at the 0.05 level

\* denotes rejection of the hypothesis at the 0.05 level

\*\*MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigen value)

Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigen value	Statistic	Critical Value	Prob.**
None *	0.590471	49.99384	33.87687	0.0003
At most 1	0.321049	21.68356	27.58434	0.2371
At most 2	0.273643	17.90397	21.13162	0.1335
At most 3	0.188089	11.66839	14.26460	0.1237
At most 4	0.062584	3.619204	3.841466	0.0571

Max-Eigen value test indicates 1 cointegrating eqn(s) at the 0.05 level

\* denotes rejection of the hypothesis at the 0.05 level

\*\*MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalised by  $b'S11*b=I$ ):

LNREER	NFA_NEW5	OPN	PRODCB01	TOT_RBI
-19.27843	-15.90203	9.469238	16.04872	5.681182
6.836298	40.64217	-7.563447	-43.78349	-4.493442
-0.990187	5.088981	1.702128	26.57326	0.536729
15.77818	-13.78895	7.213263	41.59651	9.799301
-4.978042	-11.73734	-0.771714	-13.31855	6.543474

Unrestricted Adjustment Coefficients (alpha):

D(LNREER)	0.006795	0.001079	-0.004055	-0.008153	0.004792
D(NFA_NEW5)	-0.002047	-0.002680	0.003121	-0.000118	0.001302
D(OPN)	-0.024224	0.026769	0.006267	-0.002991	0.000380
D(PRODCB01)	-0.003108	-0.000576	-0.001411	-0.000948	1.27E-05
D(TOT_RBI)	0.011721	-0.005038	0.007747	-0.011460	-0.003522

1 Cointegrating Equation(s):      Log likelihood      726.4417

Normalised cointegrating coefficients (standard error in parentheses)

LNREER	NFA_NEW5	OPN	PRODCB01	TOT_RBI
1.000000	0.824861	-0.491183	-0.832470	-0.294691
	(0.26314)	(0.07935)	(0.40632)	(0.08126)

Adjustment coefficients (standard error in parentheses)

D(LNREER)	-0.130998
	(0.07494)
D(NFA_NEW5)	0.039463
	(0.02462)
D(OPN)	0.466996



	(0.13962)
D(PRODCB01)	0.059915
	(0.01167)
D(TOT_RBI)	-0.225953
	(0.09423)

2 Cointegrating Equation(s):      Log likelihood      737.2835

Normalised cointegrating coefficients (standard error in parentheses)

LNREER	NFA_NEW5	OPN	PRODCB01	TOT_RBI
1.000000	0.000000	-0.392077	0.065192	-0.236276
		(0.07058)	(0.36733)	(0.07416)
0.000000	1.000000	-0.120148	-1.088258	-0.070818
		(0.04926)	(0.25635)	(0.05175)

Adjustment coefficients (standard error in parentheses)

D(LNREER)	-0.123619	-0.064188
	(0.07946)	(0.16954)
D(NFA_NEW5)	0.021141	-0.076377
	(0.02503)	(0.05341)
D(OPN)	0.649998	1.473166
	(0.12804)	(0.27318)
D(PRODCB01)	0.055980	0.026027
	(0.01228)	(0.02620)
D(TOT_RBI)	-0.260394	-0.391129
	(0.09899)	(0.21121)

3 Cointegrating Equation(s):      Log likelihood      746.2355

Normalised cointegrating coefficients (standard error in parentheses)

LNREER	NFA_NEW5	OPN	PRODCB01	TOT_RBI
1.000000	0.000000	0.000000	6.617552	-0.101229
			(1.29171)	(0.35945)

0.000000	1.000000	0.000000	0.919649	-0.029434
			(0.38853)	(0.10812)
0.000000	0.000000	1.000000	16.71190	0.344440
			(3.17052)	(0.88227)

Adjustment coefficients (standard error in parentheses)

D(LNREER)	-0.119604	-0.084822	0.049279
	(0.07875)	(0.16896)	(0.04706)
D(NFA_NEW5)	0.018050	-0.060492	0.006201
	(0.02350)	(0.05043)	(0.01405)
D(OPN)	0.643793	1.505057	-0.421181
	(0.12699)	(0.27247)	(0.07589)
D(PRODCB01)	0.057377	0.018845	-0.027477
	(0.01165)	(0.02499)	(0.00696)
D(TOT_RBI)	-0.268065	-0.351703	0.162275
	(0.09673)	(0.20754)	(0.05781)

4 Cointegrating Equation(s):      Log likelihood      752.0697

Normalised cointegrating coefficients (standard error in parentheses)

LNREER	NFA_NEW5	OPN	PRODCB01	TOT_RBI
1.000000	0.000000	0.000000	0.000000	0.228562
				(0.08858)
0.000000	1.000000	0.000000	0.000000	0.016398
				(0.05790)
0.000000	0.000000	1.000000	0.000000	1.177291
				(0.25820)
0.000000	0.000000	0.000000	1.000000	-0.049836
				(0.05555)

Adjustment coefficients (standard error in parentheses)

D(LNREER)	-0.248251	0.027606	-0.009534	-0.385105
	(0.09518)	(0.16955)	(0.05230)	(0.25001)
D(NFA_NEW5)	0.016184	-0.058862	0.005348	0.162524

	(0.02967)	(0.05285)	(0.01630)	(0.07793)
D(OPN)	0.596599	1.546300	-0.442756	-1.518700
	(0.15997)	(0.28495)	(0.08790)	(0.42018)
D(PRODCB01)	0.042414	0.031922	-0.034318	-0.101619
	(0.01432)	(0.02551)	(0.00787)	(0.03761)
D(TOT_RBI)	-0.448890	-0.193676	0.079608	0.137830
	(0.11526)	(0.20532)	(0.06334)	(0.30275)

Vector Error Correction Estimates

Sample: 2001Q1 2014Q4

Included observations: 56

Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
LNREER(-1)	1.000000
NFA_NEW5(-1)	0.824861 (0.26314) [ 3.13468]
OPN(-1)	-0.491183 (0.07935) [-6.18992]
PRODCB01(-1)	-0.832470 (0.40632) [-2.04882]
TOT_RBI(-1)	-0.294691 (0.08126) [-3.62636]
C	-0.733238

Error Correction:	D(LNREER)	D(NFA_NEW5 )	D(OPN)	D(PRODCB01)	D(TOT_RBI)
CointEq1	-0.130998 (0.07494) [-1.74793]	0.039463 (0.02462) [ 1.60294]	0.466996 (0.13962) [ 3.34473]	0.059915 (0.01167) [ 5.13354]	-0.225953 (0.09423) [-2.39783]
C	0.002875 (0.00389) [ 0.73955]	-0.000563 (0.00128) [-0.44047]	0.010132 (0.00724) [ 1.39901]	-0.001306 (0.00061) [-2.15691]	-0.007857 (0.00489) [-1.60745]
R-squared	0.053549	0.045421	0.171617	0.327968	0.096228
Adj. R-squared	0.036022	0.027743	0.156276	0.315522	0.079492
Sum sq. resids	0.045700	0.004932	0.158614	0.001108	0.072250
S.E. equation	0.029091	0.009556	0.054197	0.004530	0.036578
F-statistic	3.055251	2.569421	11.18722	26.35326	5.749602
Log likelihood	119.6474	181.9880	84.80514	223.7862	106.8227
Akaike AIC	-4.201693	-6.428141	-2.957327	-7.920936	-3.743668
Schwarz SC	-4.129359	-6.355807	-2.884993	-7.848602	-3.671334
Mean dependent	0.002875	-0.000562	0.010132	-0.001306	-0.007857
S.D. dependent	0.029630	0.009692	0.059003	0.005476	0.038125
Determinant resid covariance (dof adj.)		4.46E-18			
Determinant resid covariance		3.72E-18			
Log likelihood		726.4417			
Akaike information criterion		-25.40863			
Schwarz criterion		-24.86613			

Changes in terms of trade:

VAR Lag Order Selection Criteria

Endogenous variables: LNREER NFA OPN PRODCB01 TOT\_5

Exogenous variables: C

Sample: 2001Q1 to 2014Q4

Included observations: 56

Lag	LogL	LR	FPE	AIC	SC	HQ
0	409.1079	NA	3.71e-13	-14.43243	-14.25159	-14.36232
1	753.8793	615.6632	4.09e-18	-25.85283	-24.76782*	-25.43218
2	787.9856	54.81370	3.02e-18	-26.17806	-24.18887	-25.40686
3	814.3882	37.71800	3.04e-18	-26.22815	-23.33479	-25.10640
4	848.5126	42.65548	2.45e-18	-26.55402	-22.75649	-25.08173
5	902.4569	57.79752*	1.06e-18*	-27.58775*	-22.88604	-25.76491*

\* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

Sample: 2001Q1 to 2014Q4

Included observations: 56

Trend assumption: Linear deterministic trend

Series: LNREER NFA OPN PRODCB01 TOT\_5

Lags interval (in first differences): No lags

Unrestricted Cointegration Rank Test (Trace)

Hypothesised	Eigen value	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.590471	104.8690	69.81889	0.0000
At most 1 *	0.321049	54.87513	47.85613	0.0095
At most 2 *	0.273643	33.19157	29.79707	0.0196
At most 3	0.188089	15.28760	15.49471	0.0537
At most 4	0.062584	3.619204	3.841466	0.0571

Trace test indicates 3 cointegrating eqn(s) at the 0.05 level

\* denotes rejection of the hypothesis at the 0.05 level

\*\*MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigen value)

Hypothesised		Max-Eigen	0.05	
No. of CE(s)	Eigen value	Statistic	Critical Value	Prob.**
None *	0.590471	49.99384	33.87687	0.0003
At most 1	0.321049	21.68356	27.58434	0.2371
At most 2	0.273643	17.90397	21.13162	0.1335
At most 3	0.188089	11.66839	14.26460	0.1237
At most 4	0.062584	3.619204	3.841466	0.0571

Max-Eigen value test indicates 1 cointegrating eqn(s) at the 0.05 level

\* denotes rejection of the hypothesis at the 0.05 level

\*\*MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalised by  $b'S11*b=I$ ):

LNREER	NFA	OPN	PRODCB01	TOT_5
-19.27843	-16.69713	9.469238	16.04872	5.410649
6.836298	42.67427	-7.563447	-43.78349	-4.279468
-0.990187	5.343430	1.702128	26.57326	0.511170
15.77818	-14.47840	7.213263	41.59651	9.332668
-4.978042	-12.32420	-0.771714	-13.31855	6.231880

Unrestricted Adjustment Coefficients (alpha):

D(LNREER)	0.006795	0.001079	-0.004055	-0.008153	0.004792
D(NFA)	-0.001950	-0.002553	0.002973	-0.000113	0.001240
D(OPN)	-0.024224	0.026769	0.006267	-0.002991	0.000380
D(PRODCB01)	-0.003108	-0.000576	-0.001411	-0.000948	1.27E-05
D(TOT_5)	0.012307	-0.005290	0.008135	-0.012033	-0.003698

1 Cointegrating Equation(s):      Log likelihood      726.4417

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Normalised cointegrating coefficients (standard error in parentheses)

LNREER	NFA	OPN	PRODCB01	TOT_5
1.000000	0.866104	-0.491183	-0.832470	-0.280658
	(0.27630)	(0.07935)	(0.40632)	(0.07739)

Adjustment coefficients (standard error in parentheses)

D(LNREER)	-0.130998
	(0.07494)
D(NFA)	0.037584
	(0.02345)
D(OPN)	0.466996
	(0.13962)
D(PRODCB01)	0.059915
	(0.01167)
D(TOT_5)	-0.237251
	(0.09894)

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2 Cointegrating Equation(s):      Log likelihood      737.2835

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Normalised cointegrating coefficients (standard error in parentheses)

LNREER	NFA	OPN	PRODCB01	TOT_5
1.000000	0.000000	-0.392077	0.065192	-0.225025
		(0.07058)	(0.36733)	(0.07062)
0.000000	1.000000	-0.114427	-1.036436	-0.064234
		(0.04691)	(0.24414)	(0.04694)

Adjustment coefficients (standard error in parentheses)

D(LNREER)	-0.123619	-0.067397
	(0.07946)	(0.17802)
D(NFA)	0.020134	-0.076377
	(0.02384)	(0.05341)
D(OPN)	0.649998	1.546824
	(0.12804)	(0.28684)

D(PRODCB01)	0.055980	0.027328
	(0.01228)	(0.02751)
D(TOT_5)	-0.273413	-0.431220
	(0.10394)	(0.23286)

3 Cointegrating Equation(s):      Log likelihood      746.2355

Normalised cointegrating coefficients (standard error in parentheses)

LNREER	NFA	OPN	PRODCB01	TOT_5
1.000000	0.000000	0.000000	6.617552	-0.096409
			(1.29171)	(0.34233)
0.000000	1.000000	0.000000	0.875857	-0.026697
			(0.37003)	(0.09807)
0.000000	0.000000	1.000000	16.71190	0.328038
			(3.17052)	(0.84026)

Adjustment coefficients (standard error in parentheses)

D(LNREER)	-0.119604	-0.089063	0.049279
	(0.07875)	(0.17740)	(0.04706)
D(NFA)	0.017190	-0.060492	0.005906
	(0.02239)	(0.05043)	(0.01338)
D(OPN)	0.643793	1.580310	-0.421181
	(0.12699)	(0.28609)	(0.07589)
D(PRODCB01)	0.057377	0.019788	-0.027477
	(0.01165)	(0.02624)	(0.00696)
D(TOT_5)	-0.281468	-0.387753	0.170389
	(0.10157)	(0.22881)	(0.06070)

4 Cointegrating Equation(s):      Log likelihood      752.0697

Normalised cointegrating coefficients (standard error in parentheses)

LNREER	NFA	OPN	PRODCB01	TOT_5
1.000000	0.000000	0.000000	0.000000	0.217678



				(0.08436)
0.000000	1.000000	0.000000	0.000000	0.014873
				(0.05252)
0.000000	0.000000	1.000000	0.000000	1.121230
				(0.24591)
0.000000	0.000000	0.000000	1.000000	-0.047463
				(0.05290)

Adjustment coefficients (standard error in parentheses)

D(LNREER)	-0.248251	0.028986	-0.009534	-0.385105
	(0.09518)	(0.17803)	(0.05230)	(0.25001)
D(NFA)	0.015413	-0.058862	0.005093	0.154784
	(0.02826)	(0.05285)	(0.01553)	(0.07422)
D(OPN)	0.596599	1.623615	-0.442756	-1.518700
	(0.15997)	(0.29920)	(0.08790)	(0.42018)
D(PRODCB01)	0.042414	0.033518	-0.034318	-0.101619
	(0.01432)	(0.02679)	(0.00787)	(0.03761)
D(TOT_5)	-0.471334	-0.213528	0.083588	0.144722
	(0.12102)	(0.22636)	(0.06650)	(0.31789)

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## Annex 6

Dependent Variable: LNREER

Method: Fully Modified Least Squares (FMOLS)

Date: 05/20/15 Time: 12:14

Sample: 2001Q1 to 2014Q4

Included observations: 56

Cointegrating equation deterministics: C

Long-run covariance estimate (Bartlett kernel, Newey-West fixed bandwidth  
= 4.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
NFA_NEW_	-0.582467	0.318004	-1.831636	0.0728
OPN	0.194955	0.089353	2.181839	0.0338
PRODCB01	-0.123240	0.459258	-0.268346	0.7895
TOT_RBI	0.023081	0.092256	0.250185	0.8034
C	3.934104	1.105704	3.558009	0.0008
R-squared	0.679447	Mean dependent var		4.662196
Adjusted R-squared	0.654305	S.D. dependent var		0.069766
S.E. of regression	0.041020	Sum squared resid		0.085814
Durbin-Watson stat	0.715821	Long-run variance		0.002447

## Annex 7

Date: 05/20/15 Time: 14:31

Sample: 2001Q1 2014Q4

Included observations: 56

Trend assumption: Linear deterministic trend

Series: LNREER NFA OPN PRODCB01 TOT\_RBI

Lags interval (in first differences): No lags

### Unrestricted Cointegration Rank Test (Trace)

Hypothesised	Eigen value	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.554869	119.3559	69.81889	0.0000
At most 1 *	0.359790	62.69878	47.85613	0.0011
At most 2 *	0.232357	31.48163	29.79707	0.0317
At most 3	0.140614	12.97148	15.49471	0.1159
At most 4	0.033205	2.363851	3.841466	0.1242

Trace test indicates 3 cointegrating eqn(s) at the 0.05 level

\* denotes rejection of the hypothesis at the 0.05 level

\*\*MacKinnon-Haug-Michelis (1999) p-values

### Unrestricted Cointegration Rank Test (Maximum Eigen value)

Hypothesised	Eigen value	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.554869	56.65711	33.87687	0.0000
At most 1 *	0.359790	31.21714	27.58434	0.0163
At most 2	0.232357	18.51016	21.13162	0.1119
At most 3	0.140614	10.60763	14.26460	0.1750
At most 4	0.033205	2.363851	3.841466	0.1242

Max-Eigen value test indicates 2 cointegrating eqn(s) at the 0.05 level

\* denotes rejection of the hypothesis at the 0.05 level

\*\*MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'S11\*b=I):

LNREER	NFA	OPN	PRODCB01	TOT_RBI
-18.32444	-30.95863	11.03054	28.77960	8.077859
0.482433	-30.18677	3.930475	45.63092	-1.187547
-0.108404	-17.18270	0.881978	-12.17969	0.589955
18.52076	-7.208961	2.887946	23.07700	7.235420
-3.332166	-13.21259	-1.510350	-7.394545	2.714213

Unrestricted Adjustment Coefficients (alpha):

D(LNREER)	0.003906	-0.005478	0.003283	-0.009139	0.001134
D(NFA)	-0.000914	0.002155	-0.001777	-0.000806	0.001112
D(OPN)	-0.032434	-0.018704	-0.010681	-0.000915	-0.002045
D(PRODCB01)	-0.002592	0.001254	0.001194	-0.000463	-7.56E-05
D(TOT_RBI)	0.009911	0.008826	-0.006823	-0.006422	-0.003399

1 Cointegrating Equation(s):      Log likelihood      925.5004

Normalised cointegrating coefficients (standard error in parentheses)

LNREER	NFA	OPN	PRODCB01	TOT_RBI
1.000000	1.689472	-0.601958	-1.570558	-0.440824
	(0.27020)	(0.06476)	(0.35772)	(0.06651)

Adjustment coefficients (standard error in parentheses)

D(LNREER)	-0.071575
	(0.06185)
D(NFA)	0.016744
	(0.01846)
D(OPN)	0.594342
	(0.10975)

D(PRODCB01)	0.047502
	(0.00932)
D(TOT_RBI)	-0.181614
	(0.07493)

2 Cointegrating Equation(s):      Log likelihood      941.1089

Normalised cointegrating coefficients (standard error in parentheses)

LNREER	NFA	OPN	PRODCB01	TOT_RBI
1.000000	0.000000	-0.371937	0.957430	-0.493951
		(0.07427)	(0.41275)	(0.09636)
0.000000	1.000000	-0.136149	-1.496318	0.031446
		(0.03678)	(0.20443)	(0.04773)

Adjustment coefficients (standard error in parentheses)

D(LNREER)	-0.074217	0.044432
	(0.06066)	(0.14310)
D(NFA)	0.017784	-0.036774
	(0.01784)	(0.04207)
D(OPN)	0.585319	1.568730
	(0.10161)	(0.23968)
D(PRODCB01)	0.048107	0.042405
	(0.00890)	(0.02099)
D(TOT_RBI)	-0.177356	-0.573267
	(0.07234)	(0.17064)

3 Cointegrating Equation(s):      Log likelihood      950.3640

Normalised cointegrating coefficients (standard error in parentheses)

LNREER	NFA	OPN	PRODCB01	TOT_RBI
1.000000	0.000000	0.000000	10.34099	-0.761336
			(1.94663)	(0.43273)
0.000000	1.000000	0.000000	1.938576	-0.066432
			(0.62488)	(0.13891)
0.000000	0.000000	1.000000	25.22887	-0.718897
			(4.89839)	(1.08890)

Adjustment coefficients (standard error in parentheses)

D(LNREER)	-0.074573	-0.011987	0.024451
	(0.06022)	(0.15286)	(0.03858)
D(NFA)	0.017976	-0.006243	-0.003175
	(0.01739)	(0.04415)	(0.01114)
D(OPN)	0.586477	1.752258	-0.440704
	(0.09880)	(0.25077)	(0.06329)
D(PRODCB01)	0.047978	0.021885	-0.022613
	(0.00849)	(0.02156)	(0.00544)
D(TOT_RBI)	-0.176617	-0.456026	0.137998
	(0.07073)	(0.17954)	(0.04531)

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4 Cointegrating Equation(s):      Log likelihood      955.6678

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Normalised cointegrating coefficients (standard error in parentheses)

LNREER	NFA	OPN	PRODCB01	TOT_RBI
1.000000	0.000000	0.000000	0.000000	0.281866
				(0.07891)
0.000000	1.000000	0.000000	0.000000	0.129133
				(0.05452)
0.000000	0.000000	1.000000	0.000000	1.826200
				(0.22525)
0.000000	0.000000	0.000000	1.000000	-0.100880
				(0.03646)

Adjustment coefficients (standard error in parentheses)

D(LNREER)	-0.243830	0.053894	-0.001942	-0.388428
	(0.08059)	(0.14562)	(0.03740)	(0.18534)
D(NFA)	0.003043	-0.000430	-0.005503	0.075087
	(0.02459)	(0.04444)	(0.01141)	(0.05656)
D(OPN)	0.569524	1.758857	-0.443347	-1.677950
	(0.14041)	(0.25370)	(0.06516)	(0.32291)
D(PRODCB01)	0.039398	0.025224	-0.023951	-0.042628
	(0.01198)	(0.02165)	(0.00556)	(0.02756)
D(TOT_RBI)	-0.295566	-0.409727	0.119450	0.622877
	(0.09848)	(0.17794)	(0.04570)	(0.22648)

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## Annex 8

### India's Productivity Adjusted REER vis-à-vis China (Changing base year)

Time\ Base	1990=	1991=	1992=	1993=	1994=	1995=	1996=	1997=	1998=	1999=	2000=	2001=	2002=	2003=	2004=	2005=
1990	100															
1991	100	100														
1992	96	96	100													
1993	81	81	84	100												
1994	106	106	110	131	100											
1995	98	98	102	121	93	100										
1996	84	84	87	103	79	85	100									
1997	84	84	87	103	79	85	100	100								
1998	77	77	80	96	73	79	93	93	100							
1999	76	76	79	94	72	77	91	91	98	100						
2000	78	78	81	96	74	80	93	93	101	103	100					
2001	81	81	84	100	77	83	97	97	105	107	104	100				
2002	88	88	91	109	83	90	105	105	114	116	113	109	100			
2003	99	99	102	122	93	101	118	118	127	130	126	122	112	100		
2004	102	102	106	126	97	104	122	122	132	135	131	126	116	104	100	
2005	107	107	111	132	101	109	128	128	138	141	137	132	121	108	105	100
2006	108	108	112	133	102	110	129	129	140	142	138	133	123	110	106	101
2007	115	115	119	141	108	117	137	137	148	151	147	141	130	116	112	107
2008	107	107	111	132	101	109	128	128	138	141	137	132	122	108	105	100
2009	104	104	107	128	98	106	124	124	134	136	133	128	118	105	101	97
2010	113	113	118	140	107	116	136	136	146	149	145	140	129	115	111	106
2011	111	111	115	137	105	113	132	132	143	146	142	137	126	112	108	104
2012	103	103	107	127	97	105	123	123	133	135	132	127	117	104	100	96
2013	99	99	103	122	94	101	118	118	128	130	127	122	113	100	97	93

Source: Authors' calculations



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