RESERVE BANK OF INDIA
OCCASIONAL PAPERS

Vol. 33, No. 1 & 2: 2012 ISSN 0972 - 7493

RESERVE BANK OF INDIA

EDITORIAL COMMITTEE

The objective of the *Reserve Bank of India Occasional Papers* is to publish high quality research produced by the staff of the Reserve Bank of India on a broad array of issues of interest to a large audience including academics and policy makers. The papers selected for publications are subject to intense review by internal and external referees. The views expressed in the articles, notes and reviews published in this journal are those of the authors and do not reflect the views of the Editorial Committee or of the Reserve Bank of India. Moreover, the responsibility for the accuracy of statements contained in the contributions rests with the author(s).

The Reserve Bank of India Occasional Papers are only published through the website and no hard copies are printed.

All correspondence may be addressed to the Editorial Committee, Reserve Bank of India Occasional Papers, Department of Economic and Policy Research, Reserve Bank of India, Post Box No. 1036, Mumbai-400 001; E-mail: occasionalpapers@rbi.org.in or rajeevjain@rbi.org.in.

RESERVEBANKOFINDIA

OCCASIONAL PAPERS

RESERVE BANK OF INDIA

RESERVE BANK OF INDIA

OCCASIONAL PAPERS

VOL. 33, NO. 1 & 2: 2012

Published by Deepak Mohanty for the Reserve Bank of India and printed by him at Alco Corporation, Gala No. A-25, A Wing, Gr. Floor, Veerwani Industrial Estate, Goregaon (E), Mumbai-400063.

Reserve Bank of India Occasional Papers

Vol. 33, No. 1 & 2: 2012

Threshold Level of Debt and Public Debt Sustainability: The Indian Experience

Balbir Kaur and Atri Mukherjee*

The objective of the paper is twofold. The first objective is to assess the sustainability of public debt in India. In addition, an attempt has also been made to examine the relationship between public debt and growth in the Indian context. The sustainability analysis, based on empirical assessment of inter-temporal budget constraint and fiscal policy response function at the general government level for the period 1980-81 to 2012-13, indicates that the debt position in India is sustainable in the long run. The empirical results also reveal that there is a statistically significant non-linear relationship between public debt and growth in India, implying a negative impact of public debt on economic growth at higher levels. The threshold level of general government debt-GDP ratio for India works out to be 61 per cent, beyond which an inverse relationship is observed between debt and growth. This threshold level is lower than the actual level of debt at 66.0 per cent of GDP in end March 2013. This calls for a greater focus on a credible fiscal consolidation to safeguard against adverse debt dynamics should the interest rate-growth differential turn less favourable, keeping in view the recent slowdown in growth.

JEL Classification : H63, E62, O40
Keywords : public debt, gross fiscal deficit, growth

Introduction

The non-linear relationship between growth and debt has been a subject of wide interest and debate since the time of publication of the paper by Reinhart and Rogoff on the subject. In their paper "Growth in a time of Debt" (2010), Reinhart and Rogoff (R&R) argue that growth slows down sharply when the government debt to gross domestic product (GDP) ratio exceeds a threshold level of 90 per cent. The median growth falls by one per cent and the average growth falls

* Balbir Kaur and Atri Mukherjee are Adviser and Assistant Adviser in the Department of Economic and Policy Research, Reserve Bank of India. The views expressed in the paper are those of the authors and do not necessarily reflect the views of the Reserve Bank. The authors are grateful to Dr. D. Subbarao, Dr. Urjit Patel and Shri Deepak Mohanty for encouragement and support. The authors would also like to thank Dr. Rathin Roy, Dr. Ashima Goyal, Dr. Himanshu Joshi and Shri Sanjay Hansda for their valuable comments on the paper.

by considerably more for debt-GDP ratios above the threshold of 90 per cent. The non-linear effect of debt on growth is considered to be reminiscent of "debt intolerance" resulting in non-linear response of market interest rates when debt tolerance levels are reached. These results have been supported by a number of other studies (Kumar and Woo, 2012; Cecchetti *et al.,* 2011; Checherita and Rother, 2010 and Baum *et al.,* 2012), although they differ, though not markedly, in terms of the threshold level of debt-GDP ratio. Herdon, Ash and Pollin (2013), however, point out that the conclusions of R&R may not hold because of coding errors, selective exclusion of available data and unconventional weighting of summary statistics in the methodology used by the authors. After correcting for these statistical drawbacks, they come to the conclusion that there is no evidence of a negative relationship between debt and growth beyond the threshold level of 90 per cent.

Based on the most up-to-date work that incorporates the corrections and latest set of data, R&R continue to hold that growth slows down (by about 1 percentage point) when debt hits 90 per cent of GDP. In other words, slower growth is associated with higher debt. However, critiques[1] are of the view that an association is definitely not a cause. The direction of causality could be from growth to debt with slower growth causing high debt. While this debate is still unsettled, this paper seeks to test its validity, and estimate the threshold level of public debt in India. In addition, the paper also provides a comprehensive analysis of the sustainability of public debt in India through the use of different approaches including inter-temporal budget constraint and fiscal policy response function.

The paper is organised as follows. Section II provides a brief description of various channels through which high public debt levels are said to impact growth, inflation and other macroeconomic variables. Section III presents a review of literature relating to determination of threshold level of debt based on both debt-growth relationship and fiscal/debt sustainability aspects. Section IV covers evolution of combined

[1] Paul Krugman (2013); Elmeskov and Sutherland (2012).

debt position of central and state governments in India from 1980-81 to 2012-13. It also analyses the impact of developments in the primary balances along with interest rate and growth dynamics on the evolution of public debt in India. Section V examines debt sustainability in the Indian context in terms of various indicators of public debt sustainability, inter-temporal budget constraint and fiscal policy response function of the government. Section VI analyses the debt-growth relationship in India. Concluding observations are covered in Section VII.

Section II
Interplay of High Public Debt and Macro-Economic Variables

Fiscal expansion financed through debt issuances and the resultant public debt accumulation have important influences over the economy both in the short-run as well as the long run. Debt *per se* may not be bad. It depends on the utilisation of funds raised through borrowings. In case it is used for capital formation, it could contribute to the real income of future generation and add to repayment capacity of the government as well. On the contrary, the use of borrowings to finance only current expenditure poses the risk of debt rising to unsustainable levels.

There are different channels through which elevated and rising levels of public debt could operate and impact growth, *viz.,* reduced investment/capital accumulation following the pressure on long-term interest rates (Baum *et al.,* 2012), reduced (perceived) returns on investment due to uncertainty about future prospects and policies, and risk of introduction of distortionary taxes. Besides these, there are other risk factors, such as, volatility in interest rates, reduced present and future productive government spending, reduced scope for countercyclical policies and vulnerabilities associated with debt build-up that tend to contribute to slowdown in economic activity and growth at higher levels of debt.

High public debt levels, through higher issuances of government debt, crowd out private investment, in the absence of debt neutrality or Ricardian equivalence, particularly when the economy is operating at or near full employment situation. Pattillo *et al.*, (2002) indicate that the effect of debt on growth works through reduction in total factor

productivity growth and physical capital accumulation. Cournede (2010) points out the impact of high debt levels on cost of capital and in turn on the intensity of capital in production. The lower productivity level affects potential output and growth and the effect could be substantial in case investment in research and development reduces in response to higher cost of capital. Kumar and Woo (2012) also point argue that debt accumulation has a larger adverse impact on domestic investment of emerging market economies *vis-a-vis* advanced economies.

The persistence of debt overhang raises the risk of sovereign insolvency, particularly during economic downturns. Higher the debt, higher is the risk of repayment ability or probability of default which, in turn, leads to widening of sovereign spreads, thereby making attainment of debt sustainability all the more difficult to achieve. Moreover, higher sovereign spreads get transmitted to higher private lending spreads, affecting both investment and consumption.

High and rising public debt arising from unsustainable fiscal policies also increases the risk of an eventual monetisation of persistent deficits, with consequent impact on inflation. If the long-run interest rate-growth rate differential turns positive, a higher debt-GDP ratio, for a given primary deficit-GDP ratio, could increase the anticipated inflation tax in the form of higher seigniorage revenue through increased issuance of base money. It could also tempt the government to erode the real value of current and future debt service through unanticipated burst of inflation, with inflation having the largest impact on long-term, fixed-rate, and local-currency denominated debt. Fear of the government inflating away a part or the whole of its domestic currency denominated debt burden in future could lead to a rise in nominal interest rates associated with higher inflationary expectations and higher inflation risk premium (Buiter and Patel, 2010).

In emerging markets, high public debt levels tend to generate significant inflationary pressures. R&R (2010) point out that median inflation more than doubles (from less than seven per cent to 16 per cent), as debt in emerging markets rises from the low range of 0-30 per cent to above 90 per cent. The existence of a strong and stable impact of

debt growth on inflation in developing and some advanced economies establishes the indirect negative impact of debt on growth in these countries.

Section III
Review of Literature

In the theoretical and empirical literature, the threshold level of debt has been defined based on two strands of thought *viz.,* debt-growth dynamics and fiscal/debt sustainability perspective in different countries over a period of time. In terms of debt-growth dynamics, increases in debt-GDP ratio beyond the threshold level are associated with a negative impact on growth, while they give rise to debt servicing, liquidity and solvency concerns from the view point of debt sustainability.

The recent empirical studies have primarily focused on the debt-growth relationship and been motivated by the R&R's (2010) work, raising concerns regarding negative impact of debt on growth when debt-GDP ratio exceeds the threshold level of 90 per cent. Baum *et al. (*2012) and Chang and Chiang (2009) have looked at the impact of debt on short-term growth, while the focus of other studies is on medium-term/long-run economic growth. The short-term growth effect is studied in terms of either direct impact of debt on growth or indirect impact running through fiscal multipliers linked to shocks to government expenditure or taxes while also being influenced by the initial level of debt.

Reinhart and Rogoff (2010) show that growth rates in both developed and developing countries with the public debt to GDP ratio higher than 90 per cent are about 1 percentage point lower than in the less indebted countries. Growth in emerging markets (EMs) slows down by an annual two percentage points when their external debt reaches 60 per cent of GDP and the decline is even sharper for external debt levels in excess of 90 per cent of GDP. Other empirical studies also establish that public debt beyond a certain threshold is negatively correlated with economic growth (Egert, 2012; Elmeskov & Sutherland, 2012; Greenidge *et al.,* 2012; Kumar & Woo, 2012; Cecchetti *et al.,* 2011; Checherita & Rother, 2010; Baum *et al.,* 2012; Cordella *et al.,* 2005). The negative effect of debt on growth is attributed, among others, to

both the crowding out effect and the debt overhang effect. However, the direction of causality has not been unambiguously established. Elmeskov and Sutherland (2012) admit that high debt levels have a negative impact on growth but they argue that correlation is not the same as causation. While high levels of public debt could be detrimental to growth, low economic growth could itself lead to high levels of public debt *i.e.,* reverse causality. Easterly (2001) argues that the causality runs from growth to debt. In the Indian context, while Singh (1999) found that the domestic debt held by the public and economic growth are not causally related, Rangarajan and Srivastava (2005) indicate that growth may be adversely impacted on account of large structural primary deficit and interest payments relative to GDP.

The non-linearity in the impact of debt on growth has been examined in empirical studies based on various model specifications. Reinhart and Rogoff (2010) use correlations between debt and growth while Kumar and Woo (2012) and Egert (2012) study the impact of public debt on growth along with other determinants of growth in a general growth framework. The statistical techniques used in empirical exercises include OLS, quadratic, spline and panel regressions, besides using exogenously/endogenously determined threshold debt levels and calculating debt thresholds based on credit ratings of major rating agencies[2]. The threshold level of debt varies for different regions/ country groups as also across countries.

The determination of public debt thresholds, based on the concept of sustainable public debt level, has primarily been guided by necessary and sufficient conditions of debt sustainability as defined in the theoretical literature. In the pioneering work on debt sustainability, Domar (1944) said that GDP should grow faster than public debt for debt to be sustainable. Subsequently, Buiter *et al.* (1985) suggested that sustainable fiscal policy is the one that is capable of keeping the public sector net worth to output ratio at its current level. Blanchard *et al.* (1990) introdicate two conditions for a sustainable fiscal policy: (i) the ratio of debt to GNP should converge in the long run to its initial level,

[2] Bannister and Barrot 2011.

and (ii) the present discounted value of the ratio of primary budget deficit to GNP should be equal to the negative of the current level of debt to GNP.

The debt sustainability conditions revolve around the government's inter-temporal or the present value budget constraint (PVBC). This has been put differently in various empirical studies. In Lengrenzi and Milas (2011) work, the PVBC requires that the present value of outlays (current and future) equals the present value of revenues (current and future). The transversality condition under the PVBC constrains the debt to grow at a slower rate than the interest rate (Chalk and Hemming, 2000). Buiter and Patel (2010) refer to the standard solvency constraints *viz.,* (i) the present discounted value of the terminal government non-monetary debt be non-positive and (ii) the outstanding value of the government's non-monetary debt cannot exceed the present discounted value of its future primary surpluses. In terms of the first constraint, the growth rate of public debt cannot be greater than the effective interest rate on the public debt. Gerson and Nellor (1997) define fiscal sustainability as a situation of overall fiscal balance rather than a constant debt ratio.

In the Indian context, the sustainability of public debt has been empirically examined based on various approaches including the Domar stability condition and time series methods, such as, stationarity of debt series, unit root and co-integration tests. While the earlier studies of the 1990s (Buiter and Patel, 1992, 1995; Jha, 1999 and Cashin and Olekalns, 2000) drew attention to non-stationarity of debt series and violation of solvency conditions/inter-temporal budget constraint, the subsequent studies based on the co-integration and other techniques have admitted a weakly sustainable condition or sustainable public debt situation (Jha and Sharma, 2004). After addressing the issue of regime shift, Goyal, Khundrakpam and Ray (2004) find that while fiscal stance of the central and state governments at the individual level is unsustainable, it is weakly sustainable for the combined finances of centre and states. Some of these studies indicate that the stationarity - based sustainability tests are satisfied when structural or regime-based breaks in debt-GDP series are accounted for. Tronzano (2012) finds the existence of first-order cointegration between revenue and expenditure flows but could

not confirm the existence of a deeper long-run equilibrium between stock and flow fiscal variables and cautioned that an adverse shock on the real economy may destabilise the debt pattern in India.

Bohn (2008) argues that the failure of stationarity and co-integration could not be interpreted as evidence of unsustainable fiscal policy. The time series tests are backward looking and do not fully exploit the implications of uncertainty in deriving appropriate tests of fiscal sustainability. He suggests that the positive response of primary balance relative to GDP to public debt relative to GDP of a country be considered as an indicator of dynamic sustainability[3]. Using this framework and Fincke and Greiner's model of time-varying coefficients[4] for testing public debt sustainability, Tiwari (2012) did not find any clear-cut evidence on the sustainability of public debt in India during the period 1970-2009.

Section IV
Debt Dynamics in India

IV.1: Evolution of India's Public Debt[5]

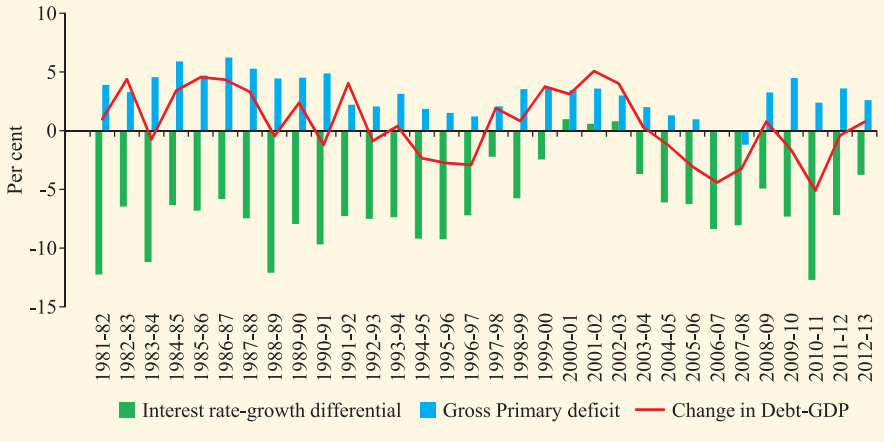
The fiscal position of the central and state governments had remained comfortable in the first three decades since Independence. The revenue account of the central government turned into deficit in the year 1979-80, while the state finances exhibited signs of fiscal stress since the mid-1980s. Given this backdrop, both the centre and states started with moderate debt levels, with the consolidated public debt to GDP ratio at 47.9 per cent in end March 1981. However, the debt position deteriorated steadily thereafter to reach a high of 72.9 per cent in end March 1992. This was also the period characterised by high primary deficits with the primary deficit-GDP ratio at 6.2 per cent

[3] IMF (2003) estimated fiscal policy reaction function; the positive response of the primary balance to debt was considered as indicative of long-run solvency of the fiscal policy stance. It was found that countries with a lower and more volatile revenue base, less ability to adjust expenditures, as well as greater disparity between the real interest and growth rates, are able to sustain lower debt levels.

[4] This captures change in the response of government with respect to public debt over time.

[5] Public debt refers to consolidated debt position of the centre and states in India.

Figure 1: Public Debt Growth in India



in 1986-87 (Figure 1), giving rise to concerns regarding high growth in public debt of India (Seshan, 1987; Report of the Comptroller and Auditor General of India, 1988).

There was some improvement in debt position during the period 1992-93 to 1997-98, which reflected the impact of macro-economic and structural reforms undertaken in the aftermath of the balance of payments crisis in the early 1990s. However, this improvement could not be sustained, as all the key deficit indicators of the central and state governments deteriorated sharply thereafter, due to additional expenditure liabilities linked to the implementation of the Fifth Pay Commission award as also sluggish revenue growth on account of poor performance of public sector undertakings. Reflecting these developments, the debt liabilities accumulated sharply and the public debt-GDP ratio increased to 83.2 per cent in end March 2004.

IV.2: Fiscal Consolidation and Public Debt Growth

Fiscal reforms at the central government level were led by the enactment of the Fiscal Responsibility and Budget Management (FRBM) Act, 2003. Around the same time, most states also operationalised fiscal rules with a focus on a phased improvement in their fiscal deficit and debt-gross state domestic product (debt-GSDP) ratios. The state government initiatives were also supported by the implementation of Debt Swap

Scheme (DSS) from 2002-03 to 2004-05 and Debt Consolidation and Relief Facility (DCRF) from 2005-06 to 2009-10. While the DSS allowed the state governments to pre-pay their high cost loans from the central government, the DCRF provided for debt consolidation and debt/interest relief on outstanding central government loans, subject to the enactment of the FRBM Act and reduction in revenue deficit, as per stipulated rules, during the award period. As a result of these measures, the outstanding debt-GDP ratio of the states at the consolidated level declined from 31.8 per cent in end March 2004 to 26.6 per cent in end March 2008. A similar improvement was evident in debt position of the central government. This trend has continued thereafter (barring 2008-09) with the public debt-GDP ratio of the general government (central and state governments) declining to 66.0 per cent in end March 2013.

IV.3 Features of Public Debt in India

It is important to analyse the composition, ownership, and maturity pattern of public debt that provide an idea about liquidity and pricing risks associated with the level of debt and its profile. In the Indian context, the central government debt accounts for around 70 per cent of the total public debt of the general government. Within public debt, domestic/internal liabilities remain the predominant component, with external debt accounting for less than 3 per cent of the total public debt (Annex Table A.1). Market loans of the central and state governments account for over 50 per cent of the total public debt in India.

As regards ownership pattern of central and state government securities, more than 50 per cent of these securities are held by the scheduled commercial banks, reflective of the mandatory statutory liquidity reserve requirements. Insurance companies hold about 20 per cent of these securities (Annex Table A.2). Notwithstanding an increase in the share of short-term debt in the recent period, it accounts for less than 10 per cent of the total public debt in India (Annex Table A.3). The long maturity profile of India's public debt along with a small share of floating rate debt (less than 5 per cent) tends to limit rollover risks, and insulate the debt portfolio from interest rate volatility (Annex Table A.4).

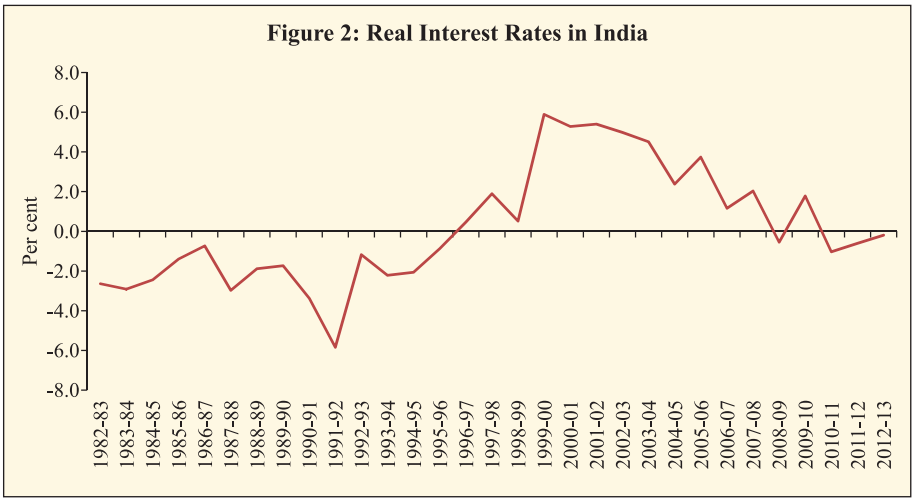
IV.4: Inflation and Interest Rates: Impact on Public Debt

The declining debt levels across countries during the 1970s were attributed to the negative real interest rates following high inflation rates in these countries (Hall and Sargent 2011). In the context of EMs, empirical studies refer to the phenomenon of the government inflating away a part or the whole of its domestic currency denominated debt burden in future, in case financial markets are characterised by financial repression. Financial repression refers to a set of government policies that keep the real interest rates low or negative than would otherwise prevail, for the purpose of reducing the interest burden on government debt. An environment of low or negative real interest rates, characterised as financial repression, can be achieved either through lower nominal interest rates or through higher inflation rate or through a combination of the two (Reinhart and Sbrancia, 2011). The negative real interest rates help to liquidate or erode the real value of government debt. The year, in which the real interest rate turns negative, is considered as a liquidation year. During the liquidation years, the negative real interest rate on government debt generates savings to the government, which is also known as financial repression revenue.

In this section, following the methodology of Reinhart and Sbrancia (2011), an attempt has been made to examine the presence of financial repression in the Indian context and if so, its benefit to the government in terms of lower interest burden. The time period covered for the analysis is 1982-83 to 2012-13. For this purpose, the real interest rate in India has been worked out using the Fisher equation such that:

$$r_t = (1+i_{t-1}) / (1+\pi_t) - 1$$

Where i = nominal interest rate; r = real interest rate; and π = inflation rate. Effective interest rate on general government debt has been used as a proxy for nominal interest rate. Inflation rates have been measured in terms of GDP deflator. The calculations reveal that real interest rates in India were negative during the period 1982-83 to 1995-96 but turned positive thereafter. The real interest rate has again turned negative in the recent period (Figure 2). The years marked by negative real interest rates are considered as liquidation years.



The savings/revenues to the government during these years through liquidation effect are measured in terms of real interest rate times the stock of outstanding debt of the government. The financial repression revenues, thus calculated, are expressed as a share of GDP as well as a share of tax revenues (Table 1).

It may be observed from Table 1 that in India, during the period 1982-83 to 1995-96, the annual liquidation of debt *via* negative real interest rates amounted to 1.5 per cent of GDP and 10.3 per cent of the tax revenues of the government[6]. Annual debt reduction of 1.5 per cent of GDP accumulates to around 21.2 per cent reduction in the debt to GDP ratio during this period[7].

Table 1: Government Revenue from Liquidation Effect

(per year)

Period	Financial Repression Revenues/GDP (%)	Financial Repression Revenues / Tax Revenues (%)
1982-83 to 1995-96	1.5	10.3
1996-97 to 2007-08	-2.5	-17.0
2008-09 to 2012-13	0.1	0.3

[6] As per the calculations of Reinhart and Sbrancia (2011), the annual financial repression revenues worked out to be 1.5 per cent of GDP and 27.2 per cent of tax revenues for India during the period 1949-1980.

[7] Giovannini and de Melo (1993), based on the ex-post differential between the domestic and international interest rates and the stock of government debt held outside the central bank, estimated that an annual average revenue of at least 2.86 per cent was earned by the Government from financial repression during 1980-85 in India.

Following a gradual development of market-based instruments to finance government deficits, move towards a market-determined interest rate system through auction of government securities, phasing out of the automatic monetisation of fiscal deficit through the two Supplemental Agreements between the Government and the Reserve Bank and discontinuation of the Reserve Bank's subscription to primary issuances of government securities from April 1, 2006, the liquidation effect ceased to exist during the period 1996-97 to 2007-08, when the real interest rates turned positive. During the last 5 years (except 2009-10), the real interest rate has again turned negative, despite sharp increases in market borrowings of the central government. The annual financial repression revenue accruing to the government was, however, of much smaller magnitude at 0.1 per cent of GDP and 0.3 per cent of tax revenues during this period.

IV.5: Growth and Interest Differentials: Impact on Public Debt

The growth of public debt in nominal terms depends on two parameters, *viz.*, interest rate on public debt and the size of the primary surplus/deficit. In case the primary balance is in deficit, both interest liabilities and primary deficits contribute to accumulation of additional debt liabilities in any economy. However, when public debt relative to GDP is considered, its evolution also depends on an additional variable *i.e.*, the growth-interest rate differential. This implies that in case the interest rate is lower than the growth rate of the economy, it helps to offset the impact of primary deficit on debt growth and it may be possible to keep debt to GDP ratio stable even in a situation of primary deficits.

Theoretically, in case the real (nominal) rate of interest is lower than the rate of growth of real (nominal) GDP, the debt stabilising primary balance can be negative[8]. However, it is desirable that government primary expenditure minus government revenue as a proportion to GDP is less than or equal to zero, on an average, so that the debt burden is ultimately liquidated.

[8] Charles *et al.* (2010) find that the debt stabilising surpluses for several countries in developing Asia had been negative.

In the Indian context, it has been observed that the favourable growth-interest rate differential has muted the impact of persistence of primary deficits on public debt-GDP ratio (Table 2). Rangarajan and Srivastava (2003, 2005) in their study covering the period 1955-2000 find that even with persistence of primary deficits for a long period of time, the debt to GDP ratio could be contained in India as the GDP growth exceeded the interest rates. Available data shows that the primary surplus was recorded only in two years: 2006-07 and 2007-08. Considering the fact that the interest rate - growth rate differential has gradually narrowed down with a progressive move towards market determination of yields on government debt issuances and given the difficulties in sustaining high rates of growth, it would be challenging to maintain fiscal/debt sustainability in absence of a turnaround in primary balance position in the medium to long run.

IV.6: Public Debt in India *vis-a-vis* Other Country Groups

Public Debt in India (as a per cent to GDP) has witnessed a steady decline since 2004, aided, in large part, by the FRBM Act 2003 of the central government and similar fiscal responsibility legislations at the state level and high nominal GDP growth *vis-à-vis* incremental debt. Although fiscal deficit to GDP ratio increased in 2008-09 and

Table 2: Decomposition of Debt Accumulation Relative to GDP

(per cent)

	Changes in Debt-GDP ratio	Cumulative Primary deficit-GDP ratio	Cumulative Interest rate and Growth differential
1980-81 to 1989-90	22.13	48.01	-38.34
1990-91 to1999-00	2.00	26.15	-41.03
2000-01 to 2009-10	-3.36	20.87	-28.66
2010-11 to 2012-13	0.46	8.58	-13.70
Memo:			
Debt-GDP Ratio at the end of			
1980-81	47.94		
2012-13	66.00		

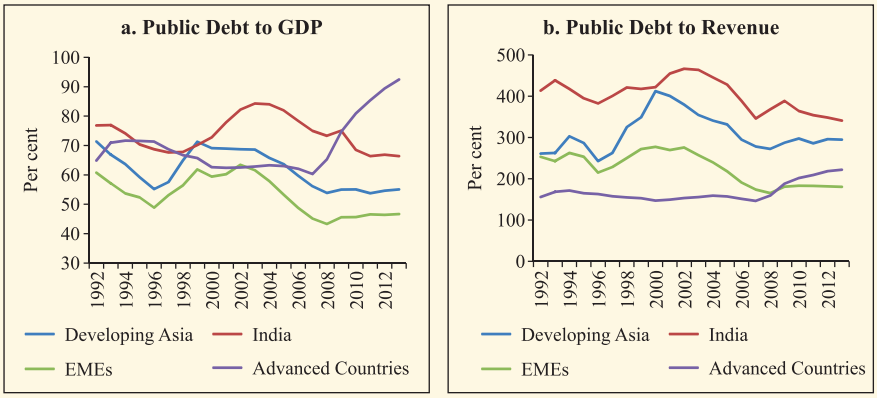
Source: Handbook of Statistics on the Indian Economy, RBI, and National Accounts Statistics, CSO.

2009-10 due to counter-cyclical measures taken by the government to insulate Indian economy from the adverse impact of global economic crisis, the declining trend in debt-GDP ratio was maintained, which was largely supported by higher nominal GDP growth up to 2011-12. In 2012-13, with the nominal GDP growth in India falling below the growth in public debt, the debt-GDP ratio increased again. India's public debt - GDP ratio has, in general, been significantly higher than the average for emerging markets, developing Asia and advanced economies (Figure 3a).

Public debt to government revenue ratio, which is a useful indicator of the vulnerability of a country's public finances and the solvency of the government, shows that India's public debt as a ratio to revenue is very high, although it has declined during the recent period (Figure 3b). So, the country's capacity to support high levels of public debt is constrained by its ability to raise revenues.

A comparison of debt and other fiscal indicators across major emerging market and developing economies (EMDEs) suggests that India is an outlier in almost all parameters. Countries which have high debt-GDP ratio, such as, Brazil and Hungary have a lower debt-revenue ratio than India (Table 3).

Figure 3: Trend in Public Debt[9]



Source: World Economic Outlook, IMF.

[9] May not be strictly comparable across countries due to definitional and data coverage issues.

Table 3: Fiscal Indicators for Select Emerging Market Economies

(Per cent)

Countries	2006				2012				2013			
	Debt-GDP	Debt-Revenue	Overall Balance-GDP	Primary Balance-GDP	Debt-GDP	Debt-Revenue	Overall Balance-GDP	Primary Balance-GDP	Debt-GDP	Debt-Revenue	Overall Balance-GDP	Primary Balance-GDP
Argentina	76.4	256.4	-1.1	4.0	47.7	118.7	-4.3	-0.9	47.8	114.6	-3.6	-1.3
Brazil	67.0	193.6	-3.5	3.3	68.0	180.4	-2.7	2.2	68.2	183.8	-3.0	1.9
China	16.2	89.0	-0.7	-0.2	26.1	115.0	-2.2	-1.4	22.9	103.2	-2.5	-1.8
Colombia	36.8	134.8		1.7	32.8	115.9	0.2	1.8	32.5	115.7	-1.0	0.7
Egypt	90.3	315.7	-9.2	-4.2	80.6	356.6	-10.7	-5.2	88.7	371.1	-14.7	-7.3
Hungary	65.9	154.0	-9.4	-5.7	79.2	170.3	-2.0	2.0	79.8	167.6	-2.7	1.2
India	77.1	379.8	-6.2	-1.3	66.7	343.8	-8.0	-3.6	67.2	342.9	-8.5	-3.8
Indonesia	39.0	192.1	0.2	2.6	24.0	134.8	-1.7	-0.4	25.8	142.5	-2.2	-0.8
Malaysia	41.5	172.2	-2.7	-1.7	55.5	219.4	-4.5	-3.1	57.1	229.3	-4.3	-3.0
Mexico	37.8	175.0	-1.0	1.8	43.5	184.3	-3.7	-1.2	43.6	193.8	-3.8	-1.2
Pakistan	54.4	400.0	-3.4	-0.5	63.8	487.0	-8.4	-4.0	66.5	503.8	-8.5	-3.9
Peru	33.1	164.7	1.9	3.7	20.5	94.5	2.1	3.0	18.3	88.4	0.3	1.1
Philippines	51.6	271.6	0.0	4.8	41.9	234.1	-0.9	1.7	41.0	226.5	-0.8	1.8
Poland	47.7	118.7	-3.6	-1.0	55.6	144.8	-3.9	-1.1	57.8	157.1	-4.6	-1.9
Russia	9.0	22.8	8.3	8.9	12.5	33.9	0.4	0.8	13.8	37.5	-0.7	-0.2
South Africa	32.6	111.6	1.2	4.1	42.3	151.6	-4.8	-2.1	43.0	154.7	-4.9	-2.1
Thailand	42.0	188.3	2.2	3.5	45.4	197.4	-1.7	-0.8	47.2	219.5	-2.7	-2.2
Turkey	46.5	141.8	-0.7	4.4	36.1	103.7	-1.6	1.2	36.1	99.7	-2.3	0.7

Source: World Economic Outlook Database and Fiscal Monitor, 2013, International Monetary Fund.

Section V
Public Debt Sustainability

Sustainable level of public debt varies across different countries depending on the country-specific circumstances. Besides the magnitude of debt, the characteristics of public debt – currency composition, maturity pattern and debt servicing at fixed or floating rates – also contribute significantly to determining the sustainable level of debt. This section looks at public debt sustainability in the Indian context, based on different approaches to assessment of sustainability of public debt.

V.1: Indicator Analysis

Following the conventional debt sustainability analysis, the sustainability of public debt in India has been examined using indicator analysis, taking period averages of various indicators during four different phases (Table 4). These phases have been identified on the basis of the inflexion points in the general government debt. Phases I and III witnessed distinct pressure on debt sustainability, with the average nominal public debt growth exceeding the average nominal GDP growth during these periods. The stability condition which requires the

Table 4: Fiscal Sustainability of General Government : Indicator-based Analysis *(Contd.)*

Sl. No.	Indicators	Symbolic Representation	Phase-I (1981-82 to 1991-92)	Phase II (1992-93 to 1996-97)	Phase III (1997-98 to 2003-04)	Phase IV (2004-05 to 2012-13)
1	Rate of growth of public debt (D) should be lower than rate of growth of nominal GDP (G)	D - G < 0	4.45	- 2.84	4.14	- 2.98
2	Rate of growth of public debt (D) should be lower than effective interest rate (i)	D - i < 0	12.94	5.26	5.82	4.21
3	Real rate of interest (r) should be lower than real output growth (g)	r - g < 0	-7.67	-7.58	-1.57	-6.67
4(a)	Primary balance (PB) should be in surplus	PB / G > 0	-0.05	-0.02	-0.03	-0.02
4(b)	Primary revenue balance (PRB) should be in surplus and should be adequate enough to cover interest payments (IP)	PRB / G > 0	-0.01	-0.01	0.00	-0.02
		PRB/IP>100	-42.93	-29.05	3.47	-36.42
5(a)	Revenue Receipts (RR) as a per cent to GDP should increase over time	RR/ G ↑↑	18.41	17.76	17.22	19.86
5(b)	Revenue variability should decline over time	CV (RR/G) ↓↓	4.86	2.54	4.40	4.31
5(c)	Public debt to revenue receipts ratio should decline over time	D / RR ↓↓	3.37	3.90	4.34	3.63
5(d)	Public debt to tax revenue ratio should decline over time	D / TR ↓↓	4.22	4.88	5.41	4.45

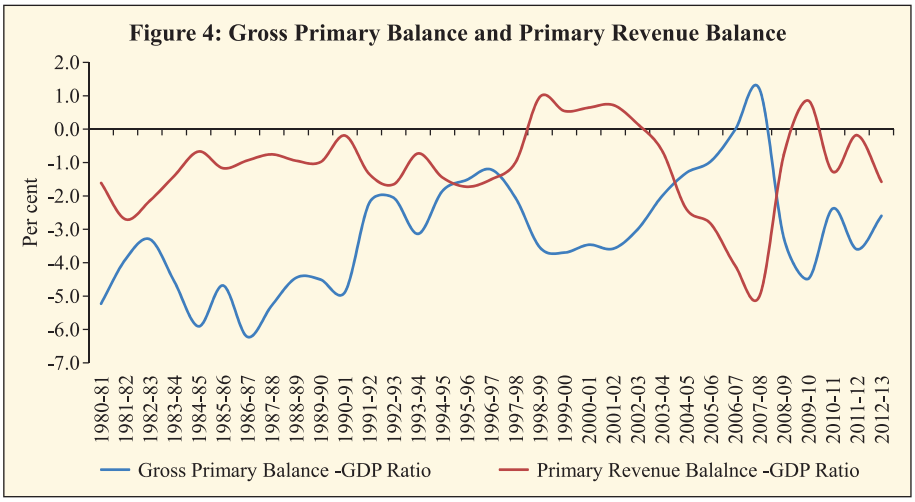
Table 4: Fiscal Sustainability of General Government : Indicator-based Analysis *(Concld.)*

Sl. No.	Indicators	Symbolic Representation	Phase-I (1981-82 to 1991-92)	Phase II (1992-93 to 1996-97)	Phase III (1997-98 to 2003-04)	Phase IV (2004-05 to 2012-13)
6(a)	Interest burden defined by interest payments (IP) as a per cent to GDP should decline over time	IP / G ↓↓	3.28	4.86	5.71	5.06
6(b)	Interest payments (IP) as a per cent of revenue expenditure (RE) should decline over time	IP / RE ↓↓	15.84	22.92	24.66	22.10
6(c)	Interest payments (IP) as a per cent of revenue receipts (RR) should decline over time	IP / RR ↓↓	17.72	27.38	33.13	25.54

real interest rate to remain below the real output growth, was, however, satisfied in all the four phases.

The necessary conditions for sustainability as given in indicators 1 and 3 of Table 4 were fulfilled during the periods of fiscal consolidation, *viz.,* phases II and IV, but the sufficient condition of generating primary surpluses was not met during any of the four phases. In fact, with the exception of 2006-07 and 2007-08, primary balances of the general government remained in deficit during the last three decades (Figure 4). Favourable interest rate-growth differential has, however, more than compensated for the absence of primary surpluses, resulting in a sharp decline in debt-GDP ratio between 2004-05 and 2010-11, barring a brief increase in the immediate aftermath of the global financial crisis. With a decline in the interest rate-growth differential and an increase in primary deficits, the growth in public debt has increased in 2012-13.

Although the debt-GDP ratio declined in phase II reflecting the impact of reforms, debt sustainability indicators in terms of debt service burden (as expressed by indicators 5 and 6 in Table 4) deteriorated. There was a regime shift from large dependence on monetised financing (through the issuance of 91-day Treasury bills (T-bills))



to bond financing, resulting in a rise in the average effective cost of debt during this phase. This was also evident from the decline in the share of T-bills (91-day and 182/364-day T-bills) in outstanding debt of central government to 6.6 per cent in phase II (from 10.5 per cent in phase 1). The debt service burden deteriorated further in phase III as it was characterised by an up-trend in interest rates. However, this trend reversed in phase IV due to the combined impact of improvement in revenue buoyancy and reduction in interest rates from the highs seen in the 1990s and early 2000s. The average interest payments have, however, continued to pre-empt around one-fourth of revenue receipts during phase IV, which is higher than the tolerable ratio of interest burden[10]. The high level of incremental debt which was acquired during 2008-09 and 2009-10 has contributed significantly to the rising interest burden in recent years.

Post-crisis fiscal correction in India had been slow and the observed improvement in 2010-11 was primarily due to large one-off receipts from spectrum auctions. The central government has, however, reverted to a revised path of medium-term fiscal consolidation in line with the Kelkar Committee recommendations in 2012-13. A progressive move towards fiscal sustainability, if maintained, would facilitate further

[10] Interest payments as one-fifth of revenue receipts is considered a tolerable ratio of interest burden (Dholakia *et al.*, 2004).

improvement in the public debt-GDP ratio. This would be more credible and sustainable from the viewpoint of debt sustainability in case it is driven by the objective of achievement of primary surpluses.

V.2: Inter-temporal Budget Constraint

Going beyond the indicator - based analysis, the fiscal/debt sustainability issue has been examined empirically through the assessment of inter-temporal government budget constraint. In the empirical work, this is analysed through test of stationarity properties of the government debt stock (in level and first difference), examination of the long-term relationship between government revenues and expenditures and that between primary balances and debt.

In this Section, we have made an attempt to test empirically, whether India's fiscal policy stance is sustainable, *i.e.,* whether it satisfies the inter-temporal budget constraint. This test of fiscal policy sustainability examines whether the past behaviour of government revenue, expenditure and the fiscal deficit could be continued indefinitely without prompting an adverse response from the investors who finance government borrowings. The inter-temporal budget constraint as derived by Cashin and Olekalns (2000) is as follows:

$$G_t - R_t = \sum_{S=0}^{\infty} (1 + r)^{-S+1} (\Delta R_{t+s} - \Delta G_t + r \Delta B_{t+s-1})$$

Where G is government expenditure including interest payments, R is government revenue, B is the stock of debt, and r is the real rate of interest. The inter-temporal budget constraint, under the assumption that the funding of interest payments are not made from the new debt issuances (*i.e.,* no-*ponzi* scheme), imposes restrictions on the time series properties of government expenditures and revenues. This requires that government expenditure, revenue and stock of debt are all stationary in the first differences. The stationarity property also restricts the extent of deviation of G_t from R_t over time. In case G_t and R_t are I (1) and cointegrated, then the error correction mechanism would push government finances towards the level required by the inter-temporal budget constraint and ensure fiscal and debt sustainability in the long term.

The stationarity properties of the stock of government debt, government expenditure and revenues in the Indian context have been

tested using annual data for the period 1980-81 to 2012-13. The variables have been converted into real terms with logarithmic transformation. The results of the Augmented Dickey Fuller (ADF) unit root test indicate that the null hypothesis of unit root cannot be rejected for all the three variables. It was also found that all the series are integrated of order 1, *i.e.,* stationary in the first difference (Table 5).

Since log R_t and log G_t were found to be I (1), the cointegration between the two series has been tested through the standard Engle and Granger's (1987) procedure. Following Hakkio and Rush (1991), cointegration between log R_t and log G_t is tested by estimating the regression:

$$\text{Log } (R_t) = \alpha + \beta \log (G_t) + \varepsilon_t, \text{ where } 0 < \beta \leq 1$$

Cointegration requires that residuals from the above equation are stationary. The equation is estimated using simple OLS. The residuals series obtained from the estimated equation was found to be stationary I(0)[11]. Thus, the two series, *viz.,* log R_t and log G_t were found to be cointegrated indicating a long-term co-movement between the two series and suggesting that the current fiscal policies in India are sustainable in the long run. This result is also supported by the study of Jha and Sharma (2004)[12].

Table 5: Unit Root Test

Variable (X)	ADF	
	Log X	D log (X)
Stock of Government Debt (B)	-0.90	-3.71*
Government Expenditure (G)	0.65	-5.20*
Government Revenue (R)	0.86	-5.52*

Note: * denotes significant at 1% level.

[11] The value of ADF test statistic for the estimated residual series was found to be -3.12 which was significant at 5 per cent level.

[12] However, there is also a view that the case for further and sustained fiscal correction based solely on the evolution of debt-GDP ratios and the inter-temporal budget constraint may be weak. It may be appropriate to look at the composition of public sector expenditure and the crowding-out or crowding-in effect of public investment on private investment besides the impact of fiscal policy on allocative efficiency of resource use in the economy. For instance, Aschauer (1988, 1989) argues that it is important to distinguish between various categories of government expenditure. The empirical results of his study revealed that the non-military public capital stock is far more important in determining productivity than either the flow of overall non-military expenditure or military expenditure.

V.3: Fiscal Policy Response Function

The time series tests of fiscal sustainability have been criticised in the empirical literature for not explicitly identifying the fiscal policy reaction functions that underlie the data. Bohn (1995, 1998), therefore, suggested an alternative model-based approach to fiscal sustainability. This approach looks at the inter-temporal budget constraint in terms of a feedback relationship from the stock of initial debt to the primary surplus in an economy characterised by risk-averse lenders and uncertainty. In this fiscal reaction function approach, it is analysed whether primary surplus relative to GDP is a positive function of public debt (relative to GDP). In case fiscal authorities take corrective measures in response to deterioration in debt position, rising debt ratios lead to higher primary surpluses relative to GDP that indicates a tendency towards mean reversion. According to Bohn, a stable and strictly positive feedback from debt stock to primary surplus is a sufficient condition for fiscal (debt) sustainability. We have also used this approach in the following analysis.

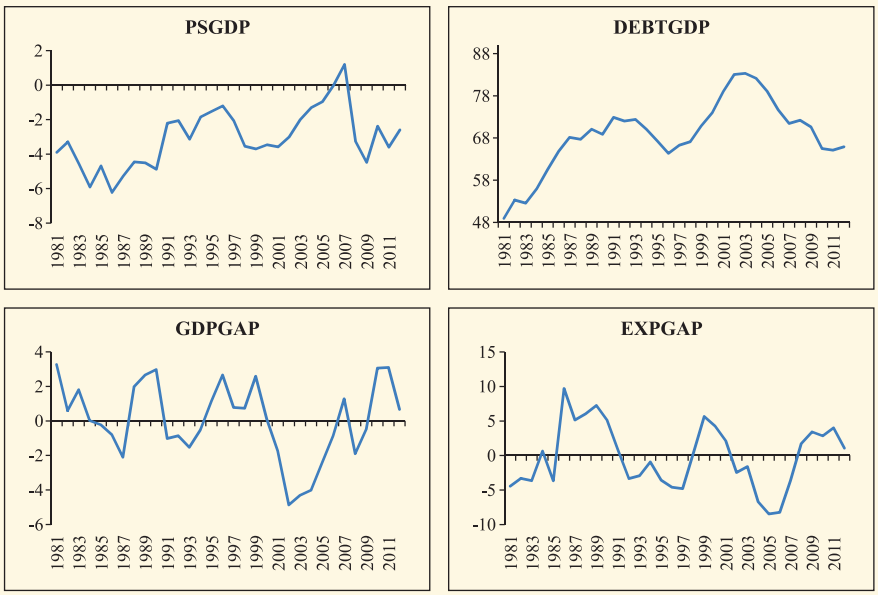
Model Specification: The following equation is estimated:

$$S_t = \alpha_0 + \beta D_{t-1} + \alpha_1 GDPGAP_t + \alpha_2 EXPGAP_t + \varepsilon$$

Here S is the primary surplus to GDP ratio; D is the public debt to GDP ratio; GDPGAP is the deviation of actual output from the trend; EXPGAP is the deviation of actual primary expenditure from the trend; and ε is the error term. The business cycle variable GDPGAP has been included to account for the fluctuations in revenues. The variable EXPGAP captures the impact of deviations of real primary expenditure from its long-term trend on the primary surplus ratio. Here 'β' is the key coefficient, which measures the response of primary surplus to debt. A value of this coefficient between zero and unity is consistent with a sustainable fiscal policy response to debt. A negative coefficient implies potentially destabilising response.

Data: Annual data for the period 1981-82 to 2012-13 has been used for the analysis. All the data pertain to the general government (centre and states combined). Primary balance of the general government has been considered as the dependent variable. Combined liabilities of the central and state governments have been used to represent public debt of India. GDP at market prices has been used for the analysis. GDPGAP has been worked out by extracting the deviation in real GDP from its

Figure 5: Plots for Variables used in the Estimation
(Figures are in per cent)



trend through HP-filter. The deviation is expressed as a per cent of real GDP. EXPGAP has been calculated in a similar manner using real primary expenditure of the general government. The movements in the dependent and the explanatory variables are plotted in Figure 5.

Results: Before proceeding with the estimation, all the series were tested for stationarity. While all the explanatory variable series were found to be stationary, *i.e.,* I (0), the dependent variable series, *i.e.,* primary surplus to GDP ratio was found to be non-stationary. However, after controlling for the years 2006-07 and 2007-08 (which were the years when the general government in India recorded primary surpluses), the series became stationary. In view of this, a dummy variable (d surplus) has been introduced in the model to control for the impact of these years. In addition, allowance has been made in the estimations for the response of primary balance to GDP ratio to be non-linear and vary with debt levels by introducing a square term of the debt to GDP ratio as an additional explanatory variable.

The OLS estimation results of the fiscal policy response function are presented in Table 6. The coefficients of all the explanatory variables

Table 6: Estimation Results

Explanatory Variables	Estimated Coefficients	
	Model 1 (Linear)	Model 2 (Non-linear)
Constant	-10.59* (0.00)	-30.83* (0.00)
D_{t-1}	0.11* (0.00)	0.71* (0.00)
D_{t-1}^{2}		-0.004* (0.01)
GDPGAP	0.25* (0.00)	0.19* (0.01)
EXPGAP	-0.22* (0.00)	-0.25* (0.00)
d surplus	1.69* (0.01)	1.62* (0.00)
AR(1)		-0.25 (0.18)
Adjusted R^2	0.81	0.88
DW	2.05	2.24
p-value of LM statistics (1st lag)	0.49	0.10

Note: 1) Figures in the parentheses represent respective P values.
2) * denotes significant at 1% level.

were found to be significant at one per cent level. Positive coefficient of D indicates that primary surplus increases (or primary deficit falls) in India in response to rising debt ratios. This implies that the primary balance in India responds in a stabilising manner to increases in debt. Positive coefficient of GDPGAP implies that primary balance improves when GDP is above the trend. The negative coefficient of EXPGAP, on the other hand, indicates that primary balance deteriorates when primary expenditure is above the trend. These findings are in line with the *a priori* expectations.

In the non-linear equation approach (Model 2), the response of the primary balance to debt is better represented in terms of a quadratic function rather than a linear response function. The results suggest that the primary balance function has an inverted 'u' shape, implying that the adjustment parameter first rises and then falls.

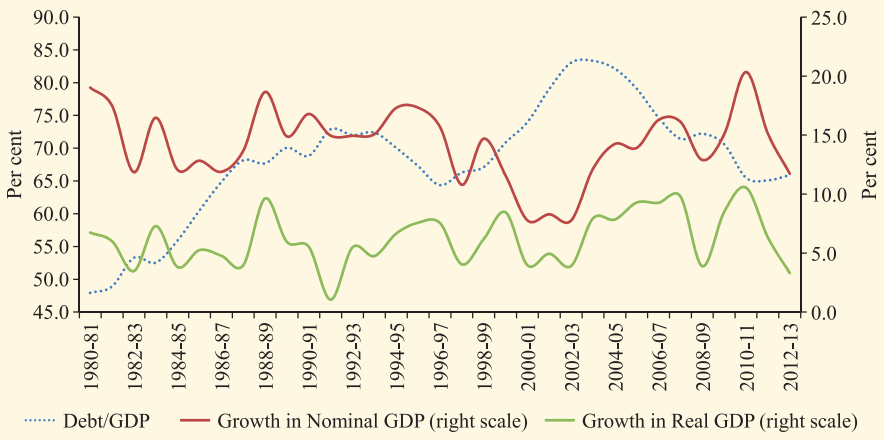
Both the models exhibited no residual serial correlation at the first lag included. The p-values of the Breusch-Godfrey LM-statistics (as presented in Table 6) are insufficient to reject the null hypothesis of no autocorrelation.

Section VI
Impact of Public Debt on Growth: Threshold Level of Debt

There is a general belief among the economists that slower growth is associated with higher level of debt. Several economists argue that growth slows down sharply when the government debt to GDP ratio exceeds a certain threshold level. There is, however, no consensus regarding the threshold level of debt, beyond which the growth suffers. In addition, the threshold level may vary widely across advanced and emerging market economies. In this section, an attempt has been made to examine the link between government debt real economic growth in India during the period 1981-82 to 2012-13. In India, the level of government debt seems to have an inverse relation with the growth in GDP at market prices (Figure 6).

Model Specification: Empirical studies have considered different set of control variables to analyse the impact of public debt on economic growth. Some of these control variables include: population, investment, export, openness, fiscal balance and years of schooling. In this paper,

Figure 6: Public Debt and Growth in GDP at Market Prices



the impact of public debt on growth has been assessed by estimating the following equation:

$$y_t - y_{t-1} = \alpha D_t + \beta_1 D_t^2 + \beta_2 (i_t - i_{t-1}) + \beta_3 \pi_t + \beta_4 (T_t - T_{t-1}) + \beta_5 GFD_t + \varepsilon_t$$

where y is the real GDP; D is public debt to GDP ratio; D^2 is the square of public debt to GDP ratio[13]; i is real investment; π is inflation rate; T is international trade in real terms; GFD is the ratio of gross fiscal deficit to GDP.

Data: The dependent variable real GDP is measured by GDP at constant market prices. Combined outstanding liabilities of the central and state governments of India have been used as a measure of the level of public debt. Gross domestic capital formation at constant prices has been used as a proxy for real investment. Inflation rate is measured by growth in WPI. International trade is measured as the sum of non-oil exports and imports in rupee terms at constant prices. Gross fiscal deficit pertains to the general government. All the data are obtained from the Handbook of Statistics on the Indian Economy. Summary statistics of the relevant variables are furnished in Table 7. The correlation matrix given in Annex 2 indicates absence of any serious multicollinearity problem in the selected set of explanatory variables. It has been observed that there is no statistically significant contemporaneous correlation between debt-GDP ratio and GFD-GDP ratio.

Results: Before estimation, all the variables have been tested for their stationarity properties. Augmented Dickey Fuller (ADF) unit

Table 7: Summary Statistics

Variable	High	Low	Mean	Standard Deviation
Real GDP Growth	10.5	1.1	6.2	2.3
Public Debt to GDP	83.3	48.9	68.8	8.3
Growth in Real Investment	29.8	-16.5	8.4	9.3
Inflation rate	13.7	3.3	6.8	2.6
Growth in international trade	35.6	-0.4	18.7	9.1
Gross fiscal Deficit to GDP	9.6	4.0	7.6	1.4

[13] In several studies using the neo-classical growth model to study the relationship between debt/external debt and growth, the debt variable in quadratic form is included in the equation that captures the non-linear relationship (Boamah and Moore 2009).

root test was conducted to find out whether the time series used for the analysis are stationary or not. The results of the ADF test indicate that the null hypothesis of unit root can be rejected for all the variables. After ensuring that all the series are I (0), the equation is estimated by OLS and the results are presented in Table 8.

The coefficients of all the explanatory variables are significant and on the expected lines. The positive sign of D_t indicates that accumulation of public debt leads to higher growth in real GDP up to a certain level. The negative sign of D_t^2 shows that the association of public debt and real GDP turns negative beyond a certain threshold. The growth in real investment has the expected positive sign which is significant at 1 per cent level. Trade openness, as expressed in terms of growth in non-oil exports and imports, also has a significant positive impact on growth. High inflation and high fiscal deficit, on the other hand, have adverse impact on growth. The dummy variable (d97) which has been used to control the impact of growth slowdown in 1997-98 was found to be significant.

Based on the coefficients of D_t and D_t^2, the threshold level of public debt for India works out to be around 61 per cent of GDP.

These econometric findings are broadly in line with the results on threshold level of debt of Mohanty (2013) and debt simulation forecasts of Topalova and Nyberg (2010). While Mohanty has placed

Table 8: Estimation Results

Explanatory Variables	Estimated Coefficients	P-Value
Public Debt to GDP Ratio (D_t)	0.32*	0.00
Square of Public Debt to GDP ratio (D_t^2)	-0.003*	0.00
Growth in Real Investment ($i_t - i_{t-1}$)	0.14*	0.00
Inflation rate (π_t)	-0.36*	0.01
Growth in international trade ($T_t - T_{t-1}$)	0.08**	0.03
Gross fiscal Deficit to GDP (GFD_t)	-0.46**	0.04
Dummy Variable (d97)	-4.24*	0.01
Adjusted R^2	0.57	
DW Statistics	2.13	
LM statistics (1st lag)		0.53

Note: * and ** denote significant at 1% and 5% level, respectively.

the threshold level of debt for India at 60 per cent of GDP, Topalova and Nyberg have estimated the general government debt target/ceiling of at most 60-65 per cent of GDP to signal commitment to fiscal discipline. The debt simulation exercises undertaken by this IMF study are based on the premise that the interest rate-growth differential would remain favourable and contribute, on average, about 3 percentage points reduction in the debt to GDP ratio per annum. It may be pertinent to note that the Thirteenth Finance Commission (FC-XIII) had set a target of 68 per cent of GDP for the combined debt of centre and states to be attained by 2014-15.

Section VII
Conclusion

In this study, the sustainability of public debt in India at the general government level was assessed through indicator-based analysis as well as empirical exercises.

The empirical analysis carried out in this paper focused on estimation of inter-temporal budget constraint and fiscal policy response function to assess the sustainability of the present fiscal policy in India. The estimation results reveal that there is a co-integrating relationship between general government expenditure and revenue in India, which satisfies the inter-temporal budget constraint. Moreover, the estimated fiscal policy response function reveals that the primary fiscal balance in India responds in a stabilising manner to the increase in debt. Thus, both the results indicate that the current fiscal policies in India are sustainable in the long run. However, it would be interesting to take up a more comprehensive sustainability analysis covering broader aspects, *viz.,* costs of high public debt levels with respect to, *inter alia,* crowding out of private investment, distortions on account of large sectoral interventions like National Food Security Act, Mahatma Gandhi National Rural Employment Guarantee Act, *etc*, as areas of further research.

The paper has also examined empirically the impact of public debt on growth in the Indian context. The results of the empirical exercise revealed that there is a statistically significant non-linear relationship between public debt and growth, implying a negative impact of public

debt on economic growth at higher levels. The threshold level of general government debt-GDP ratio for India has turned out to be 61 per cent, *i.e.,* the level beyond which an inverse relationship is observed between debt and growth. This threshold level is lower than the actual level of debt at 66.0 per cent in end March 2013. There are other risks linked to volatility in international financial markets, and the narrowing down of the interest rate-growth differential domestically. In these circumstances, it would be desirable to strengthen the process of fiscal consolidation both at the level of centre and states in the medium-term so that borrowing is used only to meet capital expenditure which would aid future growth. In addition, a turnaround in primary balance position from deficit to surplus in the medium-term would be critical. It would be important in the context of inter-temporal budget constraint faced by the government and the need to provide for fiscal space to meet challenges in an uncertain domestic and global environment.

References

Adams, Charles, Benno Ferrarini, and Donghyun Park. 2010. "Fiscal Sustainability in Developing Asia". ADB Economics Working Paper Series No. 205, June 2010.

Aschauer, David Alan. 1988. "Is Public Expenditure Productive?". *Journal of Monetary Economics,* Vol. 23 (1989).

Aschauer, David Alan. 1989. "Does Public Capital Crowd Out Private Capital?". *Journal of Monetray Economics,* Vol. 24 (1989).

Baum, Anja Westphal, Cristina Checherita and Rother, Philipp. 2012. "Debt and Growth: New Evidence for the Euro Area". 14th Public Finance Workshop, Banca DÍtalia, 29-31 March 2012.

Blanchard, Olivier J., Jean-Claude Chouraqui, Robert P. Hagemann and Nicola Sartor. 1990. "The Sustainability of Fiscal Policy: New Answers to an Old Question". OECD Economic Studies, No. 15 (Autumn).

Boamah, D., and W. Moore. 2009. "External Debt and Growth in the Caribbean". *Money Affairs*, Jul–Dec.

Bohn, Henning. 1995. "The Sustainability of Budget Deficits in a Stochastic Economy". *Journal of Money, Credit, and Banking,* Vol. 27, No.1.

Bohn, Henning. 1998. "The Behavior of U.S. Public Debt and Deficits". *Quarterly Journal of Economics,* Vol. 113 (August).

Bohn, Henning. 2008, "The Sustainability of Fiscal Policy in the United States". In: R. Neck and J. Sturm, "Sustainability of Public Debt", MIT Press.

Buiter, W. H. and U. Patel. 1992. "Debt, Deficits and Inflation: An Application to Public Finances in India". *Journal of Public Economics,* Vol. 47, No.2.

Buiter, W. H. and U. Patel. 1995. *Public Economics in India.* Oxford University Press, chapter Solvency and Fiscal Correction in India: An Analytical Discussion.

Buiter, W. H. and U. Patel. 2010. "Fiscal Rules In India: Are They Effective?". National Bureau of Economic Research Working Paper No. 15934, April 2010.

Buiter, W. H., Torsten Persson and Patrick Minford. 1985. "A Guide to Public Sector Debt and Deficits". *Economic Policy,* Vol. 1, No.1

Cashin, Paul and Nilss Olekalns. 2000. "An Examination of the Sustainability of Indian Fiscal Policy". University of Melbourne Department of Economics Working Papers No. 748.

Cecchetti, Stephen G., M. S. Mohanty and Fabrizio Zampolli. 2011. "The Real Effects of Debt". Monetary and Economic Department, BIS Working Papers No 352, September 2011.

Chalk, Nigel and Richard Hemming. 2000. "Assessing Fiscal Sustainability in Theory and Practice". IMF Working Paper No. WP/00/81.

Chang, T. and G. Chiang. 2009. "The Behavior of OECD Public Debt: A Panel Smooth Transition Regression Approach". The Empirical Economics Letters 8 (1).

Checherita, C. and P. Rother. 2010. "The Impact of High and Growing Government Debt on Economic Growth - An Empirical Investigation for the Euro Area". ECB Working Paper No. 1237.

Cordella, Tito, Antonio Ricci Luca and Marta Ruiz-Arranz. 2005. "Debt Overhang or Debt Irrelevance? Revisiting the Debt-Growth Link". IMF Working Paper, WP/05/223, December 2005.

Cournède, Boris. 2010. "Gauging The Impact of Higher Capital and Oil Costs on Potential Output". Economics Department Working Papers Eco/Wkp(2010)45, Organisation for Economic Co-operation and Development.

Dholakia, R. H., T. T. Ram Mohan and Navendu Karan. 2004. "Fiscal Sustainability of Debt of States". Report submitted to the Twelfth Finance Commission, New Delhi.

Domar, Evsey D. 1944. "The Burden of the Debt and the National Income". American *Economic Review,* Vol. 34, No.4.

Easterly, William R. 2001. "Growth Implosions and Debt Explosions: Do Growth Slowdowns Cause Public Debt Crises?". *Contributions to Macroeconomics*, Vol. 1, No.1.

Égert, Balázs. 2012. "Public Debt, Economic Growth and Nonlinear Effects: Myth or Reality?". 14th Public Finance Workshop, Banca DÍtalia, 29-31 March 2012.

Elmeskov, Jørgen and Douglas Sutherland. 2012. "Post-Crisis Debt Overhang: Growth Implications Across Countries". Second International Research Conference on "Monetary Policy, Sovereign Debt and Financial Stability: The New Trilemma", 1-2 February, 2012, Reserve Bank of India, Mumbai, India.

Engle, Robert F. and C. W. J. Granger. 1987. "Co-Integration and Error Correction: Representation, Estimation, and Testing". *Econometrica*, Vol. 55, No.2.

Gerson, Philip and David Nellor. 1997. "Philippine Fiscal Policy: Sustainability, Growth, and Savings" in Macroeconomic Issues Facing ASEAN Countries, edited by John Hicklin, David Robinson and Anoop Singh (Washington: International Monetary Fund).

Giovannini, Alberto and Martha de Melo. 1993. "Government Revenue from Financial Repression." *American Economic Review,* Vol. 83, No.4.

Goyal, R., J.K. Khundrakpam and Partha Ray. 2004. "Is India's Public Finance Unsustainable? Or, are the Claims Exaggerated?" *Journal of Policy Modeling,* Vol. 26 (2004).

Greenidge, Kevin, Roland Craigwell, Chrystol Thomas and Lisa Drakes. 2012. "Threshold Effects of Sovereign Debt: Evidence from the Caribbean". IMF Working Paper No. WP/12/157.

Hakkio, Craig S. and Mark Rush. 1991. "Cointegration: How short is the long-run?". *Journal of International Money and Finance,* Vol. 10, No.4.

Hall, G. J. and T. J. Sargent. 2011. "Interest Rate Risk and Other Determinants of Post-WW II U.S. Government Debt/GDP Dynamics". *American Economic Journal: Macroeconomics*, Vol. 3, No.3.

Herndon, Thomas, Michael Ash and Robert Pollin. 2013. "Does High Public Debt Consistently Stifle Economic Growth? A Critique of Reinhart and Rogoff". Political Economy Research Institute, Working Paper Series, Number 322.

Jha, R. 1999. *Fifty Years of Development Economics*. Himalaya Publishing Company, chapter Some Rudimentary Macroeconomics of the Budgetary Deficit and Debt.

Jha, R. and A. Sharma. 2004. "Structural Breaks, Unit Roots and Cointegration: A Further Test of the Sustainability of the Indian Fiscal Deficit". *Public Finance Review*, Vol. 32, No.2.

Kumar, Manmohan S. and Jaejoon Woo. 2012. "Public Debt and Growth". 14th Public Finance Workshop, Banca DÍtalia, 29-31 March, 2012.

Legrenzi, G. and C. Milas. 2011. "Debt Sustainability and Financial Crises: Evidence from the GIIPS". The Rimini Centre for Economic Analysis, WP 11-42.

Mohanty, M. 2013. "Public Debt Management and Macroeconomic Stability". Paper presented at the 2nd meeting of SAARC Public Debt Managers' Forum at Jaipur, India, during December 6-7, 2013.

Pattillo, C., H. Poirson and L. Ricci. 2002. "External Debt and Growth", IMF Working Paper 02/69.

Rangarajan, C and D. K. Srivastava. 2003. "Dynamics of Debt Accumulation in India: Impact of Primary Deficit, Growth and Interest Rate" . *Economic and Political Weekly,* Vol 38, No.46, November.

Rangarajan, C. and D. K. Srivastava. 2005, "Fiscal Deficits and Government Debt in India: Implications for Growth and Stabilisation", NIPFP, Working Paper No. 35.

Reinhart, C. and K. Rogoff. 2010. "Growth in a Time of Debt". *American Economic Review:* Papers & Proceedings, Vol. 100, No.2.

Reinhart Carmen M. and M. Belen Sbrancia. 2011. "The Liquidation of Government Debt". NBER Working Paper No. 16893.

Seshan, A. 1987. "The Burden of Domestic Public Debt in India*". Reserve Bank of India, Occasional Papers*, Vol. 8, No.1.

Singh, Charan. 1999. "Domestic Debt and Economic Growth in India". *Economic and Political Weekly*, No. 23, June 5, 1999.

Tiwari, Aviral Kumar. 2012. "Debt Sustainability in India: Empirical Evidence from Estimating Time Varying Parameters". *Economics Bulletin*, 2012, Vol. 32, No.2.

Topalova, Petia and Dan Nyberg. 2010. "What level of Public Debt Could India Target?". IMF Working Paper, WP/10/7, January.

Tronzano, Marco. 2012. "Multicointegration and Fiscal Sustainability in India: Evidence from Standard and Regime Shifts Models". https://editorialexpress.com/cgi-bin/conference/download.cgi?db_name=ICEEE5&paper_id=27.

Annex 1

Table A.1: Liabilities Position of the Centre and States

(Amount outstanding at the end of March)

(Per cent of GDP)

	Components	1990-91	2000-01	2004-05	2010-11	2011-12 RE	2012-13 BE
	1	2	3	4	5	6	7
I.	**Centre (1+2)**	**62.7**	**53.9**	**61.5**	**50.5**	**49.8**	**49.5**
	1 Internal liabilities (A+B)	**56.4**	**50.8**	**59.6**	**48.5**	**47.9**	**47.7**
	A) Internal debt (i+ii)	30.7	37.1	39.4	34.2	35.7	36.8
	i) Market loans & bonds	27.8	35.0	37.2	30.8	31.4	32.6
	ii) Ways & means from the RBI	2.9	2.1	2.2	3.4	4.3	4.3
	a. Treasury bills	1.6	1.0	1.5	3.1	3.9	3.6
	b. Securities issued to International Financial Institutions	1.3	1.0	0.7	0.4	0.3	0.7
	B) Other liabilities of which	25.7	13.8	20.3	14.3	12.2	10.9
	i) Small savings	10.0	0.3	10.2	7.3	6.3	5.5
	ii) Provident funds	2.3	1.9	1.9	1.4	1.4	1.3
	2 External debt	**6.3**	**3.0**	**1.9**	**2.0**	**1.9**	**1.8**
II.	**States**	**10.9**	**16.4**	**26.3**	**21.6**	**20.6**	**20.3**
	1. Market loans & bonds	3.1	4.0	7.5	7.9	8.4	9.1
	2. Ways & means from the RBI	0.2	0.3	0.0	0.0	0.0	0.0
	3. Provident funds *etc.*	3.4	4.3	4.0	2.9	2.8	2.7
	4. Loans from banks & other institutions	0.5	1.3	2.1	1.0	0.9	0.8
	5. Special securities issued to NSSF	0.0	2.6	8.7	6.3	5.4	4.8
	6. Reserve funds and deposits & advances	3.7	3.8	4.0	3.3	3.1	2.8
III.	**Total**	**68.9**	**73.7**	**82.1**	**65.5**	**65.5**	**66.0**

Notes: Total debt of centre and states may not add up due to adjustments on account of inter-governmental transactions.

Source: Indian Public Finance Statistics, Government of India and Handbook of Statistics on the Indian economy, RBI.

Table A.2: Ownership Pattern of Central and State Government Securities

(Per cent of Total Securities)

Category of Holders	2008	2009	2010	2011	2012
1	2	3	4	5	6
1. Reserve Bank of India (own account)	6.6	7.1	8.9	8.6	10.4
2. Scheduled commercial banks	51.0	50.4	52.0	51.4	53.8
3. Primary Dealers	0.3	0.1	0.1	0.1	2.8
4. Insurance Companies	19.7	17.6	18.3	20.6	20.3
5. Financial Institutions	1.0	1.3	2.1	2.0	0.2
6. Mutual Funds	0.3	0.5	0.2	0.4	0.5
7. Provident Funds	4.0	4.0	4.3	4.6	4.8
8.Others	17.1	18.9	14.2	12.4	7.3
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: Handbook of Statistics on the Indian Economy, RBI

Table A.3: Short Term Debt of the General Government

Year	Amount (₹ billion)	Per cent of Public Debt	Per cent of GDP
1	2	3	4
2007-08	1345	5.2	2.7
2008-09	2604	8.6	4.6
2009-10	3178	8.9	4.9
2010-11	2796	6.9	3.6
2011-12	4330	9.1	4.8

Source: Status Paper on Government Debt, GoI

Table A.4: Floating Rate Debt of the Central Government

Year	Internal Floating Debt		External Floating Debt		Total Floating Debt	
	Per cent of Public Debt	Per cent of GDP	Per cent of Public Debt	Per cent of GDP	Per cent of Public Debt	Per cent of GDP
1	2	3	4	5	6	7
2001-02	0.3	0.1	3.7	1.7	3.9	1.9
2005-06	2.3	1.0	1.8	0.8	4.1	1.7
2009-10	1.6	0.6	2.1	0.8	3.7	1.5
2011-12	1.6	0.6	2.4	0.9	3.9	1.6
2012-13 RE	1.2	0.5	2.3	0.9	3.5	1.4

Source: Status Paper on Government Debt, GoI

Annex 2

Correlation Matrix for Debt Threshold Equation					
Variables	**Public Debt to GDP**	**Growth in Real Investment**	**Inflation Rate**	**Growth in International Trade**	**Gross Fiscal Deficit to GDP**
1	2	3	4	5	6
Public Debt to GDP	1.00				
Growth in Real Investment	0.33 (0.07)	1.00			
Inflation Rate	-0.02 (0.92)	-0.18 (0.31)	1.00		
Growth in International Trade	0.26 (0.15)	0.06 (0.73)	0.49* (0.00)	1.00	
Gross Fiscal Deficit to GDP	0.24 (0.18)	-0.06 (0.75)	-0.10 (0.59)	-0.14 (0.46)	1.00

Note: 1. Figures in the parentheses indicate respective p values.
2. * indicates significant at 1 per cent level.

Reserve Bank of India Occasional Papers

Vol. 33, No. 1 & 2: 2012

*Real Time Business Conditions Index: A Statistically Optimal Framework for India**

Dipankar Biswas,*

Nivedita Banerjee

and

Abhiman Das

The measurement of business conditions on real time basis is a challenging task as the state of real economy is constantly evolving. In this context, in order to achieve an accurate and timely estimate of the state of real activity in a systematic, replicable and statistically optimal manner, this paper proposes a framework to construct a real-time business conditions index for India. The study is primarily motivated by the seminal work of Aruoba, Diebold and Scotti (2009), which proposed a high frequency business conditions assessment for the US economy. Based on various economic indicators measured at different frequencies, this paper develops a real-time business conditions index for India following a dynamic factor model framework for extracting signals from continuously evolving states. A Kalman filter routine is used for signal extraction from state-space representation as well as evaluation of likelihood function. Empirical results show that this coincident indicator tracks the overall economic activity reasonably well.

JEL Classification : C61, E32, E37

Keywords : Business cycle; Dynamic factor model; Turning points; State-space model; Expansion

Introduction

The state of the real economy of a country evolves in a continuous fashion. Economic agents and policy makers, making decisions in real time, require accurate and timely estimates of the state of real activity.

* The authors are working in the Department of Statistics and Information Management, Reserve Bank of India, Mumbai. Views expressed in the paper are those of the authors and not of the Reserve Bank of India. An earlier version of this paper was published as RBI Working Paper, WPS (DEPR): 3/2011.

The authors are grateful to Prof. S. Boragan Aruoba, University of Maryland, US for helping to implement the methodology in the Indian context.

In the light of the changing nature of the economy, where more and more activities are being channelised through both organized and unorganized business sectors, the assessment of business conditions on real time basis is of paramount importance, particularly for central banks. From mid-1980s until 1998, the Reserve Bank of India (RBI) used a monetary-targeting framework. In the year 1998, the RBI's Working Group on Money Supply, in its report, pointed out that monetary policy exclusively based on money demand could lack precision and hence it was necessary to monitor a set of additional indicators for monetary policy formulation. Accordingly, the RBI adopted a multiple indicator approach from 1998 wherein, besides monetary aggregates, information pertaining to currency, credit, fiscal position, merchandise trade, capital flows, inflation rate, exchange rate, refinancing and transactions in foreign exchange etc., were juxtaposed with data on output and the real sector activity for drawing policy perspectives. Monitoring a wide range of variables and studying their dynamic interactions are now possible partly because of the development of more sophisticated econometric models. In this context, in 2002, the RBI's Working Group of Economic Indicators provided importance to deal with the business cycle analysis and to construct a composite index of leading indicators for Indian economy. In 2007, the RBI's Working Group of Leading Indicators for Indian Economy, in its report, recommended two series, viz., monthly Index of Industrial Production (IIP) and quarterly Non-Agricultural GDP (NAGDP), as the reference frame of business cycle in India. The Group also constructed Composite Index of Leading Indicators (CILI) for each of these two reference series following international best practices. As proposed by the Group, the outlook for business cycle movement for 2-3 quarters ahead is regularly examined internally in RBI and serves as an important input to the monetary policy making.

It has been, however, observed that the proposal of the Working Group of Leading Indicators to provide an outlook for business condition of the Indian economy is not sufficient on real time basis due to the following reasons. Firstly, most frequent data used for developing leading indicators is observed on monthly basis. For real time measurement, moving beyond the monthly frequency is a basic pre-

requisite. Some important indicators (e.g., asset prices, yield curve term premium) are observed at daily frequency, which potentially contain important information on the overall economic activity. Secondly, the report did not take into account the assumption of continuously evolving state of the economy, which is essential to real time measurement. Lastly, the provisional and partially revised data used for the leading index also affects the performance to predict future movements of aggregate economic activity in the real-time framework (Diebold and Rudebusch, 1991).

Against this backdrop, we propose a framework motivated by the earlier work of Aruoba, Diebold and Scotti (2009), for the high frequency business conditions assessment for India in a systematic, replicable and statistically optimal manner. Giving the latest information of various macroeconomic indicators of different frequencies, our objective is to assess the current state of economic activity based on a real-time index and to update our assessment as more information flows in. Our assessment is as on today, and not beyond. In that sense, the index is coincident (not leading) to the business condition.

The paper is organised as follows: Section II reviews select literature on the real-time data analysis. Section III describes the empirical analysis concerned with the development of real-time business conditions index for Indian economy. The description of software used for empirical analysis is mentioned in Section IV. Finally, Section V summarises the results, with a few concluding remarks in Section VI.

Section II
Literature Review

In empirical econometrics, the use of real-time data is not a recent area of study. A long list of literature can be mentioned in this regard. Early studies of real-time data focused on the sensitivity of certain statistics to data vintage. Gartaganis and Goldberger (1955) did the first work on real-time data analysis. They mainly confined themselves to the properties of statistical discrepancy between Gross National Product (GNP) and gross national income in United States, after data were revised in 1954. Howrey (1978) focused on the use of preliminary data in econometric forecasting and indicated clearly that the intelligent use

of preliminary data would be expected to result in a meaningful reduction in prediction error variances. Diebold and Rudebusch (1991) examined the ability of composite index of leading economic indicators to predict future movements in aggregate economic activities based on real-time analysis. They used the provisional and partially revised data for the leading index that were actually available historically, along with recursive out-of-sample forecasts. They found substantial deterioration of forecasting performance in the real-time framework. Orphanides and Simon van Norden (2002) examined the reliability of several detrending methods for estimating the output gap in real time. They focused on the extent to which output-gap estimates were updated over time as more information arrived and data were revised. They suggested that, great caution would be required for measuring output gap on real-time basis.

Later research posed the problem more formally as a signal-extraction problem. Evans (2005) focused on estimating high-frequency GDP, equated business conditions with GDP growth and used state space methods to estimate daily GDP growth using data on preliminary, advanced, and final releases of GDP and other macroeconomic variables. Anderson and Gascon (2009) used a state-space model to estimate the "true" unobserved measure of total output in the US economy. The analysis used the entire history (i.e., all vintages) of selected real-time data series to compute revisions and corresponding statistics for those series. The revision statistics, along with the most recent data vintage, were used in a state-space model to extract filtered estimates of the "true" series.

In the Indian context, some studies (Dua and Banerji, 1999, 2004) related to business cycles and coincident economic indicators are important. These studies use the classical NBER approach to determine the timing of recessions and expansions in the Indian economy, as well as the chronology of growth rate cycles, viz., the timing of pickup and slowdown in economic growth. The reference chronology for business as well as growth rate cycles is determined on the basis of the consensus of key coincident indicators of monthly frequency along with a composite coincident index comprising those indicators, which track

fluctuations in current economic activity. However, our aim is to assess the current state of economic activity based on the latest information of various macroeconomic indicators of varying frequencies.

This study is primarily motivated by an empirical study of Aruoba, Diebold and Scotti (2009) on the US economy. They constructed a framework for measuring economic activity at high frequency, potentially in real time. They used a variety of stock and flow data observed at mixed frequencies and performed a prototype empirical application for illustrating the gains achieved by moving beyond the customary monthly data frequency. The four key ingredients of their work are as follows:

1. *Treatment of business conditions as an unobserved variable, related to the observed indicators.* Latency of business conditions is consistent with economic theory (e.g., Lucas 1977), which emphasizes that the business cycle is not about any single variable, but the dynamics and interactions (or co-movements) of many variables.

2. *Explicit incorporation of business conditions indicators measured at different frequencies.* Important business conditions indicators arrive at a variety of frequencies, including quarterly (e.g., GDP), monthly (e.g., industrial production), weekly (e.g., employment), and continuously (e.g., asset prices), and the incorporation of all of them provides continuously updated measurements.

3. *Explicit incorporation of indicators measured at high frequencies.* As the goal is to track the high frequency evolution of real activity, it is important to incorporate (or at least not exclude from the outset) the high frequency information flow associated with high frequency indicators.

4. *Extraction and forecasting of latent business conditions using linear yet statistically optimal procedures, which involve no approximation.* The appeal of exact as opposed to approximate procedures is obvious, but achieving exact optimality is not straight forward, due to complications arising from temporal aggregation of stocks versus flows in systems with mixed-frequency data.

The study proposed a dynamic factor model that permitted optimal extraction of the latent state of macroeconomic activity being illustrated by a four-variable empirical application and in a parallel calibrated simulation (detailed theory is mentioned in the technical appendix). The following four indicators with varying frequencies were chosen as business conditions indicators:

1. Yield curve term premium, defined as the difference between 10-years and 3-months US Treasury yield, at daily frequency.
2. Initial claims for unemployment insurance, a weekly flow variable.
3. Employees on non-agricultural payrolls, a monthly stock variable.
4. Real GDP, a quarterly flow variable.

The real activity indicator thus obtained from the empirical analysis threw new light on the area of business cycle measurement and simultaneously outperformed the so-called National Bureau of Economic Research (NBER) chronology in some economic as well as statistical sense. First, although the real activity indicator broadly coincided with the NBER chronology, it had a propensity to indicate earlier turning points, especially peaks. Second, the indicator was available at high frequency and hence, a useful "nowcast", whereas the NBER chronology was available only monthly and with very long lags. Third, it was evident that incorporation of weekly data in real activity indicator was very helpful for providing real time information, as compared to NBER chronology. However, incorporation of daily data did not improve the performance of the indicator; still a daily state space setup was needed to accommodate the variation in weeks per month and weeks per quarter. Fourth, based on a simulation calibrated to the empirical results, it was observed that, incorporating high frequency data improved the accuracy of the extracted factor. Lastly, the real time performance (preferably, daily) of the business conditions would be assessed at any point of time by re-estimating the system based on latest-vintage data.

Presently, six macroeconomic indicators are used to construct the Aruoba-Diebold-Scotti Business Conditions Index (ADS Index). These are weekly initial jobless claims, quarterly real GDP, monthly payroll

employment, monthly industrial production, monthly real personal income less transfers, and monthly real manufacturing and trade sales. All these are important and widely monitored. The ADS Index is updated weekly, following the release of that week's new and/or revised component indicator data.

Section III
Development of Real Time Business Conditions Index for India

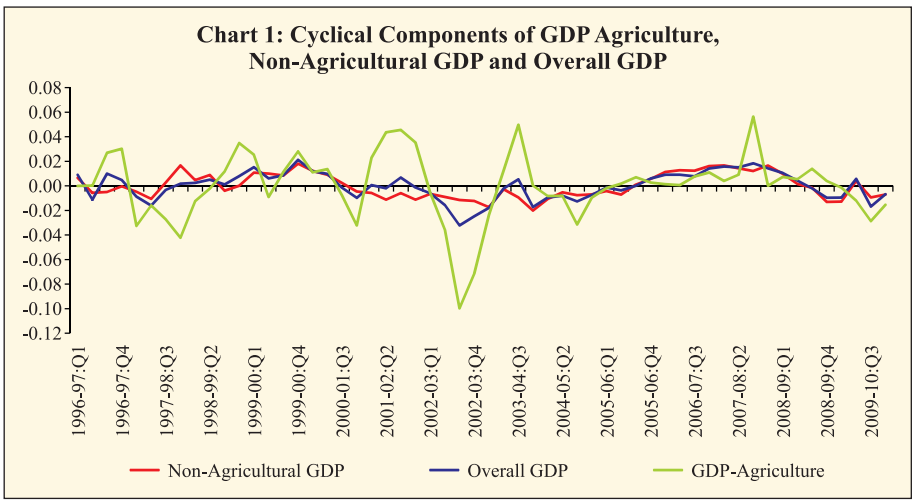
It has been pointed out in Section 2 that, the business conditions of an economy are latent, and are related to some observed indicators. In order to develop a real time business conditions indicator in Indian context, the prime objective is to select those observed indicators from the existing information base on the same lines as was mentioned in the study of Aruoba, Diebold and Scotti (2009). The information base includes national income aggregates, index of industrial production, capital market performance, monetary and banking statistics, price statistics, fiscal statistics, trade data, etc. Some important series along with their source, frequency, availability, and economic as well as statistical justification for inclusion in the selected list are discussed in Table 1.

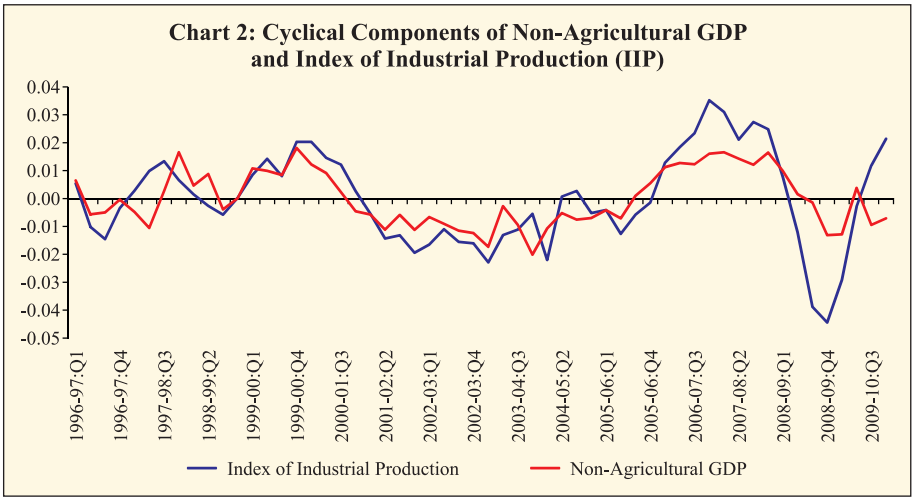
Table 1: List of Selected Indicators

Sl. No.	Name of the Indicator	Unit of Measurement	Frequency	Source
1	Real Non-Agricultural GDP	Rs. Crore	Quarterly	Central Statistics Office (CSO)
2	Index of Industrial Production (IIP)	---	Monthly	-Do-
3	Production of commercial motor vehicles	Thousand Numbers	Monthly	-Do-
4	Cargo Handled at Major Ports	Million Tonne	Monthly	-Do-
5	Revenue on Railways Freight Traffic	Million Tonne	Monthly	-Do-
6	Number of applicants on the live registers of employment exchange	Thousand Numbers	Monthly	-Do-
7	Narrow Money (M_1)	Rs. Crore	Fortnightly	RBI
8	Money Supply (M_3)	Rs. Crore	Fortnightly	RBI
9	WPI Primary Articles	---	Weekly	Ministry of Commerce and Industries
10	Foreign Exchange Reserve	Rs. Crore	Weekly	RBI
11	Yield Curve Term Premium(difference between 10-years Govt. Bond and 91 days Treasury yields)	---	Daily	RBI
12	BSE Sensex	---	Daily	Bombay Stock Exchange (BSE)

a. *Real Gross Domestic Product* - Ideally the Real Gross Domestic Product (GDP) represents almost all aspects of the economic activities. In the literature of business cycle, the cyclical fluctuation of Real GDP is a well-accepted reference frame of the business conditions of the economy as it includes all the three sectors viz., primary, secondary and tertiary. In India, the Central Statistics Office (CSO) of Ministry of Statistics and Programme Implementation releases the quarterly figures of GDP with a two month time lag. In the report of RBI's Working Group of Leading Indicators for Indian Economy, the quarterly Non-agricultural GDP (NAGDP) was taken as a reference series of business cycle due to the dependence of agricultural sector on monsoon performance. In the context of the Indian economy, the agriculture and allied sector contributes almost 20 per cent to the total GDP. However, the performance of agriculture sector depends heavily on rainfall. The high volatility in agricultural sector may be observed from the movement of cyclical component of GDP Agriculture with standard deviation 0.26 (Chart 1). On the other hand, the standard deviation of each of the Overall GDP and Non-Agricultural GDP cycles is 0.13. Moreover, Chart 1 depicts similar movements of Overall GDP and Non-Agricultural GDP cycles (with correlation 0.87). Based on these observations, Non-agricultural GDP is considered more preferable than overall GDP.

Chart 1: Cyclical Components of GDP Agriculture, Non-Agricultural GDP and Overall GDP





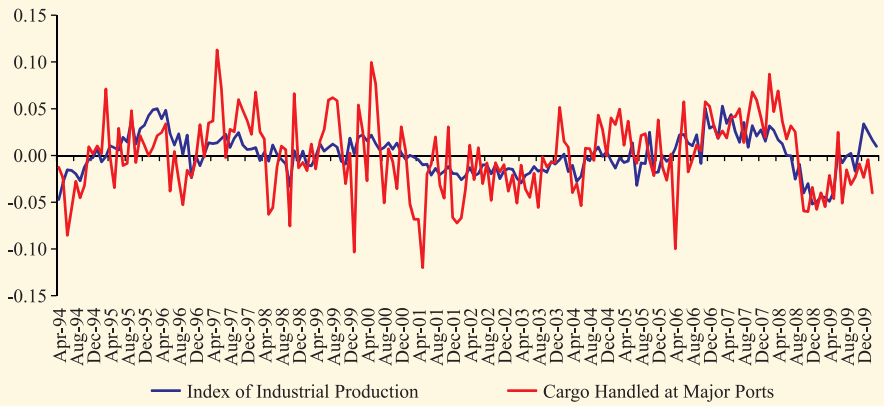
b. *Index of Industrial Production* – In the ADS index, out of six macroeconomic series, one is monthly industrial production and accordingly, in this study, monthly Index of industrial Production (IIP) has also been considered. The index is regularly published by CSO with a two month lag. It may also be mentioned that, OECD uses monthly Industrial Production as the reference series for business cycle analysis. Chart 2 presents the coincidental movements of Non-Agricultural GDP and IIP cycles with correlation 0.81. As the Non-Agricultural GDP has nearly 83 per cent share in overall GDP, it is well justified that IIP also reflects the business conditions of the economy with frequency higher than quarterly intervals.

c. *Indicators observing industrial activities* – There are some other indicators that show the performance of industrial activities. Transportation of goods by road is a good indicator of industrial

Table 2: Cross-correlation between Non-agricultural GDP and IIP

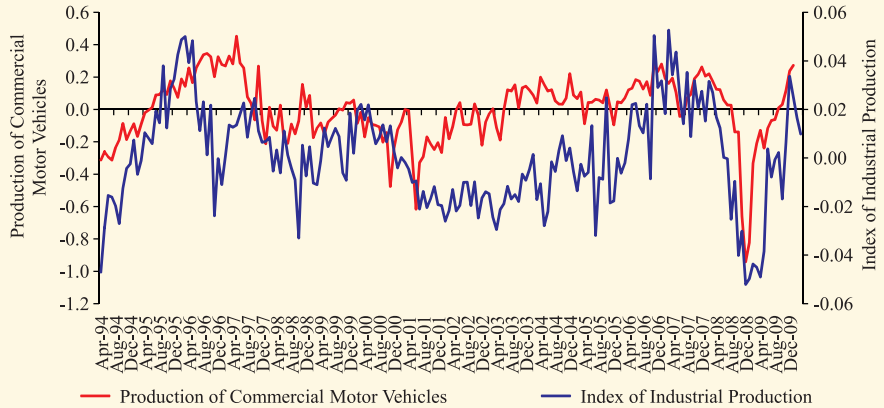
i	lag	lead		i	Lag	lead
0	0.4321	0.4321		6	0.1256	-0.0078
1	0.3473	0.3130		7	0.1796	0.0219
2	0.2624	0.1940		8	0.2336	0.0472
3	0.1776	0.0749		9	0.2564	0.0348
4	0.0928	-0.0445		10	0.1797	-0.0139
5	0.0716	-0.0374		11	0.1031	-0.0627

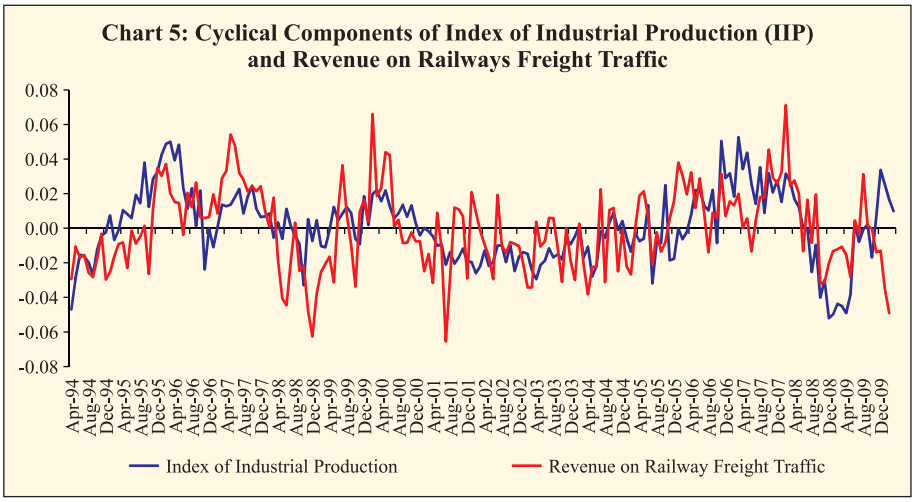
Chart 3: Cyclical Components of Index of Industrial Production (IIP) and Cargo Handled at Major Ports



production process. Thus 'Production of commercial motor vehicles' is taken as an indicator. Moreover, increased levels of production, consumption and trade also get reflected, particularly in a large country such as India, in increased transportation of goods. Thus, the two series, *viz*., 'Cargo Handled at Major Ports' and 'Revenue on Railways Freight Traffic' are also considered in this study. The data of these series are regularly released in the monthly capsule report of CSO with two months lag. The movements of cyclical components of the three industrial activities indicators vis-à-vis IIP are presented in Charts 3 to 5. All show coincidental movement with IIP cycle.

Chart 4: Cyclical Components of Index of Industrial Production (IIP) and Production of Commercial Motor Vehicles





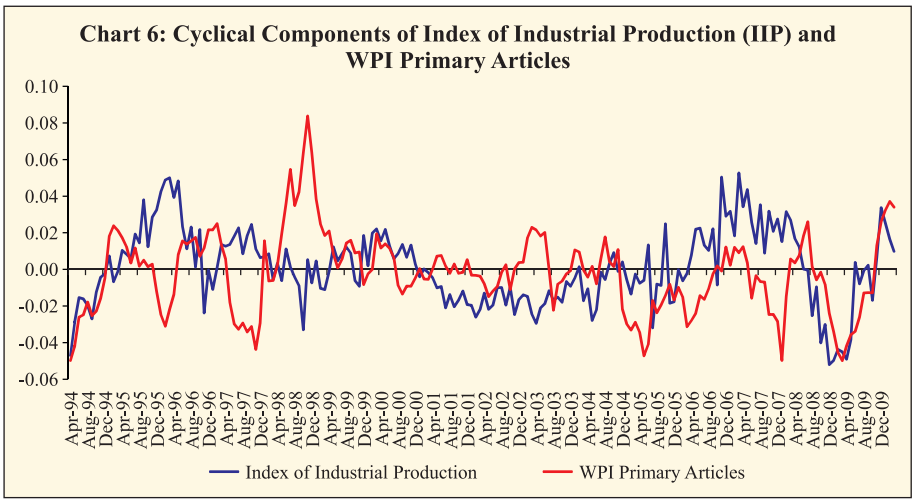
d. *WPI Primary Articles* – In the ADS Index, the price factor was not considered directly, but the daily yield curve term premium (i.e., difference between 10-year and 3-months US Treasury yield) had taken into account inflation expectations to some extent. In our study, we consider WPI Primary Articles compiled by Ministry of Commerce and Industries, due to the following reasons.

(i) WPI Primary Articles data are available at weekly frequency[1]. Although WPI Manufactured Products is more related to industrial production than WPI Primary Articles, it is presently compiled on monthly basis. Moreover, although WPI of 'Fuel and Power' is available on weekly basis, the prices of some products included in the 'Fuel and Power' group are administered by the government.

(ii) The cyclical movement of WPI Primary Articles is somehow coincident to IIP cycle, although divergence is clearly observed in most cases (Chart 6).

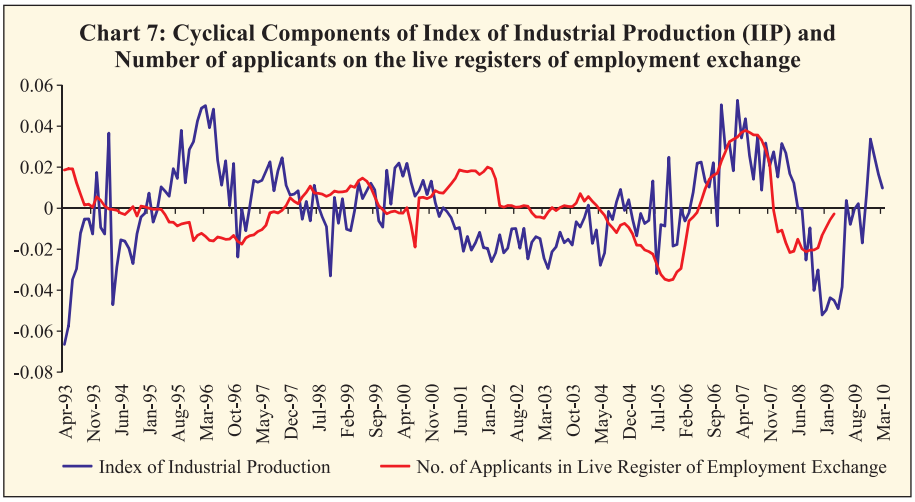
e. *Employment and Unemployment indicator* – The comprehensive employment series, which is available on a regular basis, is the estimated average daily employment in factories. But it is available

[1] This was the case until January 14, 2012. Subsequently WPI headline and all its sub-components are compiled on monhly frequency from February 2012.



only on an annual basis. Data on unemployment rate are not complied on a regular basis. The series, 'Number of applicants on the live registers of employment exchange', released in Monthly Abstract of Statistics by CSO, gives some indication of the number of unemployed in the cities. But this suffers from the well-known limitations such as the changing (increasing) number of unemployment exchanges over the years, possibility of incomplete as well as multiple registrations, registration by those currently employed because they are looking for better jobs or through failure to cancel registration, etc. Despite these limitations, Chitre (2001) found this series as a useful coincident indicator of the industrial production and, therefore, is included in the present study (Chart 7). Another limitation of the series is its long lag period for releasing the data. For example, the Monthly Abstract of Statistics, September-October 2009 publication released the data upto March 2009.

f. *Yield Curve Term Premium* – In the study of Aruoba, Diebold and Scotti (2009), the only series with daily frequency was yield curve term premium, defined as the difference between 10-years and 3-months US Treasury yield. On the same lines, in this study, the difference between yields of 10-years government securities and 91-days Treasury Bills is included in the list. These data are available on real-time basis.



g. *BSE Sensex* – Another daily indicator, as mentioned by Aruoba, Diebold and Scotti (2009), is asset price. As a proxy of asset price, daily Sensex data of Bombay Stock Exchange (BSE) has been examined. It was observed that, in connection with the economic activity of the country, Sensex seems to be noisy as well as volatile. Also, on examining the cross correlation of BSE Sensex with Non-Agricultural GDP (NAGDP), IIP and weekly Foreign Exchange Reserve, we have seen that the correlation is not encouraging.

h. *Foreign Exchange Reserves* - As selected indicators are expected to be highly correlated with each other, we have examined the

Table 3: Cross Correlation between cyclical components- BSE-Sensex with Non-Agricultural GDP (NAGDP), IIP and Foreign Exchange Reserves

NAGDP Vs BSE-Sensex			IIP Vs BSE-Sensex			Reserves Vs BSE-Sensex		
I	**lag**	**lead**	**i**	**Lag**	**lead**	**i**	**lag**	**lead**
0	0.2936	0.2936	0	0.1667	0.1667	0	0.0222	0.0222
1	0.2910	0.2964	1	0.1684	0.1655	1	0.0187	0.0263
2	0.2885	0.2991	2	0.1703	0.1642	2	0.0153	0.0304
3	0.2859	0.3019	3	0.1719	0.1630	3	0.0115	0.0347
4	0.2833	0.3045	4	0.1734	0.1616	4	0.0078	0.0391
5	0.2807	0.3069	5	0.1751	0.1600	5	0.0040	0.0437
6	0.2783	0.3093	6	0.1767	0.1583	6	0.0002	0.0484
7	0.2760	0.3115	7	0.1781	0.1566	7	-0.0035	0.0532
8	0.2737	0.3136	8	0.1799	0.1546	8	-0.0073	0.0577
9	0.2714	0.3156	9	0.1821	0.1528	9	-0.0113	0.0619
10	0.2691	0.3175	10	0.1840	0.1508	10	-0.0154	0.0659

Table 4: Cross Correlation between cyclical components - Foreign Exchange Reserves with Non-Agricultural GDP (NAGDP) and IIP

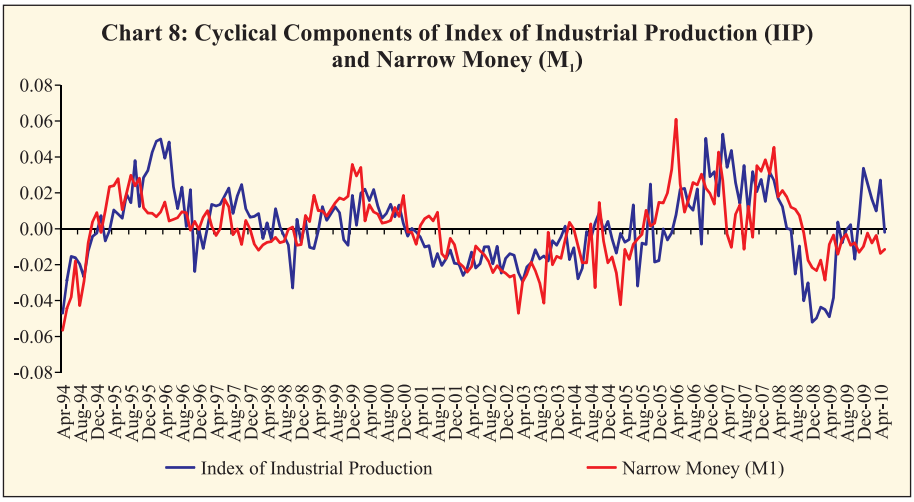
NAGDP Vs Reserves				IIP Vs Reserves		
i	**Lag**	**Lead**		**i**	**lag**	**lead**
0	-0.0528	-0.0528		0	0.0360	0.0360
1	-0.0514	-0.0545		1	0.0329	0.0393
2	-0.0499	-0.0562		2	0.0295	0.0426
3	-0.0484	-0.0578		3	0.0261	0.0459
4	-0.0470	-0.0596		4	0.0223	0.0489
5	-0.0456	-0.0613		5	0.0183	0.0518
6	-0.0443	-0.0631		6	0.0138	0.0548
7	-0.0431	-0.0648		7	0.0096	0.0579
8	-0.0419	-0.0666		8	0.0053	0.0611
9	-0.0408	-0.0685		9	0.0012	0.0635
10	-0.0398	-0.0704		10	-0.0029	0.0657

cross-correlation among different series at different frequencies. It was found that, the Foreign Exchange Reserves, which was considered as a stock variable available at weekly frequency, has a poor correlation with the economic activity, i.e., NAGDP as well as with IIP, and hence is not considered fit for the requirement.

i. *Money Supply and Narrow Money*–Besides weekly variables, Narrow Money (M_1) and Money Supply (M_3) have been considered as fortnightly stock variable for testing coincidence with IIP and NAGDP cyclical components. The cross-correlations of M_1 and M_3 with NAGDP and IIP separately were examined and found that Narrow Money had a better relationship with IIP and GDP than Money Supply and hence was selected (Table 5 and Charts 8 and 9).

Table 5: Cross Correlation between cyclical components - M_1 and M_3 with NAGDP and IIP

M_1 Vs NAGDP				M_1 Vs IIP				M_3 Vs NAGDP				M_3 Vs IIP		
i	**lag**	**lead**		**i**	**lag**	**lead**		**i**	**lag**	**lead**		**i**	**lag**	**lead**
0	0.6763	0.6763		0	0.5586	0.5586		0	0.1287	0.1287		0	-0.2187	-0.2187
1	0.6464	0.7230		1	0.5972	0.5383		1	0.2700	-0.0008		1	-0.2026	-0.2112
2	0.5806	0.6534		2	0.5527	0.4547		2	0.4322	-0.1132		2	-0.2235	-0.2069
3	0.4357	0.5182		3	0.5087	0.4392		3	0.5224	-0.2116		3	-0.2362	-0.1797
4	0.4030	0.4323		4	0.5059	0.3858		4	0.5782	-0.3264		4	-0.2228	-0.1499
5	0.2699	0.2348		5	0.4454	0.2912		5	0.5886	-0.4753		5	-0.2328	-0.1532
6	0.1092	0.1010		6	0.3878	0.2854		6	0.5751	-0.5606		6	-0.2285	-0.0966
7	0.0243	-0.0267		7	0.3465	0.2390		7	0.5986	-0.6325		7	-0.2549	-0.0589
8	-0.1208	-0.1072		8	0.3334	0.2225		8	0.5342	-0.6227		8	-0.2298	-0.0127
9	-0.2517	-0.1798		9	0.2679	0.2092		9	0.5034	-0.6113		9	-0.2625	0.0602
10	-0.3874	-0.2564		10	0.2404	0.1820		10	0.4240	-0.5991		10	-0.2833	0.1063



Based on the above-mentioned indicators as well as the methodology (described in the Technical Appendix), four indicators were finally selected (Table 6).

We implimented this methodology using a program in RATS software to construct a real-time business conditions index in the Indian context. Instead of weekly variable (as used in ADS index), we have considered here a fortnightly available stock variable, i.e. Narrow Money (M_1).

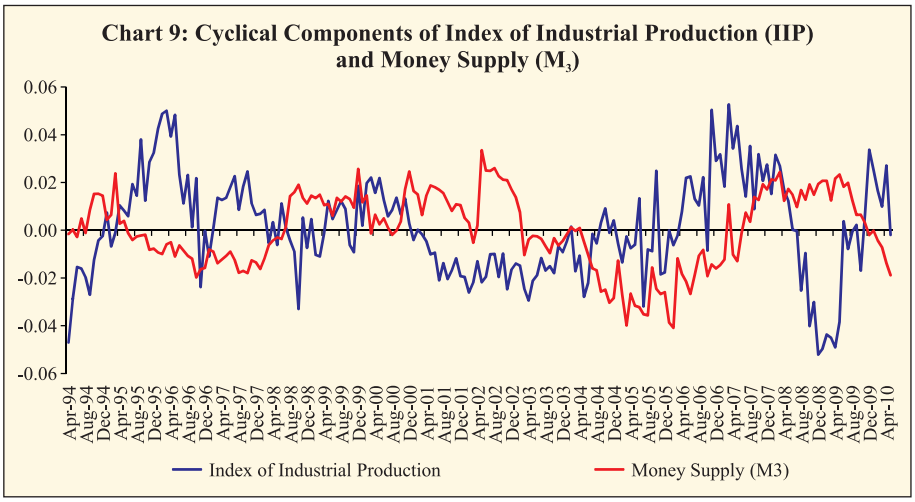


Table 6: Finally Selected Indicators

Serial no.	Variable Name	Frequency of Availability	Variable Type
1	Yield Curve Term Premium	Daily	Stock
2	Narrow Money(M_1)	Fortnightly	Stock
3	Index of Industrial Production	Monthly	Flow
4	Non-Agricultural GDP	Quarterly	Flow

Section IV
Software

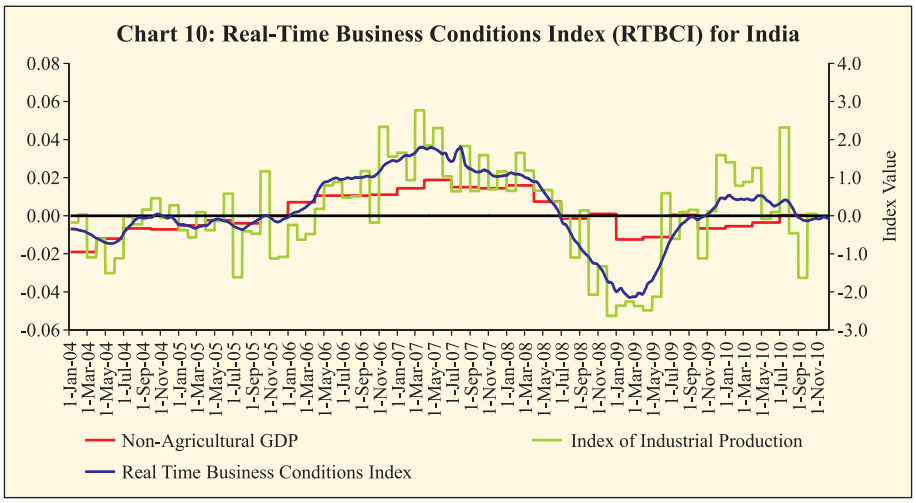
First, we have extracted the cyclical component from the four selected series as we try to find an indicator for business cycle. We did the extraction based on the following procedure:

I. Seasonal adjustment of the series using X-12 ARIMA methodology.

II. HP Filter to remove the smoothed trend from the seasonally adjusted series and finally extracting the cyclical component.

Then the series having cyclical component only has been used in the program as an input. After that, we have defined the matrices of the state-space model following the theory stated in the paper by Aruoba, Diebold and Scotti (2009). In their paper, they considered a weekly flow variable, but in our case we have considered a fortnightly stock variable. Again, instead of monthly stock variable, we have considered a flow variable. The matrix coefficients have been changed accordingly. We have used Dynamic Linear Model for estimating the coefficients. We obtain our start-up values in two steps as follows. In the first step, we use only daily and stock variables, which drastically reduce the dimension of the state vector, resulting in very fast estimation. This yields preliminary estimates of all measurement equation parameters for the daily and stock variables and all transition equation parameters, as well as a preliminary extraction of the factor (via a pass of the Kalman smoother).

In the second step, we use the results of the first step to obtain start-up values for the remaining parameters, that is, those in the flow variable measurement equations. We simply regress the flow variables on the smoothed state extracted in the first step and take the coefficients as our start-up values. With the model cast in state-space form, and for given parameters, we use the Kalman filter and smoother to obtain optimal extractions of the latent state of real activity.



Section V
Empirical Results

Based on the four finally selected indicators, viz., daily Yield curve term premium, fortnightly Narrow Money (M_1), monthly Index of Industrial Production (IIP), and quarterly Non-Agricultural GDP (NAGDP), the Real-time Business Conditions Index (RTBCI) was constructed (Chart 10). Data period of the selected variables is presented in Table 7.

Chart 10 displays the cyclical movements of Non-Agricultural GDP (NAGDP) and Index of Industrial Production (IIP) along with the daily movement of RTBCI. It is observed that there is a coincidental movement among these three series. The movement of RTBCI beyond

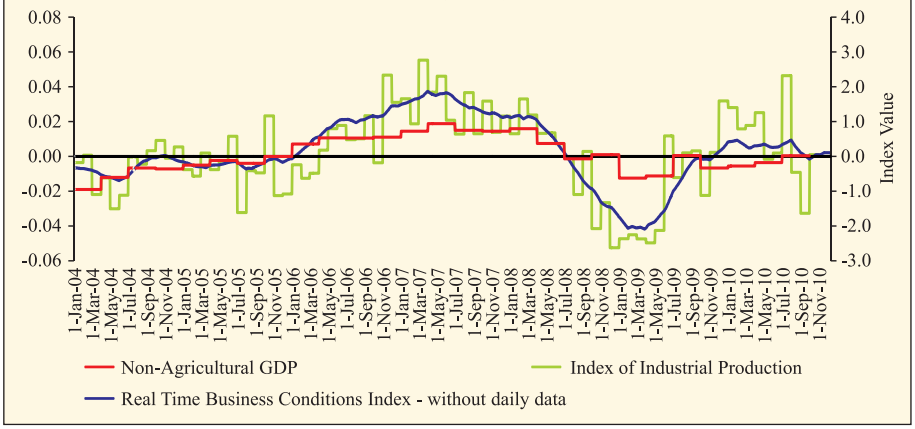
Table 7: Data Period of Selected Indicators

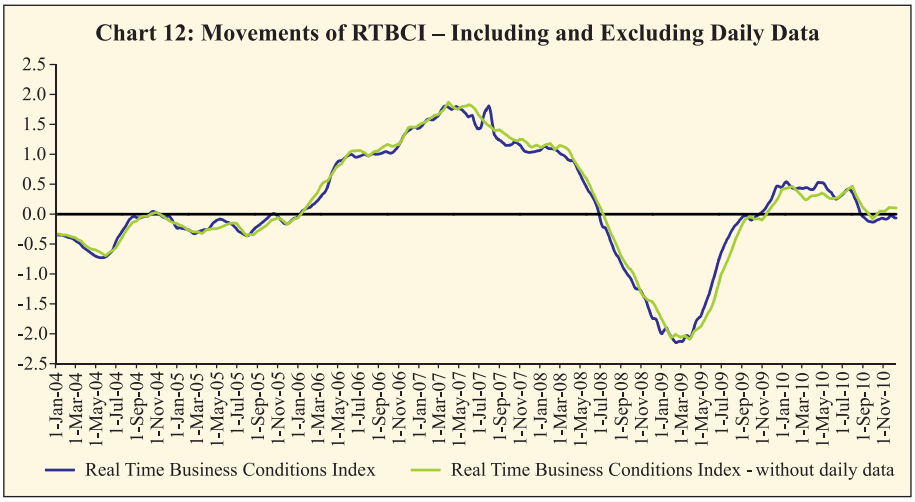
Sr. No.	Variable Name	Frequency of Availability	Variable Type	Period
1	Yield Curve Term Premium	Daily	Stock	1-Dec-2003 to 10-Dec-2010
2	Narrow Money (M_1)	Fortnightly	Stock	Fortnight ended 12-Dec-2003 to Fortnight ended 19-Nov-2010
3	Index of Industrial Production	Monthly	Flow	Dec-2003 to October 2010
4	Non-Agricultural GDP	Quarterly	Flow	Q4:2003-04 to Q2:2010-11

the vertical red line indicates the state of the economy which is otherwise not observed from the macro aggregates. The momentum as per the RTBCI as on December 10, 2010, indicates somewhat low acceleration of economic activity.

In order to see the importance of daily data for real-time measurement, a separate analysis was done to construct an index using the three selected indicators except daily "Yield curve term premium" data. The reason behind this is to examine if the RTBCI using fortnightly data performs better than the earlier index constructed using daily data. Chart 11 displays the cyclical movements of Non-Agricultural GDP (NAGDP) and Index of Industrial Production (IIP), along with the daily movement of RTBCI without daily data. Although this chart indicates co-movement between these three series, the next step is to search for any lag difference between the movements of RTBCI and RTBCI without daily data. Chart 12 displays the movements of RTBCI and RTBCI without daily data. In this chart it is observed that, the turning points of RTBCI including daily data is earlier than those of RTBCI without daily data. The lag difference varies approximately from 1 to 6 weeks. This implies that, if the turning point occurs in the business cycle movement, then RTBCI will capture the turning point earlier than RTBCI without daily data. For example, the turning point occurred in January 2009 in IIP cycle was captured by RTBCI (value corresponding

Chart 11: Movements of NAGDP Cycle, IIP Cycle, and RTBCI – Excluding Daily Data





to January 3, 2009 was the lowest) four weeks earlier than that captured by RTBCI without daily data (value corresponding to January 31, 2009 was the lowest). This justifies the importance of usage of daily data while constructing the Index.

Section VI
Concluding Remarks

Real time decision making requires accurate and timely understanding of the state of real activity. In the light of the changing nature of the economy where increasingly more and more activities are channelised through both the organized and unorganized business sectors, the measurement of business condition on real time basis is extremely difficult. In this context, in order to achieve an accurate and timely estimate of the state of real activity in a systematic, replicable and statistically optimal manner, this paper proposes a framework to construct a real-time business conditions index for India. Based on various economic indicators measured at different frequencies, this paper develops a real-time business conditions index for India following a dynamic factor model framework for extracting signals from continuously evolving states. A Kalman filter routine is used for signal extraction from state-space representation as well as evaluation of likelihood function. Empirical results show that this coincident indicator tracks the overall economic activity reasonably well.

Technical Appendix
Measurement of Real-time Business Condition

As indicated earlier, the framework for measuring real time economic activity at high frequency as presented in this paper was developed by Aruoba, *et al.* (2008). Detailed methodology is documented there. A brief description is presented in this technical appendix.The frequency of the dynamic factor model considered here is daily. However, daily data are mostly not observed for major variables and so will be shown missing. As a result, missing data and temporal aggregation were treated explicitly. In this process, measurement equations were obtained for both stock and flow variables which were observed. This allowed us to incorporate lagged state variables in the measurement equations and also the trend, which are important characteristics of macro data.

a. Dynamic Factor Model: Framework for Daily Frequency

Though this approach can handle higher (intraday) frequencies, we have assumed that the state of the economy evolves at daily frequency. Obviously, there will be many macro variables which are observed at monthly or quarterly or annual frequency and hence are not observed daily. If the underlying business conditions x_t at day *t* follows an *AR(p)* dynamics, then

$$x_t = \rho_1 x_{t-1} + \rho_2 x_{t-2} + \cdots + \rho_p x_{t-p} + e_t \quad (1)$$

where, e_t is standard white noise with unit variance.

For our case to track and project real economic activity, x_t is scalar. So, following Stock and Watson (1989), we use a single-factor model. Suppose y_t^i, the i^{th} daily economic or financial variable at day *t*, depends linearly on x_t and various other exogenous variables and/or lags of y_t^i. Then

$$y_t^i = c_i + \beta_i x_t + \delta_{i1} w_t^1 + \cdots + \delta_{ik} w_t^k + y_{i1} y_{t-D_i}^i + \cdots + y_{in} y_{t-nD_i}^i + u_t^i \quad (2)$$

where, w_t are exogenous variables and the u_t^i are contemporaneously and serially uncorrelated innovations. It should be mentioned that, we introduce lags of the dependent variable y_t^i in multiples of D_i, where $D_i > 1$ is a number linked to the frequency of the observed y_t^i (We will discuss D_i in detail in the next subsection). Modeling persistence only at the daily frequency would be inadequate, as it would decay too quickly.

b. Missing Data, Stocks vs. Flows, and Temporal Aggregation

We have mentioned above that y_t^i denotes the i^{th} variable observed on daily basis. However, most other variables, although evolving daily or intra-daily, are not actually observed daily. If $\widetilde{y_t^i}$ denotes the same variable observed at a lower frequency, then $\widetilde{y_t^i}$ and y_t^i are explicitly related depending on whether y_t^i is a stock or flow variable. Let us consider y_t^i as the stock variable. Then at any time *t*, either $\widetilde{y_t^i} = y_t^i$, if y_t^i is observed, otherwise, $\widetilde{y_t^i} = NA$, meaning 'not available'. So the measurement equation for the stock variable is:

$$\widetilde{y_t^i} = \begin{cases} y_t^i = c_i + \beta_i x_t + \delta_{i1} w_t^1 + \cdots + \delta_{ik} w_t^k + \gamma_{i1} y_{t-D_i}^i + \\ \qquad \cdots + \gamma_{in} y_{t-nD_i}^i + u_t^i, \ \ if\ y_t^i\ \ is\ observed \\ NA, \qquad\qquad otherwise \end{cases} \tag{3}$$

Now consider flow variables. Flow variables observed at non-daily frequencies are intra period sums of the corresponding daily values,

$$\widetilde{y_t^i} = \begin{cases} \sum_{j=0}^{D_i-1} y_{t-j}^i\ , \quad if\ y_t^i\ \ is\ observed \\ NA, \qquad\qquad otherwise \end{cases} \tag{4}$$

where, D_i is the number of days per observational period (e.g., $D_i = 7$, if y_t^i is measured weekly). Combining this fact with Equation (2), we arrive at the flow variable measurement equation

$$\widetilde{y_t^i} = \begin{cases} \sum_{j=0}^{D_i-1} c_i + \beta_i \sum_{j=0}^{D_i-1} x_{t-j}^i + \delta_{i1} \sum_{j=0}^{D_i-1} w_{t-j}^1 + \cdots + \delta_{ik} \sum_{j=0}^{D_i-1} w_{t-j}^k \\ +\gamma_{i1} \sum_{j=0}^{D_i-1} y_{t-D_i-j}^i + \cdots + \gamma_{in} \sum_{j=0}^{D_i-1} y_{t-nD_i-j}^i + u_t^{*i}\ , \ \ if\ y_t^i\ \ is\ observed \\ NA, \qquad\qquad\qquad\qquad\qquad\qquad otherwise \end{cases} \tag{5}$$

where, $\sum_{j=0}^{D_i-1} y_{t-D_i-j}^i$ is by definition the observed flow variable one period ago $\tilde{y}_{t-D_i}^i$, and u_t^{*i} is the sum of the u_t^i over the tilde period.

Though D_i is a time variable, we treat it as fixed. But, in our subsequent empirical implementation, we allow for time-varying D_i. Here we treat u_t^{*i} as white noise with $var(u_t^{*i}) = D_i \times Var(u_t^i)$.

c. Trend

The trend is captured by the exogenous variables w_t. Assuming deterministic polynomial trend, we can write $w_{t-j}^1 = t - j$, $w_{t-j}^2 = (t-j)^2$,

and so on, we have that

$$\sum_{j=0}^{D_i-1}[c_i + \delta_{i1}(t-j) + \cdots + \delta_{ik}(t-j)^k] \equiv c_i^* + \delta_{i1}^* t + \cdots + \delta_{ik}^* t^k. \quad (6)$$

Therefore, we have the stock variable equation,

$$\widetilde{y_t^i} = \begin{cases} c_i^* + \beta_i x_t^i + \delta_{i1}^* t + \cdots + \delta_{ik}^* t^k + \nu_{i1}\tilde{y}_{t-D_i}^i + \\ \qquad \cdots + \nu_{in}\tilde{y}_{t-nD_i}^i + u_t^{*i}, \text{ if } y_t^i \text{ is observed} \\ \text{NA}, \qquad \text{otherwise} \end{cases}, \quad (7)$$

and the flow variable equation,

$$\widetilde{y_t^i} = \begin{cases} c_i^* + \beta_i \sum_{j=0}^{D_i-1} x_{t-j}^i + \delta_{i1}^* t + \cdots + \delta_{ik}^* t^k + \gamma_{i1}\tilde{y}_{t-D_i}^i + \\ \qquad \cdots + \gamma_{in}\tilde{y}_{t-nD_i}^i + u_t^{*i}, \text{ if } y_t^i \text{ is observed} \\ \text{NA}, \qquad \text{otherwise} \end{cases} \quad (8)$$

This completes the specification of our model, which has a natural state-space form.

d. State-Space Representation, Signal Extraction and Estimation

State space representation, filtering and estimation presented here relates to specific econometric issues as indicated above.

State-Space Representation

Our model is trivially cast in state-space form as

$$\begin{aligned} \boldsymbol{y}_t &= \boldsymbol{Z}_t\boldsymbol{\alpha}_t + \boldsymbol{\Gamma}_t\boldsymbol{w}_t + \boldsymbol{\varepsilon}_t \\ \boldsymbol{\alpha}_{t+1} &= \boldsymbol{T}\boldsymbol{\alpha}_t + \boldsymbol{R}\boldsymbol{\eta}_t \\ \boldsymbol{\varepsilon}_t &\sim (\boldsymbol{0}, \boldsymbol{H}_t) \\ \boldsymbol{\eta}_t &\sim (\boldsymbol{0}, \boldsymbol{Q}), \textit{ for } t = 1,2, \ldots, \mathcal{T}. \end{aligned} \quad (9)$$

where $\boldsymbol{y}_t = N \times 1$ vector of observed variables,

$\boldsymbol{\alpha}_t = m \times 1$ vector of state variables,

$\boldsymbol{w}_t = e \times 1$ vector of predetermined variables including a constant term (unity), k trend terms and $N \times n$ lagged dependent variables,

$\boldsymbol{\varepsilon}_t$= vector of measurement shocks

$\boldsymbol{\eta}_t$= vector of transition shocks.

Here, $\boldsymbol{y}_t$ includes missing values for holidays and also for other variables which are observed much less often than daily. That is, $\boldsymbol{y}_t$ has a large number of *NA* values.

Signal Extraction

With the model cast in state-space form, and for given parameters, we use the Kalman filter and smoother to obtain optimal extractions of the latent state of real activity. We use the contemporaneous Kalman filter using the unconditional mean and covariance matrix of the state vector (Durbin and Koopman, 2001).

Let, $\mathcal{Y}_t \equiv \{\boldsymbol{y}_1, \boldsymbol{y}_2, \dots, \boldsymbol{y}_t\}$, $\boldsymbol{a}_{t\,|t} \equiv E(\boldsymbol{\alpha}_t\,|\mathcal{Y}_t)$, $\boldsymbol{P}_{t\,|t} \equiv var(\boldsymbol{\alpha}_t\,|\mathcal{Y}_t)$, $\boldsymbol{a}_t \equiv E(\boldsymbol{\alpha}_t\,|\mathcal{Y}_{t-1})$, and $\boldsymbol{P}_t \equiv var(\boldsymbol{\alpha}_t\,|\mathcal{Y}_{t-1})$. The Kalman filter updating and prediction equations are:

$$\boldsymbol{a}_{t\,|t} = \boldsymbol{a}_t + \boldsymbol{P}_t \boldsymbol{Z}_t^{/} \boldsymbol{F}_t^{-1} \boldsymbol{v}_t$$

$$\boldsymbol{P}_{t\,|t} = \boldsymbol{P}_t - \boldsymbol{P}_t \boldsymbol{Z}_t^{/} \boldsymbol{F}_t^{-1} \boldsymbol{Z}_t \boldsymbol{P}_t^{/}$$

$$\boldsymbol{a}_{t+1} = \boldsymbol{T}\boldsymbol{a}_{t\,|t}$$

$$\boldsymbol{P}_{t+1} = \boldsymbol{T}\boldsymbol{P}_{t\,|t}\boldsymbol{T}^{/} + \boldsymbol{R}\boldsymbol{Q}\boldsymbol{R}^{/}$$

where, $\boldsymbol{v}_t = \boldsymbol{y}_t - \boldsymbol{Z}_t\boldsymbol{a}_t - \boldsymbol{\Gamma}_t\boldsymbol{w}_t$, $\boldsymbol{F}_t = \boldsymbol{Z}_t\boldsymbol{P}_t\boldsymbol{Z}_t^{/} + \boldsymbol{H}_t$ for $t = 1,2, \dots, \mathcal{T}$. (10)

Note that the Kalman filter remains valid with missing data. If all elements of y_t are missing, we skip updating and the recursion becomes

$$\boldsymbol{a}_{t+1} = \boldsymbol{T}\boldsymbol{a}_t$$

$$\boldsymbol{P}_{t+1} = \boldsymbol{T}\boldsymbol{P}_t\boldsymbol{T}^{/} + \boldsymbol{R}\boldsymbol{Q}\boldsymbol{R}^{/}. \qquad (11)$$

If some but not all elements of y_t are missing, we replace the measurement equation with

$$\boldsymbol{y}_t^* = \boldsymbol{Z}_t^*\boldsymbol{\alpha}_t + \boldsymbol{\Gamma}_t^*\boldsymbol{w}_t + \boldsymbol{\varepsilon}_t^*$$

$$\boldsymbol{\varepsilon}_t^* \sim N(\boldsymbol{0}, \boldsymbol{H}_t^*)$$

where, $\boldsymbol{y}_t^*$ contains the elements of the $\boldsymbol{y}_t$ vector that are observed, andits dimension $N^* < N$. $\boldsymbol{y}_t^*$ and $\boldsymbol{y}_t^* = \boldsymbol{W}_t\boldsymbol{y}_t$, $\boldsymbol{W}_t$ is a matrix whose N^* rows are the rows of I_N corresponding to the observed elements of y_t. In the same

fashion, we define, $\boldsymbol{Z}_t^* = \boldsymbol{W}_t\boldsymbol{Z}_t$, $\boldsymbol{\Gamma}_t^* = \boldsymbol{W}_t\boldsymbol{\Gamma}_t$, $\boldsymbol{\varepsilon}_t^* = \boldsymbol{W}_t\boldsymbol{\varepsilon}_t$, and $\boldsymbol{H}_t^* = \boldsymbol{W}_t\boldsymbol{H}_t\boldsymbol{W}_t^{/}$. We replace $\boldsymbol{y}_t$, $\boldsymbol{Z}_t$, and $\boldsymbol{H}_t$ with $\boldsymbol{y}_t^*$, $\boldsymbol{Z}_t^*$, and $\boldsymbol{H}_t^*$, respectively while applying the Kalman filter, which remains valid with missing data again.

Estimation

Following standard practice, we evaluate the Gaussian pseudo log-likelihood function via the prediction error decomposition for estimation of the parameters as,

$$logL = -\frac{1}{2}\sum_{t=1}^{T}\left[Nlog2\pi + \left(log|\boldsymbol{F}_t| + \boldsymbol{v}_t^{/}\boldsymbol{F}_t^{-1}\boldsymbol{v}_t\right)\right]. \quad (12)$$

In calculating the log likelihood, if all elements of $\boldsymbol{y}_t$ are missing, the contribution of period t to the likelihood is zero. When some elements of $\boldsymbol{y}_t$ are observed, the contribution of period t is written as, $\left[N^*log2\pi + \left(log|\boldsymbol{F}_t^*| + \boldsymbol{v}_t^{*/}\boldsymbol{F}_t^{*-1}\boldsymbol{v}_t^*\right)\right]$, where N^* is the number of observed variables, and we obtain $\boldsymbol{F}_t^*$ and $\boldsymbol{v}_t^*$ by filtering the transformed $\boldsymbol{y}_t^*$ system.

e. Empirical Application

We now present a simple application involving the daily term premium, fortnightly Narrow Money, monthly IIP, and quarterly NAGDP. We describe in turn the data, the specific variant of the model that we implement subtleties of our estimation procedure, and our empirical results.

Business Conditions Indicators

Our analysis covers the period from December 1, 2003 through July 2, 2010, which are 2406 observations of daily data. We use a seven-day week and four indicators. Moving from highest frequency to lowest frequency, the first indicator is the yield curve term premium, defined as the difference between 10-year Government securities and 3-month Indian Treasury yields. We measure the term premium daily; hence there are no aggregation issues. We treat holidays and weekends as missing. The second indicator is Narrow Money, a fortnightly stock variable covering the seven-day period from Sunday to Saturday. We set the end-of-fortnight value to the end-of-fortnight daily value, and we treat other days as missing. The third indicator is IIP, a monthly flow

variable. We set the end-of-month value to the sum of the daily values within that month, and we treat other days as missing. The fourth and final indicator is NAGDP, a quarterly flow variable. We set the end-of-quarter value to the sum of daily values within the quarter, and we treat other days as missing. Basically, we want the variables chosen to illustrate the flexibility of our framework. Hence we choose four variables measured at four different frequencies ranging from very high (daily) to very low (quarterly), and representing both stocks (term premium, narrow money) and flows (IIP, NAGDP). Since we are seeking a 'Business Cycle' indicator, we have extracted the cyclical component from the data (except the daily variable). This cyclical series is taken as our input.

Model Implementation

In the development thus far we have allowed for general polynomial trend and general *AR(p)* dynamics. In the prototype model that we now take to the data, we make two simplifying assumptions that reduce the number of parameters to be estimated by numerical likelihood optimization. First, we de-trend prior to fitting the model rather than estimating trend parameters simultaneously with the others, and second, we use simple first-order dynamics throughout. In future work, we look forward to incorporating more flexible dynamics but, as we show below, the framework appears quite encouraging even with simple *AR(*1*)* dynamics.

In the model implementation, both the latent business conditions $\boldsymbol{x}_t$ and other observed variables follow zero-mean *AR(*1) process. That means, for fortnightly narrow money, monthly IIP, and quarterly NAGDP, the lagged values of these variables are elements of the $\boldsymbol{w}_t$ vector, which are denoted by $\tilde{y}^2_{t-f}$, $\tilde{y}^3_{t-M}$, and $\tilde{y}^4_{t-q}$, where *f* denotes the number of days in a fortnight, *M* denotes the number of days in a month and *q* denotes the number of days in a quarter. In implementation, we adjust *M* and *q* according to the number of days in the relevant month or quarter. Finally, instead of adding a lag of the term premium in $\boldsymbol{w}_t$ for the term premium, we model the autocorrelation structure using an *AR(*1*)* process for the measurement equation innovation.

The equations that define the model are

$$\begin{bmatrix}\tilde{y}_t^1\\ \tilde{y}_t^2\\ \tilde{y}_t^3\\ \tilde{y}_t^4\end{bmatrix} = \begin{bmatrix} \beta_1\beta_2\beta_3\beta_4 \\ 0 \quad \beta_2 \quad 0 \quad \beta_4 \\ \cdot \quad \cdot \quad \cdot \quad \cdot \\ \cdot \quad \cdot \quad \cdot \quad \cdot \\ 0 \quad 0 \quad 0 \quad \beta_4 \\ \cdot \quad \cdot \quad \cdot \quad \cdot \\ \cdot \quad \cdot \quad \cdot \quad \cdot \\ 0 \quad 0 \quad 0 \quad \beta_4 or\ 0 \\ 0 \quad 0 \quad 0 \quad \beta_4 or\ 0 \\ 0 \quad 0 \quad 0 \quad \beta_4 or\ 0 \\ 1 \quad 0 \quad 0 \quad 0 \end{bmatrix} \begin{bmatrix} x_t \\ x_{t-1} \\ \cdot \\ \cdot \\ \cdot \\ x_{t-\bar{q}-1} \\ x_{t-\bar{q}} \\ u_t^1 \end{bmatrix} + \begin{bmatrix} 0 & 0 & 0 \\ \gamma_2 & 0 & 0 \\ 0 & \gamma_3 & 0 \\ 0 & 0 & \gamma_4 \end{bmatrix} \begin{bmatrix} \tilde{y}_{t-f}^2 \\ \tilde{y}_{t-M}^3 \\ \tilde{y}_{t-q}^4 \end{bmatrix} + \begin{bmatrix} 0 \\ u_t^{*2} \\ u_t^{*3} \\ u_t^{*4} \end{bmatrix}$$

$$\Longrightarrow \tilde{\boldsymbol{y}}_t = \boldsymbol{Z}_t\boldsymbol{\alpha}_t + \boldsymbol{\Gamma}_t\boldsymbol{w}_t + \boldsymbol{\varepsilon}_t$$

$$\begin{bmatrix} x_{t+1} \\ x_t \\ \cdot \\ \cdot \\ \cdot \\ x_{t-\bar{q}} \\ x_{t-\bar{q}+1} \\ u_{t+1}^1 \end{bmatrix} = \begin{bmatrix} \rho & 0 & . & . & . & 0 & 0 & 0 \\ 1 & 0 & . & . & . & 0 & 0 & 0 \\ 0 & 0 & . & . & . & 0 & 0 & 0 \\ 0 & 0 & . & . & . & 0 & 0 & 0 \\ . & . & . & . & . & . & . & . \\ . & . & . & . & . & . & . & . \\ . & . & . & . & . & . & . & . \\ 0 & 0 & . & . & . & 0 & 0 & 0 \\ 0 & 0 & . & . & . & 1 & 0 & 0 \\ 0 & 0 & . & . & . & 0 & 0 & \gamma_1 \end{bmatrix} \begin{bmatrix} x_t \\ x_{t-1} \\ \cdot \\ \cdot \\ \cdot \\ x_{t-\bar{q}-1} \\ x_{t-\bar{q}} \\ u_t^1 \end{bmatrix} + \begin{bmatrix} 1 & 0 \\ 0 & 0 \\ . & . \\ . & . \\ . & . \\ 0 & 0 \\ 0 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} e_t \\ \zeta_t \end{bmatrix}$$

$$\Longrightarrow \boldsymbol{\alpha}_{t+1} = \boldsymbol{T}\boldsymbol{\alpha}_t + \boldsymbol{R}\boldsymbol{\eta}_t$$

where, $\begin{bmatrix}\boldsymbol{\varepsilon}_t\\ \boldsymbol{\eta}_t\end{bmatrix} \sim N\left(\begin{bmatrix}\mathbf{0}_{4\times1}\\ \mathbf{0}_{2\times1}\end{bmatrix}, \begin{bmatrix}\boldsymbol{H}_t\mathbf{0}\\ \mathbf{0}\boldsymbol{Q}\end{bmatrix}\right)$, $\boldsymbol{H}_t = \begin{bmatrix}0 & 0 & 0 & 0\\ 0 & \sigma_{2t}^{*2} & 0 & 0\\ 0 & 0 & \sigma_{3t}^{*2} & 0\\ 0 & 0 & 0 & \sigma_{4t}^{*2}\end{bmatrix}$, and $\boldsymbol{Q} = \begin{bmatrix}1 & 0\\ 0 & \sigma_1^2\end{bmatrix}$.

The notation corresponds to the system discussed in the state-space representation with $N = 4$, $k = 3$, $m = 93$, $p = 1$, and $r = 2$. As the maximum possible number of days in a quarter is 92, we use the current factor and 91 lags in our state vector. Finally, reflecting the number of days in a quarter, we adjust the number of nonzero elements in the fourth row of the $\boldsymbol{Z}_t$.

References

Anderson, Richard G. and Gascon Charles S., (2009), "Estimating U.S. Output Growth with Vintage Data in a State-Space Framework", Federal Reserve Bank of St. Louis *Review*, July/August, 91(4), pp. 349-69.

Aruoba, S. B. (2008), "Data Revisions Are Not Well-Behaved," *Journal of Money, Credit and Banking*, 40, 319–340.

Aruoba, S. B., Diebold Francis X. and Scotti Chiara, (2009), "Real-Time Measurement of Business Conditions", *Journal of Business and Economic Statistics*, October, Vol. 27, No. 4, pp. 417-427.

Burns, A. F., and Mitchell, W. C., (1946), *Measuring Business Cycles*, New York: NBER.

Diebold, Francis X. and Rudebusch, Glenn D., (1991), "Forecasting Output with the Composite Leading Index: A Real-Time Analysis", *Journal of the American Statistical Association*, September, 86(415), pp. 603-10.

----------, (1996), "Measuring Business Cycles: A Modern Perspective," *The Review of Economics and Statistics*, 78, 67–77.

Diebold, F. X., Rudebusch, G. D., and Aruoba, S. B., (2006), "The Macroeconomy and the Yield Curve: A Dynamic Latent Factor Approach," *Journal of Econometrics*, 131, 309–338.

Dua, P., and Banerji, A., (1999), "An Index of Coincident Economic Indicators for the Indian Economy", *Journal of Quantitative Economics*, 15, 177-201.

----------, (2004), "Coincident Index, Business Cycles and Growth Rate Cycles: The Case of India" in *Macroeconomic Modelling*, ed., K. Krishnamurty and V. Pandit, Oxford University Press.

Durbin, J., and Koopman, S. J., (2001), *Time Series Analysis by State Space Methods*, Oxford University Press.

Evans, M. D. D., (2005), "Where Are We Now?: Real Time Estimates of the Macro Economy," *The International Journal of Central Banking*, September,127–175.

Gartaganis, Arthur J. and Goldberger, Arthur S., (1955), "A Note on the Statistical Discrepancy in the National Accounts", *Econometrica*, April, Vol. 23, No. 2, pp. 166-173.

Hamilton, J. D., (1989), "A New Approach to the Economic Analysis of Nonstationary Time Series and the Business Cycle," *Econometrica*, 57, 357–384.

Harvey, A.C., (1989), *Forecasting, Structural Time Series Models and the Kalman Filter,* Cambridge University Press.

Howrey, E. P., (1978), "The Use of Preliminary Data in Econometric Forecasting", *The Review of Economics and Statistics*, April, Vol. 60, No. 2, pp.193-200.

----------, (1984), "Data Revision, Reconstruction, and Prediction: An Application to Inventory Investment," *Review of Economics and Statistics*, 66,386–393.

Liu, H., and Hall, S. G., (2001), "Creating High-Frequency National Accounts with State-Space Modelling: A Monte Carlo Experiment," *Journal of Forecasting*, 20, 441–449.

Mariano, R. S., and Murasawa, Y., (2003), "A New Coincident Index of Business Cycles Based on Monthly and Quarterly Series," *Journal of Applied Econometrics*, 18, 427–443.

Orphanides, A. and Norden, Simon van, (2002), "The Unreliability of Output-Gap Estimates in Real Time", *The Review of Economics and Statistics*, November, Vol. 84, No. 4, pp. 569-583.

Reserve Bank of India, (1998), "Report of the Working Group on Money Supply", Reserve Bank of India, Mumbai.

----------, (2002), "Report of the Working Group of Economic Indicators", Reserve Bank of India, Mumbai.

----------, (2007), "Report of the Technical Advisory Group on Development of Leading Indicators for the Indian Economy", Reserve Bank of India, Mumbai.

Stock, J. H., and Watson, M.W., (2002), "Macroeconomic Forecasting Using Diffusion Indexes," *Journal of Business & Economic Statistics*, 20, 147–162.

Reserve Bank of India Occasional Papers

Vol. 33, No. 1 & 2: 2012

Asset Pricing Model for Inefficient Markets: Empirical Evidence from the Indian Market

Debasish Majumder*

Over last four decades, empirical research on market efficiency experienced a phenomenal growth covering all sorts of markets ranging from an emerging to a developed one. However, the dilemma of market efficiency still remains intractable. It is more likely that any literature review in respect of market efficiency would produce contradictory results: for a single paper producing empirical evidence supporting the market efficiency, we can perhaps find a contradictory paper which empirically establishes market inefficiency. Paradoxically, popular models in finance developed in 1970s or 1980s were based on the assumption that the market under consideration was efficient. The conventional bond or stock or option pricing models are common examples of this type. In an alternative approach, we propose a transformation on original market returns in the objective of relaxing the strong assumption of market efficiency behind application of an asset pricing model. This modification will widen the scope of rational models on asset pricing ranging from an efficient to an inefficient market.

JEL Classification : G12, G14

Keywords : Capital Asset Pricing Model, Arbitrage Pricing Theory, Efficient market hypothesis

I. Introduction

A generation ago, the efficient market hypothesis was widely accepted by financial economists as a principle to explain the price behavior in a financial market. It was, therefore, the theoretical basis for much of the financial market researches during the 1970s and the 1980s. Among the theories developed at that time, bond, stock and option pricing theories were the leading examples which presumed that the underlying market is informationally efficient. The theory assumed that market prices adjust to new information without delay and, as a result, no arbitrage opportunities exist that would allow investors to achieve above-average returns without accepting above-average risk. This hypothesis is

* Debasish Majumder is Assistant Adviser (dmajumdar@rbi.org.in) in the Department of Statistics and Information Management, Reserve Bank of India. The views expressed in this paper are those of the author alone and not of the institution to which he belongs.

associated with the view that price movements approximate those of a random walk. If new information develops randomly, then so will market prices, making the market unpredictable apart from its long-run uptrend. Under such a backdrop, the Geometric Brownian Motion (GBM) process, also called a lognormal growth process, had gained wide acceptance as a valid model for the growth in the price of a stock over time. The Black-Scholes option pricing model was a common example of the above type of models. Conversely, the Capital Asset Pricing Model (CAPM), or its any modified versions, depends on identifying a "market portfolio" that is mean-variance efficient. Practically, such a portfolio could be any index of an efficient capital market. Thus, a tradition grew according to which it was legitimate to consider any market index as a proxy of such a portfolio. However, prior to the use of the model, the question of the validity of the applicability of efficient market hypothesis to the market under consideration was hardly addressed. Even if such a question is addressed, any literature review in respect of market efficiency would likely to produce contradictory results: for a single paper producing empirical evidences supporting the market efficiency, we can perhaps find a contradictory paper which empirically establishes market inefficiency. In such circumstances, mispricing cannot be avoided in application of asset pricing models for a set of markets whose true nature is unknown to researchers.

For the purpose of avoiding mispricing caused by a standard asset pricing model, several scholars advocate an unconventional approach to asset pricing. One of these approaches might be an unconditional or conditional autoregressive processes which are expected to perform better compared to a standard arbitrage pricing model, particularly when stock returns are predictable through time. Here, the dilemma is that on some occasions, lagged returns cannot explain a major portion of the variation in equity returns. Alternatively, the researcher can select a combination of the market return and lagged returns to develop an empirical model providing a better fit to the equity data. However, critics may question the theoretical justifications of these models.

The question is 'what would be the appropriate asset pricing model for those markets which are not uniformly efficient for all periods?'. The model proposed in the present paper might be an answer. It adopted

methodologies in the line of Majumder (2006)[1]: equity price changes due to investors' sentiments (collective) can be modeled and isolated from original equity price movements (or returns). The residual part is the portion of the equity price (or return) that is governed by the factors which caused a systematic change in it. Such prices (or returns) would correspond to a hypothetical efficient stock market and can be used as an effective input in the bond or stock pricing formula. The process of transforming the original market to a hypothetical market, which is relatively efficient, smooths out, at least partially, the abnormal volatility and large autocorrelations often found in the asset return data without changing the properties of the original asset pricing model. The outcome might be a superior alternative to a conventional model in terms of its greater applicability. The rest of the paper is organised as follows. Section II provides the literature review. Section III describes the asset-pricing model. Section IV provides data description and stylised facts. Section V provides empirical findings. Section VI concludes.

Section II
Literature Review

Beginning with Sharpe (1964) and Lintner (1965), economists have systematically studied the asset pricing theory or, precisely, the portfolio choice theory of a consumer. Sharpe (1964) and Lintner (1965) introduced the Capital Asset Pricing Model (CAPM) to investigate the relationship between the expected return and the systematic risk. From the day CAPM was developed, it was regarded as one of the primary models to price an equity or a bond portfolio. However, economists of the later generation worked out an Intertemporal Capital Asset Pricing Model (ICAPM) and Arbitrage Pricing Theory (APT) which are more sophisticated in comparison with the original CAPM (*e.g.,* Merton, 1973; Ross, 1976). These models and also models for pricing options as developed by Black and Scholes (1973) effectively predict asset returns for given levels of risks which are useful information to an investor in the case of selecting his portfolio or a banker in the case of monitoring the financial health of a company. Over last four decades, investors,

1 Majumder (2006) developed his model for stock pricing in the context of modeling credit risk.

bankers and market researchers used such models to predict asset returns in normal market conditions. The "normal market condition" essentially means equity prices are not driven by any sentiment or stocks are not systematically overvalued or undervalued by the market players. In such circumstances, markets act like efficient markets (*e.g.,* Fama, 1970; Fama, 1991; Fama, 1998). But, an anomaly arises when such conditions are not applicable for a capital market. For example, Chan, Gup & Pan (1997), Rubinstein (2001), Malkiel (2003 & 2005) and many others provided empirical evidences in favour of market efficiency. Conversely, we can provide references of studies by Fama and French (1988), Poterba and Summers (1988), Lo and MacKinlay (1988), Cutler, Poterba and Summers (1989) and Jegadeesh (1990) whose findings are indicative of a market inefficiency.

Over the past 20 years, several scholars documented overtime predictability in stock returns in different set of markets. For developed markets, we can quote examples of Blandon (2007), Jegadeesh and Titman (1993), Gregoriou, Hunter and Wu (2009), Avramov, Chordia, Goyal (2006), Pesaran and Timmermann (1995) and Kramer (1998) who empirically established the existence of autocorrelation in equity returns for daily, weekly and monthly returns. Chen, Su, Huang (2008) observed positive autocorrelation in US stock market even in shorter horizon returns than the daily returns. Similar results for emerging markets were observed by Chang, Lima and Tabak (2004), Mollah (2007) and Harvey (1995a and 1995b). Empirical results by these authors established that in many occasions past returns contain additional information about expected stock returns. In those circumstances, it is expected that an unconditional or a conditional autoregressive process performs better compared to a standard APT model. This might be the motivation of Conrad and Kaul (1988), LeBaron (1992) and Koutmos (1997) to model a stock-return as a suitable autoregressive process. However, many scholars observed that return autocorrelations are sample dependent and may exhibit sign reversals (*e.g.,* Chan, 1993, p. 1223; Knif, Pynnonen & Luoma, 1996, p. 60; McKenzie and Faff, 2005). Alternatively, the combination of the market return and the lagged returns might develop an empirical model providing a better fit to the equity data. However, critics may question about theoretical justifications of this kind of models.

The autocorrelations in equity returns might be an outcome of the scenario when an individual investor's investment decision is atleast partially guided by investors' sentiments (*e.g.,* Barberis, Shleifer & Vishny, 1998; Majumder, 2006). We generally observe that investors' sentiments peak or trough when the market experiences extreme events. The effects gradually reduce with a reduction in volatility and finally reach normal levels with low volatility. Consequently, it can be argued that the equity price today is an outcome of the combined effect of news/information released in the market and subsequent sentiments cultivated by them. Essentially, any analysis on the equity market remains incomplete if the effect of any one of the above two factors is neglected. Because of this feature of the equity market, it is generally observed that equity prices do adjust to new information, but the adjustment process is not instantaneous. Consequently, underreactions and overreactions by investors are common (*e.g.,* Chopra, Lakonishok and Ritter, 1992; Barberis, Shleifer and Vishny, 1998). In the case of such underreactions or overreactions, the equity price gradually adjusts to its fair value after a certain period. Gradual price adjustments after underreaction induce a positive autocorrelation, a price reversal caused by overreaction induces a negative autocorrelation in equity returns. Essentially, underreactions and overreactions are results of market sentiments that lead all the stocks to move in a particular direction resulting in an equity return to be correlated with itself or to any other stock return. In addition to the above, the occasional exuberance or pessimism by investors to certain information leads the stock return to be more volatile. Even in a developed market like the US, it can be observed that equity returns are more volatile than implied by equity fundamentals (*e.g.,* Shiller, 1981; Leroy and Porter, 1981; and Shiller, 1987). These characteristics of the equity return are even common in an emerging market like India and also the volatility in equity return is higher in the developing world as compared to the developed world (see Parametric Portfolio Associates, 2008). These are the common evidence of inefficiencies in emerging markets as well as developed markets.

The standard bond or stock pricing models are not applicable for an inefficient market. In an alternative approach, we have worked out

a model which incorporates market sentiments in the domain of the standard rational model of asset pricing. Our model is applicable for a 'less than' efficient market and, therefore, may be a useful input in investors' toolkits.

Section III
The Asset-pricing Model

The capital market is composed of a continuum of investors who purchase or sell financial assets in the form of equities. We assume that the market is frictionless. However, the behavior of investors is governed by market sentiments. As an example, post-election uncertainty or uncertainty in policies of newly elected governments often induces a panic among investors which subsequently may lead to a major downfall in equity prices. The stock market crash in India on 17th May 2004 was an example (Majumder, 2006). It was the biggest ever fall at that time in a single day's trading in the Indian equity market which occurred due to the panic that the newly elected government could halt economic reforms. The outcome, however, was independent of the fundamentals of Indian firms. Thus, any upturn/downturn in equity prices might be a consequence of any of the hundreds of unforeseen events, such as frauds or war or droughts or hikes/fall in oil prices *etc.* These events are not predictable. All the same, influencing market sentiment they change overall supply/demand conditions and consequently disrupt the stability of markets. While it is impossible to predict ex-ante all of these events causing stock price movements, the common approach to develop an asset pricing model accepted by earlier generation economists include selecting firm-specific and macroeconomic factors which have an influence on general decisions of an investor. These factors are of two kinds: one set of factors is correlated with equity fundamentals and the other set of factors is uncorrelated with them. Ideally, effects of fundamentals on the stock return cause a systematic change in it. This would essentially be the systematic component of the stock return. This component is influenced by factors like the financial health of the firm, implicit market risk and the economy's position in the business cycle, *etc.* The financial health of a firm can be assessed by some parameters like the firm size, the leverage, earnings-to-price ratios, book-to-market equity ratios, *etc.* These factors are responsible for cross sectional

variation in the stock returns. In contrast, nonfundamentals would essentially be the transitory component of the stock return which is influenced by factors like market sentiments and noise. In the short run, the market sentiment influences all the stocks in a specific direction, either upward or downward. The resulting stock returns depart from their fair values. In course of time it reverts to its original position. Therefore, the short-run expectation of the return of a stock depends, with other factors, on the market sentiments. However, in the long run, the market reaches its normal position where the effects of sentiments are zero and, therefore, the expectation would be consistent with fundamentals.

The return based on the firm's equity prices at time t, R_t^E, can be broadly decomposed into two parts: the part that is consistent with equity fundamentals (R_t^{Ex}), the part that is unexplained by fundamentals (R_t^{UEx}):

$$R_t^E = R_t^{Ex} + R_t^{UEx} \tag{1}$$

It can be assumed that R_t^{Ex} is governed by the factor, F_t, which is composed of the linear combination of all factors correlated to fundamentals. Similarly, R_t^{UEx} may be assumed to be governed by market sentiments, S_t, and the noise (e). Market sentiments are unobservable. However we developed an approach to quantify the effects of market sentiments through modelling returns of the market portfolio which is presented in the next section. If the factors, F_t and S_t are linearly related to form R_t^E, we can write:

$$R_t^E = (1-\alpha)F_t + \alpha S_t + e \tag{2}$$

where α is the relative weight to the factor S_t. Any change in equity price is observable from the market. However, the influence of either F or S on the equity price cannot be separated directly. We can segregate the effect of F and S from the equity price under certain reasonable assumptions: factors F and S can be viewed as two assets which form a portfolio E. Consequently, equation (2) can be represented in terms of betas:

$$\beta_{E,S} = (1-\alpha)\beta_{F,S} + \alpha\beta_{S,S} \tag{3}$$

where $\beta_{I,S} = \frac{\text{Covariance}(I,S)}{\text{Variance}(S)}$ gives the sensitivity of the returns on asset I (I=E/F/S) to asset S. By definition, the factor S_t is uncorrelated to that of F_t and e. Therefore,

$$\alpha = \beta_{E,S} \quad (4)$$

A. The Market Sentiments

Our model is based on the basics of isolating effects of non-fundamentals from the equity return. The residual part of which is the component of the equity return governed by the factors which caused a systematic change in it. Therefore, this part can be taken as an input in an asset pricing model. Non-fundamentals would essentially be investors' sentiments. However, effects of investors' sentiments are not observable from the market and also never clearly defined in economics literature. According to the theory of capital markets, news/ information released in the market is the driving force behind an investors' investment decision. However, apart from news/information, an individual investor's investment decision is also guided by collective beliefs, also termed investors' sentiments. Investors' sentiments peak or trough when the market experiences extreme events. We are experienced, in the one extreme, investors' sentiments render into a panic which may lead a sharp downturn in the market index. In the other extreme, positive sentiments may cause a significant rise in the market index. Therefore, the initial step in modeling market sentiments might be based on the assumption that effects of market sentiment are properly summarised into a diversified market portfolio. However, it is not necessarily implied that sentiments are the only factors behind any ups or downs of market returns. Movements in the market return are essentially due to the combined effects of market fundamentals and collective investors' sentiments. Consequently, it is not difficult for a researcher to segregate the above two effects by fitting a linear model.

We can go back to the basics of asset pricing theory that indicates the market portfolio is a well-diversified portfolio, which is the optimal portfolio for at least one utility-maximising investor. Because of the diversified nature of that portfolio, the nonsystematic risks of each asset

sums up net to zero. The only risk that exists in the market portfolio is the systematic risk. Therefore, the return of such a portfolio is regulated by those factors which fuel systematic risk. These factors may be of two types: one linked to fundamentals and others not so linked. Here, unlike the equity of a single firm, fundamentals are more economy-specific than firm-specific. For a given factor structure, we can divide the return of the market portfolio (R_t^M) into two parts: the part consistent with market fundamentals (R_t^{Mx}) and the part unexplained by fundamentals (R_t^{UMx}):

$$R_t^M = R_t^{Mx} + R_t^{UMx} \tag{5}$$

R_t^{Mx} is influenced by the elements like the growth of macro variables, external shocks and any upturn/downturn of domestic/or international markets. Conversely, the components of R_t^{UMx} include investors' sentiment (S_t) and noise (e^M). Investors' sentiment collectively generates underreactions or overreactions to certain information. Consequently, the market return departs from its fair value. In course of time, it reverts to its original position. Therefore,

$$R_t^{UMx} = S_t + e^M \tag{6}$$

Using equations (6), equation (5) can be rewritten as below:

$$R_t^M = S_t + R_t^{Mx} + e^M \tag{7}$$

The market sentiment, S_t, is unobservable. At the same time, it can be defined as the stationary departure of the market return from its fair value. This part of the market return is explained by the exuberance or pessimism by investors to certain information. Consequently, any autocorrelation that is observed in the market return is the result of possible bullish/bearish responses by investors to market information. R_t^{Mx} is the fair value of market return and when this part is estimated by fitting a standard model for predicting market return (see Appendix) we also can get an estimate of S_t. An alternative representation of equation (7) would be

$$E\left(R_t^M - R_t^{Mx}\right) = S_t \tag{8}$$

where E(.) is the expectation operator. Equation (8) reveals that an unbiased estimator of the market sentiment (S_t) is $\left(R_t^M - R_t^{Mx}\right)$.

B. The long run versus short run expectations

The systematic component of the equity return (R_t^{Ex}) would essentially be the part of the return which is consistent with equity fundamentals. In the equation (2), this part is $(1-\alpha)F_t$. Using equations (2), (4) and (8) R_t^{Ex} can be solved as below:

$$R_t^{Ex} = E\left(R_t^{E} - \beta_{E,(M-Mx)}\left(R_t^{M} - R_t^{Mx}\right)\right) \quad (9)$$

where E(.) is the expectation operator. As per our notations, R_t^{Ex} is the part of the equity return consistent with fundamentals and which, therefore, can be explained by an efficient asset pricing model. Unlike the traditional approach, R_t^{Ex} is not the simple expectation of the equity return, but it is the expectation of the equity return where effects of market sentiments on a particular stock have been eliminated. Equation (9) reveals that if a hypothetical equity market is formed with the equity return as $R_t^{EH} = \left(R_t^{E} - \beta_{E,(M-Mx)}\left(R_t^{M} - R_t^{Mx}\right)\right)$ and all other parameters are identical to the existing equity market, then such a market would be an efficient market because, in that market, equities are not systematically overvalued or undervalued by market players and prices are consistent with fundamentals. The above market may be used efficiently as an input in any common bond or stock pricing model.

Let us assume that $\text{ø}\left(F_1, F_2, ----, F_N\right)$ is a general asset pricing model for a common bond or stock where $(F_1, F_2, ----, F_N)$ is the set of factors influencing the value of the underlying asset. In this case, common factors are market returns, interest rates, exchange rates, oil price inflation, *etc.* In the present model, ø is applied on the transformed returns comprising the hypothetical market. The model facilitates to isolate the long run expectation of the asset return (E^L) from the short run expectation (E^s). In the long run, the effects of the market sentiments are zero; therefore, the expectation of the asset return would essentially be:

$$E^L\left(R_t^{E}\right) = E\left(R_t^{EH}\right) = \text{ø}\left(F_1, F_2, ----, F_N\right) \quad (10)$$

On the other hand, in the short run, the expectation of return would be governed by, with other factors, market sentiments and may be assessed from the following equation:

$$E^S\left(R_t^{E}\right) = E\left(R_t^{EH}\right) + \beta_{E,(M-Mx)}E\left(\left(R_t^{M} - R_t^{Mx}\right)\right) = \text{ø}\left(F_1, F_2, ----, F_N\right) + \beta_{E,(M-Mx)}\alpha_M \quad (11)$$

where the intercept (α_M) of regressing the market return on select factors as shown in the appendix gives an estimate of $E\left(R_t^M - R_t^{Mx}\right)$. If the underlying market is efficient, then equity prices instantaneously adjust to new information. In such a case, unenthusiastic or overenthusiastic responses to information, if any, would occur randomly. Consequently, the long-run and the short-run expectation of the equity return would be identical and, therefore, our model would be transformed to a common asset pricing model.

C. The adjustments, when factors F and S are not uncorrelated

News/information released in the market is the driving force behind any systematic or unsystematic changes in the equity return. Unsystematic changes occur due to effects of investors' sentiments on equity prices. Upon these consequences one may argue that occasionally factor F, which is consistent with equity fundamentals, might be correlated to factor S, which is driven by investors' sentiments. In such situation, $\beta_{F,S}$ in equation (3) would be nonzero. We can estimate $\beta_{F,S}$ by the iterative procedure described below. Equation (3) gives an estimate of α in terms of betas:

$$\alpha = \frac{\beta_{E,S} - \beta_{F,S}}{1 - \beta_{F,S}} \tag{12}$$

Using the value of α, the return on the asset F can be evaluated from equation (2) as below:

$$F_t = E\left(\frac{\left(1 - \beta_{F,S}\right)R_t^E - \left(\beta_{E,S} - \beta_{F,S}\right)S_t}{\left(1 - \beta_{E,S}\right)}\right) \tag{13}$$

Let us denote the value of F_t and $\beta_{F,S}$ in the (i-1)th iteration is $F_t(i-1)$ and $\beta_{F,S}(i-1)$ respectively. Based on the equation (13), we can compute the i^{th} approximation of F_t as follows:

$$F_t(i) = \frac{\left(1 - \beta_{F,S}(i-1)\right)R_t^E - \left(\beta_{E,S} - \beta_{F,S}(i-1)\right)S_t}{\left(1 - \beta_{E,S}\right)} \tag{14}$$

Using the above equation, the set of values of $F_t(i)$ can be calculated for t = 1,2,…,n. Accordingly, the i th approximation of $\beta_{F,S}$ would be,

$$\beta_{F,S}(i) = \frac{\text{Covariance}\left(F(i), S\right)}{\text{Variance}\left(S\right)} \tag{15}$$

The first approximation of $\beta_{F,S}$ might be $\beta_{F,S}(1)=0$. Using equation (14) and (15) it is possible to generate a series of appoximations for $\beta_{F,S}$. The process converges if $\left|\beta_{F,S}(i)-\beta_{F,S}(i-1)\right|<\varepsilon$. Accordingly, we can obtain a desired degree of accuracy by considering a smaller ε.

Section IV
Data Description and Stylized Facts

National Stock Exchange (NSE) in India maintains 11 major indices and 14 sectoral indices, details of which are given in the Annex. These indices are computed on a free float-adjusted market capitalisation weighted methodology which is a popular approach. They are comparable across sectors and, therefore, used extensively in empirical research. Among these major and sectoral indices compiled by the NSE, six indices are selected for our empirical analysis. These indices are: S&P CNX Nifty (P1), CNX Nifty Junior (P2), S&P CNX Defty (P3), Bank Nifty (P4), CNX Midcap (P5) and CNX Infrastructure (P6)[2].

Based on these indices, applicability of standard asset pricing models is examined by us for Indian markets. These models have been recognised as useful quantitative tools behind an investor's asset allocation strategies or in monitoring performances of his existing investments. However, these models are useful to the extent they are supported by empirical regularities observed in market returns. Unfortunately, all conventional forms of these models and their empirical validity have been questioned by several scholars over past twenty years (see Bird, Menzies, Dixon, and Rimmer (2010); Majumder (2011)). This tenet of research was the exploration of certain regularities in market returns which were not the fruit of the standard models. Predominant among these observed empirical phenomena would be the predictability of portfolio returns through time. On many occasions, past returns contain additional information about expected asset returns which lead asset returns to be serially correlated. Serial dependence in portfolio returns is evidence in favour of market inefficiency which is examined by us for Indian markets. This test has been performed separately for the original market and the hypothetical market to show that hypothetical market

2 Details of these indices are available in the NSE-India site: www.nse-india.com. Daily portfolio price data are obtained from the above site.

returns are, in general, not autocorrelated and so meet the prerequisites of applying an asset-pricing model.

Section V
Empirical Findings

Prior to manipulating any asset pricing model for predicting equity returns, it is worthwhile to examine whether the capital market is informationally efficient. One effective way to test this might be through investigating serial correlation properties of equity returns. Such test is also useful to examine existence of investors' sentiment in the equity market. In the present paper, the test is performed on daily portfolio returns in the similar line of Jegadeesh (1990). The particular cross-sectional regression model used in the empirical tests is

$$R_{i,t} - \overline{R}_{i,t} = a_{0t} + \sum_{j=1}^{6} a_{jt} R_{i,t-j} + u_{i,t} \qquad (16)$$

where $R_{i,t}$ is the return on the portfolio i in day t, $\overline{R}_{i,t}$ is the mean daily return and $u_{i,t}$ is the random error. a_{it}'s are regression coefficients. Parameter estimation and the test statistics are obtained separately for the original equity market and the hypothetical equity market constructed using the equation (9) of our model. Empirical results based on original equity market are compared with results based on hypothetical equity market. Additionally, on account of exploring the performances of our model in different stress scenarios, we have historically simulated two scenarios based on the daily return volatility. These scenarios are: low to medium volatile scenario and high volatile scenario.

Scenarios can be based on a significant market events in the past (a historical scenario) or on a plausible market event that has yet to happen (a hypothetical scenario). A historical scenario is generated from historical data and is used extensively in financial research (BCBS, 2009). It involves identifying risk factors based on actual historical events. The basic insight of this method is that the events which happened in reality are plausible to reappear. With this method, the range of observed risk factors changes during a historical episode is applied to the portfolio to get an understanding of the portfolio's risk in case such a situation recurs (Blaschke, *et al.,* 2001, p. 6). We have identified historical events which caused large movements in equity returns in the Indian markets

that include equity market crash in May 2004, May 2006, the recent financial crisis that began since July 2007 and many others.

Movements in returns as consequences of these events provide the high volatile scenario and if these consequences are separated from the historical dataset, it gives low to medium volatile scenario. The return distribution of a portfolio under a simulated historical scenario is given by the empirical distribution of past returns on this portfolio. Regression model in the equation (16) has been estimated using daily returns over the period January, 2003 to March, 2009 separately for low to medium volatile scenario and high volatile scenario. Results for the original and the hypothetical market are presented in the table 1 and 2 respectively.

Table 1: Cross Sectional Regression Estimates for the Original Market

Portfolios		**Estimated Regression Coefficient**							**R^2**
		$\hat{a}_0$	$\hat{a}_1$	$\hat{a}_2$	$\hat{a}_3$	$\hat{a}_4$	$\hat{a}_5$	$\hat{a}_6$	
Low to Medium Volatile Scenario	P1	0.162* (3.89)	0.079* (2.26)	-.086* (-2.42)	0.062 (1.75)	-0.063 (-1.75)	-0.067 (-1.89)	-0.038 (-1.06)	0.025
	P2	0.191* (4.09)	0.144* (4.09)	-.086* (-2.42)	0.038 (1.05)	-0.056 (-1.58)	-0.051 (-1.41)	0.002 (0.04)	0.032
	P3	0.171* (3.77)	0.095* (2.69)	-.071* (-1.99)	0.080* (2.24)	-0.066 (-1.86)	-0.042 (-1.18)	-0.031 (-0.86)	0.023
	P4	0.194* (3.10)	0.086* (2.46)	-0.015 (-0.42)	0.036 (1.01)	-.073* (-2.04)	-.076* (-2.12)	-0.022 (-0.61)	0.022
	P5	0.167* (4.13)	0.202* (5.77)	-.114* (-3.17)	0.101* (2.78)	-0.036 (-0.99)	-0.017 (-0.48)	-0.031 (-0.88)	0.050
	P6	0.193* (3.41)	0.102* (2.63)	-0.074 (-1.88)	0.061 (1.56)	-.098* (-2.49)	-0.014 (-0.37)	0.005 (0.15)	0.025
High Volatile Scenario	P1	-0.023 (-0.28)	0.079* (2.15)	-0.055 (-1.51)	0.006 (0.16)	-0.016 (-0.42)	0.003 (0.09)	-0.063 (-1.72)	0.013
	P2	-0.053 (-0.56)	0.176* (4.81)	-0.067 (-1.80)	0.031 (0.83)	-0.038 (-1.03)	-0.003 (-0.07)	-0.042 (-1.14)	0.034
	P3	-0.049 (-0.55)	0.096* (2.63)	-0.031 (-0.85)	0.021 (0.57)	-0.018 (-0.49)	0.016 (0.43)	-.082* (-2.24)	0.016
	P4	-0.044 (-0.43)	0.152* (4.17)	-.082* (-2.22)	0,019 (0.51)	-0.049 (-1.32)	-0.035 (-0.96)	-0.081 (-2.21)	0.038
	P5	-0.037 (-0.47)	0.233* (6.37)	-.099* (-2.64)	0.064 (1.70)	-0.022 (-0.60)	-0.001 (-0.03)	-0.016 (-0.44)	0.055
	P6	-0.136 (-1.20)	0.099* (2.46)	-.080* (-2.01)	0.020 (0.50)	-0.021 (-0.51)	0.001 (0.03)	-.103* (-2.58)	0.025

* Indicates the corresponding coefficient is statistically significant at 5% level of significance.
Note: t-statistics are given in the parantheses.

Table 2: Cross Sectional Regression Estimates for the Hypothetical Market

Portfolios		Estimated Regression Coefficient							R^2
		$\hat{a}_0$	$\hat{a}_1$	$\hat{a}_2$	$\hat{a}_3$	$\hat{a}_4$	$\hat{a}_5$	$\hat{a}_6$	
Low to Medium Volatile Scenario	P1	-.019* (-2.19)	0.159* (4.53)	-0.030 (-0.86)	0.073* (2.06)	-0.063 (-1.76)	0.001 (0.04)	0.026 (0.74)	0.032
	P2	0.020 (0.96)	0.042 (1.19)	-0.059 (-1.70)	-0.041 (-1.18)	0.023 (0.67)	-.078 (-1.98)	0.022 (0.63)	0.013
	P3	-0.013 (-1.01)	0.048 (1.37)	0.014 (0.39)	-0.027 (-0.79)	-.089* (-2.52)	0.070 (1.97)	0.011 (0.31)	0.015
	P4	-0.026 (-0.69)	0.053 (1.51)	-0.004 (-0.13)	-0.023 (-0.65)	0.001 (0.00)	-0.050 (-1.41)	-0.008 (-0.23)	0.006
	P5	0.036 (1.95)	0.127* (3.63)	-0.016 (-0.46)	0.067 (1.89)	-0.017 (-0.47)	0.012 (0.34)	-.099* (-2.78)	0.029
	P6	0.023 (0.94)	0.045 (1.16)	-0.008 (-0.23)	0.016 (0.42)	-0.044 (-1.14)	0.055 (1.44)	0.041 (1.07)	0.009
High Volatile Scenario	P1	0.016 (0.99)	0.037 (1.01)	-0.046 (-1.28)	0.004 (0.11)	-0.059 (-1.62)	-0.065 (-1.78)	-0.034 (-0.94)	0.013
	P2	-0.019 (-0.64)	0.036 (0.99)	-0.056 (-1.55)	-0.002 (-0.06)	-0.067 (-1.83)	-0.057 (-1.58)	0.016 (0.45)	0.013
	P3	-0.012 (-0.55)	-0.100 (2.01)	-0.022 (-0.60)	0.005 (0.42)	-0.052 (-1.41)	0.006 (0.18)	-0.055 (-1.51)	0.017
	P4	-0.001 (-0.03)	0.121* (3.32)	-0.024 (-0.65)	-0.028 (-0.77)	0.020 (0.54)	-0.019 (-0.53)	0.015 (0.41)	0.016
	P5	-0.012 (-0.46)	0.053 (1.45)	-0.051 (-1.41)	-0.012 (-0.35)	-0.009 (-0.25)	-.092* (-2.52)	-0.008 (-0.23)	0.014
	P6	0.030 (0.97)	-0.053 (-1.32)	-0.003 (-0.09)	-0.023 (-0.56)	-0.004 (-0.11)	-0.038 (-0.95)	-0.029 (-0.74)	0.005

* Indicates the corresponding coefficient is statistically significant at 5% level of significance.
Note: t-statistics are given in the parantheses.

Table 1 shows that coefficients for one day lagged return are positive and statistically significant for all sampled portfolios in low to medium volatile scenarios and also in high volatile scenario. Moreover, the coefficient, a_1, is bigger in absolute magnitude than the rest. The results indicate positive first order autocorrelation for returns in the original equity market. In addition to this, table 1 indicates one or more higher order autocorrelations are different from zero for almost all portfolios. However, the average R^2 of the daily cross-sectional regressions is 0.032; *i.e.,* on average the lagged returns considered here can explain 3.2 percent of the cross-sectional variation in individual security returns. Our results are consistent with the findings of earlier authors (see Kramer, 1998; Blandon, 2007). Narasimhan & Pradhan (2003)

tested the validity of CAPM for size based portfolios in Indian markets and they confirmed failure of the model for most of the portfolios. The reason might be over time dependencies of the return series. Contrarily, Table 2 indicates that for almost all occasions, coefficients for lagged returns are not statistically significant for both the scenarios resulting a very low R^2 of regression. Therefore, in general, stock returns in the hypothetical market are not autocorrelated. The results can be verified further by presenting F-statistics under the hypothesis that all slope coefficients are jointly equal to zero.

Table 3: F-Statistics for testing joint significance of all slope coefficients

Portfolios	Original Market		Hypothetical Market	
	Low to Medium Volatile Scenario	High Volatile Scenario	Low to Medium Volatile Scenario	High Volatile Scenario
P1	3.45*	1.57	4.43*	1.60
P2	4.30*	4.41*	1.76	1.60
P3	3.23*	2.12*	2.08	2.09
P4	3.01*	4.91*	0.81	2.04
P5	7.12*	7.21*	3.96*	1.80
P6	2.78*	2.67*	1.01	0.56

* Indicates the F-Statistic is statistically significant at 5% level of significance

Table 3 indicates that for the original market almost all F statistics are statistically significant at 5 per cent significant level indicating all slope coefficients are not jointly equal to zero. However, results are opposite for the hypothetical market where most of the F statistics are statistically insignificant. The results indicate that the original equity market returns are autocorrelated for at least one lag, however the hypothetical market returns are not so autocorrelated.

Section VI
Conclusion

Over last four decades, empirical research on market efficiency experienced a phenomenal growth covering all sorts of markets ranging from an emerging to a developed one. Paradoxically, findings of many of these studies are contradictory even for the same stock market under study. Indian markets might be prominent examples of this controversy.

Conflicting outcomes of econometric tests employed for these emerging markets documented by several authors reveal the fact that market efficiency is often a sample- or situation-dependent phenomenon which makes hard to detect the true nature of these markets. Simultaneously, it becomes difficult to select an asset pricing model which is applicable for these markets. Unfortunately, 'mispricing' might be a common outcome of application of any familiar asset pricing model for these markets whose true nature is unknown to the researcher. The foundation for this mispricing is well encapsulated by the words, irrational exuberance/ or pessimism, which reflect a period when emotions take over and valuation plays at best a limited role in determining equity prices. In these circumstances, stock returns become predictable over time. In Indian markets, on many occasions, the daily equity return is significantly predictable by its own past observations. The CAPM, however, cannot explain such predictability.

In view of widening the applicability of rational models for asset-pricing ranging from an efficient to an inefficient market, we propose a transformation through which the original market would be transformed to a hypothetical market which is relatively efficient. In this framework, we assumed that the equity price today is an outcome of the combined effect of news/information released in the market and subsequent sentiments cultivated by them. The effect of the market sentiment on equity price (or return), however, is unobservable. We developed a model to estimate this component which was subsequently filtered out from original equity returns. The filtered returns were used as inputs in constructing the hypothetical market. In that market, investors' sentiments cannot induce investors to systematically overvalue/ or undervalue a stock and, therefore, apart from the noise, the equity price (or returns) would be governed only by its fundamental value. In this connection, our empirical study for Indian equity market has established the following: original equity market returns are autocorrelated for at least one lag. However the hypothetical market returns are, in general, not so autocorrelated. Therefore, transformed returns comprising the hypothetical market meet the prerequisites of applying an asset-pricing model and, therefore, any conventional bond or stock pricing model could be efficiently manipulated for those returns. The approach will

widen the scope of asset-pricing models ranging from a strict efficient market to an inefficient market.

Appendix: Modeling predictable component of the market return

Dynamics of stock market returns can be modeled efficiently by an ICAPM based approach pioneered by Merton (1973) and Campbell (1993). Some variants of this class of models provide superior in-sample and out-of-sample forecasts (see Guo and Savickas 2006). Adopting Campbell's (1993) results that the conditional excess stock market return, $E\left(R_t^M\right)-r_t^f$, is a linear function of its conditional variance, $\sigma^2_{M,t-1}$, and its conditional covariance with the discount rate shock, $\sigma_{M,DR,t-1}$, our model is translated to:

$$E\left(R_t^M\right)-r_t^f=\alpha_M+\gamma_1\sigma^2_{M,t-1}+\gamma_2\sigma_{M,DR,t-1} \quad \text{(A1)}$$

where α_M is the slope of the regression, γ_1 and γ_2 are regression coefficients. r_t^f is the risk free rate of return. According to Merton (1980) and Andersen *et al.* (2003) realised stock market variance $\left(\sigma^2_{M,t-1}\right)$ is the sum of squared daily excess stock market returns in a specified time period. $\sigma_{M,DR,t-1}$ may be computed by the approach adopted by Guo and Savickas (2006): at first, we can calculate the daily idiosyncratic shock to i th stock using Capital Asset Pricing Model (CAPM):

$$e_{i,t}=R_t^i-\alpha-\beta R_t^M \quad \text{(A2)}$$

where R_t^i is the return on the i th stock. The discount rate shock is the weighted average of all e_i s, the weight for the i th stock is the proportion of market capitalization of the i stock to the total market capitalisation. Using the relation $\sigma_{M,DR,t}=\beta_{M,DR,t}\sigma^2_{DR,t}$, where $\beta_{M,DR,t}$ is the loading of stock market returns on the discount rate shock and $\sigma^2_{DR,t}$ is conditional variance of the discount rate shock, we can rewrite equation (A1) as:

$$R_t^M-r_t^f=\alpha_M+\gamma_1\sigma^2_{M,t-1}+\gamma_2\beta_{M,DR,t-1}\sigma^2_{DR,t-1}+e_t^{M*} \quad \text{(A3)}$$

where e_t^{M*} is the residual of the regression; $E\left(e_t^{M*}\right)=0$. For simplicity, we assume that $\beta_{M,DR,t}\left(\approx\beta_{M,DR}\right)$ is constant across time. In equation (A3), $\sigma^2_{M,t}$ and $\sigma^2_{DR,t}$ are estimated as the variance of daily excess stock market returns and conditional variance of the discount rate shock respectively which are computed based on a stipulated time period.

In an alternative approach, we can fit a GARCH (1,1)-type model for estimating $\sigma^2_{M,t}$ and $\sigma^2_{DR,t}$:

$$\sigma^2_{M,t} = \alpha_0 + \alpha_1 \varepsilon^2_{t-1} + \alpha_2 \sigma^2_{M,t-1} \quad \text{(A4)}$$

$$\sigma^2_{DR,t} = \beta_0 + \beta_1 \varepsilon^2_{t-1} + \beta_2 \sigma^2_{DR,t-1} \quad \text{(A5)}$$

A common interpretation of the intercept, α_M, is that α_M is the deviation of the average market return from its fair value $\left(R_t^{Mx}\right)$. When this deviation is zero the regression model presented in equation (A3) will converge to standard ICAPM model for predicting market return. In that case, estimated fair return would be:

$$R_t^{Mx} = r_t^f + \gamma_1 \sigma^2_{M,t-1} + \gamma_2 \beta_{M,DR,t-1} \sigma^2_{DR,t-1} \quad \text{(A6)}$$

References

Andersen, T., T. Bollerslev, F. Diebold, and P. Labys. (2003), "Modeling and Forecasting Realized Volatility", *Econometrica* Vol.71: 579-625.

Avramov, D., T. Chordia, and M. Goyal. (2006), Liquidity and Autocorrelations in Individual Stock Returns", *The Journal of Finance* Vol. 61: 2365-2394.

Barberis, N., A. Shleifer, and R. Vishny. (1998), "A model of investor sentiment, Journal of Financial Economics", Vol. 49: 307-343.

BCBS, Bank for International Settlements (2009). "Principles for sound stress testing practices and supervision", www.bis.org/publ/bcbs155.pdf.

Bird, R., G. Menzies, P. Dixon, and M. Rimmer (2010). "The economic costs of US stock mispricing, *Journal of Policy Modeling*", doi:10.1016/j.jpolmod.2010.10.010

Black, F., and M. Scholes (1973). "The pricing of options and corporate liabilities", *Journal of Political Economy,* Vol. 81: 637-659.

Blandon, J.G. (2007). "Return Auto correlation Anomalies in two European Stock Markets", *Revista de Análisis Económico,* Vol. 22: 59-70.

Blaschke Winfrid *[et al.]* Stress Testing of Financial Systems: An Overview of Issues, Methodologies, and FSAP Experiences [Online] // International Monetary Fund. - June 2001. - http://www.imf.org/external/pubs/ft/wp/2001/wp0188.pdf.

Cutler, D., J. Poterba, and L. Summers (1989), "What moves stock prices?", *Journal of Portfolio Management* Vol. 15: 4–12.

Campbell, J. (1993). "Intertemporal Asset Pricing Without Consumption Data", *American Economic Review,* Vol. 83: 487-512.

Chan, K. (1993). "Imperfect information and cross-autocorrelation among stock prices:, J*ournal of Finance,* Vol. 48: 1211 –1130.

Chan, K.C., B.E. Gup, and Ming-Shiun. Pan (1997). "International Stock Market Efficiency and Integration: A Study of Eighteen Nations", *Journal of Business Finance & Accounting,* Vol. 24: 803–813.

Chang, E.J., E.J.A. Lima, and B.M. Tabak (2004). "Testing for predictability in emerging equity markets", *Emerging Markets Review,* Vol. 5: 295-316.

Chen, C.R., Y. Su, and Y. Huang (2008). "Hourly index return autocorrelation and conditional volatility in an EAR–GJR-GARCH model with generalized error distribution", *Journal of Empirical Finance,* Vol. 15: 789–798.

Chopra, N., J. Lakonishok, and J.R. Ritter (1992). "Measuring Abnormal Performance: Do Stocks Overreact?", *Journal of Financial Economics,* Vol. 31: 235-268.

Conrad, J., and G. Kaul (1988). "Time-Variation in Expected Return", *The Journal of Business,* Vol. 61: 409-425.

Fama, E.F. (1970). ''Efficient Capital Markets: A Review of Theory and Empirical Work'', *Journal of Finance,* Vol. 25: 383-417.

Fama, E.F. (1991). "Efficient Capital Markets: II", *Journal of Finance,* Vol. 46: 1575-1617.

Fama, E.F. (1998). "Market efficiency, long-term returns, and behavioral finance", *Journal of Financial Economics,* Vol. 49: 283-306.

Fama, E.F., and K.R. French (1988). "Permanent and temporary components of stock market prices", *Journal of Political Economy,* Vol. 96: 246-273.

Finkelstein, B. (2006). *The Politics of Public Fund Investing: How to Modify Wall Street to Fit Main Street*. New York: Touchstone Publisher.

Gregoriou, A., J. Hunter and F. Wu (2009). "An empirical investigation of the relationship between the real economy and stock returns for the United States", J*ournal of Policy Modeling,* Vol. 31: 133–143.

Guo, H., and R. Savickas (2006). "Understanding Stock Return Predictability", Working Paper 2006-019B, Federal Reserve Bank of St. Louis.

Harvey, C.R. (1995a). "Predictable risk and returns in emerging markets", *The Review of Financial Studies,* Vol. 8: 773-816.

Harvey, C.R. (1995b). "The Risk Exposure of Emerging Equity Markets", *World Bank Economic Review,* Vol. 9: 19-50.

Jegadeesh, N. (1990). "Evidence of Predictable Behavior of Security Returns", *The Journal of Finance,* Vol. 45: 881-898.

Jegadeesh, N., and S. Titman (1993). "Returns to buying winners and selling losers: implications for stock market efficiency", Journal of Finance 48: 65-91.

Knif, J., S. Pynnonen, and M. Luoma (1996), Testing for common autocorrelation features of two Scandinavian stock markets, *International Review of Financial Analysis,* Vol. 5: 55– 64.

Koutmos, G. (1997). "Do emerging and developed stock markets behave alike? Evidence from six Pacific Basin stock markets", *Journal of International Financial Markets, Institutions and Money,* Vol. 7: 221–234.

Kramer, W. (1998). "Note: Short-term predictability of German stock returns", *Empirical Economics,* Vol. 23: 635-639.

LeBaron, B. (1992). "Some relations between volatility and serial correlations in stock market returns", *Journal of Business,* Vol. 65: 199–219.

Leroy, S., and R. Porter (1981). "The Present Value Relation: Test Based on Variance Bounds", *Econometrica,* Vol. 49: 555-577.

Lintner, J. (1965). "The valuation of risk assets on the selection of risky investments in stock portfolios and capital budgets", *Review of Economics and Statistics,* Vol. 47: 13-37.

Lo, Andrew.W., and A.C. MacKinlay (1988). "Stock market prices do not follow random walks: Evidence from a simple specification test", *Review of Financial Studies,* Vol. 1: 41-66.

Majumder, D. (2006). "Inefficient markets and credit risk modeling: Why Merton's model failed", *Journal of Policy Modeling,* Vol. 28: 307-318.

Majumder, D. (2011). "Asset Pricing when market sentiments regulate assets returns: evidence from emerging markets", *Journal of Quantitative Economics,* Vol. 9: PP. 89-117.

Malkiel, B.G. (2003). "The Efficient Market Hypothesis and Its Critics", *Journal of Economic Perspectives,* Vol. 17: 59–82.

Malkiel, B.G. (2005). "Reflections on the Efficient Market Hypothesis: 30 Years Later", *The Financial Review,* Vol. 40: 1–9.

McKenzie, M.D., and R.W. Faff (2005). "Modeling conditional return autocorrelation", *International Review of Financial Analysis,* Vol. 14: 23– 42.

Merton, R.C. (1973). "An intertemporal capital asset pricing model", *Econometrica,* Vol. 41: 867-887.

Merton, R. (1980). "On Estimating the Expected Return on the Market: An Exploratory Investigation", *Journal of Financial Economics ,* Vol. 8: 323-361.

Mollah, A.S. (2007). "Testing weak-form market efficiency in emerging market: evidence from Botswana stock exchange", *International Journal of Theoretical and Applied Finance,* Vol. 10: 1077-1094.

Narasimhan S & Pradhan (2003). "Conditional CAPM and Cross Sectional Returns - A Study of Indian Securities Market" may be downloaded from (http://www.nse-india.com/content/press/jun2003b.pdf.

Parametric Portfolio Associates (2008). Emerging Markets: Portfolio structuring to capture long term growth, Emerging Markets Whitepaper, spring, http://www.parametricportfolio.com/.

Pesaran, M.H., and A. Timmermann (1995). "Predictability of Stock Returns: Robustness and Economic Significance", *The Journal of Finance,* Vol. 50: 1201-1228.

Poterba, J., and L. Summers (1988). "Mean Reversion in Stock Prices: Evidence and Implications", *Journal of Financial Economics,* Vol. 22: 27-59.

Ross, S. (1976). "The arbitrage theory of capital asset pricing", *Journal of Economic Theory,* Vol. 13: 341–60.

Rubinstein, M. (2001). "Rational markets: Yes or no? The affirmative case", *Financial Analysts Journal,* Vol. 57: 15–28.

Sharpe, W.F. (1964). "Capital asset prices: A theory of market equilibrium under conditions of risk", *Journal of Finance,* Vol. 19: 425-442.

Shiller, R.J. (1981). "Do Stock Prices Move Too Much To Be Justified by Subsequent Changes in dividends?", *American Economic Review,* Vol. 71: 421-436.

Shiller, R.J. (1987). "Fashions, Fads and Bubbles in Financial Markets", in: Knights, Raiders and Targets, eds., The Impact of the Hostile Takeover, Oxford University Press, UK.

Annex: The source of data

On account of monitoring the performance of the overall economy or a sector of the economy National Stock Exchange (NSE), India maintains 11 major indices and 14 sectoral indices:

Major Indices	Sectoral Indices
S&P CNX Nifty	CNX Auto
CNX Nifty Junior	CNX Bank
CNX 100	CNX Energy
CNX 200	CNX Finance
S&P CNX 500	CNX FMCG
CNX Midcap	CNX IT
Nifty Midcap 50	CNX Media
CNX Smallcap Index	CNX Metals
S&P CNX Defty	CNX MNC
S&P CNX Nifty Dividend	CNX Pharma
CNX Midcap 200	CNX PSU Bank
	CNX Infrastructure
	CNX Realty
	S&P CNX Industry

These indices are computed on a free float-adjusted market capitalisation weighted methodology and are used extensively in empirical research. Historical data for daily closing prices for these indices is available in the NSE-India site. From this list of indices, we have chosen 6 portfolios for our analysis. These portfolios are: S&P CNX Nifty (P1), CNX Nifty Junior (P2), S&P CNX Defty (P3), Bank Nifty (P4), CNX Midcap (P5) and CNX Infrastructure (P6). Data on daily closing prices for these 6 indices for the period January, 2003 to March, 2009 has been downloaded from the above site.

Reserve Bank of India Occasional Papers

Vol. 33, No. 1 & 2: 2012

Recent Trends in Rural Wages: An Analysis of Inflationary Implications

G V Nadhanael*

The study looks at the recent increase in rural wages and its implication for inflation. Using Vector Error Correction Model (VECM), the paper empirically tests for the presence of a wage-price spiral in rural India. The analysis in this paper brings out the following major inferences: (a) increases in real wages have been a recent phenomenon; (b) during 2000-2007 period, real wages remained constant or declined in rural areas and money wages were largely responding to inflation; (c) since 2007, wage changes are not explained by changes in prices, but wages impact prices as increase in real wages has been feeding into cost of production; (d) MGNREGA wages were higher than market wages for most labour supply states indicating that the pressure on market wages in those states could be significant; (e) the coverage of MGNREGA has remained relatively low to exert pressure from demand arising out of cash transfers and (f) reduced work force participation rates in recent period both on account of increased participation in education and withdrawal of female work force as well as shift of labour away from agriculture could have contributed to labour market tightening and increase in wages. The paper also finds that the recent period increase in wages have not resulted in convergence of rural wages across states.

JEL : E24, E31
Keywords : Inflation, Wage-price Spiral, Labour Market Tightening

Introduction

Recent developments in rural wages, especially since 2007 has received much public attention. It has, by now been a well established fact that in the recent years, wages in rural areas have increased at a rate higher than the inflation thereby contributing to increase in real wages (RBI, 2012). This period is also characterised by the introduction of the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) which provides 100 days of wage employment for one member of a family. It has been argued that MGNREGA has been one of the factors that has contributed to increase in wages (CACP, 2012).

* Research Officer, Prices and Monetary Research Division, Department of Economic and Policy Research, Reserve Bank of India, Mumbai. The views expressed in this paper are personal and does not belong to the institution to which the author belong.

While increase in wages could be beneficial for the rural labourers from a social welfare point of view, sustained increase in wages have a number of macroeconomic implications. First, increase in wages, unaccompanied by productivity increases, could lead to a wage-price spiral, thereby offsetting the positive impact of initial increase in real wages on welfare. Second, the ability of public policy, particularly monetary policy to keep inflation under control could be limited if there is pressure from wage-price spiral. Also, if increase in wages in one sector leads to subsequent increase in wages across the economy, the competitiveness of the economy could be negatively impacted, if such wage increases are not matched with productivity increases. In this context, the present study looks at the recent trends in wages to identify whether there has been a structural break in the trend in wages and what are the factors that could explain the recent trends. The paper also looks at the inter-state distribution of wage rates so as to understand whether the recent increase in wages could exert more persistent pressure or it could be a one-off shock.

The paper is organised as follows. Following the introduction we look at the major debates on rural wages in India. This is followed by a short section on data sources available on rural wages. Trends in rural wages are analysed in the next section with special focus on the recent period. This is followed by the analysis of factors that could explain the recent trends in rural wages. The implications of increase in wages for inflation are discussed in the next section followed by conclusions.

Section II
Debates on Trends in Rural Wages in India

The studies in rural wage trends in India started in early 1970s when different scholars tried to analyse the impact of green revolution on rural standard of living. Agricultural wage change was considered an indicator of changes in rural standard of living. A pioneering study on trends in agricultural wages was been undertaken by Bardhan (1970). He found that real wages in Punjab (including Haryana), Delhi and Himachal Pradesh and Western Uttar Pradesh did not show any significant responsiveness to increase in agriculture productivity while

in Kerala, agricultural wages increased more than proportionately to increase in productivity. After analysing the different possible reasons for this, he came to the conclusion that peasant organisations were the most important factor determining this increase in the level of wages. He also concluded that Green Revolution did not have substantial effects on the rural standard of living because it failed to improve the share of rural agricultural labourers in total produce. Krishnaji (1971) and Jose (1974) made use of Agricultural Wages in India (AWI) data to analyse the movements of money wages and real wages across the States and over time. Studying wage movements of male agricultural labourers, they found that money wages were lagging behind rise in prices. They also concluded that interstate variations in wage rates did widen over time. The general conclusion of these studies was that Green Revolution did not have significant impact on the rural standard of living.

Lall (1976) questioned the findings of the earlier studies and argued that these studies had used AWI data, which is subject to a lot of methodological problems, and the conclusions will be altered if one uses National Sample Survey (NSS) data. Again, selection of mid-1960s as the terminal period in the earlier studies would lead to misleading conclusions as the impact of green revolution was felt only after a lag. Sreedhar (1988) also questioned the use of peak period wage rates as the representative wage rate for the year because the peak wage for each crop differed and the time of peak rate also differed in different States.

Another set of studies, which focused on agricultural wage movements, tried to analyse agricultural wage using a demand and supply framework. The first major study in this framework was done by Herdt and Baker (1972). Using AWI data they tried to analyse the trends in agricultural wages. The study concluded that in India the supply curve of labour was perfectly elastic while the demand curve for labour was negatively sloped. This led to a situation in which increases in the demand for labour pushed up the total employment rather than increasing the wages. The study thus gave some useful insights into the problems of the existence of surplus labour. Using

the data from NSS surveys Lall (1976) argued that wages did operate in a demand-supply framework and responded to agricultural growth. According to the study, decline in rural poverty in the 1970s could be considered as an indicator for improving the rural standard of living in India. He argued that the benefits of new technology were shared by both workers and the producers. Acharya (1989) sought to focus on the demand and supply aspects of wage determination. To him there was a decline in real wages during the 1970s, but it was not uniform across States. Effect of poor monsoon, the inflationary spiral created by oil shock and Bangladesh war were some of the factors found to be affecting the agricultural wages in all the States. Coming to the State-specific factors, immobility of people and resources and differential productivity were found to be significant in influencing the wage disparities across States.

Srivastava and Singh (2005) focussed on the rate of growth of real wages in agricultural sector in pre-reform and post-reform period and tried to examine the factors affecting the growth in real wages in the two time periods. The study made use of both rural labour enquiry (RLE) and AWI data for the analysis. The paper argued that there had been an increased growth of real wages in agriculture in the pre reform period. But in the post reform period there was a substantial decline in the growth rate of agricultural real wages in poor States though money wages continued to rise. With regard to the determinants of growth rate, the study found that during the post reform period, the agricultural growth variables have a lesser effect on the growth of real wages. Moreover, investments in agriculture have declined. The growth in wages in post reform period was more from the non-farm diversification of workforce than from the growth of the sector itself. Nadhanael (2005) found that agricultural productivity affects growth of wages over time whereas sectoral distribution of labour force is one of the key determinants of wage disparities across states.

Recent works on rural wages have focused on the determinants of sudden increase in rural wages. Gulati *et al* (2013) found that both ‘push’ and ‘pull’ factors have played a significant role in rising real

farm wages. However, the impact of growth variables was much higher than MGNREGA. Datta *et al* (2012) found that the MGNREGA wages remain more or less equal with the rural wages in majority of the states and therefore, the role of MGNREGA in pushing up market wages may be limited. Majority of these studies, however, remain silent about the inflationary implications of this sudden increase in wages.

Section III
Data sources on Rural Wages

There are five different sources from which data on rural wages are available. They are Agricultural Wages in India (AWI), Rural Labour Enquiry (RLE), National Sample Survey Organisation (NSSO) surveys on Employment and Unemployment, Wage Rates in Rural India (WRRI) and Commission on Agriculture Costs and Prices (CACP) Studies. Before analysing the trends in rural wages, it would be worthwhile to summarise the characteristics of the data available from various sources.

The studies in the 1970s and 1980s mostly used the AWI database as it was the principal data source available. The data is published by the Directorate of Economics and Statistics in two publications *viz.,* Agricultural Situation in India (monthly publication) and annual publication of Agricultural Wages in India. AWI data has, however, always been used by researchers with a precaution. The data is collected without adequate conceptual clarity or proper data collection methodology (Rao, 1972; Himanshu, 2005; and Sharma, 2001; Chavan and Rajashree, 2006). There is no clear definition of wage or worker given by AWI data. There is also no well-defined method to convert kind wages to cash wages.

Rural Labour Enquiry and NSSO are other major sources of data for agricultural and rural wages in India which are compiled from the quinquennial employment and unemployment survey conducted by the NSSO. The data are available only with a gap of five to six years, and therefore is less suitable for analysing the trends over the period due to the problems of end-point comparison (Baby, 1996). However, this data source is considered to be superior to AWI because of its definitional clarity in concepts used and better sampling methodology (Lall, 1976).

It is to be noted that the concept of wage earnings as defined in RLE/ NSSO is the total sum of earnings received in cash and kind (kind being converted into money value) on a current weekly status (employment status of the seven days preceding the date of survey). Earnings in kind include recurring perquisites like food grains, cooked meals, fuel, tobacco etc. and also housing, clothes, shoes, bonus etc. which is non-recurring perquisites. Rural retail price is used for converting kind wages into monetary equivalence (Labour Bureau, 2004).

Costs of cultivation studies, which are an extension of earlier Farm Management Studies, also provide data on wages. The wage rates obtained through these studies are based on a better sampling and estimation technique and are considered as superior to other data sources. However, cost of cultivation studies do not publish the wage estimates on a regular basis. Moreover, there have been changes overtime with respect to the number of crops included in the cost of cultivation studies. Though several independent scholars have tried to work out the wage rates using the CACP studies, lack of data in a published format still act as a problem for using these to analyse the trends in wages.

The Technical Working Group on Rural Retail Prices, set up by the NSSO in 1976 to revise the estimates of Consumer Price Index of Agricultural Labourers (CPI-AL) recommended that wage data of rural workers are to be collected on a continuous basis. Though the data collection started from 1986-87, due to the questions about the veracity of data it was not published till 1998. The wage data are collected on a monthly basis from around 600 villages spread over 66 NSSO defined agro-climatic regions of different states. From 1998 onwards, the data is available in the monthly publication of Indian Labour Journal.

The above review of data sources on rural wages in India brings out the conclusion that the data available from the labour bureau survey of wage rates in rural India could serve as the appropriate database for analysis. The only drawback of this data source is that it is not available for years prior to 1998. Also for our analysis of overall wage movements, we restrict our focus only on the trends in wages of rural unskilled labourers (male) on account of the following reasons. First averaging

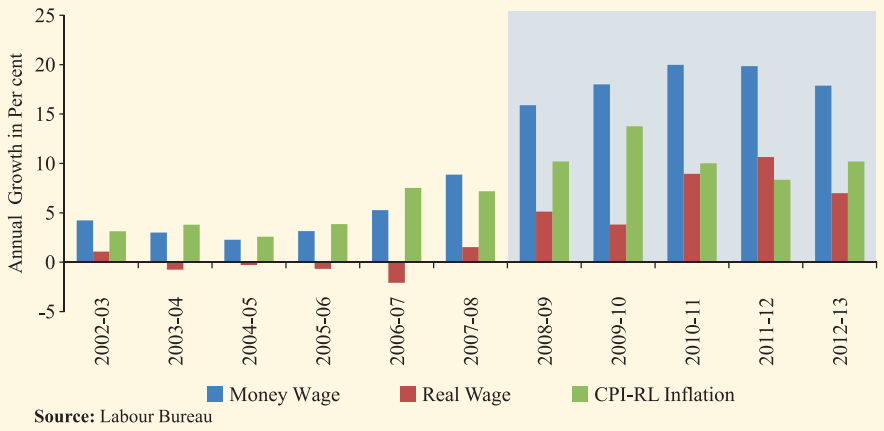
of agricultural wages across occupations may not be meaningful given the seasonal characteristics of agricultural occupations. Also, unskilled labourers have the least bargaining power in the rural areas and therefore, the trends in their wages could be representative of the movements in subsistence wages. Finally, given the greater inter-connectedness of rural labour markets, analysis of wage trends in a single occupation which provides consistent information could be more desirable. For the present analysis, we use data from June 2000 as the all India aggregated data for period 1998-2000 is not comparable with the later data due to changes in methodology of aggregation.

Section IV
Trends in Rural Wages in India

The trends in rural wages since 2000 indicate that there has been a significant pick-up in the pace of increase in rural wages since 2007-08. This increase was far in excess of inflation in rural areas in recent months which led to increase in real wages (Chart 1). This is in contrast to the previous period of early 2000s when the money wage increases remained moderate leading to falling real wages during 2003-04 to 2006-07.

There has been an attempt to study the impact of increase in rural wages on inflation. Empirical estimates based on monthly wages for rural unskilled labourers and CPI inflation (CPI-Rural Labourers-

Chart 1: Wages and Inflation in Rural Areas



Source: Labour Bureau

RL), using granger causality indicated that there is a bi-directional causality between wage inflation and price inflation implying that there is evidence of a wage-price spiral (RBI Annual Report 2011-12, Box: II.8).

This analysis however, presumes that the underlying trend in both wages and inflation has not undergone any major change over the entire period of analysis. However, as we saw above, there has been a significant change in the behaviour of money wages in the recent years. Therefore, one may have to look for the structural break in the wages and inflation and then estimate the relationship separately for the different regimes. Therefore, we first empirically test for the structural break in wage series. Though there are a number of methods to identify the structural break within the series, most of the conventional methodologies like the 'Chow test' require the researcher to make prior assumptions regarding the timing of the structural break. Recent work by Bai and Perron (2003) however, help to estimate and test for structural breaks in a time series endogenously rather than one based on exogenous information. This reduces the risk of specification error by the researcher while making judgement on the timing of structural break. The methodology considers all possible combination of breaks in the series to select that point which minimises the sum of squared residuals in the full-sample. We use the methodology proposed by Bai and Perron (2003) to identify the structural break in wage data[1]. From a time series point of view, though there could be multiple breaks present in the series but we are interested in the most significant break in the wage series and therefore, the test was conducted by imposing a restriction of a single structural break. The result of structural break test is provided in Table 2.

We see that there is a significant break in the money wage growth since July 2007, a comparison of the coefficient of time (growth rate as the specification is log linear) is almost five times higher in the second period as compared to the first. It may noted that this is the period of large scale implementation of MGNREGA which could be a regime change in terms of the overall rural labour market. Therefore, analysing

[1] See Balakrishnan and Parameswaran (2007) for a detailed discussion on use of Bai-perron structural break test.

Table 2: Test for Structural Break in Money Wage Growth

Dependent Variable: Log of Money Wage Sequential F-statistic determined breaks:			1	
Break Test	**F-statistic**	**Scaled F-statistic**	**Critical Value****	
0 vs. 1 *	8024.672	16049.34	14.34	
* Significant at the 0.01 level. ** Bai-Perron (2003) critical values.				
Break dates: 2007M07				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
2000M07 - 2007M06				
C	3.892824	0.003640	1069.450	0.0000
@TREND	0.002910	5.21E-05	55.83045	0.0000
2007M07 - 2012M11 -- 65 obs				
C	2.656859	0.010815	245.6573	0.0000
@TREND	0.014381	7.66E-05	187.8268	0.0000

the wage-price linkage in these two periods in a combined way may lead to distorted results as these two periods are characterised by two distinct regimes.

The earlier study has used granger causality test to see the link between wages and inflation. However, the granger causality is usually conducted in a stationary series by differencing the non-stationary series. This entails a significant loss of information. Moreover, if the series are co-integrated in levels, the granger causality on differenced series may not represent the underlying long-term relation between the variables. In this context, we look at the wages and prices (as represented by price index) at levels to see whether they exhibit stable relationships over the two different regimes.

Section V
Estimation of Wage-Price Linkage

The approach to empirical estimation in the paper for understanding the link between wages and inflation follows the cointegration analysis by estimating long-run relationship between the variables and the short-run dynamics employing vector error correction model (VECM). First,

we test for unit roots to identify the level of integration of the variables and see whether the variables are integrated of the same order. Then we proceed to cointegration tests to see the long-run relationships between wages and prices. Then, the short-run dynamics are analysed by estimating a VECM to check for the presence of stability of relationship between the variables. Finally we also look at the block exogeneity tests to see the direction of relationship between wages and prices. We attempt estimation over the two distinct periods as identified in the analysis of structural break.

The unit root tests indicate that the variables log of money wages (allindia_lmw) and log of CPI-rural labourers price index (allindia_lrl) are non-stationary at levels and stationary at first difference (Table 3).

Given that the variables are non-stationary at levels and stationary at first differences, they are integrated of the order 1. This would help us to test for whether there exists a long-run relationship between the variables. This is done using Johansen's cointegration tests. The lag length was selected to be two based on the Schwarz information criteria (SIC), given the small sample size for both the periods. The results of the cointegration tests are given in Annex 1, which indicate the presence of one co-integrating vector in both the periods under observation.

Given that there is only one co-integrating relationship in both the periods, the specification of the long-run relation has to take into account the nature of endogeneity of the variables. The block exogeneity tests are conducted to identify which variable is exogenous and the specification

Table 3: Unit Root Tests

Variable (X)	Augmented Dickey Fuller (ADF)		Philips Perron (PP)	
	Log X	ΔLog X	Log X	ΔLog X
2000m7 to 2007m6				
AllIndia_MW	0.76	-9.61**	0.92	-9.60**
AllIndia_RL	0.34	-4.13**	-0.30	-4.23**
2007m7 to 2012m11				
AllIndia_MW	0.45	-9.98**	0.49	-9.90**
AllIndia_RL	1.21	-5.27**	1.66	-5.29**

Notes: **denote significance at 1% level. Lag length for ADF test was decided on the basis of SIC.

is formulated appropriately. The results of Wald exogeneity tests for both the periods are presented in Annex 2.

The block exogeneity tests indicate that the long-run relationship in the first period could be specified as one where money wages is the dependant variable and CPI-RL as the explanatory variable. In the second period, the relationship reverses and CPI-RL turn out to be the dependant variable and money wage turn out to be the explanatory variable. The specification and estimated results both for the co-integrating equation and the error correction equation are given below. The lag length for short run equation was selected on the basis of SIC.

ECM Specification

Variables: Y=log (Money Wage), X=log (CPI-RL)

Period 1: July 2000 to June 2007

Long run equation:

$$Y_t = \alpha_{11} + \beta_{11} X_t + \mu_{1t} \quad \text{…. } (1)$$

Short run equation:

$$\Delta Y_t = \sigma_1 + \gamma_{11}\Delta Y_{t-1} + \gamma_{12}\Delta Y_{t-2} + \lambda_{11}\Delta X_{t-1} + \lambda_{12}\Delta X_{t-2} + \theta_1 \mu_{1t-1} + \varepsilon_{1t} \quad \text{…. } (2)$$

Period 2: July 2007 to November 2012

Long run equation:

$$X_t = \alpha_{21} + \beta_{21} Y_t + \mu_{2t} \quad \text{…. } (3)$$

Short run equation:

$$\Delta X_t = \sigma_2 + \lambda_{21}\Delta X_{t-1} + \lambda_{22}\Delta X_{t-2} + \gamma_{21}\Delta Y_{t-1} + \gamma_{22}\Delta Y_{t-2} + \theta_2 \mu_{2t-1} + \varepsilon_{1t} \quad \text{…. } (4)$$

ECM Results

Period 1: July 2000 to June 2007

Long run equation:

$Y_t = 1.24 + 0.91 X_t$ Adj R^2=0.99

t value *(2.3) (-28.6)*

Short run equation:

$\Delta Y_t = 0.0 + 0.16\Delta Y_{t-1} + 0.18\Delta Y_{t-2} + 0.36\Delta X_{t-1} - 0.56\Delta X_{t-2} - 0.49\mu_{1t-1}$ *Adj* R^2=0.27

t value *(1.3) (1.6) (1.8) (1.4) (-2.3) (-5.4)*

Period 2: July 2007 to November 2012

Long run equation:

$X_t = 3.69 + 0.55\ Y_t$ Adj R^2=0.99

t value *(5.7) (-19.0)*

Short-run equation:

$\Delta X_t = 0.0 + 0.77\ \Delta X_{t-1} - 0.24\ \Delta X_{t-2} - 0.12 \Delta Y_{t-1} + 0.18 \Delta Y_{t-2} - 0.05 \mu_{2t-1}$ *Adj* R^2*=0.40*

t value *(1.5) (6.3) (-1.9) (-1.4) (2.1) (1.5)*

The results indicate that the first period was characterised by money wages adjusting to prices. The elasticity of money wages to prices remain above 0.9 indicating that wages were almost identically getting adjusted to price level changes, keeping the real wages constant. If real wages remain constant, the scope of wages feeding into inflation and generating a wage-price spiral is limited. Any disturbance in the long-term relationship was corrected within a short period of time as evident from a high negative error correction term in the short run equation.

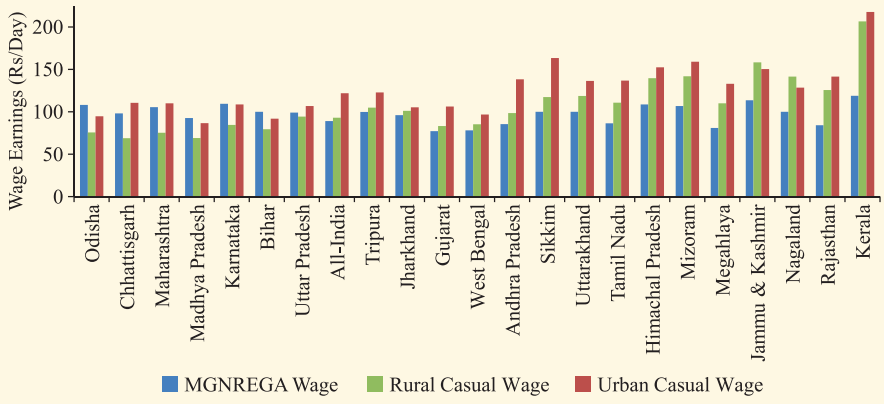
In the second period, wages become a determinant of inflation in the long-term relationship. This could be possible as there has been a significant increase in real wages in the recent period. The wages could have been influenced by a host of factors. Increase in real wages could lead to further inflation as wage cost push up costs of production and thereby lead to further increase in prices. Also wages could push up demand in rural areas thereby leading to pressure on prices from the demand side. The error correction term in the short run equation for the second period has the desirable sign but has a very low value and significant only at about 14 per cent.

Even though we do not find evidence of relationship running from prices to wages during the second period, the Government has indexed MGNREGA wages to CPI-AL, from January 2011which could translate to further wage-price spiral if market wages move in line with MGNREGA wages. Thereby a risk of wage-price spiral cannot be ruled out.

Section VI
What explains increasing wages?

Though MGNREGA is seen as one of the factors responsible for pushing up wage levels, its impact is conditional on whether the current market wages are below or above to the wage rates offered under

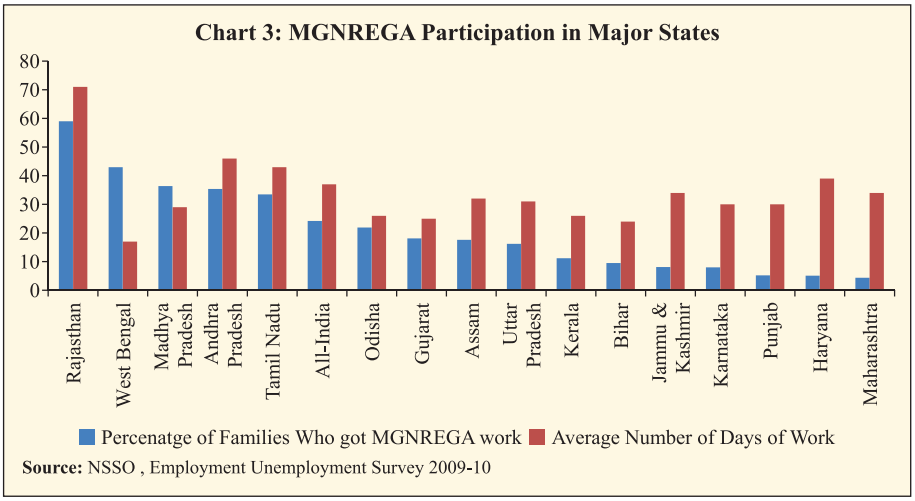
Chart 2: Wage Earnings of Casual Labourers: 2009-10



Source: NSSO, Employment Unemployment Survey 2009-10

MGNREGA. It is found that in all the major labour supplying states (Odisha, Chhattisgarh, Maharashtra, Madhya Pradesh, Bihar and Uttar Pradesh), the wages received under MGNREGA were higher than the wages received in rural labour market (Chart 2). Therefore this could act as a source of pressure as wages could catch up with MGNREGA wage levels. Even in states where the MGNREGA wage is lower than the market wages, there could be pressure on market wages if labourers raise their reservation wages with the introduction of MGNREGA as the opportunity cost of not getting employment declines. Also, if the market wage is set as a mark-up over MGNREGA wage, it could influence the overall wage structure. Also, as the major labour supplying states have MGNREGA wages higher than market wages, it could slowdown migration and thereby influence the wage rates in these states. Further empirical evidence, however, is called for before ascertaining claims on these grounds.

MGNREGA could have provided a floor to overall rural wages and pushed up costs and therefore adding to inflation but the direct impact of MGNREGA in terms of additional demand may be limited. This is because the coverage of MGNREGA so far has not been significant enough to exert major pressure from demand arising out of cash transfers. Overall at the all India level, only 24.2 per cent of the families in rural areas received MGNREGA job and even among them the average number of days of employment is only 37 during 2009-10

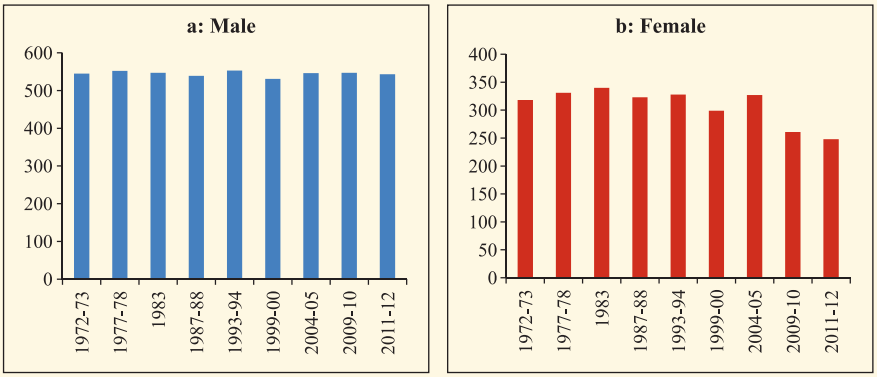


(Chart 3). It is seen that in most states, the number of families covered under MGNREGA is low (less than 50 per cent of rural families) and the number of days of employment under MGNREGA is also much lower than the offer of 100 days of employment.

Apart from the impact of higher inflation and institutional factors such as MGNREGA on wages, another factor which could have influenced the overall wage structure in the rural areas in the recent period is the trends in work force participation rates (WPR). It has been found that there has been a significant decline in work force participation among women in most age groups (Chart 4a&b). Among men, though overall work participation remains almost stable, within the age group of 15-24 there is a significant fall in WPR. Improved educational facilities could explain the withdrawal of young population from work force while decline in female work force participation could be part of the overall development process where with economic development; there is a decline in female work force participation initially before increasing again (the 'U' shaped pattern as referred to in the economic theory). It is also recognised that declining work force participation among women could also be an effect of increasing wages (and therefore increasing welfare) and therefore it would be difficult to establish a one way relationship between increasing wages and work force participation.

Chart 4: Trends in Rural Work Participation Rates (Usual Status)

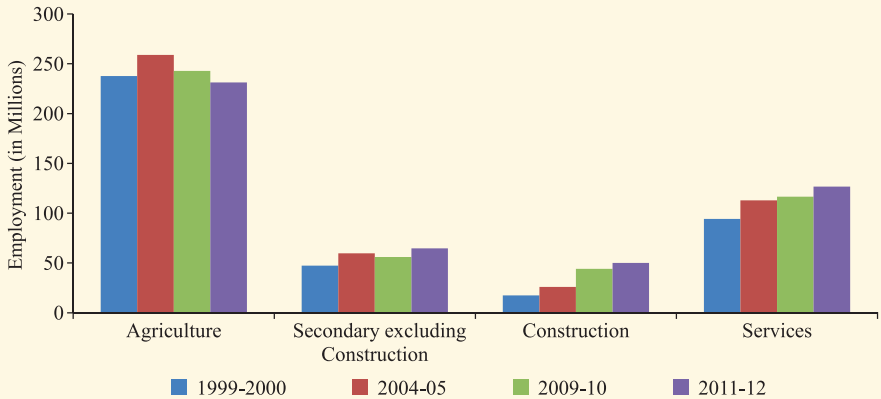
(Per 1000 Population)



Source: NSSO Employment and Unemployment Survey Report No. 554

A decline in work participation rate need not lead to a tightening in labour market, if the total population is increasing. However, labour marker tightening could be significant if along with decline in work force participation rate there is a sectoral shift in employment. Recent evidence in the Indian case indicates that, there has been a decline in absolute number of workers employed in agriculture with construction and services segment attracting more workers out of agriculture (Chart 5). This could have been another additional factor leading to increase in rural wages.

Chart 5: Sectoral Distribution of Workforce: Usual Status



Source: NSSO Survey- Various rounds

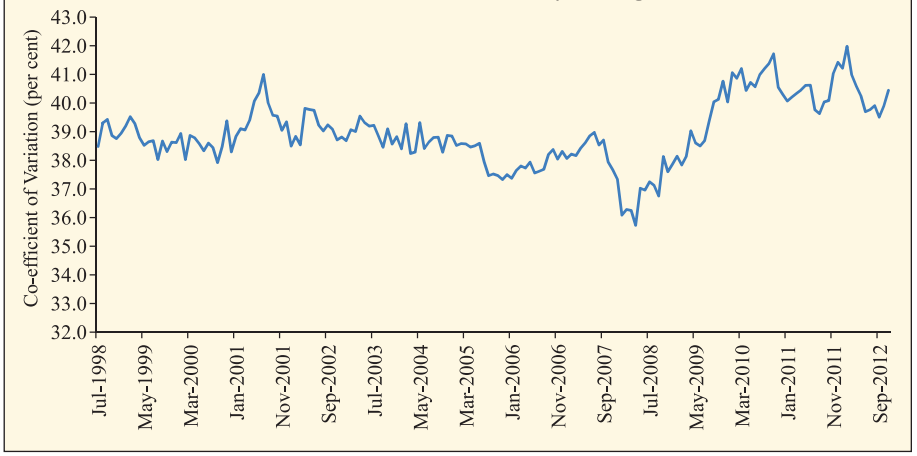
Section VII
Has wages converged in the recent period?

As there has been a significant increase in rural wages since 2007, one critical aspect could be whether this period is also associated with convergence of wage rates across different states. Given that the MGNREGA provides near-uniform wage rates across the states, the low wage states are expected to have a larger pressure from MGNREGA scheme on market wages as compared to the high wage states. On the other hand, if the increase in wages is driven by a reduction in labour supply, or that the market wage is set as a mark-up over the statutory wage, the pressure on wages could be similar in different states. Therefore, identifying whether the wages have converged across states in the recent period could provide important insights into whether the pressure from wages could be temporary or more persistent.

The co-efficient of variation of wages across 20 major states for the period under study is plotted in Chart 6. The chart indicate an increase in variability since 2007 which could indicate that the convergence of wage rates did not occur during the period of high wage inflation.

Following the convergence literature in economic growth, we test for wage convergence across states. Two common ways to assess convergence in the literature is Sigma (σ) convergence and Beta (β)

Chart 6: Inter-state Variability in Wages



convergence. Under σ convergence, if the measure of dispersion of wage across regions declines over time, it could be concluded that the wages are converging and *vice-versa*. The empirical estimation of σ convergence could be attempted by regressing the measure of variation (co-efficient of variation in the present case) over time. A positive and significant coefficient for time variable (t) would imply divergence and negative and significant coefficient for t would denote divergence. The estimated results are:

CV_Wage = 39.9** - 0.018**t (period 2000m7 to 2007m6)

CV_Wage = 30.65** + 0.062**t (period 2007m7 to 2012m11)

** Signficant at 1 per cent

The results indicate that in the first period wages exhibited convergence whereas in the second period wages exhibited divergence.

β convergence is estimated by regressing the growth rate of wages over the initial values. The specification of the regression equation takes the form

$Wg_i=\alpha+ \beta W_{it}$

where W_{gi} is the growth rate of wage in state i over the time period under observation and W_{it} is the initial wage level in the state. If wages are converging, then the low wage states should have a faster growth than high wage states. This would imply a negative relationship between the initial levels and the growth rates. We have estimated trend growth of wages in each state for both the periods using a log linear specification for both the periods. Subsequently, we have regressed the estimated growth rates over the initial wage levels. The estimated results for both the period are as:

$Wg=0.037**-0.00W_{2000}$ (period 2000m7 to 2007m6)

$Wg=0.014**+0.00W_{2007}$ (period 2000m7 to 2007m6) N=20

The β convergence results presented here do not show evidence of either convergence or divergence. The limited number of observations could be a major limitation is estimating β convergence.

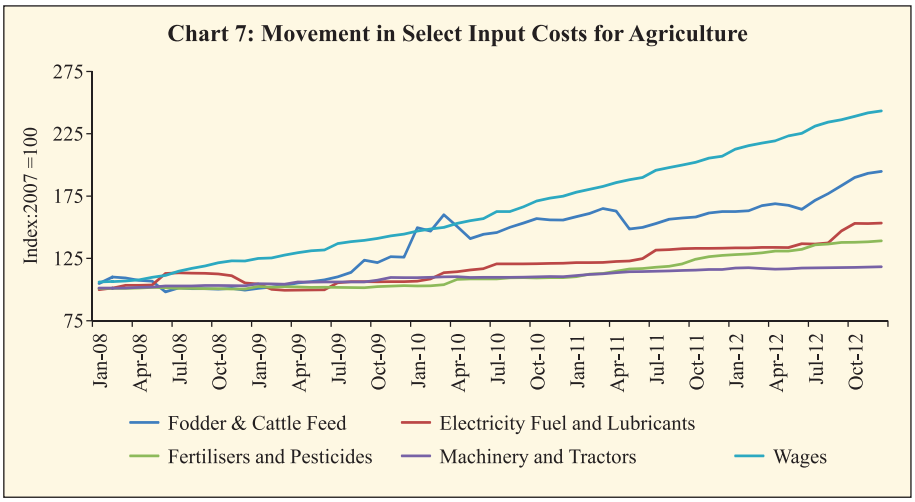
Section VIII
Impact of Rising Wages on Cost of Production

In order to understand the inflationary implications of rising wages, one has to also look at the contribution of wage costs to overall cost of production. Using the limited data available from the CACP reports, we have tried to see how the increase in wages would impact the cost of production. We have computed the share of labour cost in total operational cost for key food items by taking paddy as representative item for cereals, tur (arhar) for pulses and groundnut for oilseeds. The data indicate that labour cost account for a majority of the operational cost in all the crops (Table 4).

Given that labour cost constitute the most important operational cost, the increase in cost of production has been dominated by rising wages. Other costs to production have also gone up significantly in the recent period. However, a comparative analysis of trends in cost of

Table 4: Share of Labour Cost in Total Operational Cost during 2010-11

Paddy		Tur (Arhar)		Groundnut	
States	***Share in %***	***States***	***Share in %***	***States***	***Share in %***
Andhra Pradesh	57.1	Andhra Pradesh	51.5	Andhra Pradesh	51.9
Assam	60.6	Bihar	60.2	Gujarat	29.6
Bihar	60.9	Gujarat	44.2	Karnataka	44.7
Chhattisgarh	45.5	Karnataka	47.5	Maharashtra	43.6
Gujarat	48.4	Madhya Pradesh	51.0	Odisha	58.8
Haryana	54.4	Maharashtra	47.6	Tamil Nadu	54.6
Himachal Pradesh	61.8	Odisha	63.3		
Jharkhand	57.5	Tamil Nadu	61.3		
Karnataka	51.4	Uttar Pradesh	40.1		
Kerala	54.9				
Madhya Pradesh	49.3				
Maharashtra	50.1				
Odisha	64.5				
Punjab	43.8				
Tamil Nadu	47.2				
Uttar Pradesh	48.4				
Uttarakhand	40.1				
West Bengal	63.2				



production in agriculture indicates that the increase in labour cost has surpassed the increase in cost in the case of most other inputs (Chart 7).

This increase in cost of production could also feed into the Minimum Support Prices (MSP). Given that the MSP fixation follows a cost-plus approach, this could result in significant hikes in MSPs and as market prices adjust to higher support prices, further increase in food prices would lead to a spiral. This indicates that the impact of wage increases on inflation has materialised prominently through the cost-push channel. This is also corroborated by the earlier analysis on wage-price spiral.

IX. Conclusion

Looking at the recent trends in rural wages, the paper tries to analyse its implications for inflation. The sharp increases in real wages since 2007 has led to significant changes in the wage-price dynamics in the rural area. While in the period prior to 2007, money wages were responding to changes in prices, in the recent period, prices are determined by wages. Both high and sustained inflation and institutional factors like the introduction of MGNREGA could explain some part of the increase in wages. Apart from this, reduced work force participation rates in recent period both on account of increased participation in education and withdrawal of female work force has also contributed

to labour market tightening and increase in wages. There has also been a shift of labour away from agriculture, further contributing to labour market tightening. State-wise analysis indicates that wages have not converged in the recent period, despite significant increase in wages. This could be on account of significant pressure on market wages even in high wage states. The pressure on inflation from rising wages has been mostly from the cost-push side, given the dominant contribution of increasing wage costs to overall cost of production. This calls for raising agricultural productivity to reduce unit labour costs, so as to enable a real wage growth environment in a non-inflationary manner.

The present study does not empirically test the impact of MGNREGA on rural wages. However, given that the MGNREGA wages are indexed to rural inflation, this could lead to a potential wage-price spiral as the finding indicates that in the recent period causality runs from wages to prices. Also, MGNREGA wages were found to be higher than market wages for most labour supply states indicating that the pressure on market wages in those states could be significant. However, it is also recognised that the coverage of MGNREGA has remained relatively low which could limit the demand pressures. This calls for future work in terms of exploring the possibility of exploring variations in wages across states on the dimensions of participation rates in MGNREGA; the differences in the MGNREGA wage and the market wage as well as indicators of structural changes in rural labour market.

References

Acharya, S. (1989), "Agriculture Wages in India: A Disaggragated Analysis", *Indian Journal of Agricultural Economics, Vol. 44, No.2.*

Baby, A.A. (1996), *Trends in Agricultural Wages in Kerala,* Occasional Paper Series Centre for Development Studies, Trivandrum.

Balakrishnan, Pulapre and M. Parameswaran (2007), "Understanding Economic Growth in India: A Prerequisite" *Economic and Political Weekly*, Vol - 42 No. 27-28, July 14.

Bardhan, P.K. (1970), "The Green Revolution and Agricultural Laborers", *Economic and Political Weekly*, Special Number, July 1970.

Chavan, P. and B. Rajshree (2006), "Trends in Agricultural Wages in India", *Economic and Political Weekly*, Vol. 41, No.38

CACP (2012), "*Report of the Commission on Agricutural Costs and Prices, Khariff, 2012"*, Government of India.

Dutta. Puja, Rinku Murgai, Martin Ravallion and Dominique van de Walle (2012), "Does India's Employment Guarantee Scheme Guarantee Employment?" *World Bank Policy Research Working Paper 6003.*

Gulati. Ashok, Surbhi Jain and Nidhi Satija (2013) *"Rising Farm Wages in India The 'Pull' and 'Push' Factors"* CACP, Department of Agriculture and Co-operation, Government of India

Herdt, R.W. and Baker, E.A. (1972), "Agricultural Wages Production and High Yielding Varieties" *Economic and Political Weekly,* Vol. 7, No. 13.

Himanshu (2005), "Wages in Rural India: Sources, Trends and Comparability", *Indian Journal of Labour Economics*, Vol. 48, Number 2, April-June.

Jose A.V. (1974), "Trends in Real Wage Rates of Agricultural Labourers" *Economic and Political Weekly* Vol. 9, No. 13.

Jushan Bai and Pierre Perron, (2003). "Computation and analysis of multiple structural change models," *Journal of Applied Econometrics*, Vol. 18 No 1 pages 1-22.

Krishnaji, N. (1971), "Wages of Agricultural Labourers", *Economic and Political Weekly* Vol. 6, No. 39.

Labour Bureau (2004), *Rural Labour Enquiry Report on Employment and Unemployment of rural Labour Households 1999-2000*, Ministry of Labour Government of India, Shimla.

Lall, D. (1976), "Agricultural Growth: Real Wages and the Rural Poor in India" *Economic and Political Weekly*, Vol. 11, No. 26.

Nadhanael, G. V (2005), "Wages and Earnings of Agricultural Labourers in India: An Inter- State Analysis", M.Phil Dissertation submitted to the Jawaharlal Nehru University, Centre for Development Studies, Thiruvananthapuram (unpublished).

Rao, V.M. (1972), "Agricultural Wages in India: A Reliability Analysis" *Indian Journal of Agricultural Economics*. Vol 8, No.2.

Reserve Bank of India (RBI), (2012) "Macroeconomic and Monetary Developments in India 2011-12".

Sreedhar,V. (1988) *"Agricultural Wages in TamilNadu 1950-51 to 1980-81", M*Phil Dissertation Submitted to JNU, Centre for Development Studies, Trivandrum (Unpublished).

Srivastava, R and R. Singh (2005) "Economic Reforms and Agricultural Wages in India" *Indian Journal of Labour Economics* Vol. 51. No.3.

Sharma, H.R. (2001), "Employment and Wage Earnings of Agricultural Labourers: A State wise Analysis" *The Indian Journal of Labour Economics,* Vol. 44, No.1.

Annex 1: Co-integration Tests

Period 1: 2000m7 to 2007m6 Series: ALLINDIA_LMW ALLINDIA_LRL				
Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	**Eigenvalue**	**Trace Statistic**	**0.05 Critical Value**	**Prob.****
None * At most 1	0.330781 0.033500	36.60037 2.862237	15.49471 3.841466	0.0000 0.0907
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	**Eigenvalue**	**Max-Eigen Statistic**	**0.05 Critical Value**	**Prob.****
None * At most 1	0.330781 0.033500	33.73814 2.862237	14.26460 3.841466	0.0000 0.0907

Both Trace and Max Eigen value tests indicate the presence of one co-integrating vector.

Sample: 2007M07 2012M11 Series: ALLINDIA_LRL ALLINDIA_LMW Lags interval (in first differences): 1 to 2				
Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	**Eigenvalue**	**Trace Statistic**	**0.05 Critical Value**	**Prob.****
None * At most 1	0.384033 0.070770	36.26751 4.770943	20.26184 9.164546	0.0001 0.3095
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	**Eigenvalue**	**Max-Eigen Statistic**	**0.05 Critical Value**	**Prob.****
None * At most 1	0.384033 0.070770	31.49656 4.770943	15.89210 9.164546	0.0001 0.3095

Both Trace and Max Eigen value tests indicate the presence of one co-integrating vector.

Annex 2: VEC Granger Causality/Block Exogeneity Wald Tests

Sample: 2000M07 2007M06			
Dependent variable: D(ALLINDIA_LMW)			
Excluded	**Chi-sq**	**df**	**Prob.**
D(ALLINDIA_LRL)	5.300195	2	0.0706
All	5.300195	2	0.0706
Dependent variable: D(ALLINDIA_LRL)			
Excluded	**Chi-sq**	**df**	**Prob.**
D(ALLINDIA_LMW)	1.074988	2	0.5842
All	1.074988	2	0.5842

Sample: 2007M07 2012M11			
Dependent variable: D(ALLINDIA_LMW)			
Excluded	**Chi-sq**	**df**	**Prob.**
D(ALLINDIA_LRL)	3.556590	2	0.1689
All	3.556590	2	0.1689
Dependent variable: D(ALLINDIA_LRL)			
Excluded	**Chi-sq**	**df**	**Prob.**
D(ALLINDIA_LMW)	7.320708	2	0.0257
All	7.320708	2	0.0257

Reserve Bank of India Occasional Papers

Vol. 33, No. 1 & 2: 2012

Is India's Trade Balance Sensitive to Real Exchange Rates? A Bilateral Trade Data Analysis

Vivek Kumar and Vishal Maurya*

India's considerable current account is characterised by large merchandise trade deficit even though invisibles account has been in surplus. In this context, this study analysed the effect of real exchange rate on India's bilateral trade balance with her trading partner countries. This is the first attempt to examine the long-run effects of bilateral real exchange rate on bilateral trade balance of India with her 89 trading partner countries. The study uses Fully Modified Ordinary Least Square (FMOLS) method, a non-parametric heterogeneous panel cointegration technique, for removing the endogeneity problem among regressors. The result shows an existence of a long-run relationship between India's trade balance and real exchange rate. India's trade balance would improve with the real depreciation of exchange rate in the long run but deteriorate with the rise of India's real income.

JEL Classification : F31, F41, C33

Keywords : Trade balance, Real depreciation, Exchange rate, Panel Cointegration, Panel FMOLS

Introduction:

India has been experiencing the current account deficit (CAD) with intermittent changes. In 1991, it reached a high of 3 percent of GDP and forex reserves were almost depleted to the level that the import bill could not be financed even for three weeks leading to major balance of payments (BoP) crisis. To overcome this problem, government took several policy initiatives to improve the BoP crisis including acceptance of the chapter VIII of the International Monetary Fund (IMF) thereby making the current account transactions convertible. Accordingly, under the exchange rate management system, the unified exchange rate was accepted and initiatives were taken for promoting the export, attracting non-resident deposits, *etc.*

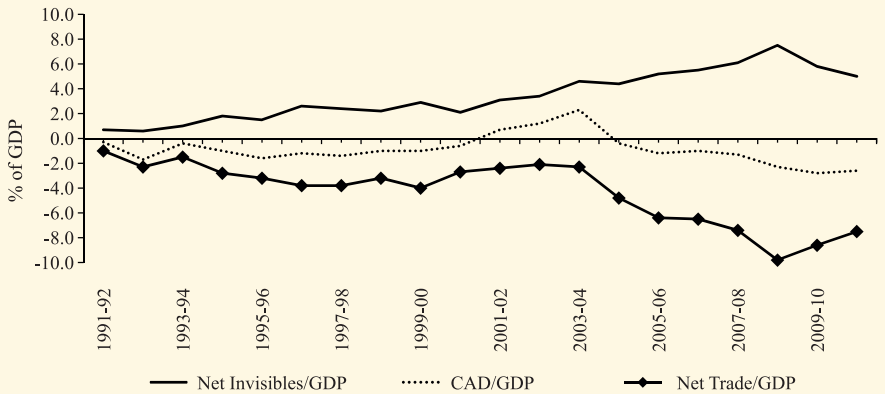
* Vivek Kumar is Assistant Adviser and Vishal Maurya is Research Officer in the Department of Statistics and Information Management (DSIM) of Reserve Bank of India (RBI), Mumbai. The views expressed in the paper are those of the authors and not of the institution to which they belong. The authors are grateful to Dr. O.P. Mall, Adviser, DSIM for his valuable suggestions which improved this article.

Due to these initiatives, the CAD moderated in the range of 1 to 2 percent of GDP till the period 2007-08 including brief surplus period during 2001-02 to 2003-04. In the recent period, large CAD posed a serious concern for the policy makers as it reached to 2.6 percent of GDP in 2010-11 and has remained higher than that level in the subsequent period. Large trade deficit has been the main driver for the CAD even though the invisibles account has remained in a surplus for a long time (Chart 1).

The reason for the merchandise trade deficit in recent years is continuous higher growth in imports as compared to exports. There are two approaches namely internal approach and external approach, which help to reduce trade deficit through increasing country's competitiveness. The internal approach depends on the supply-side policies like curbing inflation, improving labour market conditions, increasing labour productivity, etc., whereas external approach depends on depreciating the local currency.

On the presumption that a simple relationship exists among the exchange rate, the price of imports and exports and the subsequent demand for imports and exports. However, the outcome depends on the price elasticity of demand for both imports and exports. When the exchange rate appreciates or depreciates, the relative prices of imports and exports change. As per the Marshall-Lerner conditions, devaluation/ depreciation of currencies will be effective to correct the adverse trade

Chart 1: Major components of Current Account as percentage of GDP



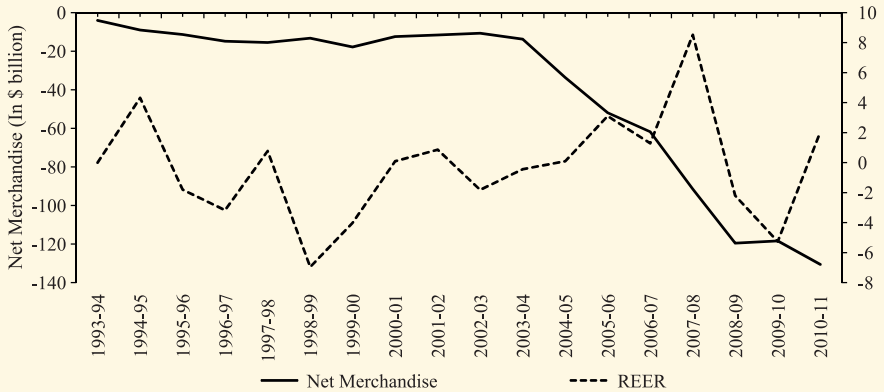
Source: Handbook of Statistics on the Indian Economy.

balance if the sum of elasticity of import and exports is more than unity. Empirical studies show that Marshall-Lerner condition holds in the industrialised countries in the long run even though trade balance would deteriorate in the short run in the event of currency depreciation. For export and import contract made before the depreciation of currency, post-devaluation would increase the import bill which would deteriorate the trade balance in the short run. However, in the long run, imports begin to decline and exports pick up with depreciation of currency. Consequently, deterioration in the trade balance is halted and trade balance condition starts to improve. Such phenomenon is also known as J-curve effect.

The movement of India's trade balance *vis-a-vis* the percentage change in real effective exchange rate based on 36-currency bilateral trade is shown below in Chart 2. It may be observed that depreciation of real exchange rate has impact on improving the bilateral trade for the period 1993-94 to 2003-04 and 2008-09 to 2009-10.

The remainder of the paper is organised as follows: Section II presents a brief overview of studies undertaken on the impact of exchange rate on the trade balance. Section III describes the econometric methodology. Section IV presents the theoretical model used here. Data sources and definitions are provided in the section V along with the empirical results. Section VI, the final section, provides the summary and conclusions.

Chart 2: Movement of Net Merchandise *vis-a-vis* Real Effective Exchange Rate



Source: Handbook of Statistics on the Indian Economy.

Section II
A Brief Literature Review

A number of empirical studies investigate the effects of real exchange rate on India's trade balance. Most of them employ an aggregate approach (see Bahmani-Oskooee (1991), Bahmani-Oskooee and Alse (1994), Buluswar *et al.* (1996), Tarlok Singh (2002) for more details). While these traditional studies use aggregate trade data to investigate export and import demand elasticities in order to establish whether the so-called Marshall-Lerner condition holds, they suffer from an aggregation bias. They overlook significant elasticities with some trading partners, it can be more than offset by insignificant elasticities with other trading partners in the process of aggregation. If the responses to changes in exchange rates differ across trading partners, the aggregate trade flow approach could provide misleading results.

Junz and Rhomberg (1973), Magee (1973), Miles (1979), Levin (1983), Meade (1988), Noland (1989), Rose (1990), Bahmani-Oskooee and Malixi (1992), Boyd et al. (2001), Lee and Chinn (2002), Lal and Lowinger (2002), Hacker and Hatemi-J (2003), and others have a major contribution in the study for aggregate trade data for countries other than India. A number of studies also had been carried out based on bilateral trade to avoid the aggregation base errors. A pioneer work relating to bilateral trade includes Rose and Yellen (1989), Marquez (1990),Bahmani-Oskooee and Brooks (1999), Gupta-Kapoor and Ramakrishnan (1999), Wilson (2001), Bahmani-Oskooee and Kanitpong (2001), Hacker and Hatemi-J (2003, 2004), Bahmani-Oskooee and Goswami (2003), Onafowora (2003), Bahmani-Oskooee and Ratha (2004, 2007). For detailed review of previous studies on bilateral trade, we refer Bahmani-Oskooee and Ratha (2004a). In their study, Bahmani-Oskooee and Ratha (2004a) found that real depreciation of currency has different impact on trade balance in the short run while in the long run the real depreciation of the currency improves the trade balance.

In the context of India, no study on the effect of exchange rate on the bilateral trade has been done except the study by Arora *et al.* (2003) and Dhasmana (2012). Arora *et al.* (2003) have investigated the short-run and the long-run effects of real depreciation of the rupee on India's' trade balance with her seven largest trade partners for quarterly

data of the period 1977-1998. They used the ARDL (Pesaran and Shin 1995, Pesaran *et al.* 1996) technique to investigate the impact of currency depreciation on improving trade balance against seven largest merchandise trade partners. They found a positive impact of real depreciation of currency on India's trade balance with Australia, Germany, Italy and Japan in the long run. Recently, Dhasmana (2012) has supported the finding of Arora *et al.* (2003) and found that real exchange rate volatility depreciation is associated with an improvement in India's trade balance in the long run.

In addition to the limitations of aggregated data, the results of above cited studies suffered from the problem of endogeneity among each variable. Rose and Yellen (1989), Summary (1989) and Bahmani-Oskooee and Wang (2006) showed in their respective studies that trade balance, income, and real exchange rate are endogenous. To avoid this problem of endogeneity, Chiu *et al.* (2010) utilises the fully modified ordinary least squares (FMOLS) approach proposed by Phillips and Hansen (1990) and extended by Pedroni (2000) to investigate the effect of real exchange rate changes on the U.S. trade balance. They found that geographical structure and income per capita of the partner countries may also affect the bilateral trade balance.

In this paper, we follow the Chiu *et al.* (2010) study to examine the effects of bilateral real exchange rates on bilateral trade balance for India *vis-a-vis* eighty nine of her trading partners (see Appendix 2 for the list of countries) for the period 1991-2010. We have considered the data since 1991 due to change in the exchange rate policy from fixed exchange rate regime to floating exchange rate regime. Trade with partner countries can be influenced by many factors like the geographical location of the partner countries, income level of the partner countries, international treaty with the partner country and member of international organisation. Thus, this study classifies the sample data into ten sub-samples to explore whether the locations, international treaty and levels of the real income of the India's trading partners exhibit different impacts on the relationship between currency depreciation and the India's bilateral trade balance. In addition to the ten sub-sample groups, we have also considered one more group of ten

major partner countries which constituted around 55 per cent of India's total trade.

Section III
Empirical methodology

III.1. Panel unit root tests

In this study, we have used the panel unit root tests given by Maddala and Wu (1999, hereafter MW) and Im et al. (2003, hereafter IPS) for testing the level of integration of all the variables. The ability of these tests to allow for heterogeneity in the autoregressive coefficient makes them more powerful than the tests developed by Levin and Lin (1993) and Levin et al. (2002). The IPS tests solved the serial correlation problem of Levin and Lin's tests by assuming the heterogeneity between units in a dynamic panel framework. In IPS test, a separate ADF regression has been specified for each cross section as:

$$\Delta y_{i,t} = \alpha_i + \rho_i y_{i,t-1} + \sum_{j=1}^{p} \phi_{ij} \Delta y_{i,t-j} + \varepsilon_{i,t}; i = 1, 2, ..., N; t = 1, 2, ..., T, \qquad (3.1)$$

where y_i is the variable under consideration, α_i is the individual fixed effect, and p lag period need to be specified for making residuals uncorrelated over time. It tests the null hypothesis that each series in the panel contains a unit root, *i.e.,* $H_0: \rho_i = 0$ for all i against the alternative hypothesis that at least one of the individual series in the panel is stationary, *i.e.*, $\rho_i < 0$ for at least one i.

Im *et al.* (2003) formulated their model under the restrictive assumption that T should be the same for all cross-sections, requiring a balanced panel to compute the $\bar{t}$-test statistic.

The $\bar{t}$ statistic is based on averaging individual Augmented Dickey-Fuller (ADF, hereinafter) statistics and can be written as follows:

$$\bar{t} = \frac{1}{N} \sum_{i=1}^{N} t_{iT}, \qquad (3.2)$$

where t_{iT} is the ADF t-statistic for country i based on the country specific ADF regression, as in Eq. (3.1). IPS showed that under the null hypothesis of non-stationary in panel data framework, the $\bar{t}$ statistic follows the standard normal distribution asymptotically. The standardised statistic t_{IPS} is expressed as:

$$t_{IPS} = \frac{\sqrt{n}\left(\bar{t} - \frac{1}{N}\sum_{i=1}^{N} E[t_{iT}|\rho_i = 0]\right)}{\sqrt{\frac{1}{N}\sum_{i=1}^{N} Var[t_{iT}|\rho_i = 0]}}. \tag{3.3}$$

One can reject the null hypothesis as given above when the t_{IPS} statistic is smaller than a critical value from the lower tail of a standard normal distribution.

MW attempted to provide unit root test statistics, based on Fisher-type non-parametric test (1932), for unbalanced panel. Assuming that there are *N* unit root tests, the *MW* test takes the following form:

$$\lambda = -2\sum_{i=1}^{N} \ln\pi_i \tag{3.4}$$

Where π_i is the probability limit values from regular DF (or ADF) unit root tests for each cross-section *i*. The MW test statistic is distributed as Chi-squared with 2N degrees of freedom under the hypothesis of cross-sectional independence. In order to consider the dependence between cross-sections, MW propose obtaining the π_i -values by using bootstrap procedures by arguing that correlations between groups can induce significant size distortions for the test. MW also propose that the methodology can be applied to panel cointegration tests, whether they are tests using no cointegration as null, or cointegration as null (for more details, see Chapter 6 of Maddala and Kim (1998)).

Breitung (2000) found that the IPS test is more sensitive to the specification of deterministic trends as compared to the MW test. Moreover, the advantage of MW test over IPS test is that the former is robust to the different lag lengths in the individual ADF regressions.

III.2. Panel cointegration tests

Once it is confirmed that all the variables are stationary at first difference, the next step is to test for the cointegration among these variables. For this, we used the panel cointegration tests proposed by Pedroni (1999). Like IPS and MW unit root tests, Pedroni's cointegration methodology (see Pedroni (1999, 2004) for details) also takes into account the heterogeneity by allowing specific parameters to vary across individual members of the sample. The advantage of taking into account of such heterogeneity is that it helps us in relaxing

the unrealistic assumption of identical vectors of cointegration among individuals in the panel.

The implementation of Pedroni's cointegration test requires estimating first the following long-run relationship:

$$y_{it} = \alpha_i + \delta_t + \sum_m \beta_{mi}\, x_{mit} + \varepsilon_{it}, \tag{3.5}$$

for $i = 1, 2,\ldots,N$; $t = 1, 2,\ldots,T$; where N refers to the number of individual members in the panel and T refers to the number of observations over time. The structure of estimated residuals is as follows:

$$\hat{\varepsilon}_{it} = \hat{\rho}_i\, \varepsilon_{it-1} + \hat{u}_{it}\,. \tag{3.6}$$

Pedroni (2004) presents seven tests that can be divided into two groups. The test statistics in the first group (that Pedroni terms the 'within-dimension' or 'panel statistics' test) are averages of the cointegration test statistics across cross-sections. The alternative hypothesis for those tests is $p_i = p < 1$ for all i. The test statistics in the second group (referred to as the 'between-dimension' or 'group statistics' test) are based on averaging the individual estimated values of p_i for each cross-section unit i. The alternative hypothesis for those tests is $p_i < 1$ for all i. For both groups, Pedroni constructs two non-parametric and one parametric test statistics that take autocorrelation into consideration: (i) A Phillips-Perron (1988) type p statistic, (ii) a Phillips-Perron (1988) type t-statistic, and (iii) a Dickey-Fuller (1979) type t-statistic. Pedroni also develops a non-parametric panel variance ratio test statistic.

The finite sample distribution for the seven statistics has been tabulated by Pedroni through Monte Carlo simulations. The calculated test statistic must be smaller than the tabulated critical value to reject the null hypothesis.

III.3. Panel Cointegration estimations

Although Pedroni's methodology allows us to test the presence of cointegration, it cannot provide an estimate of the long-run relationship. For panel frameworks, several estimators are proposed in the presence of cointegration: Ordinary Least Square (OLS), Fully Modified OLS (FMOLS) and Dynamic OLS (DOLS). Chen *et al.* (1999) analysed the properties of the OLS estimator and found that the bias-corrected OLS estimator generally does not improve over the OLS estimator.

These results suggest that alternatives such as the FMOLS estimator or the DOLS estimator may be more promising in cointegrated panel regressions.

In this paper, we have considered FMOLS to examine the effect of exchange rate on India's trade balance. The FMOLS is popular in conventional time series econometrics, for it is believed to eliminate endogeneity in the regressors and serial correlation in the errors. Pedroni (2000, 2001) proposes two methods to apply the fully modified method to panel cointegration regression: the pooled (or within group) panel FMOLS estimator and the group-mean (between-group) FMOLS estimator. We use the between-group FMOLS estimator as it permits greater flexibility in the presence of the heterogeneity of cointegrating vectors.

The group-mean panel FMOLS estimator can be written as:

$$\hat{\beta}^{*}_{GFM} = \frac{1}{N}\sum_{i=1}^{N}\left[\frac{\sum_{t=1}^{T}(x_{it}-\bar{x}_i)y^{*}_{it} - T\hat{\gamma}_i}{\sum_{t=1}^{T}(x_{it}-\bar{x}_i)^2}\right] \tag{3.7}$$

where $y^{*}_{it} = (y_{it}-\bar{y}_i) - \frac{\hat{\Omega}_{21,i}}{\Omega_{22,i}}\Delta x_{it}$ and $\hat{\gamma}_i = \Gamma_{21,i} + \hat{\Omega}^{0}_{21,i} - \frac{\hat{\Omega}_{21,i}}{\Omega_{22,i}}(\Gamma_{22,i} + \hat{\Omega}^{0}_{22,i})$.

Here, $\hat{\Omega}_i = \hat{\Omega}^{0}_i + \hat{\Gamma}_i + \hat{\Gamma}'_i$ is the estimated long-run covariance matrix of the stationary vector consisting of the estimated residuals from the co-integration regression and the deference in independent variables. $\hat{\Omega}^{0}_{21,i}$is the long-run covariance between the stationary error terms (ε_{it} in Eq. (3.5)) and the unit root autoregressive disturbances. $\hat{\Omega}^{0}_{22,i}$ is the long-run covariance among the deference in independent variables. $\hat{\Gamma}_i$ is a weighted sum of the autocovariance and a bar over these letters denotes the mean for *i* members.

As the expression following the summation over the *i* is identical to the conventional time series FMOLS estimator, we see that the between-group estimator can be constructed simply as $\hat{\beta}^{*}_{GFM} = \frac{1}{N}\sum_{i=1}^{N}\hat{\beta}^{*}_{FM,i}$, where $\hat{\beta}^{*}_{FM,i}$ is the conventional FMOLS estimator applied to the ith member of the panel. Likewise, the associated t-statistic for the between-group FMOLS estimator can be constructed as:

$$t_{\beta^*_{GFM}} = \frac{1}{\sqrt{n}} \sum_{i=1}^{N} \left(\hat{\beta}^*_{FM,i} - \beta \right) \left(\hat{\Omega}^{-1}_{11,i} \sum_{t=1}^{T} (x_{it} - \bar{x}_i)^2 \right)^{1/2} \quad (3.8)$$

where β is a value under the null hypothesis. The above t-statistic is standard normal as T and N approach infinity.

Section IV
The Trade Balance Model

The international trade between the countries depends on the relative competitiveness in producing the goods and the national income of the country. In this model, the real exchange rate as proxy of competitiveness of producing goods and real GDP as the proxy for the national income are considered as influencing factors affecting the bilateral trade balance. Therefore, the model is specified as follows:

$$\text{In } TB_{it} = \alpha_i + \beta_1 \ln GDP_{IN,t} + \beta_2 \ln GDP^*_{it} + \beta_3 \ln RER_{it} + \varepsilon_{it} \text{ i=1,2,...,N; t=1,2,...,T} \quad (4.1)$$

where TB_{it} is a measure of trade balance defined as the ratio of India's exports to country i over her imports from country i; GDP_{IN} and GDP_i is real income of India and her ith partner country respectively at constant price of year 2000; $RER_i = E_i \text{ x } CPI_N / CPI_i$ denotes the bilateral real exchange rate between India and her trading partner i where E_i is the nominal exchange rate measured as one unit of INR in terms of the currency of her trading partners i. Here CPI_{IN} and CPI_i is the consumer price index of the India and her trading partners i at constant 2005 price. The real effective exchange rate based on CPI is often regarded as measures of a country's competitiveness. The CPI contains information of prices on final traded and non-traded goods, including imports. Since labor input is often priced in line with CPI growth, one could regard it as a useful indicator for the cost of production (Marsh and Tokarick, 1994). Furthermore, α_i is an unobserved country-specific effect and ε_{it} is the error term. Also, all variable are expressed in natural logarithm.

The volume of exports (imports) to a foreign country (domestic country) ought to increase as the real income and purchasing power of the trading partner (domestic economy) rises, and vice versa. So we expect $\beta_1 < 0$ and $\beta_2 > 0$. However, if the rise in real income is due to an increase in the production of import-substitute goods, imports may decline as income increases in which case $\beta_1 > 0$ and $\beta_2 < 0$. The impact of exchange rate changes on trade balance is ambiguous, that is, β_3 could

be positive or negative. If there is a real depreciation or devaluation of the domestic currency, that is RER decreases, then the increased competitiveness in prices for the domestic country should result in it exporting more and importing less (the "volume effect"). However, the lower RER also increases the value of each unit of import (the "import value effect"), which would tend to diminish the trade balance. Krugman and Obstfeld (2001) argued that in the short run import value effects prevail, whereas the volume effects dominate in the longer run.

Section V
Data and empirical results

V.1 *Data*

The annual data used in this study cover the period from 1991 to 2010. To explore the possible impact of international treaty, locations and the income levels of the India trading partners on the relationship between trade balance and real exchange rate, we classify the 89 trading partners into 11 groups (3 International treaty group, 4 regional group, 3 Income group and a group of Major trade partner countries, see Annex 2 for further details). The first three groups are International treaty group which includes Oil exporting countries, SAARC countries and ASEAN countries. The four regional groups include Africa, America, Europe and Asia and Oceania, and the three income groups based on 2008 gross national income (GNI) per capita (the World Bank Atlas method) are low income (US$975-3,855), middle income (US$3856–$11,905), and high income (US$11,906 or more). The data of exports and imports are taken from the Direction of Trade statistics published by the International Monetary Fund. The domestic and foreign real gross domestic product (GDP), CPI, and nominal exchange rate come from World Development Indicators. In the wake of the European Union and the new currency 'Euro', the nominal exchange rates are defined as one unit of INR in terms of Euros. We convert their nominal exchange rates into one unit of INR in terms of Austrian schilling, Belgian franc, Cypriot pound, Dutch guilder, Estonian kroon, Finnish markka, French franc, German Mark, Greek drachma, Irish pound, Italian lira, Luxembourgish franc, Maltese lira, Monegasque franc, Portuguese escudo, Sammarinese lira, Slovak koruna, Slovenian tolar, Spanish peseta, Vatican lira by multiplying the fixed converted ratios: 13.7603, 40.3399, 0.585274,

2.20371, 15.6466, 5.94573, 6.55957, 1.95583, 340.75, 0.787564, 1936.27, 40.3399, 0.4293, 6.55957, 200.482, 1936.27, 30.126, 239.64, 166.386, 1936.27 respectively.

Limitation of the data: As per guidelines of International Monetary Fund (IMF) or World trade organization (WTO), the data on merchandise trade has been compiled based on the physical movement of goods crossings the boundary of compiling economy. Those goods which do not cross the boundary of the compiling economy will not be recorded in the merchandise trade statistics. As per the guidelines of IMF, the goods exported/imported by the subsidiaries of the Indian companies should be counted in the statistics of those countries where the subsidiaries are incorporated. We have used the Consumer Price Index (CPI) to convert the nominal GDP and nominal exchange rate to real one. As in the case of India, Wholesale Price Index (WPI) is considered as a better price index, but making the data comparable with other countries, we have used CPI.

V.2 *The unit root tests*

The outcome of the two panel unit roots test: IPS and MW are given below. It may be seen that both the tests fails to reject the null hypothesis of unit root for all the groups (Table 1), *i.e.*, the panel data series for the entire four variables at level are non-stationary. Hence, we test for stationary of the variables at first difference and both the IPS and MU test results indicate that variables at first difference are stationary (Table 2). This implies that all the variables under consideration follows an I (1) process.

V.3 Panel Co-integration tests

Since all the variables are stationary at first difference, we employ panel cointegration test (Pedroni, 1999) to test the existence of cointegration among the variables. The results of the tests are given in Table 3. We use four within-group tests and three between-group tests to check whether the panel data are cointegrated. All the tests reject the null hypothesis of no cointegration between the variable at 1 per cent level of significance for the group of all the countries, Africa, America, Europe, Asia & Oceania, HL, ML, and LI whereas for other groups, the null hypothesis is rejected at 5 per cent or 10 per cent level of

Table 1: Panel Unit roots test-At Level

Test	Groups	ln TB		ln GDP_{IN}		ln GDP*		ln RERi	
		Intercept	Intercept & Trend	Intercept	Intercept & Trend	Intercept	Intercept & Trend	Intercept	Intercept & Trend
IPS	Oil Exporting Countries	-0.39 (0.34)	2.25 (0.98)	-2.25*** (0.01)	-0.43 (0.33)	-1.06 (0.14)	-0.54 (0.30)	-1.07 (0.14)	-2.17*** (0.01)
	SAARC	-1.60 ** (0.05)	-0.94 (0.18)	-1.66** (0.04)	-1.06 (0.14)	-2.14** (0.02)	-0.32 (0.37)	1.05 (0.85)	-1.05 (0.14)
	ASEAN	0.01 (0.50)	0.56 (0.71)	-1.66 (0.14)	-1.06 (0.14)	-3.34*** (0.00)	-3.69*** (0.00)	0.69 (0.75)	-1.43* (0.07)
	Africa	-2.83*** (0.00)	-0.46 (0.32)	-0.68 (0.24)	-0.23 (0.40)	-1.07 (0.15)	1.30 (0.90)	-1.35* (0.08)	-1.96** (0.02)
	America	-1.24 (0.10)	0.24 (0.60)	-2.71*** (0.00)	-1.87** (0.03)	-5.09*** (0.00)	-0.29 (0.38)	-1.05 (0.14)	-0.45 (0.32)
	Europe	-1.27 (0.10)	-1.00 (0.15)	-3.41*** (0.00)	-2.02** (0.02)	-7.07*** (0.00)	4.82 (1.00)	-1.83** (0.03)	-1.04 (0.15)
	Asia & Oceania	-1.47* (0.07)	0.77 (0.78)	-4.92*** (0.00)	-0.64 (0.26)	-5.32*** (0.00)	-0.45 (0.32)	1.15 (0.87)	-3.44*** (0.00)
	HL	-0.54 (0.29)	-0.11 (0.45)	-5.46*** (0.00)	-1.47* (0.07)	-9.09*** (0.00)	4.16 (1.00)	0.34 (0.64)	-1.43* (0.07)
	ML	-2.26*** (0.01)	0.37 (0.64)	-2.20*** (0.01)	-1.52** (0.06)	-5.56 (1.00)	-0.96 (0.16)	-1.84** (0.03)	-2.55 (0.18)
	LI	-3.19*** (0.00)	-1.51* (0.06)	-2.71*** (0.00)	-0.31 (0.37)	0.11 (0.54)	1.64 (0.95)	-1.09 (0.13)	-3.43*** (0.00)
	Major Countries	-2.06*** (0.01)	-0.72 (0.23)	-3.94*** (0.00)	-1.84** (0.03)	-7.44*** (0.00)	-0.23 (0.40)	0.56 (0.71)	-1.40* (0.07)
	All Countries 1991-2010	-3.27 (1.00)	-0.47 (0.31)	-6.05 (0.12)	-2.03 (0.22)	-9.03 (0.20)	2.43 (0.99)	-1.44* (0.07)	0.45 (0.66)
MW	Oil Exporting Countries	14.79 (0.54)	4.60 (0.99)	27.04** (0.04)	18.08 (0.32)	19.35 (0.25)	18.73 (0.28)	29.29** (0.02)	34.10*** (0.00)
	SAARC	17.67* (0.06)	15.95 (0.10)	16.02* (0.09)	12.90 (0.22)	19.74** (0.03)	9.22 (0.51)	10.45 (0.40)	14.22 (0.16)
	ASEAN	8.36 (0.59)	5.73 (0.83)	16.02* (0.09)	12.90 (0.22)	29.30*** (0.00)	31.33*** (0.00)	4.90 (0.90)	16.52* (0.08)
	Africa	90.85*** (0.00)	59.40 (0.35)	69.17 (0.11)	52.55 (0.60)	74.86** (0.04)	35.97 (0.98)	78.90** (0.02)	91.22*** (0.00)
	America	40.17 (0.10)	31.36 (0.40)	46.80** (0.02)	39.47 (0.11)	80.8*** (0.00)	33.50 (0.30)	41.47* (0.07)	32.24 (0.35)
	Europe	48.81 (0.16)	51.43 (0.10)	65.50*** (0.00)	50.82 (0.11)	122.49*** (0.00)	7.30 (1.00)	48.30 (0.17)	46.80 (0.21)
	Asia & Oceania	72.98* (0.06)	52.72 (0.59)	108.64*** (0.00)	57.21 (0.42)	136.25*** (0.00)	67.24 (0.14)	59.03 (0.36)	100.26*** (0.00)
	HL#	75.26 (0.31)	79.64 (0.20)	133.88*** (0.00)	77.65 (0.24)	211.64*** (0.00)	32.02 (1.00)	65.07 (0.64)	86.90** (0.09)
	ML	89.36** (0.02)	57.50 (0.76)	90.57** (0.02)	78.24 (0.14)	145.57*** (0.00)	84.28** (0.06)	98.72 (0.12)	108.29 (0.16)
	LI	76.80*** (0.00)	56.54* (0.07)	64.54*** (0.01)	40.30 (0.54)	53.37 (0.11)	27.11 (0.95)	60.80** (0.03)	75.08* (0.09)
	Major countries	32.68** (0.04)	25.35 (0.18)	46.90*** (0.00)	27.52 (0.12)	89.57*** (0.00)	19.15 (0.51)	20.40 (0.43)	39.43*** (0.00)
	All Countries 1991-2010	241.44*** (0.00)	193.68 (0.19)	289.00*** (0.00)	196.22 (0.16)	410.59*** (0.00)	143.41 (0.97)	224.60*** (0.01)	140.08 (0.98)

Notes: P-values are given in parentheses. ***, **, and * indicate the 1%, 5%, and 10% significant levels, respectively.
In the Sequel High income group countries will be denoted as HL, Middle income group countries as ML and Low income countries with LI.

Table 2: Panel Unit roots test-At first difference

Test	Groups	ln TB		ln GDP_{IN}		ln GDP*		ln RERi	
		Intercept	Intercept & Trend	Intercept	Intercept & Trend	Intercept	Intercept & Trend	Intercept	Intercept & Trend
IPS	Oil Exporting Countries	-2.60*** (0.00)	-1.20*** (0.11)	-6.19*** (0.00)	-5.53*** (0.00)	-7.02*** (0.00)	-5.73*** (0.00)	-7.29*** (0.00)	-5.18*** (0.00)
	SAARC	-4.08*** (0.00)	-2.61*** (0.00)	-5.58*** (0.00)	-4.65*** (0.00)	-5.04*** (0.00)	-4.33*** (0.00)	-5.16*** (0.00)	-3.99*** (0.00)
	ASEAN	-4.32*** (0.00)	-3.37 *** (0.00)	-5.58*** (0.00)	-4.65*** (0.00)	-5.30*** (0.00)	-3.91*** (0.00)	-4.74*** (0.00)	-3.00*** (0.00)
	Africa	-9.00*** (0.00)	-5.18*** (0.00)	-9.42*** (0.00)	-6.34*** (0.00)	-7.38*** (0.00)	-4.88*** (0.00)	-10.17*** (0.00)	-5.62*** (0.00)
	America	-8.47*** (0.00)	-5.96*** (0.00)	-8.94*** (0.00)	-6.73*** (0.00)	-7.22*** (0.00)	-5.88*** (0.00)	-6.48*** (0.00)	-4.53*** (0.00)
	Europe	-9.76*** (0.00)	-6.34*** (0.00)	-10.64*** (0.00)	-8.08*** (0.00)	-4.28*** (0.00)	-4.73*** (0.00)	-5.98*** (0.00)	-2.29*** (0.01)
	Asia & Oceania	-7.87*** (0.00)	-5.84*** (0.00)	-11.04*** (0.00)	-9.98*** (0.00)	-10.0*** (0.00)	-9.50*** (0.00)	-10.97*** (0.00)	-7.28*** (0.00)
	HL	-10.24*** (0.00)	-6.53*** (0.00)	-12.75*** (0.00)	-10.70*** (0.00)	-7.40*** (0.00)	-7.62*** (0.00)	-8.72*** (0.00)	-4.48*** (0.00)
	ML	-11.02*** (0.00)	-6.54*** (0.00)	-12.35*** (0.00)	-7.97*** (0.00)	-10.48*** (0.00)	-6.54*** (0.00)	-11.18*** (0.00)	-5.92*** (0.00)
	LI	-8.97*** (0.00)	-6.39*** (0.00)	-9.57*** (0.00)	-8.11*** (0.00)	-8.37*** (0.00)	-7.54*** (0.00)	-10.37*** (0.00)	-9.10*** (0.00)
	Major Countries	-10.07*** (0.00)	-8.53*** (0.00)	-8.21*** (0.00)	-8.41*** (0.00)	-5.63*** (0.00)	-7.20*** (0.00)	-6.35*** (0.00)	-5.31*** (0.00)
	All Countries 1991-2010	-17.49*** (0.00)	-11.02 *** (0.00)	-20.16*** (0.00)	-15.02*** (0.00)	-15.11*** (0.00)	-12.13*** (0.00)	-17.30*** (0.00)	-9.91*** (0.00)
MW	Oil Exporting Countries	33.18*** (0.00)	23.71*** (0.09)	68.58*** (0.00)	58.11*** (0.00)	76.84*** (0.00)	64.50*** (0.00)	80.61*** (0.00)	56.5*** (0.00)
	SAARC	35.72*** (0.00)	24.04*** (0.00)	47.71*** (0.00)	38.01*** (0.00)	43.11*** (0.00)	35.74*** (0.00)	44.07*** (0.00)	33.14*** (0.00)
	ASEAN	37.15*** (0.00)	28.99*** (0.00)	47.79*** (0.00)	38.02*** (0.00)	45.34*** (0.00)	32.81*** (0.00)	40.41*** (0.00)	25.87*** (0.00)
	Africa	203.98*** (0.00)	154.77*** (0.00)	210.8*** (0.00)	175.42*** (0.00)	176.72*** (0.00)	148.56*** (0.00)	229.51*** (0.00)	172.35*** (0.00)
	America	126.09*** (0.00)	96.56*** (0.00)	134.37*** (0.00)	105.54*** (0.00)	110.42*** (0.00)	94.27*** (0.00)	98.04*** (0.00)	76.42*** (0.00)
	Europe	171.31*** (0.00)	125.04*** (0.00)	185.6*** (0.00)	149.68*** (0.00)	81.99*** (0.00)	94.92*** (0.00)	109.8*** (0.00)	62.52*** (0.01)
	Asia & Oceania	172.01*** (0.00)	138.38*** (0.00)	228.77*** (0.00)	205.67*** (0.00)	215.16*** (0.00)	201.12*** (0.00)	227.26 *** (0.00)	160.45*** (0.00)
	HL	247.55*** (0.00)	185.56*** (0.00)	297.22*** (0.00)	264.09*** (0.00)	181.18*** (0.00)	201.81*** (0.00)	207.57*** (0.00)	137.74*** (0.00)
	ML	257.74*** (0.00)	201.85*** (0.00)	286.78*** (0.00)	230.34*** (0.00)	246.43*** (0.00)	199.45*** (0.00)	267.05*** (0.00)	192.02*** (0.00)
	LI	160.38*** (0.00)	116.91*** (0.00)	170.02*** (0.00)	141.36*** (0.00)	154.32*** (0.00)	135.58*** (0.00)	182.64*** (0.00)	162.85*** (0.00)
	Major Countries	119.72*** (0.00)	94.05*** (0.00)	96.07*** (0.00)	91.47*** (0.00)	66.23*** (0.00)	79.32*** (0.00)	76.73*** (0.00)	61.88*** (0.00)
	All Countries 1991-2010	-4.08*** (0.00)	-2.61*** (0.00)	-5.58*** (0.00)	-4.65*** (0.00)	-5.04*** (0.00)	-4.33*** (0.00)	-5.16*** (0.00)	-3.99*** (0.00)

Notes: P-values are given in parentheses. ***, **, and * indicate the 1%, 5%, and 10% significant levels, respectively.

Table 3: Panel cointegration test

Countries	Within-dimension (panel)				Between-dimension (group)		
	v-Stat	ρ-Stat	PP-Stat	ADF-Stat	ρ-Stat	PP-Stat	ADF-Stat
Oil Exporting Countries	0.20 (0.39)	1.51 (0.12)	-1.90* (0.06)	-2.30** (0.02)	2.29** (0.02)	-2.80*** (0.00)	-3.60*** (0.00)
SAARC	-2.15** (0.03)	1.583 (0.11)	-0.64 (0.32)	-3.73*** (0.00)	2.25** (0.03)	-0.66 (0.32)	-5.43*** (0.00)
ASEAN	0.34 (0.37)	-0.43 (0.36)	-3.47*** (0.00)	-3.46*** (0.00)	0.287 (0.38)	-3.58*** (0.00)	-3.58*** (0.00)
Africa	-5.25*** (0.00)	5.99*** (0.00)	-5.58*** (0.00)	-8.72*** (0.00)	7.72*** (0.00)	-8.20*** (0.00)	-8.52*** (0.00)
America	-3.50*** (0.00)	2.67*** (0.01)	-7.26*** (0.00)	-6.07*** (0.00)	4.25*** (0.00)	-11.10*** (0.00)	-6.75*** (0.00)
Europe	-3.26*** (0.00)	4.46*** (0.00)	-7.21*** (0.00)	-8.69*** (0.00)	5.97*** (0.00)	-11.3*** (0.00)	-8.49*** (0.00)
Asia & Oceania	-2.54*** (0.01)	4.14*** (0.00)	-5.10*** (0.00)	-8.06*** (0.00)	5.72*** (0.00)	-6.54*** (0.00)	-9.16*** (0.00)
HL	-3.62*** (0.00)	5.33*** (0.00)	-8.53*** (0.00)	-10.10*** (0.00)	7.35*** (0.00)	-15.00*** (0.00)	-11.10*** (0.00)
ML	-4.70*** (0.00)	6.50*** (0.00)	-7.78*** (0.00)	-8.68*** (0.00)	8.49*** (0.00)	-8.60*** (0.00)	-7.47*** (0.00)
LI	-4.63*** (0.00)	3.42*** (0.00)	-4.11*** (0.00)	-7.91*** (0.00)	4.83*** (0.00)	-5.97*** (0.00)	-9.32*** (0.00)
Major countries	-1.38 (0.15)	1.73* (0.08)	-1.96** (0.05)	-4.03*** (0.00)	2.21** (0.03)	-2.92*** (0.00)	-4.49*** (0.00)
All Countries 1991-2010	-7.63*** (0.00)	10.71*** (0.00)	-11.60*** (0.00)	-15.30*** (0.00)	14.00*** (0.00)	-17.5*** (0.00)	-16.00*** (0.00)

Notes: P-values are given in parentheses. ***, **, and * indicate the 1%, 5%, and 10% significant levels, respectively.

significance. It suggests that there is a long run relationship between the trade balance, exchange rate, GDP of India and GDP of partner country.

V.4. FMOLS Results

The estimation based on the FMOLS for the Groups of countries has been provided in the Table 4. The FMOLS estimates are obtained using the RATS code provided by Peter Pedroni. The coefficient of India's real Income ($lnGDP_{IN}$) and real exchange rate ($lnRER_i$) is negative and statistically significant at 1 per cent level and 5 per cent level respectively for the group of all the countries which indicates that the trade balance will deteriorate with the increase of India's income and the depreciation of the Indian rupees will improve the trade balance

Table 4: Panel Co-integration Estimation for the Group of the Countries

Countries	FMOLS		
	ln GDP_{IN}	ln GDP*	ln RERi
Oil Exporting Countries (including Indonesia)	-3.60*** (-2.67)	4.87** (2.52)	-2.88*** (-3.50)
Oil Exporting Countries (excluding Indonesia)	-4.31*** (-3.82)	5.96*** (4.04)	-3.07 (-0.76)
SAARC	-3.08*** (-2.63)	2.93** (2.42)	0.43 (0.57)
ASEAN	1.06** (2.06)	-1.38*** (-2.92)	-1.49*** (-8.23)
Africa	-0.93*** (-2.59)	0.62** (2.25)	-0.90 (-1.29)
America	-2.57*** (-9.63)	3.70*** (9.28)	-3.33 (-1.44)
Europe	-0.66*** (-10.17)	0.84*** (8.49)	0.32 (1.36)
Asia & Oceania	-2.56*** (-5.38)	3.71*** (4.62)	-1.09*** (-4.30)
HL	-0.91*** (-13.23)	1.67*** (11.62)	-1.55 (-0.86)
ML	-3.47*** (-7.88)	4.79*** (6.66)	-0.89*** (-4.69)
LI	-0.19 (-0.30)	0.97 (0.67)	-1.14 (-0.40)
Major Countries	-0.21*** (-3.81)	1.08** (2.36)	-0.15 (-1.25)
All Countries 1991-2010	-2.35*** (-14.28)	2.88*** (13.13)	-0.74** (-2.22)

Notes: 1. Dependence variable is log TB and t-values are in parentheses.
2. ***, **, and * indicate the 1%, 5%, and 10% significance levels, respectively.

in the long run, respectively. Also, the coefficient of partner country's real income ($lnGDP_i$) is positive and statistically significant at 1 per cent level of significance and is greater than the coefficient of $lnGDP_{IN}$ indicating that the increase in the partner country's real income in comparison to India's real income will improve India's trade balance more effectively.

The empirical results for the three different international treaty groups reveal that the India's bilateral trade balances with her trading partners in SAARC countries become worse if India's real income rises. When the real income rises in SAARC countries, the demand for India's

goods and services increases and the India's trade balance improves. The depreciation of the exchange rate has no impact on improving the India's trade balances with the SAARC countries. In case of the SAARC countries, the income level of the partner countries have the major role in fostering the trade between these countries rather than the exchange rate because of the probable advantage of the proximities of countries in mitigating the transport costs. However, the coefficient of real exchange rate ($lnRER_i$) of ASEAN group is found to be negative and statistically significant which implies that the depreciation of the Indian rupees can improve the bilateral trade balance with ASEAN countries. The real income of India and her trading partners in ASEAN countries has also significant effect on India's trade balance.

In case of the Oil exporting countries, the coefficient of real exchange rate is found to be negative and statistically significant indicating that the depreciation of the real exchange rate would improve the trade balance with the oil countries which is counter-intuitive given the high dependency of India on oil imports. However, on further examination, it was found that the Indonesia has very little share of around 2 per cent of oil export in its total export to India. We therefore, re-estimated the coefficient of the variables for the oil exporting countries excluding Indonesia and not surprisingly found that the real exchange rate is the insignificant factor for improving the trade balance in case of the oil exporting countries.

Like SAARC and ASEAN groups, the real income of India and her partner countries belonging to four regional groups, *i.e.*, Africa, America, Europe and Asia & Oceania, are found to be significant factors affecting the bilateral trade balance of India. The results reveal that the rise in the real income of these countries will improve the trade balance of India. On the other hand, the increase in the India's real income will deteriorate the bilateral trade balance of India with these countries. The coefficient of real exchange rate is statistically significant and carries correct negative signs in case of Asia & Oceania. It implies that the depreciation of the Indian rupee can improve the bilateral trade balance with this group of countries.

Turning to the empirical results for the three income groups, the estimated coefficient of the real exchange rate is found to be negative and statistically significant only in the case of middle income group

countries revealing that depreciation of Indian rupee can improve the bilateral trade balance of India with these countries. The rise in the real income of High income and Middle income group countries can improve the trade balance of India with these countries. In case of Low income group countries, neither the real income nor the real exchange rate has any impact on the India's trade balance with this group. Depreciation of real exchange rate has no impact on improving the trade balance with the major countries whereas the real income of the major countries have a significant effect on improving its trade balance with major partner countries.

In case of ASEAN and Asia & Oceania countries, the coefficient of the exchange rate is less than -1 and statistically significant which fulfils the Marshall-Learner condition of the J-curve. In the long run, therefore, there is a positive impact of the exchange rate depreciation in improving the trade balance with the countries of these groups.

The estimation based on the FMOLS for the 89 individual partner countries is given in the Annex1. The empirical results reveal that real exchange rate is statistically significant at 5 per cent level in 36 countries, out of which, 22 partners countries have the negative sign indicating that real depreciation of Indian rupee can improve the bilateral trade balance of India with these countries. The coefficient of India's real income are statistically significant for 39 partner countries with negative sign at 5 per cent level of significance, indicating that rise in India's real income will deteriorate the bilateral trade balance of India with these countries due to an increase in the imports from these countries. The coefficient of the foreign real income is statistically significant with positive sign in 36 cases whereas 13 cases are found to be statistically significant with a negative sign. The countries with positive sign of coefficient of foreign real income indicate that the rise in the income of these countries will improve the India's trade balance due to increase in the demand for goods and services of India in these countries.

In case of individual trade partner countries, it is observed that there is no impact of real exchange rate depreciation in improving the trade balance with the USA which is in agreement with the study due to Arora *et al.* (2003). However, the effect of exchange rate with Australia, Italy and Japan is found to be insignificant whereas it is significant in

case of UK for improving the trade balance of India contradicting the findings of Arora *et al.* (2003). Also, our empirical findings for India and China are consistent with Arunachalaramanan and Golait (2011) whereby the trade deficit with China can be improved by a depreciation of the real exchange rate. In case of the USA and Australia the national income of the partner countries has a positive impact on India's trade balance as the income of these partner countries increase there will be more demand of the Indian goods. In case of United Kingdom and China, the co-efficient of their real income is negative and significant at 10 per cent level which shows that the rise of their national income would not create the demand for the Indian goods, one of the reasons might be the producing of the same at their home.

In case of some of major partner countries such as with Canada, Norway, Denmark, France, Germany and Sweden, the real exchange rate is positively significant indicating the value effects of real exchange rate with these countries. With the depreciation of the real bilateral exchange rate with these countries, India's trade balance will deteriorate.

Section VI
Conclusion

In the long run, real depreciation of rupee has a negative relation with India's trade deficit *i.e.*, real depreciation of currency is effective in correcting the adverse trade balance through increased competitiveness. In case of trade with the Asia & Oceania and ASEAN countries, the elasticity of import and exports is less than -1 and validates the Marshall-Lerner condition. In the long-run, the real depreciation of INR will improve the trade balance with these groups of the countries. In case of Africa, SAARC, High-income and low income group countries, depreciation of real exchange rate would not improve the trade balance, and more structural measures may be necessary to improve trade balance. India's trade with the oil exporting countries is relatively inelastic due to large oil imports and the effect of real exchange rate on trade deficit is found to be statistically insignificant in these countries excluding Indonesia. In the case of the groups of all countries, the Marshall- Lerner condition (J-curve effect) does not hold due to the aggregation bias. However, the J-curve effect has been observed in the 17 trading partner countries of India where the major countries are Belgium, Indonesia, Malaysia and UAE.

References

Arora, S., Bahmani-Oskooee, M. and Goswami, G. G. (2003). "Bilateral J-curve between India and her trading partners", *Applied Economics*, Vol. 35, pp.1037–41.

Bahmani-Oskooee, M. and Pourheydarian, M. (1991). "The Australian J-curve: a re-examination", *International Economic Journal*, Vol. 5, pp.49–58.

Bahmani-Oskooee, M. and Malixi, M. (1992). "More evidence on the J-curve from LDCs", *Journal of Policy Modeling*, Vol. 14, pp.641–53.

Bahmani-Oskooee, M. and Alse, J. (1994). "Short-Run versus Long-Run Effects of devaluation: Error-Correction Modeling and Cointegration", *Eastern Economic Journal*, Vol. 20, pp. 453–464.

Bahmani-Oskooee, M. and Brooks, T. J. (1999). "Bilateral J-curve between US and her trading partners", *WeltwirtschaftlichesArchiv*, Vol. 135, pp.156–65.

Bahmani-Oskooee, M. and Goswami, G. G. (2003). "A disaggregated approach to test the J-curve phenomenon: Japan vs. her major trading partners", *Journal of Economics and Finance,* Vol. 27, pp.102–13

Bahmani-Oskooee, M., Kanitpong, T., (2001). "Bilateral J-curve between Thailand and her trading partners", *Journal of Economics Development,* Vol. 26, pp.107–117.

Bahmani-Oskooee, M., and A. Ratha (2004a), "J-Curve – A Literature Survey," *Applied Economics*, Vol. 36, Issue 13, pp.1377-98

Bahmani-Oskooee, M., Wang, Y., (2006). "The J curve: China versus her trading partners", *Bulletin of Economic Research* Vol. 58, No.4, pp.323–343.

Bahmnai-Oskooee, M., and A. Ratha (2007). "The Bilateral J-Curve: Sweden versus Her17 Major Trading Partners," *International Journal of Applied Economics*, Vol. 4, No.1, pp.1-13.

Boyd, Derick, Guglielmo Maria Caporale and Ron Smith, (2001), "Real Exchange RateEffects on the Balance of Trade: Cointegration and the Marshall-Lerner Condition,"*International Journal of Finance and Economics,* Vol. 6, pp.187-200.

Breitung, J., 2000. *The Local Power of Some Unit Root Tests for Panel Data*. In B. Baltagi (ed.), Nonstationary Panels, Panel Cointegration, and Dynamic Panels, *Advances in Econometrics*, 15, JAI, Amsterdam, pp.161-178.

Buluswar, M.D., Thompson, H. and Upadhyaya, K.P. (1996) "Devaluation and the trade balance in India: stationarity and cointegration". *Applied Economics*, Vol. 28, pp.429-432.

Chen, B., McCoskey, S. and Kao, C. (1999). "Estimation and Inference of a Cointegrated Regression in Panel Data: A Monte Carlo Study", *American Journal of Mathematical and Management Sciences*, Vol.19, pp.75-114.

Chiu, Y.-B., C.-C.Lee and C.-H. Sun. (2010). "The U.S. trade imbalance and real exchange rate: An application of the heterogeneous panel cointegration method", *Economic Modellings,* Vol. 27, pp.705–716

Dhasmana, Anubha (2012). "India's Real Exchange Rate and Trade Balance: Fresh Empirical Evidence", *IIM Bangalore Research Paper,* 373.

Dickey, D. and W. Fuller (1979), "Distribution of the Estimators for Autoregressive Time serieswith a Unit Root", *Journal of the American Statistical Association,* Vol. 74, pp. 427-431.

Fisher, R. A. (1932). *Statistical Methods for Research Workers,* Oliver & Boyd,Edinburgh, 4th Edition.

Gupta-Kapoor, A. and Ramakrishnan, U. (1999). "Is there a J-curve? A new estimation for Japan", *International Economic Journal,* Vol. 13, pp.71–9.

Hacker, R. S. and Abdulnasser, H.-J. (2003). "Is the J-curve effect observable for small North European economies?", *Open Economies Review,* Vol. 14, pp.119–34.

Hacker, R.S., Hatemi-J, A., 2004. The effect of exchange rate changes on trade balances in the short and long run: evidence fromGerman trade with transitional Central European economies", *Economics of Transition,* Vol. 12, pp.777–799.

Im, K.S, M.H Pesaran& Shin, Y. C (2003). "Testing for units roots in heterogeneous panels", *Journal of Econometrics*, Vol. 115, pp.53-74.

Junz, H. B. and Rhomberg, R. R. (1973). "Price-competitiveness in export trade among industrial countries", *American Economic Review,* Vol. 63, No.2, pp.412–18.

Kao, C., & Chiang, M.H (2000). "On the estimation and inference of a cointegrated regression in panel data", *Advances in Econometrics*, Vol. 15, pp.179-222.

Krugman, P. and Obstfeld, M. (2001), *International Economics: Theory and Policy,* 5th ed., Addison-Wesley, New York.

Lal, A. K. and Lowinger, T. C. (2002). "The J-curve: evidence from East Asia", *Journal of Economic Integration,* Vol. 17, pp.397–415.

Lee, J. and Chinn, M. D. (2002). "Current account and real exchange rate dynamics in the G-7 countries", *IMF Working Paper,* (#WP/02/130).

Levin, J. H. (1983). "The J-curve, rational expectations, and the stability of the flexible exchange rate system", *Journal of International Economics*, Vol. 15, pp.239–51.

Levin, A., & Lin, C. F. (1993). "Unit Root Tests in Panel Data: New Results", Discussion paper, Department of Economics, UC-San Diego.

Levin, A., Lin, C., & Chu, C. (2002). "Unit root test in panel data: asymptotic and finite sample properties", *Journal of Econometrics*, Vol. 108, No.1, pp.1-24.

Maddala, G.S., & Wu, S. (1999). "A comparative study of unit root tests with panel data and new simple test", *Oxford Bulletin of Economics and Statistics*, Vol. 61, pp.631-652.

Magee, S. P. (1973). "Currency contracts, pass through and devaluation", *Brooking Papers on Economic Activity,* Vol. 1, pp.303–25.

Marquez, J. (1990) "Bilateral Trade Elasticities", *The Review of Economics and Statistics,* Vol. 72, No.1, pp.70-77.

Marsh, Ian W., and Stephen P., Tokarick (1994). "Competitiveness Indicators: A Theoreticaland Empirical Assessment", *IMF Working Paper*, WP/94/29

Meade, E. E. (1988). "Exchange rates, adjustment, and the J-curve", *Federal Reserve Bulletin,* October, pp.633–44.

Miles, M. A. (1979). "The effects of devaluation on the trade balance and the balance of payments: some new results", *Journal of Political Economy,* Vol. 87, No.3, pp.600–20

Noland, M. (1989). "Japanese trade elasticities and the J-curve", *Review of Economics and Statistics,* Vol. 71, pp.175–9.

Onafowora, O., (2003). "Exchange rate and trade balance in East Asia: is there a J−Curve?", *Economics Bulletin,* Vol. 5, Issue 18, pp.1−13.

Pedroni, P.,(2000). "Fully modified OLS for heterogeneous cointegrated panels", *Advances in Econometrics,* Vol. 15, pp.93–130.

Pesaran, M. H. and Shin, Y. (1995). An autoregressive distributed lag modelling approach to cointegration analysis. In Centennial Volume of Rangar Frisch, (ed.) S. Strom, A. Holly, and P. Diamond, Cambridge University Press, Cambridge.

Pesaran, M. H., Shin, Y. and Smith, R. J. (1996). "Testing for the existence of a long-run relationship", DAE Working Paper No. 9622, Department of Applied Economics, University of Cambridge.

Phillips, P. and P. Perron (1988), "Testing for Unit Root in Time Series Regression", *Biometrica,*Vol. 75, pp. 335-346.

Phillips, P.C.B., Hansen, B.E., (1990). "Statistical inference in instrumental variables regression with I (1) processes", *Review of Economic Studies,* Vol. 57, No.1, pp.99–125.

Rose, A. K. (1990). "Exchange rates and the trade balance: someevidence from developing countries", *Economics Letters,* Vol. 34, pp.271–5.

Rose, A.K. and Yellen, J.L. (1989). "Is There a J-curve?" *Journal of Monetary Economics*, Vol. 24, pp.53–68.

Arunachalaramanan S. and Ramesh Golait (2011). "The Implication of renminbi revolution on India's trade –A study", RBI working paper series 2/2011

Singh, T.,(2002). "India's trade balance: the role of income and exchange rates", *Journal of Policy Modeling,* Vol. 24, No.5, pp.437–452.

Summary, R.M. (1989). "A political–economic model of U.S. bilateral trade", *Review of Economics and Statistics,* Vol. 71, No.1, pp.179–182.

Wilson, P. (2001). "Exchange rates and the trade balance for dynamic Asian economies: does the J-curve exist for Singapore, Malaysia and Korea?", *Open Economies Review,* Vol. 12, pp.389–413.

Annex 1: Panel Co-integration Estimation for the partner Countries

Country	$lnGDP_{IN}$	lnGDP*	lnRER	Country	$lnGDP_{IN}$	lnGDP*	lnRER
Argentina	-6.04***	6.87***	2.00***	Costa Rica	0.03	-1.44	-10.01***
	(-4.08)	(3.57)	(3.80)		(0.02)	(-0.63)	(-5.54)
Algeria	-14.52***	22.61***	-4.24	Côte D'ivoire	-0.44	2.17**	-1.82**
	(-3.09)	(3.49)	(-0.99)		(-0.97)	(2.23)	(-2.46)
Australia	-2.16***	2.32***	0.55	Cyprus	-20.11***	26.04***	-0.71
	(-4.65)	(3.46)	(1.11)		(-3.08)	(3.00)	(-0.13)
Austria	-0.88	0.08	1.68*	Denmark	-0.32	0.67	1.60***
	(-1.28)	(0.06)	(1.65)		(-1.26)	(1.35)	(2.86)
Bahamas	22.23***	-23.57***	-33.53***	Dominican	-17.46***	18.47***	-2.93**
	(3.62)	(-2.89)	(-4.08)	Republic	(-5.50)	(5.18)	(-2.06)
Bahrain	1.36	-0.09	-0.22	Egypt	-5.18*	6.44*	0.55
	(0.16)	(-0.01)	(-0.06)		(-1.74)	(1.75)	(0.65)
Bangladesh	-10.97***	11.27***	3.74***	Ethiopia	-6.75	6.24	-0.36
	(-5.21)	(4.89)	(3.73)		(-0.99)	(0.91)	(-0.13)
Belgium	1.06***	-1.35***	-1.35***	Fiji	-9.77***	11.29***	22.57***
	(4.10)	(-2.66)	(-3.19)		(-3.55)	(2.71)	(4.44)
Benin	4.40***	-5.47***	-1.34*	Finland	-1.50***	1.70***	-1.03*
	(4.30)	(-4.11)	(-1.89)		(-4.29)	(3.14)	(-1.88)
Bhutan	-6.89	5.73	5.83	France	-0.82*	0.90	1.89**
	(-1.56)	(1.36)	(1.00)		(-1.89)	(1.06)	(2.43)
Botswana	-50.49***	51.32***	44.09***	Gabon	-1.39*	-1.38	5.98***
	(-8.23)	(8.33)	(6.59)		(-1.89)	(-0.76)	(5.27)
Brazil	-2.79**	6.46***	-0.05	Germany	-1.16***	1.81***	0.69***
	(-2.40)	(3.46)	(-0.14)		(-11.5)	(8.06)	(3.41)
Brunei Darussalam	-10.09***	16.39***	-9.66***	Ghana	-9.51**	13.03**	-3.15***
	(-2.90)	(3.19)	(-2.81)		(-2.27)	(2.50)	(-3.61)
Bulgaria	2.06	-1.59	-0.51	Greece	-1.18***	2.53***	-0.94**
	(1.12)	(-0.51)	(-0.34)		(-3.14)	(4.40)	(-2.07)
Cameroon	-3.06**	5.21***	-9.77***	Guatemala	-3.89**	5.66*	-5.83**
	(-2.34)	(2.72)	(-10.00)		(-2.03)	(1.92)	(-2.10)
Canada	-2.40***	3.60***	1.24***	Hungary	-2.41**	3.90***	0.19
	(-14.00)	(13.15)	(3.61)		(-2.53)	(2.85)	(0.17)
Chile	-4.66***	4.87**	0.35	Iceland	1.97	-3.88**	1.74*
	(-2.76)	(2.43)	(0.25)		(1.32)	(-1.96)	(1.68)
China Mainland	8.11*	-6.43*	-0.15**	Indonesia	1.41**	-2.75***	-1.51***
	(1.79)	(-1.85)	(-2.13)		(2.55)	(-3.56)	(-7.89)
China: Honk Kong	-3.19*	3.23	-0.37	Iran	-17.64***	22.96***	0.44**
	(-1.89)	(1.39)	(-0.77)		(-5.79)	(5.80)	(2.04)
China: Macao	-5.24*	7.33	-9.86	Ireland	-0.3	0.07	-0.45
	(-1.68)	(1.55)	(-0.95)		(-0.59)	(0.13)	(-0.66)
Colombia	-19.28***	31.87***	4.42*	Israel	-0.78	1.38	0.77
	(-2.92)	(3.04)	(1.68)		(-0.83)	(1.27)	(0.8)
Congo, Dem. Rep.	12.63***	-35.78***	-0.22	Italy	-0.69***	1.53***	-0.14
	(3.70)	(-3.22)	(-0.14)		(-2.91)	(2.83)	(-0.25)
Congo: Republic	-5.94	8.28	3.17	Jamaica	-2.41	3.23	-1.63
	(-1.11)	(0.97)	(0.97)		(-0.93)	(0.43)	(-0.34)

Annex 1: Panel Co-integration Estimation for the partner Countries *(Concld.)*

Country	$lnGDP_{IN}$	lnGDP*	lnRER	Country	$lnGDP_{IN}$	lnGDP*	lnRER
Japan	-0.58***	0.56	-0.29	Seychelles	-7.62***	12.3***	-0.19
	(-2.93)	(1.51)	(-1.19)		(-6.54)	(4.51)	(-0.20)
Jordan	-2.41	2.58	1.39	Singapore	3.21	-3.01	-0.37
	(-0.96)	(0.88)	(1.34)		(1.01)	(-0.97)	(-0.17)
Kenya	4.49**	-7.12***	-2.25***	South Africa	4.19**	-6.97*	-1.82
	(2.38)	(-2.64)	(-3.09)		(1.98)	(-1.88)	(-1.61)
Korea	0.88	-0.95	-0.94**	Spain	-2.27***	3.72***	-0.10
	(1.41)	(-1.31)	(-2.24)		(-12.6)	(13.22)	(-0.50)
Kuwait	1.62	0.99	-15.25**	Sri Lanka	-3.65**	3.57*	-1.69
	(0.29)	(0.14)	(-2.01)		(-2.30)	(1.85)	(-1.57)
Madagascar	-3.04**	5.20***	-1.61*	Sudan	-13.25***	13.89***	3.20***
	(-2.39)	(2.62)	(-1.70)		(-3.57)	(3.64)	(2.87)
Malawi	13.88**	-13.23*	-14.69***	Swaziland	-6.38**	8.87**	1.79
	(2.43)	(-1.89)	(-3.35)		(-2.51)	(2.05)	(0.72)
Malaysia	3.44***	-2.99***	-3.13***	Sweden	-1.28***	0.10	2.54***
	(4.19)	(-3.5)	(-4.54)		(-2.71)	(0.14)	(3.64)
Malta	-0.56	-3.22	-33.51*	Switzerland	-3.06***	3.37**	0.15
	(-0.08)	(-0.32)	(-1.83)		(-3.99)	(2.14)	(0.12)
Mauritius	2.94**	-4.85***	2.75	Tanzania	0.22	0.16	2.74***
	(2.11)	(-2.88)	(1.44)		(0.15)	(0.10)	(6.92)
Mexico	-4.45**	6.90**	-0.08	Thailand	-1.68**	0.91	-0.21
	(-2.04)	(1.99)	(-0.05)		(-2.17)	(0.88)	(-0.32)
Morocco	-0.69	2.84	0.45	Togo	-0.91	0.39	-0.88
	(-0.25)	(0.78)	(0.20)		(-1.62)	(0.43)	(-1.14)
Nepal	5.15***	-7.34***	-2.13	Trinidad And	3.96	-4.62	-0.19
	(2.92)	(-3.01)	(-0.43)	Tobago	(0.70)	(-0.73)	(-0.03)
Netherlands	0.91***	-0.56**	-0.16	Tunisia	0.04	1.26	2.3
	(7.25)	(-2.56)	(-0.79)		(0.01)	(0.34)	(1.03)
New Zealand	-1.64***	2.73***	-0.65***	Turkey	-4.29*	6.53**	1.26
	(-4.45)	(5.08)	(-2.46)		(-1.95)	(2.12)	(1.08)
Nigeria	5.10	-7.11	1.24	UAE	1.38	-1.97	-2.39**
	(0.34)	(-0.36)	(1.12)		(0.65)	(-0.91)	(-2.29)
Norway	-3.08***	2.66***	2.72***	United	1.55***	-2.29***	-0.72**
	(-11.3)	(5.90)	(4.89)	Kingdom	(6.21)	(-5.61)	(-2.15)
Pakistan	0.96	1.43	-3.56	United States	-2.09***	3.08***	0.40
	(0.27)	(0.31)	(-1.46)	of America	(-4.07)	(4.16)	(0.55)
Philippines	-1.09	0.94	-2.22***	Uruguay	-3.66**	6.95**	-0.25
	(-0.97)	(0.63)	(-5.48)		(-1.67)	(1.93)	(-0.18)
Portugal	-1.13***	2.54***	-1.73***	Zimbabwe	0.11	1.76***	0.29*
	(-4.16)	(5.02)	(-3.12)		(0.59)	(4.39)	(1.73)
Saudi Arabia	-10.52***	17.02***	2.52	Venezuela	4.40	-12.78	-3.83
	(-3.24)	(3.58)	(1.07)		(0.75)	(-1.07)	(-0.95)
Senegal	8.87***	-11.79***	2.04				
	(3.44)	(-3.27)	(1.63)				

Annex 2: List of the India's trading partners classified into Eleven groups (3 International treaty groups, 4 regional groups, 3 Income groups and major countries group)

Oil Exporting Countries	Saarc	Asean	African	America	Europe	Asia & Oceania	High Income	Middle Income	Low Income	Major Countries
Algeria	Bangla Desh	Indonesia	Algeria	Argentina	Austria	Australia	Australia	Argentina	Bangla Desh	China mainland
Indonesia	Bhutan	Malaysia	Benin	Bahamas	Belgium	Bahrain	Austria	Algeria	Benin	Germany
Iran	Nepal	Philippines	Cameroon	Brazil	Bulgaria	Bangla Desh	Bahamas	Brazil	Bhutan	Japan
Kuwait	Pakistan	Singapore	Congo,dem.Rep.	Canada	Denmark	Bhutan	Bahrain	Bulgaria	China :Macao	Saudi Arabia
Nigeria	Sri Lanka	Thailand	Côte d'Ivoire	Chile	Finland	Brunei Darussalam	Belgium	Cameroon	Congo, Dem. Rep.	Singapore
Saudi Arabia			Egypt	Colombia	France	Cambodia	Brunei Darussalam	Chile	Côte d'Ivoire	UAE
UAE			Ethiopia	Costa Rica	Germany	China Mainland	Canada	China Mainland	Ethiopia	United kingdom
Venezuela			Gabon	Dominican Republic	Greece	China: Macao	China: Honk Kong	Colombia	Ghana	United states
			Ghana	Guatemala	Hungary	China: Honk Kong	Cyprus	Costa Rica	Jordan	Belgium
			Jordan	Jamaica	Iceland	Cyprus	Denmark	Dominican Republic	Kenya	Switzerland
			Kenya	Mexico	Ireland	Indonesia	Finland	Egypt	Madagascar	
			Madagascar	Trinidad and Tobago	Italy	Iran	France	Gabon	Malawi	
			Malawi	USA	Netherlands	Israel	Germany	Guatemala	Nepal	
			Morocco	Uruguay	Norway	Japan	Greece	Hungary	Nigeria	
			Nigeria	Venezuela	Portugal	Korea	Iceland	Indonesia	Pakistan	
			Senegal		Spain	Kuwait	Ireland	Iran	Senegal	
			Seychelles		Sweden	Malaysia	Israel	Jamaica	Sudan	
			South Africa		Switzerland	Mauritius	Italy	Malaysia	Tanzania	
			Sudan		UK	Nepal	Japan	Mauritius	Togo	
			Swaziland			New Zealand	Korea	Mexico		
			Tanzania			Pakistan	Kuwait	Morocco		
			Togo			Philippines	Netherlands	Philippines		
			Tunisia			Saudi Arabia	New Zealand	Seychelles		
						Singapore	Norway	South Africa		
						Sri Lanka	Portugal	Sri Lanka		
						Thailand	Saudi Arabia	Swaziland		
						Turkey	Singapore	Thailand		
						UAE	Spain	Tunisia		
							Sweden	Turkey		
							Switzerland	Uruguay		
							Trinidad and Tobago	Venezuela		
							UAE			
							UK			
							USA			

Reserve Bank of India Occasional Papers

Vol. 33, No. 1 & 2: 2012

Inflation Indexed Bonds and Public Policy: An Examination in the Indian Context

Sunil Kumar and Jai Chander*

Inflation Indexed Bonds (IIBs) could be very useful from the public policy perspective. This instrument has become increasingly popular across countries including emerging market and developing economies. The Government of India has also recently began issuing IIBs as part of the debt management strategy. In this paper, we have tried to examine the potential benefits of IIBs to the public policy in India from three perspectives, *viz.,* public debt management, monetary policy, and external sector management. From the public debt management perspective, we find that IIBs could benefit Government in terms of cost savings at least to the extent of inflation uncertainty premium. Further, as interest payouts on these bonds are linked to actual inflation and so are largely the tax collections, IIBs reduce the mismatch between these two cash flows that arises due to inflation. We find that inflation has significant impact on tax collections as OLS estimation suggests almost one-to-one retationship which is statistically significant. From monetary policy perspective, it has been widely articulated that IIBs for a critical amount in the Government's debt portfolio may improve public policy's credibility towards price stability, besides providing information about inflationary expectations. With regard to external sector management, we find that higher inflation causes higher gold imports. As IIBs would provide an alternative asset for inflation hedging, it is suggested that regular issuance of this instrument as part of the debt management strategy may dissuade investors from investing in gold for inflation protection which, in turn, may curtail gold imports.

JEL Classification : H63, E31, E43.

Keywords **:** Inflation Indexed Bonds, Public Debt Management, Vector Autoregression.

Fiscal policy determines the level of debt to be raised by public debt managers from the market to finance the fiscal deficit during a year. Subsequently, the public debt manager, following the broad objectives of cost minimisation over medium to long run subject to prudent risk level, decides about the debt instruments to be used keeping in view the extant as well as anticipated conditions in the financial market. In this regard, Melecky (2007) mentions that a government seeks to achieve the objective of cost minimisation within the existing

* Sunil Kumar works in the Internal Debt Management Department of the Reserve Bank of India and Jai Chander works in Middle Office, Ministry of Finance, Government of India. The usual disclaimer applies.

constraints and its risk aversion/preference[1]. Therefore, the instruments chosen by public debt manager within the mandate given by the Government form core of their debt management strategy. It may be mentioned that the public debt managers' decisions are comparable to any private borrower in terms of seeking best terms of borrowing. However, Missale (1999) draws a difference between private borrowers and government in the sense that government choice of an alternative is likely to influence the equilibrium outcome due to large size of borrowings while private borrowers' action may not influence it.

The instruments in the arsenal of public debt managers have grown over the years providing ample manoeuvring to deal with unraveling financial conditions. In fact, the innovation of debt instruments has been conditioned by ever evolving financial conditions/ structure. The investors have become increasingly demanding and require a wider choice of debt instruments (*e.g.,* conventional fixed rate bonds, linkers such as floating rate bonds (FRBs), IIBs, bonds with call and put options, *etc.*). Apart from meeting the core objective of raising market borrowings, some of these instruments arguably could provide useful information for monetary policy formulation and in the process improve the monetary policy transmission. In this regard, Falcetti and Missale (2000) argue that the short maturity debt and floating rate debt are also effective as commitment devices. It would be pertinent to mention here that countries with high level of debt try to shorten the debt maturity and resort to instruments such as FRBs and IIBs to reinforce their commitment towards anti-inflationary stance[2]. Besides improving credibility of the public policy towards its commitment to anti-inflationary stance, issuance of instrument like IIBs enables the monetary policy to derive market-based real interest rate and information about inflationary expectation. The issuance of IIBs is also presumed to allow central bank to gauge its credibility in anchoring inflationary

[1] In other words, the government not only aims to raise funding at low cost but also to structure the composition of its debt portfolio in such a way as to minimise the impact of relevant shocks on its budget or long-term expenditure plan.

[2] Missale and Blanchard (2000) show that in the period 1960-1989 in three highly indebted countries, Belgium, Ireland and Italy, the share of fixed rate long-term debt displayed a negative relation with the debt-to-GDP ratio.

expectations. Notwithstanding the above enumerated benefits of IIBs, some academicians and researchers have argued against the contribution of IIBs to price stability, which is the core mandate of the monetary policy across countries.

In this study, we have attempted an analysis of various aspects related to the issuance of IIBs as part of the debt management strategy in India. Basically, we investigate whether issuance of IIBs makes a good proposition for public policy objective in general and debt management in particular. The structure of the study is as follows. Section I dwells upon the international experience of IIBs, while the relevance of IIBs for public debt management is examined in Section II. Section III analyses the contribution of IIBs towards public policy objectives, especially monetary policy. The implications of the IIBs for external sector management, *i.e.,* through impacting gold imports have been investigated in Section IV. Section V contains conclusions.

Section I
International Experience

Though the indexation of debt has become popular in the last two decades with increasing number of sovereigns issuing inflation-linked bonds, its roots can be traced as back as in 18th century. The first indexed financial instrument was issued by the Commonwealth of Massachusetts in 1742 when it first issued bills of public debt linked to cost of silver on the London Exchange. Subsequently, the state of Massachusetts decided to link indexed debt to a broader group of commodities in the wake of silver prices appreciating more rapidly than the general price level. Since then, a number of distinguished economists have argued in favour of issuing indexed debt. Notably, Marshall proposed a plan with the intention of drawing greater attention to the concept of indexation. He proposed a passage of law permitting usage of indexation in contracts for deferred payments. Keynes was also a great supporter of indexation and he proposed in 1924 to the Royal Commission on National Debt and Taxation that the British Government issue index-linked bonds. More support for indexation stemmed from renowned economists such as Richard Musgrave, Milton Friedman and Robert Barro (Deacon, *et al,* 2004).

Garcia and Rixtel, (2007) classify issuance of IIBs by sovereigns in three broad categories during the post-war period. The first group comprises of countries which struggled with high and volatile inflation and they used IIBs for raising long-term capital. These countries are Chile (1956), Brazil (1964), Colombia (1967) and Argentina (1973). Italy also issued IIBs in 1983 with a ten-year maturity in a situation when it failed to issue nominal bonds for longer maturities. The second group includes United Kingdom (1981), Australia (1985), Sweden (1994), and New Zealand (1995). These countries issued IIBs not because of inflationary compulsions but out of a deliberate policy choice to improve the credibility of anti-inflationary policy stance. The third group, mainly comprising of industrialised countries, introduced IIBs programme in more recent years and their objective slightly overlapped with the previous group. However, this group's objective weighed more towards social benefits as IIBs were issued as a further step towards completing financial markets and providing an effective hedge against inflation to investors in the long-term. Most prominent countries in this group are Canada (1991), United States (1997), France (1998), Greece and Italy (2003), Japan (2004) and Germany (2006). Many of the countries from second group such as United Kingdom and Australia also issued IIBs at later stage for social benefits. Price (1997) categorises the country experiences with regard to issuance of IIBs broadly into two extremes: the first includes instances where high inflation left issuers with little choice but to index their obligations to the price level (for example, Argentina, Brazil, Chile and Colombia); and the second includes countries which experienced low and stable inflation but issued IIBs to complement the existing nominal bond programs. Currently, IIBs are issued in several countries but their share in total portfolio varies with few countries such as Chile, Argentina, and Brazil having quite large share of their debt under this instrument (Table 1).

In recent years, many emerging market and developing economies have also attempted issuances of IIBs. India also issued IIBs (namely capital indexed bonds) in 1997 with a five-year maturity but discontinued its issuance due to poor response. The poor response could be attributed

Table 1: Composition of Domestic Bonds issued by Central Government across Countries
(as % of total outstanding at end-2012)

Country	Floating Rate	Fixed Rate	Inflation Indexed	Exchange Rate linked
Argentina	14.8	0.8	49.5	34.8
Brazil	21.0	39.6	38.8	0.6
Chile	0.0	20.2	79.8	0.0
India	1.9	98.1	0.0	0.0
Indonesia	17.6	82.4	0.0	0.0
Canada	0.0	92.3	7.7	0.0
South Africa	0.0	74.6	25.4	0.0
Mexico	26.2	52.1	21.7	0.0
Germany	0.0	89.1	10.0	1.0
United Kingdom	0.0	76.8	23.2	0.0
United States	0.0	91.0	9.0	0.0

Source: Bank for International Settlements.

to the product structure wherein inflation protection was provided only to the principal and not to the interest payouts. In the above backdrop, the revised version of IIBs, wherein inflation protection is provided to both principal and interest payments, has been launched through auction in June 2013. The IIBs launched through auction is linked to the Wholesale Price Index (WPI) for inflation compensation. Further, an exclusive series of IIBs for retail investors has been launched in December 2013 where inflation compensation is linked to combined CPI (base: 2010=100).

Section II
IIBs and Public Debt Management

It is argued that IIBs could be effectively used in the debt management strategy, as they could be beneficial for various stakeholders, *viz.*, issuer (sovereign), investors (institutional as well as individuals), public policy, *etc.* We examine the utility of issuing IIBs as part of the debt management strategy in India in the backdrop of such utility articulated in the extant literature on the subject.

Will it be beneficial for the Issuer (Government)?

We have attempted to evaluate the utility of IIBs from issuer's perspective in terms of cost effectiveness, implications on cash management and stability of cost structure.

Cost effectiveness

The Government has the option of raising debt through fixed rate instruments and linkers (mainly floating rate bonds and inflation indexed bonds). Sovereigns across the world have been raising a large part of their debt through fixed rate bonds (nominal bonds). However, the proportion of the debt raised through inflation indexed bonds has gone up significantly over the last two decades. The yields (cost) on nominal bonds entail three components, *viz.,* real return, average expected inflation, and term/uncertainty premia ($i = r + p^e + u$). The term premia[3] is largely attributed to the uncertainty about expected inflation. Higher is the uncertainty about average expected inflation over the maturity period of a bond, higher the term premia the investors would seek for. As uncertainty about expected inflation may be proportional to the maturity period, the term premia charged by investors on nominal bonds would also be proportional to the maturity period of the nominal bonds. In case of IIBs, returns are linked to inflation and any increase in inflation is paid for in terms of higher returns. Therefore, investors would not seek for term premia for inflation uncertainty and the cost of borrowing through these instruments could potentially be lower at least to the extent of uncertainty premium (inflation risk premium) demanded on nominal bonds, provided actual inflation equals breakeven[4]/expected inflation. Such cost saving could, however, be realised after the issuances of IIBs reach a critical mass and ample liquidity is generated, otherwise illiquidity premia could overweigh the cost benefit due to absence of uncertainty premia. Furthermore, cost benefit on IIBs to the extent of uncertainty premia would also depend on the actual inflation[5]. The estimates of inflation risk premia, however, vary in the range from 0.1

[3] Term premia mainly comprises of uncertainty premia (inflation premia) and illiquidity premia.

[4] The difference between the yield on IIBs and fixed rate nominal bonds of the commensurate maturity is often called "break-even" inflation rate, which is a hypothetical rate at which return on both types of bonds is identical.

[5] If actual inflation is above the break-even inflation, the cost saving on account of absence of uncertainty premia, if any, needs to be seen along with differential between actual and break-even inflation.

to 1 percentage points (Working Group, Dutch Central Bank, 2005). Cappiello and Guene (2005) estimate the inflation risk premia for French and German long-term bonds to be around 20 and 10 basis points, respectively. In fact, the investors are generally risk averse and, thus, issuer of risky assets (*i.e.,* nominal bonds inherently containing future inflationary risk) will have to pay higher yield to investors to hold such assets[6]. In case of IIBs, inflationary risk element is eliminated and investors are ready to invest in such bonds at lower yield. According to Garcia and Rixtel (2007), Government savings of cost arises from the investors' preference for payment of premium for protection against inflation, which they get from inflation indexed bonds.

It has also been argued that IIBs could result in cost savings to the Government through indirect channel, *i.e.,* lowering of inflation risk premium on nominal bonds. The argument for lowering risk premium mainly dwells on the premise that IIBs will improve the credibility and commitment of the monetary policy towards price stability/ anti-inflationary stance[7]. Reschreiter (2004) estimates that government long-run borrowing cost could be reduced significantly in United Kingdom by issuing IIBs. However, the cost savings on issuance of IIBs need to be judged over the life of the security and not on yearly basis, as high inflation during some period will be evened out by low inflation during other period. In the above backdrop, we feel that in case of India, the issuance of IIBs may result in cost saving to the Government, at least to the extent of term/ uncertainty premia. However, such cost saving needs to be juxtaposed with illiquidity premia charged by investors on IIBs until a critical mass is achieved and reasonable liquidity is generated.

Cash Management of the Government

Another benefit that could be attributed to issuance of IIBs is from cash management perspective, as indexed interest payouts on IIBs

---

[6] For instance, corporate bonds pay higher yields than Treasury bonds with comparable maturities since corporate bonds have default risk and Treasury bonds do not (Shen, 1995).

[7] If issuance of IIBs by government achieves a critical mass, the relative gains from higher inflation may not be significant and this, in turn, would improve the credibility of the anti-inflationary (lower inflationary) policy. In such a scenario, higher inflation would cost the Government dearly whereas investors in IIBs would enjoy insurance against high inflation.

would be largely matching to revenue collections of the Government[8]. In this case, nominal interest payouts would be anchored to the actual inflation and so would largely be the tax collections of the Government and thus, leave not much of the mismatch on account of inflation. We have empirically investigated the impact of the inflation on tax collections by estimating Ordinary Least Square (OLS) taking log of tax collections (LTAX) as dependent variable and log of inflation (LWPI) and log of real GDP (LGDP) as independent variables. The estimation is based on annual data from 1990-91 to 2012-13. The variables are first-differenced in order to avoid unit root problem. The coefficient of D(LWPI) estimated at 1.06 is statistically significant at 10 per cent level of significance[i], suggesting that the response of the tax collections to inflation was almost one-on-one. Barro (1997) also supports this premise by arguing that an optimal tax approach to public debt, taking into account the Government's assets and liabilities, would favour the issuance of long-term inflation-linked bonds. As per Barro's analysis, a tax-smoothening objective dictates the optimal composition of public debt with respect to maturity and contingencies and this objective makes debt payouts contingent on the levels of public outlays and the tax base. Based on the above, we conclude that issuance of IIBs in India would facilitate efficient cash management for the Government.

Stability of cost structure

Another benefit of inflation indexed bonds is the stability of borrowings cost in real terms as the real component of the coupon on IIBs is fixed. Since the coupon rate of NFRBs is determined by current inflationary expectations, such bonds issued during high inflation period remain very costly even when inflation declines and vice versa. Table 2 below indicates that inflation in India has historically remained quite volatile and hence, issuance of IIBs would be more logical from the above mentioned real yield perspective[9].

---

[8] It may be noted that a large part of the Government's revenue is de facto indexed to inflation because taxes are collected in nominal terms.

[9] Standard deviation (SD), a standard measure of volatility, of inflation rate (based on WPI) in India was estimated at 3.6 during the last two decades. SD was 4.2 and 1.9 during 1990s and 2000s, respectively.

Some researchers have, however, pointed out that issuing IIBs along with nominal bonds will entail segmentation of the public debt market and turn various debt instruments less liquid. Eventually, this may escalate the cost of borrowing of the Government to the extent of liquidity premia and off-set the gains to be realised on account of removal of inflation risk premium. Townend (1997) compare the liquidity of IIBs and Nominal Fixed Rate Bonds (NFRBs) in terms of their bid-cover spread and reported a bid-cover ratio of 16 ticks for large trades on IIBs as opposed to 2 ticks for similar nominal bonds. Nonetheless, investors of IIBs are generally financial institutions such as insurance companies, pension funds, *etc.*, and for them liquidity is secondary concern as they largely buy such bonds to hold to maturity (HTM).

How could they be beneficial for investors?

Investors in IIBs may derive major benefits in terms of holding long-term fixed real yield assets with inbuilt protection from inflation. Although investors factor-in average inflationary expectations plus inflation risk premia while pricing NFRBs, projections about medium to long-term inflation are generally not robust especially in emerging market and developing economies where inflation path remains quite volatile. The projections of inflation are, however, credible over short-term. Hence, NFRBs may end up either underperforming or over performing in the medium to long-term. In such situations, IIBs are appropriate product for long-term investors providing insurance against inflation. Nonetheless, there are other instruments which also provide hedge against inflation. In this regard, Garcia and Rixtel (2007) put forth the argument that availability of other instruments for investors to hedge against unanticipated inflation does not stand up to empirical investigation. Shen (1995) also argues that none of the investment alternatives such as rolling over short-term Treasury securities, real assets (such as commodities and real estate), *etc*., are capable of offering investors fixed long-term yields that are free from inflation risk[10]. We

[10] Rolling over 3-month Treasury bills is inferior to investing in long-term indexed bonds. In this case, investors have to face uncertain future short-term yields and therefore, an uncertain overall long-term yield. Further, investing in real assets would be an even less satisfactory substitute for investing in indexed Treasury bonds. The correlation between yield on the real assets and inflation has been found typically quite low; for example, during post war period, correlation between inflation and growth in the price of gold, which many consider to be a relatively good hedge against inflation, is only 0.47.

have estimated the correlation coefficient between inflation rate (based on WPI index) and variation in real estate prices in Mumbai and Delhi, which could be used as proxy to measure the extent of hedging against inflation in real estate (assets) investment. The correlation coefficient has been estimated at 0.22 and 0.16, respectively during 2010:Q1-2013:Q2[11]. The low correlation between inflation rate and growth in the prices of real assets exhibits that investment in real assets does not provide any significant hedge against inflation and thus, are not a good substitute of IIBs. Further, even if investment in real assets may provide some insurance against inflation, these assets are fraught with risks other than inflation and such risks are hard to estimate. For example, demand and supply conditions would greatly influence the prices of real assets. Therefore, based on the above arguments, it may be inferred that investing in other instruments for inflation hedge may also result in trading inflation risk with other risks.

In India, inflation has remained quite volatile across the categories, *viz*., retail as well as wholesale (Table 2). It has surged significantly in the last few years. The high volatility in inflation makes it difficult for investors to have realistic projections about it and thus, the expected inflation factored - in while pricing of NFRBs fails to provide desirable real return. In such situations, the IIBs provide an opportunity for investors to earn desirable real return on their investment, as IIBs provide for actual inflation compensation.

Table 2: Volatility in Inflation Rate in India

Period	Average (%)			Standard Deviation		
	WPI	CPI-IW	CPI-AL	WPI	CPI-IW	CPI-AL
1980s	8.0	9.0	8.1	3.9	2.4	4.6
1990s	8.1	9.5	9.0	3.6	3.0	5.0
2000s	5.4	5.9	5.4	1.6	2.9	4.4
2010s	8.6	9.7	9.4	1.1	1.2	0.9
1980s-2010s	7.3	8.3	7.7	3.2	3.0	4.6

WPI=Wholesale Price Index; CPI=Consumer Price Index; IW= Industrial Workers; and AL= Agricultural Labourers.

[11] Real estate prices have been represented by housing prices index published by National Housing Bank (NHB).

Another argument in favour of investing in IIBs is that these instruments are the only long-term assets which provide hedging against two risks, *viz.*, inflation risk and credit risk. These virtues of IIBs issued by sovereigns make them truly risk-free long-term assets available for investors. Campbell and Viceira (2002) substantiate the argument that the IIBs are safe asset for long-term. From the portfolio diversification perspective also, investors should hold a part of the total assets in IIBs, especially in a scenario when inflation is quite uncertain. In fact, Fischer (1975) propagated this argument to support the issuance of inflation-linked bonds by the Government or by other issuers[12].

IIBs are particularly helpful to some of institutional investors such as pension funds whose payments obligations are linked to inflation. Regular issuance of IIBs will help portfolio management of such institutional investors and boost their growth. Thus, regular issuance of IIBs in India will help broadening the investor base and providing stability to the demand for government bonds.

Section III
IIBs and Monetary Policy

The countries with high level of debt and strong political economy may be tempted to use inflation as a tool to erode the real value of the debt and contain debt to GDP ratio. Aizenman and Marion (2009) argue in this regard that a government that has lots of nominal debt denominated in the domestic currency has an incentive to try to inflate it away to decrease the debt burden. Temptation to use inflation is greater if foreign creditors hold a significant portion of the public debt denominated in domestic currency[13]. However, if IIBs constitute a significant part of the public debt, it would disincentivise the use of inflation to reduce real value of the public debt. Furthering this argument, it may be pointed out that indexing of public debt does not eliminate the inflationary risk but

[12] He equally argued that the diversification benefits for holders of the bonds justified a positive inflation risk premium.

[13] For example, the share of foreign creditors in the US public debt increased from almost zero until 1960s to about 50 per cent in 2010. Hence, the foreign creditors would bear 50 per cent of inflation tax, should inflation be used to reduce the debt burden.

shift it from investors to Government and this way, it discourages the Government to reduce the debt burden through inflation. Furthermore, it will incentivise the Government to take all potent measures to contain inflation as rise in inflation will result in higher interest payments by the Government on IIBs. Another channel through which IIBs can affect inflation is higher savings and lower consumption, exerting downward pressure on prices. Samuelson (1988) elaborates that acceleration in savings on account of issuance of IIBs allows Government to finance a given expenditure level in less inflationary ways, thus dampening inflation. In the above backdrop, it may be concluded that issuance of IIBs in India for a critical mass has potential to improve the commitment and credibility of the public policy, in particular the monetary policy towards price stability.

In the last two decades, the independence of the central banks has increased significantly across countries. This was accompanied by the improved credibility of the central banks and their clear mandate for price stability which has considerably eliminated the uncertainty about inflationary expectations. Despite enhanced commitment towards price stability, the increased independence of central banks could not completely eradicate the inflationary risks and hence, many countries especially from emerging markets and developing economies have issued IIBs in the recent past.

Some arguments in the literature have also been made against indexing public debt from the price stability perspective and other destabilising effects. The large issuances of IIBs may lead to a higher level of indexation of the economy (*e.g.,* indexation of financial contracts, wages, *etc.*) which may undermine the policy aimed at controlling inflation. The use of appropriate policy mix can, however, prevent the indexing leading to higher inflation (Fischer, 1983)[14]. Another argument against contribution of IIBs to price stability is that their issuance may induce acceptability of inflation in public and in

[14] Fischer analyed the data of 40 countries with different level of indexation after the 1974 oil-price shock. He concluded that appropriate monetary and fiscal policies were effective in preventing the impact of higher indexation on inflation.

turn, reduce pressure on the central bank to maintain its anti-inflationary stance. Nonetheless, this argument is quite paradoxical to the central bank independence and its commitment towards price stability being its primary objective across countries.

Will they help monetary policy formulation?

In addition to the benefits accruing to Government and investors, the indexation of public debt enables central banks to derive market-determined real interest rates and inflationary expectations, which greatly contribute in firming up monetary policy stance[15]. A recent inter-departmental study by RBI (2013) empirically finds that investment and growth is sensitive to changes in real interest rate. Therefore, estimates of market determined real interest rates could help monetary policy in assessing investment and growth prospects.

The information about inflationary expectations also facilitates central banks to assess their credibility towards price stability and accordingly, central banks are in a position to affect any appropriate monetary policy actions, if required. However, critical mass of indexed debt is essential for liquidity, which remains pivotal for extracting any market related information for policy purposes. Provided inflation risk remains constant over time, the change in the difference between real yield on IIBs and nominal yield on fixed rate nominal bonds will display the change in average inflation expectations of the market participants over the residual maturity of bonds. The difference between real yield on IIBs and nominal yield on fixed rate nominal bonds is also called break-even inflation rate (BEIR) in the literature. Shen (1995) points out that without information on real yield, policymakers will not be able to know whether the change in nominal yield is attributed to variation in inflationary outlook or change in the real yield. Further, the BEIR derived from difference between real and nominal yield should be construed with enough caution since difference between yield on IIBs and NFRBs also contains inflation risk premium required by investors in *lieu* of compensation for inflation uncertainty while holding NFRBs.

---

[15] Information on expected inflation and its change would help monetary policy makers better understand inflationary pressure in the economy, allowing them to make better adjustments to monetary policy (Shen, 1995).

Similarly, real yield on IIBs may include liquidity premium due to them being relatively less liquid and to that extent change in average inflationary expectation would be underestimated. Notwithstanding the aforementioned caveats, BEIRs are best available indicators of expected inflation from the policymakers' perspective and their utility improves over time with increased issuance of IIBs under wider maturity range and improved liquidity in this segment of market. In this regard, Garcia and Rixtel (2005) points out that some caution is advisable when monitoring movements in BEIRs for monetary policy purposes and it would be useful to focus on changes rather than levels of BEIRs when interpreting them in terms of long-term inflation expectations.

In India, the central bank collects information only about short-term inflationary expectations (up to one year) through surveys and not the medium to long-term. While regular issuance of IIBs for various tenors could provide information about inflationary expectations across the term structure (*i.e.,* over short, medium and long-term). The inflationary expectations extracted from IIBs for short-term could be used to corroborate the results of the survey conducted to ascertain the same. In the above backdrop, it may be concluded that the regular issuance of IIBs could help the monetary policy formulation in India.

Will they serve any social objective?

Although IIBs provide protection to investors against inflation, issuance of such bonds by sovereigns has also some social implications. First and foremost, inflation is generally created by sovereign or monetary authority and hence, responsibility automatically dwells on sovereign to provide such investment instruments enabling public to protect their wealth. Further, issuance of IIBs by sovereigns would catalyse further financial innovations and public at large would be benefitted. For instance, pension funds, insurance companies, and mutual funds would be able to offer new financial products with inbuilt protection from inflation for retail investors[16]. As per the standard argument in the literature, IIBs should constitute an important part of

[16] Garcia and Rixtel (2007) mentions that following the introduction of US Government inflation-linked bonds, the Chicago Board of Trade introduced futures and options referenced to these bonds (five and ten year maturities). Mutual funds benchmarked on these bonds also developed and inflation-linked investment plans and annuities were introduced by pension funds.

any funded pension management arrangement because they would create pension holdings with the same characteristics as social security pension (*i.e.* provision of inflation indexed annuities).

Theoretical exposition of welfare implications of IIBs is provided by Magill and Quinzii (1997) through comparison of two second-best situations, having a nominal bond which is subject to inflationary risk or an indexed bond which is subject to risk caused by relative prices movements. They concluded with the help of a welfare gains function that indexed bonds result in higher potential gains due either to low variability of real income or strong correlation between payoffs of indexed bond and that of other securities. While discussing various aspects of IIBs, Price, (1997) argues that IIBs enhances social welfare through providing completeness to the financial markets, incentivising savings behaviour, and enabling better distribution of wealth and income.

Issuance of IIBs will also discourage public from transferring their investment from financial assets to real assets especially where future inflationary expectations are very high and in turn, would contribute to both accelerating and stabilising the savings rate. Amid high inflation, the financial disintermediation in household savings was visible in the last few years, as the share of physical savings increased from 52 per cent in 2009-10 to 68 per cent during 2012-13 notwithstanding overall decline in household savings rate during this period. RBI's Annual Report (2013) also mentions that within household savings, while the financial savings rate declined, the physical savings rate increased in 2011-12 because of households' preference for the latter in the high inflationary environment. The acceleration in savings rate is required more for higher investments and employment in emerging market and developing economies. Another important social implication is related to contribution of IIBs to distribution of real wealth. It has been argued that unanticipated inflation (or deflation) results in transfer of real wealth from lenders to borrowers (or borrowers to lenders). Investment in IIBs leads to elimination the element of uncertain inflation and arrest the redistribution of real wealth[18].

[18] Please refer to Drudi and Giordano (2000) for detailed discussion on distributional effects of IIBs.

Section IV
IIBs and External Sector Management

IIBs would provide an investment instrument to the public that will enable complete inflation hedging. It has been often observed that in the absence of such instrument, people tend to look for alternative asset class such as gold for inflation hedging. In India, IIBs were not available for investment till few months back and the people might have invested in gold for inflation protection. In order to explore the preliminary relationship between inflation and demand for gold, we have estimated the correlation between inflation rate (based on WPI index) and movement in prices of gold in India during the period 1971-72 to 2012-13. The correlation coefficient between inflation rate and change in gold prices show that both are closely associated (Table 3).

We further investigate the impact of inflation on investment in gold, especially the impact of inflation on gold imports, by estimating Ordinary Least Square (OLS) and Structural Vector Auto Regression (SVAR). The above models have been estimated taking monthly data from April 2003 to July 2013 on quantity of gold imports in metric tons (GOLDQ) and inflation rate based on Wholesale Price Index (WPIIN). The investigation of the unit root properties shows that both GOLDQ and WPIIN are of I(0) order and thus, we find it appropriate to estimate OLS and SVAR at levels. In OLS, GOLDQ has been taken as dependent variable and WPIIN as explanatory variable. The results of OLS show that the short-term and long-term coefficients of WPIIN at 2.43 and 3.70, respectively, are statistically significant at 99 per cent confidence level[ii]. This means that increase in inflation rate leads to higher gold imports. For VAR, the three lag length selection criteria, *viz.,* Akaike Information Criterion (AIC), Schwarz Information Criterion (SC), and

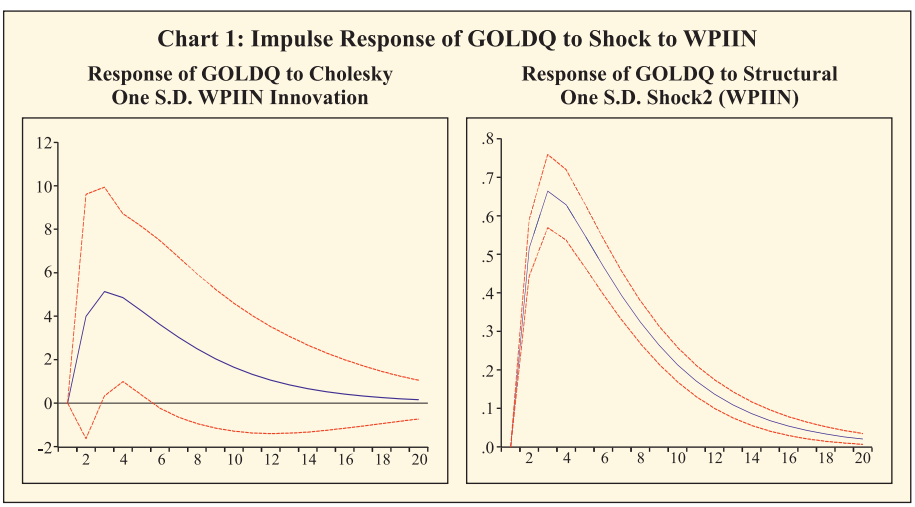
Table 3: Correlation between Inflation and Change in Gold Prices

Period	Average inflation (WPI)	Correlation coefficient
1971-1980	9.4	0.85
1981-1990	8.0	0.70
1991-2000	8.1	0.60
2001-2013	6.1	0.49

Hannan-Quinn Criterion (HQ) are used and based on majority criteria, two lags are selected[iii]. The results of the VAR Granger Casualty also show one-way causality from WPIIN to GOLDQ, *i.e.,* WPIIN causes GOLDQ and not the other way around[iv]. Further, SVAR has been estimated to capture the contemporaneous impact of the WPIIN on GOLDQ and impulse response of the GOLDQ to one standard deviation structural shock to WPIIN is found to be very robust (Chart 1).

Based on the above empirical results, it may be inferred that the high inflation may have spurred demand for gold in the recent past and due to non-availability of adequate quantity of gold domestically, India had to import large amount of gold, which contributed to widening of current account deficit (CAD). India's gold imports increased from about USD 21 billion during 2008-09 to about USD 53 billion in 2012-13 (in terms of quantity, gold imports increased from 767 metric tons to 1010 metric tons during this period) and the CAD during this period rose from about USD 28 billion to USD 88 billion. The regular issuance of IIBs by the Government would provide an alternative asset for investors for inflation hedging and thus, such issuances may dissuade investors from investing in gold to some extent and reduce the imports of gold and current account deficit. Therefore, it appears that regular issuance of IIBs by the Government could be useful in external sector management.

Chart 1: Impulse Response of GOLDQ to Shock to WPIIN



Section V
Conclusion

Overall, IIBs are considered useful debt instruments especially from a public policy perspective and have become increasingly popular across countries including emerging market and developing economies. The Canadian version of IIBs has also been launched by the Reserve Bank of India, in consultation with Government of India in June 2013. Further, the Government has launched an exclusive series of IIBs for retail investors in December 2013. Against this backdrop, this study has attempted to analyse the usefulness of the IIBs from three perspectives, *viz.,* public debt management, monetary policy, and external sector management. From public debt management perspective, it has been observed that IIBs could benefit Government in terms of cost savings at least to the extent of inflation uncertainty premium and at the same time, they are equally attractive for private investors providing them protection against inflation particularly for long-term assets. These bonds would allow the debt management to expand the bouquet of instruments and broaden the investor base and at the same time, would allow the investors to diversify their portfolio. Further, interest payouts on these bonds are linked to actual inflation and so are the tax collections of the Government. Empirical investigation through OLS estimation reveals that impact of inflation on tax collections is almost one-to-one and statistically significant. Thus, IIBs will help the alignment of cash flows of the government, particularly those cash flows which are sensitive to inflation. From monetary policy perspective, it has been widely articulated that issuance of IIBs for a critical amount in the Government's debt portfolio may demonstrate public policy's commitment towards price stability. Therefore, issuance of IIBs could potentially improve the credibility of the public policy, in particular the monetary policy, towards its primary objective of price stability. Further, IIBs could provide very useful information on market determined real yield and inflationary expectations, which are critical for the Central Bank to initiate monetary policy actions to reinforce its anti-inflationary stance. Several social benefits such as providing hedging against inflation to public at large, arresting redistribution of wealth from creditors to debtors, discouraging government from eroding public debt

through inflation, *etc*., are also associated with issuance of IIBs. With regard to external sector management, it has been argued that people invest in gold for inflation hedging and that leads to increase in gold imports and higher CAD. In order to draw a point in this context, the empirical examination of the relationship between inflation and gold imports through OLS and SVAR estimation indicated that the higher inflation causes higher gold imports. IIBs would provide an alternative investment asset for investors with inbuilt hedge against inflation and thus, issuance of this instrument may dissuade investors from investing in gold for inflation protection which in turn, may curtail gold imports. To summarise, IIBs could potentially be very useful instruments for public policy at large. Therefore, it may be desirable that IIBs become regular feature in the debt management strategy and certain portion of market borrowing of the Government of India is raised through this instrument every year.

References

Aizenman Joshua, Nancy Marion. 2009. "Using Inflation to Erode the U.S. Public Debt." NBER Working Papers 15562, National Bureau of Economic Research, Inc.

Barro, R.J., 1997. "Optimal Management of Indexed and Nominal Debt." NBER Working Papers 6197, National Bureau of Economic Research, Inc

Bodie, Zvi, Alex Kane and Robert McDonald. 1986. "Risk and Required Returns on Debt and Equity" in Financing Corporate Capital Formation, eds. by Benjamin M. Friedman, NBER.

Campbell, J. Y. and L. M. Viceira. 2002. "Strategic asset allocation: portfolio choice for long-term investors." Clarendon Lectures in Economics, Oxford: Oxford University Press.

Cappiello, Lorenzo, Stephane Guene. 2005. "Measuring Market and Inflation Risk Premia in France and in Germany." Working Paper Series No. 436, European Central Bank.

Deacon, Mark, Andrew Derry and Dariush Mirfendereski. 2004. "Inflation-Indexed Securities." Chichester: John Wiley & Sons, Ltd.

Dudley, William C., Jennifer Roush, and Michelle S. Ezer 2009. "The Case for TIPS: An Examination of the Costs and Benefits." *Federal Reserve Bank of New York Economic Policy Review,* July.

Falcetti, Elisabetta, Alessandra Missale 2000. "Public debt indexation and denomination with an independent central bank." *European Economic Review,* Vol. 46, Issue 10.

Fischer, S. 1975. "The demand for index bonds." *Journal of Political Economy*, Vol. 83, No.3.

Fischer, S. 1983. "Indexing and inflation." *Journal of Monetary Economics*, Vol. 12 No. 4.

García, J. Angel, Adrian V. Rixtel. 2007. "Inflation-linked bonds from a Central Bank perspective." *Occasional Paper No. 62,* European Central Bank.

Gong, Frank F. and Eli M. Remolina. 1996. "Inflation Risk in the US Yield Curve: The Usefulness of Indexed Bonds." Research Paper No. 9637 (November), Federal Bank of New York.

Jeffery M. Wrase. 1997. "Inflation Indexed Bonds: How do they Work." *Business Review,* July/August; Federal Reserve Bank of Philadelphia

Magill, Michael and Martine, Quinzii. 1997. "Which improves welfare more: A nominal or an indexed bond?" *Economic Theory,* Springer, Vol. 10, No.1, pages 1-37.

Melecky, Martin. 2007. "A Cross-country Analysis of Public Debt Management Strategy." Policy Research Working Paper 4287, World Bank.

Missale, A. 1999. "Public Debt Management." Oxford Press, University of Oxford.

Price, R. 1997. "The rationale and design of inflation-linked bonds." International Monetary Fund, Working Paper Series No WP/97/12

RBI. 2013. "Real interest rate impact on investment and growth - what the empirical evidence for India suggests?" Reserve Bank of India; http://rbidocs.rbi.org.in/rdocs/publications/Pdfs/IDGSRO808 2013.pdf

Reschreiter, Andreas. 2004. "Conditional funding costs of inflation-indexed and conventional government bonds." *Journal of Banking & Finance,* Vol. 28.

Roush, J. E. 2008. "The 'Growing Pains' of TIPS Issuance." Board of Governors of the Federal Reserve System Finance and Economics Discussion Series, No. 2008-08, February.

Sack, B., and R. Elsasser. 2004. "Treasury Inflation-Indexed Debt: A Review of the U.S. Experience." Federal Reserve Bank of New York *Economic Policy Review,* Vol. 10, No. 1 (May): pp.47-63.

Samuelson, L. 1988. "On the effects of indexed bonds in developing countries." *Oxford Economic Papers,* Vol. 40, No.1.

Shen, P. 1995. "Benefits and limitations of inflation indexed Treasury bonds." Federal Reserve Bank of Kansas City, *Economic Review,* third quarter.

Shiller, Robert J. 2005. 'The Invention of Inflation-Indexed Bonds." in The Origins of Values, eds. by William M. Goetzmann and K. Geert Rouwenhost, Yale School of Management, OUP.

Townend, J. 1997. "Index-linked government securities: the UK experience and perspective." in "Managing public debt: index-linked bonds in theory and practice" by De Cecco, M., L. Pecchi and G. Piga (eds); cheltenham: Edward Elger.

Working Group on Index-Linked Bonds, Dutch Central Bank, 2005.

---

[i] In order to analyse empirically the impact of inflation on tax collections of the Government of India, we have estimated simple OLS taking annual data from 1990-91 to 2012-13. The variables that have been taken in the estimation are log of WPI (LWPI), log of gross tax collections (LTAX), and log of GDP at constant prices (LGDP). Due to unit root problem, the variables have been taken in the first difference form. The results of the OLS furnished in the table below show that impact of the inflation on tax collections of the government is almost one-to-one and statistically significant.

OLS Results [D(LTAX) dependent variable]			
Explanatory variables	**Coefficient**	**t-Statistics**	**Prob.**
C	-0.06	-1.00	0.3286
D(LWPI)	1.02	1.92	0.0693
D(LGDP)	2.03	3.28	0.0037

R-squared: 0.37; Adjusted R-squared: 0.30
F-statistic: 5.78; DW Statistic: 1.94

ii The impact of inflation rate on gold imports has been estimated, taking monthly data on inflation rate (WPIIN) and quantity of gold imports (GOLDQ) from April 2003 to July 2013. The data on quantity of gold import has been derived by dividing value of gold imports by price of gold. The price of gold had been taken from the World Gold Council. The results of OLS estimation are furnished in the table below, which show that coefficient of WPIIN and lagged GOLDQ are positive and statistically significant.

OLS Results (GOLDQ dependent variable)				
Explanatory variables	**Coefficient**		**t-Statistic**	**Prob.**
	Short-term	**Long-term**		
C	29.35		8.47	0.0007
WPIIN	2.43	3.70	1.10	0.0297
$GOLDQ_{t-1}$	0.34		4.01	0.001

R-squared: 0.19; Adjusted R-squared: 0.17
F-statistics: 13.71; DW Statistic: 1.956; LM-Statistic: 0.041 (Prob: 0.83)

iii The lag selection in VAR has been done based on three lag selection criteria, *viz.,* Akaike Information Criterion (AIC), Schwarz Information Criterion (SC), and Hannan-Quinn Criterion (HQ) and results based on majority criteria indicate two lags.

VAR Lag Selection Criteria
Endogenous variables: GOLDQ, WPIIN
Sample period: 2003M04 to 2013M06
Included Observations: 115

Lag	AIC	SC	HQ
0	14.52252	14.57025	14.54189
1	12.26738	12.41060	12.32551
2	12.02387	12.26256*	12.12075*
3	12.02411	12.35827	12.15974
4	11.96369*	12.39333	12.13808
5	12.01290	12.53801	12.22604
6	12.04398	12.66458	12.29588
7	12.05284	12.76891	12.34348
8	12.09273	12.90428	12.42214

iv The VAR Granger Causality test has been conducted to corroborate the results of OLS estimates. The results given in the Table below demonstrate that null hypothesis of exclusion of WPIIN is rejected at 5 per cent significance level.

VAR Granger Causality/Block Exogeneity Wald Tests
Sample: 2005M04 2013M06
Included observations: 99

Excluded	Chi-sq	df	Prob.
Dependent variable: RGOLD			
WPIIN	6.576089	2	0.0373
All	6.576089	2	0.0373
Dependent variable: WPIIN			
RGOLD	0.833998	2	0.659
All	0.833998	2	0.659

Reserve Bank of India Occasional Papers

Vol. 33, No. 1 & 2: 2012

Major Episodes of Volatility in the Indian Foreign Exchange Market in the Last Two Decades (1993-2013): Central Bank's Response

Anand Prakash*

Indian foreign exchange market has gone through a process of gradual liberalization during the past two decades. With the adoption of market-determined exchange rate in 1993, the rupee has faced episodes of heightened volatility, the latest being post May 22, 2013 volatility on fears of tapering of quantitative easing by the US Fed. Excessive exchange rates volatility imposes real costs on the economy through its effects on international trade and investment and could also complicate the conduct of monetary policy. In view of this, there is a greater interest among the policymakers and academia in exploring the policy space available to EMEs to deal with any sharp volatility in the financial markets. Particularly, central bank responses to episodes of volatility in the foreign exchange markets have come into sharper focus. Against this backdrop, the paper analyses six major phases of volatility in Indian forex market during the period from 1993 to 2013, caused either by exogenous or endogenous factors, or a combination of both and RBI's response to contain the volatility. The analysis reveals that there has been a significant increase in exchange rate volatility in the aftermath of the global financial crisis, signifying the greater influence of volatile capital flows on exchange rate movements. An important aspect of the policy response in India to the various episodes of volatility has been market intervention combined with monetary and administrative measures to meet the threats to financial stability, while complementary or parallel recourse has been taken to communications through speeches and press releases. Availability of sufficient tools in the toolkit of a central bank is also a necessary condition to manage crisis. The paper concludes that the structural problems present in India's external sector, especially the persistence of large trade and current account deficits, will need to be addressed for a sustainable solution to the problem.

JEL Classification : F31, G15, C10
Keywords : Exchange Rate, Financial Market, Volatility

Introduction

Foreign exchange (forex) markets play a critical role in facilitating cross-border trade, investment, and financial transactions. These

* Anand Prakash is Assistant Adviser in the Financial Markets Department (FMD), RBI. The author is thankful to Shri P. Vijay Bhaskar, ED, RBI, Shri G. Mahalingam, PCGM, FMD, Shri B.M.Misra, O-in-C, DEPR and Smt. Nishita Raje, Director, FMD for their valuable suggestions and guidance. Views expressed in the paper are entirely personal and not of the institution to which the author belongs.

markets allow firms making transactions in foreign currencies to convert the currencies or deposits they have into the currencies or deposits of their choice. The importance of foreign exchange markets has grown with increased global economic activity, trade, and investment, and with technology that makes real-time exchange of information and trading possible. In a market determined exchange rate system, excessive exchange rates volatility, which is out of line with economic fundamentals, can impose real costs on the economy through its effects on international trade and investment. Moreover, at times, pressures from foreign exchange markets could complicate the conduct of monetary policy.

Indian foreign exchange market has gone through a process of gradual liberalization during the past two decades. It has indeed come a long way since its inception in 1978 when banks in India were allowed to undertake intra-day trade in foreign exchange (Reddy, 1999). However, it was in the 1990s that the Indian foreign exchange market witnessed far reaching changes along with the shifts in the currency regime in India from pegged to floating. The balance of payments crisis of 1991, which marked the beginning of the process of economic reforms in India, led to introduction of Liberalized Exchange Rate Management System (LERMS) in 1992, which was introduced as a transitional measure and entailed a dual exchange rate system. LERMS was abolished in March 1993 and floating exchange rate regime was adopted. With the introduction of market-based exchange rate regime in 1993, adoption of current account convertibility in 1994, and gradual liberalization of capital account over the years, essential underpinnings were provided for the foreign exchange market to flourish in India. Today, it constitutes a significant segment of the Indian financial markets with reasonable degree of integration with money market, government securities market and capital market, and plays an important role in the Indian economy. The conduct of exchange rate policy of Reserve Bank of India (RBI) has mainly been guided by the objective of maintaining orderly conditions in the foreign exchange market, to prevent the emergence of destabilising and self-fulfilling speculative activities, and allowing the exchange rate to reflect the macroeconomic fundamentals. The alternating phases of exchange market pressure have been dealt

with appropriate policy measures by the RBI partly to 'lean against the wind' against speculative attacks and also to 'lean with the wind' in order to ensure soft landings of the exchange rate in the face of the perceived need for correcting overvaluation (Patra & Pattanaik, 1998).

In the aftermath of the global financial crisis and the Euro zone debt crisis, emerging market economies (EMEs) have faced enhanced uncertainty. Capital flows to EMEs have become extremely volatile with excessive capital inflows to EMEs in search of better yields followed by sudden stops and reversals. Many major EM currencies, including the Indian rupee, witnessed significant depreciation in the recent period owing to the 'announcement effect' of the likely tapering of quantitative easing (QE) by the US Federal Reserve (Fed). The tightening in the overall financial market conditions started from May 22, 2013 following the testimony by Fed Chairman Ben Bernanke about the possible reduction in the bond purchases undertaken as quantitative easing (QE). Typically, those EMEs with large current account deficits (CAD) and relatively weaker macroeconomic conditions were worst affected (like India, South Africa, Brazil, Turkey and Indonesia), though currencies of countries with current account surplus (*e.g.,* Malaysia, Russia) were also been affected. As cited in the October 2013 Global Financial Stability Report (GFSR), it was found that the currencies that depreciated most were those that the 2013 *Pilot External Sector Report* had assessed as overvalued. At the same time, the high foreign exchange volatility raised the concern about the risk of overshooting which could weigh negatively on investment and growth in the affected economies. With the postponement of the tapering announced by the US Fed on September 18, 2013, the markets recovered to a large extent. The commencement of tapering by the US Fed starting from January 2014 and the subsequent announcements about the increase in its pace has not affected the stability of the rupee, which indicates that the markets have generally shrugged off QE tapering fears. The rupee has remained relatively stable as compared to other major EME currencies in the recent period.

In view of the heightened volatility in the forex market discussed above, there is a greater interest among the policymakers and academia

in exploring the policy space available to EMEs to deal with any sharp volatility in the financial markets. Particularly, central bank responses to episodes of volatility in the foreign exchange markets have come into sharper focus. Against this backdrop, the paper attempts to identify the major episodes of volatility in Indian forex market in the past two decades, caused either by exogenous or endogenous factors, or a combination of both. It tries to bridge the gap in the existing literature in documenting the central bank measures in forex market, which have hitherto focused more on empirical assessment of central bank interventions for controlling volatility. However, besides intervention, the central bank takes a number of monetary, administrative, moral suasion and other kinds of measures, which are equally, if not more, important in managing volatility. In view of the above, this paper attempts to capture the broad gamut of measures the Reserve Bank has taken to effectively manage various episodes of volatility in the past two decades. It is a descriptive documentation of each episode of forex market volatility with elaborate description of the backdrop, detailed account of the central bank measures and enumeration of the major outcomes. The information has been collected from various RBI publications as well as internal notes. This format of presentation is able to bring out clearly the various factors behind central bank actions including the macro-financial conditions, such as, CAD, fiscal deficit, level of forex reserves, inflation rate, *etc*., various measures taken by the Reserve Bank and how effective were the measures in controlling various episodes of volatility.

The period from 1993 to 2013 has been divided into six phases. Accordingly, the paper has been organized in the following eight sections. Section I provides measurement of daily annualized volatility during various episodes of exchange market pressure. Section II sets out the details of the first phase covering the period 1993-95 when the rupee witnessed appreciating pressure on the back of surge in capital inflows in post-exchange rate unification period. Section III documents the second phase covering the period 1995-96 when the rupee witnessed the first major episode of volatility in the Indian forex market resulting from the contagion effect of Mexican Crisis. Section IV focuses on the third phase covering the episodes of volatility during 1997-98 under the

impact of East Asian crisis. Section V captures fourth phase covering specific instances of volatility in the pre-crisis phase during the period 1998-2008, while Section VI captures the fifth phase covering volatility during the global financial crisis of 2007-08 and also details lessons learnt from the various past episodes of crises. The sixth phase covering the recent episode of volatility following Chairman Bernanke's testimony of May 22, 2013 and the way forward are presented in Section VII. Finally, Section VIII incorporates some concluding observations.

Section I
Measurement of Volatility: 1993-2013

Volatility in exchange rate refers to the amount of uncertainty or risk involved with the size of changes in a currency's exchange rate. Volatility in the rupee-dollar exchange rate during various episodes of heightened volatility in the forex market in the past two decades have been computed using standard deviations of daily forex market returns, which have been annualised. The rupee-dollar exchange rate data for volatility computation have been sourced from Bloomberg. An analysis of volatility in various phases of exchange rate pressures shows that volatility in rupee-dollar exchange rate has exhibited mixed trends in the past two decades of market determined exchange rate (Chart 1, Table I). After the first major episode of volatility in 1995-96 in the

Chart 1: Rupee-Dollar Exchange Rate Movements: 1993-2013

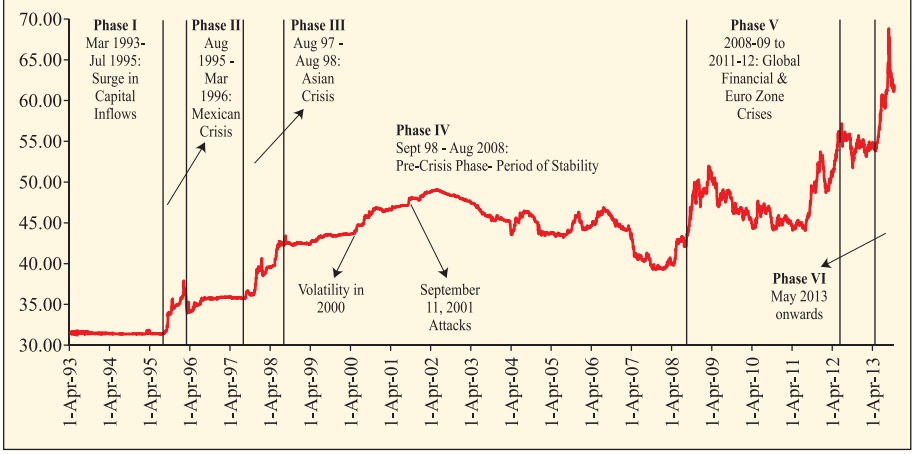


Table I: Annualised Daily Volatility in Rs-$ Exchange Rate during various Episodes of Volatility (1993-2014)

(Per cent)

Period			Volatility
September-October 1995			12.58
end-January to February 1996			13.94
August 1997 to January 1998			7.91
May to August 1998			7.63
September to November 2008			13.37
May 23 to September 4, 2013			17.14
September 4, 2013 to April 2, 2014 (after Governor Rajan took over)			9.15
Monthly Volatility during the Recent Episode			
	May 2013		4.47
	June 2013		14.75
	July 2013		10.38
	Aug 2013		25.68
	Sept 2013		18.71
	Oct 2013		8.26

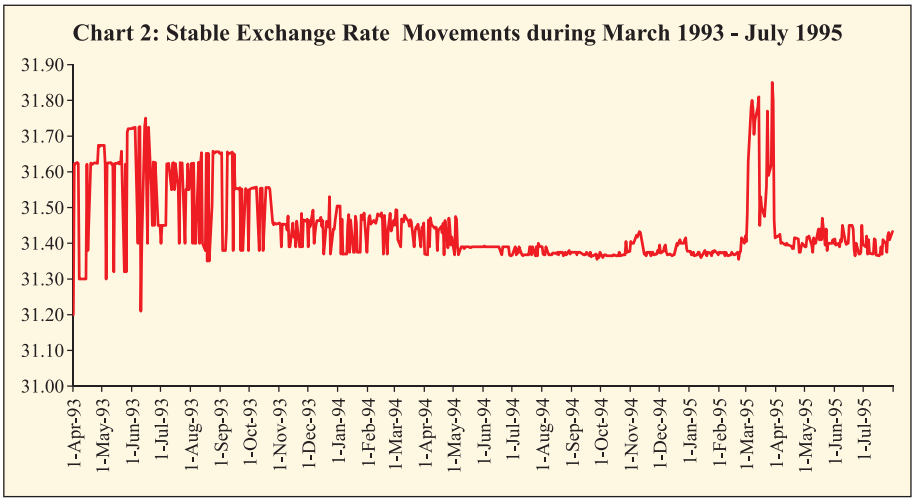
wake of Mexican crisis when volatility touched the level of around 13-14 per cent, volatility remained relatively subdued, even during the East Asian crisis of 1997-98. However, there has been a significant increase in exchange rate volatility in the aftermath of the global financial crisis, signifying the greater influence of volatile capital flows on exchange rate movements. EMEs like India, which have large current account deficit, are particularly vulnerable to the vagaries of international capital flows where a surge in capital flows in search of better yield is invariably followed by reversals/sudden stops on sudden change in risk appetite of international investors, thereby imparting significant volatility to the EME financial markets. Volatility has increased significantly in the post May 22, 2013 phase after Chairman Bernanke's testimony about the possibility of QE tapering. Among various episodes of volatility, the annualized daily volatility was maximum at around 17.14 per cent during the period from May 23 to September 4, 2013. However, it declined to 9.15 per cent during the period September 4, 2013 to April 2, 2014. In terms of month-wise exchange rate volatility during the post May 22, 2013 phase, despite a sharp increase in volatility in June 2013 *vis-à-vis* May 2013, measures announced in July 2013 had a dampening impact

on volatility. However, despite RBI's measures, August 2013 witnessed intense exchange market pressure with the volatility in rupee-dollar exchange rate touching an all time high. But the measures announced in September and October 2013 after Governor Rajan assumed office on September 4, 2013 have clearly led to a significant decline in volatility from a high of 25.7 per cent in August 2013 to 18.7 per cent in September 2013 and further to 8.3 per cent in October 2013. This bears testimony to the efficacy of RBI's measures in controlling the recent episode of volatility though other positive developments, both external as well as internal, have also buoyed the market sentiment and contributed to the strength of the rupee.

Section II
Post-Exchange Rate Unification Period (March 1993 to July 1995): Surge in Capital Flows

A. Backdrop: The first phase of the post-exchange rate unification period, spanning from March 1993 to July 1995, was marked by a surge in capital inflows on account of liberalization in the capital account and a move to a market determined exchange rate. As against FDI and Portfolio flows of US$ 341 million and US$ 92 million respectively, in 1992-93, the corresponding figures in 1993-94 were US$ 620 million and US$ 3490 million. Though the CAD increased from 0.4 per cent of GDP in 1993-94 to 1.6 per cent of GDP in 1995-96, the surplus on the capital account (3.8 per cent of GDP in 1993-94) on account of the large capital inflows more than compensated for the CAD, leading to large accretion to forex reserves. The WPI inflation which stood at 8.4 per cent in 1993-94 accelerated to 12.6 per cent in 1994-95 contributing significantly to the overvaluation of the rupee as the rupee was essentially range-bound during the period. The GFD which stood at around 7 per cent of GDP in 1993-94 declined to around 5 per cent of GDP in 1995-96. The GDP growth accelerated from 5.7 per cent in 1993-94 to 7.3 per cent in 1995-96.

B. Actions Taken: To maintain the external competitiveness of exports and stability of the rupee, which is a prerequisite for capital inflows, RBI, under Governor Rangarajan, intervened in the spot



market and purchased dollars and, thereafter, conducted Open Market Operations to partly sterilize the expansionary impact on domestic liquidity. The focus of exchange rate policy in 1993-94 was on preserving the external competitiveness of the rupee at a time when the economy was undergoing a structural transformation coupled with building up of the forex reserves.

C. **Outcome**: As a result of RBI's intervention, India's forex reserves increased from US$ 6.4 billion at the end of March 1993 to US$ 20.8 billion as at the end of March 1995, representing over 7 months of import cover. There was a prolonged period of stability in the rupee-dollar exchange rate from March 1993 to July 1995 (the USD/Rupee rate remained range bound within Rs.31.37 and Rs 31.65 per US dollar), which was followed by a period of volatility or reversal of the gains made by the rupee (Chart 2).

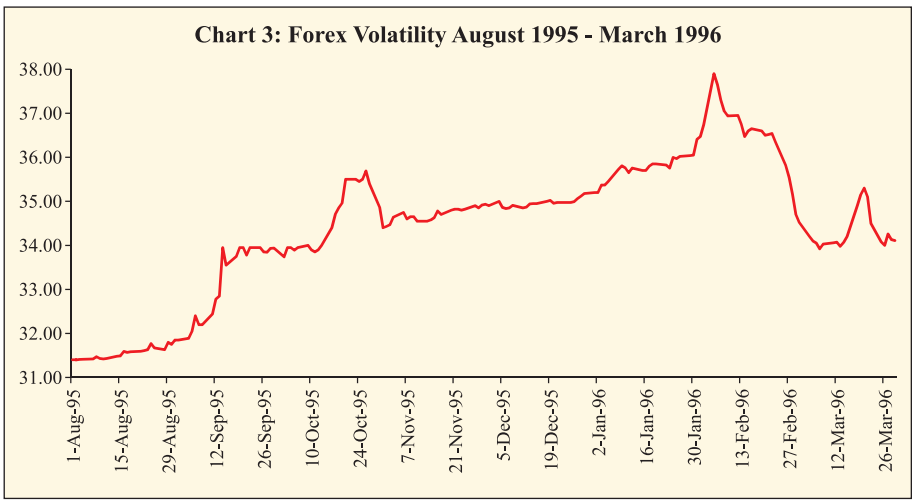
Section III
Impact of Mexican Crisis (August 1995 to March 1996)

The period from August 1995 to March 1996 has been divided into two phases. In the first phase spanning from August to December 1995, as a result of RBI's actions, stability was restored by October 1995 with rupee moving in range bound manner during the period October-December 1995. However, renewed bout of volatility surfaced

in January 1996 on the back of weak market sentiments and demand-supply mismatch, which has been covered separately.

I. August-December 1995: Contagion of Mexican Crisis

A. Backdrop: The second phase spanning from August 1995 to March 1996 was marked by intense volatility in the forex market, which was mainly on account of the spread of the contagion of the Mexican currency crisis in 1994, which entailed sharp devaluation of the Mexican peso in December 1994 on account of inappropriate policies, large CAD and weak macro-economic fundamentals, leading to sharp slowdown in capital inflows, and certain endogenous factors, which had accentuated the demand for dollar. The exchange rate of rupee, which stood at 31.40 per US dollar at end-July 1995 depreciated to 33.96 by end-September 1995 and further to 36.48 by end-January 1996 (Chart 3). It may be pointed out that the sharp depreciation of the rupee was despite the benign macroeconomic scenario at that time with real GDP growth accelerating from 5.7 per cent in 1993-94 to 7.3 per cent in 1995-96. CAD as percentage of GDP, though quite sustainable, increased from 1.0 per cent of GDP in 1994-95 to 1.6 per cent in 1995-96 mainly because of increase in imports. GFD as a percentage of GDP also moderated from around 6.96 per cent in 1993-94 to 5.05 per cent in 1995-96. However, the annual average WPI inflation rate (base 1993-94=100) was quite high at 12.6 per



cent during 1994-95, which contributed significantly towards the overvaluation of the rupee in real terms, though in nominal terms the rupee had remained mostly range bound for a substantial period of time before the volatility episode.

B. Actions Taken: As the rupee was overvalued in REER terms, the RBI allowed the rupee to depreciate but intervened in the market to ensure that the market corrections were calibrated and orderly. The RBI intervened in the second fortnight of October 1995 to the tune of US$ 912.5 million. Further, certain administrative measures were initiated to reduce the leads and lags in import payments and export realization and to improve inflows. Some of the major administrative/monetary measures taken by the RBI under Governor Rangarajan in October/November 1995, *inter alia,* included:

- Imposition of interest surcharge on import finance with effect from October 1995,
- Tightening of concessionality in export credit for longer periods,
- Easing of CRR requirements on domestic as well as non-resident deposits from 15.0 per cent to 14.5 per cent in November 1995,
- Foreign currency denominated deposits like FCNR(B) and NR(NR)RD were exempted from CRR requirements, and
- Interest rates on NRE deposits were increased.

C. Outcome: The decisive and timely policy actions brought stability to the market and the rupee resumed trading within the range of Rs.34.28 – Rs. 35.79 per US dollar in the spot segment during the period, October 1995 to December 1995.

II. January-March 1996: Renewed Volatility on Weak Sentiments

A. Backdrop: Yet another bout of sharp depreciation of the rupee was witnessed towards the end of January 1996 and in the first week of February 1996, when the rupee touched a low of Rs.37.95 in the spot market while the three-month forward premia rose to around 20 per cent. As already mentioned in the previous section, the sharp depreciation in the exchange rate of the rupee took place

despite benign macro-economic fundamentals like GDP growth accelerating to 6.4 per cent in 1994-95 from 5.7 per cent in the previous year, low CAD of 1.0 per cent in 1994-95 and reduction in GFD to 5.7 per cent of the GDP in 1994-95 from around 7 per cent in the previous year. However, the WPI inflation was quite high at 12.6 per cent. The depreciation was triggered by weak market sentiment coupled with demand-supply mismatch resulting from buoyant imports on the back of acceleration in economic activities and slowdown in capital flows to EMEs on a reassessment of the credit risks involved in the wake of the Mexican crisis.

B. Actions taken: In order to curb the volatility in the spot as well as forward market, spot sales followed by buy-sell swaps were undertaken on several occasions. In addition, direct forward sales were also resorted to. As at the end of March 1996, the RBI's cumulative forward sales obligations were to the tune of US$ 2.3 billion, spread over the next six months. As a result of the RBI's intervention operations to contain volatility in the forex market, RBI's foreign currency assets, which stood at 19.0 billion at end-August 1995, declined to US$ 15.9 billion by end-February 1996. Apart from the intervention efforts, a number of administrative measures were also initiated on February 7, 1996 to encourage faster realization of export proceeds and to prevent an acceleration of import payments, *i.e.*, to reduce the lags and leads.

The measures, *inter alia*, included:

- Increase in interest rate surcharge on import finance from 15 to 25 per cent,
- discontinuation of Post-Shipment Export Credit denominated in US dollars (PSCFC) with effect from February 8, 1996,
- Weekly reporting to the RBI of cancellation of forward contracts booked by ADs for amounts of US$ 1,00,000 and above.
- Other measures included relaxation in the inward remittance of GDR proceeds, relaxation in the external commercial borrowing (ECB) norms, freeing of interest rate on post-shipment export rupee credit for over 90 days and upto 180 days, etc.

C. Outcome: These measures enabled the rupee to stage a strong recovery in March-April 1996 and thereafter upto June 1996, the rupee generally remained range-bound within Rs.34 – Rs.35. The forward premia also declined and by the end of June 1996, the premia were well within the 10-11 per cent range, reflecting the interest rate differentials. Thus, the active intervention by the Reserve Bank in spot, forward and swap markets during the period did have an impact on the exchange market and domestic liquidity situation and helped in smoothening the volatility rather than propping up the exchange rate. The period from May 1996 to mid-August 1997 was a period of stability with the rupee trading in a narrow range of 35 - 36 per US dollar. As a result of substantial capital inflows, forex assets of the RBI increased from US$ 17.0 billion at the end of March 1996 to US$ 22.4 billion at the end of March 1997 and to around US$ 26.4 billion as at the end of August, 1997.

Section IV
Impact of East Asian Crisis (August 1997 to August 1998)

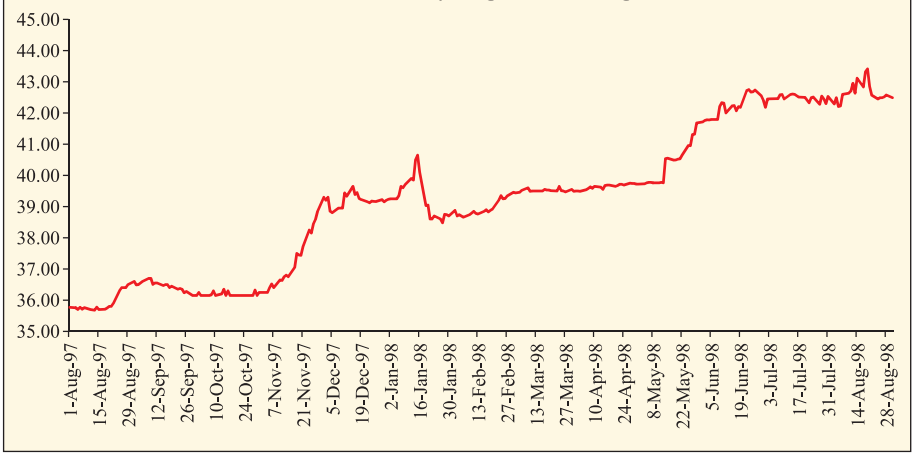
The period from August 1997 to August 1998 has been divided into two phases. In the first phase spanning from August 1997 to April 1998, as a result of RBI's actions, stability was restored by March 1998 with rupee experiencing moving in a range-bound manner during March-April 1998. However, renewed bout of volatility surfaced in May 1998 on the back of enhanced uncertainties emanating from spread of the crisis, which has been covered separately.

I. August 1997 to April 1998: Volatility in the Wake of Outbreak of Asian Crisis

A. Backdrop: The third phase spanning from mid-August 1997 to August 1998, posed severe challenges to exchange rate management due to the contagion effect of the South-East Asian crisis, economic sanction imposed by many industrialized nations after the nuclear explosion in Pokhran (India) in May 1998 and the downgrading of the sovereign rating of India by certain international rating agencies. The monthly average Rs-$ exchange

rate, which was quite stable prior to the onset of the crisis and stood at 35.92 per US dollar in August 1997, depreciated continuously during the crisis period and reached a low of 42.76 per US dollar in August 1998, i.e., a depreciation of 16 per cent during the period (Chart 4). This sharp depreciation took place against the backdrop of worsening macroeconomic fundamentals, which was reflected in significant deceleration in GDP growth to 4.3 per cent in 1997-98 from 8.0 per cent in 1996-97. GFD increased sharply from 4.8 per cent of GDP in 1996-97 to 5.8 per cent in 1997-98. The CAD, which stood at around 1.2 per cent of GDP during 1996-97, increased marginally to 1.4 per cent of GDP in 1997-98. However, WPI inflation was low at 4.4 per cent during 1997-98 (4.6 per cent in 1996-97). It may be pointed out that the relative stability in exchange rate for a prolonged period of time prior to the crisis led to some complacency on the part of market participants who kept their oversold or short position unhedged and substituted some domestic debt with foreign currency borrowings to take advantage of interest rate differential. However, in the wake of developments in South East Asia and changed perception of a depreciating rupee, there was a rush to cover un-hedged positions by the market participants in the latter part of August 1997, which resulted in the rupee coming under pressure and the forward premia firming up in the first week of September 1997.

Chart 4: Forex Volatility August 1997-August 1998



B. Actions Taken: In order to restore stability, the RBI intervened in the spot, forward and swap markets. In September 1997 alone, RBI was net seller in the forex market to the tune of US$ 978 million, while during the period November 1997 to July 1998, RBI was net seller to the tune of US$ 3.1 billion. As a result of RBI's intervention in the forward market to manage expectations and bring forward premia down, RBI's forward laibilities increased from US$ 40 million in August 1997 to a peak of US$ 3.2 billion in January 1998 but came down subsequently as normalcy returned to the market. Apart from intervention operations, the RBI also initiated stringent monetary and administrative measures to stem the unidirectional expectation of a depreciating rupee and curb speculative attacks on the currency**.** Some of the important measures taken by the RBI under Governor Rangarajan (upto November 22, 1997) and subsequently under Governor Jalan during the period from August 1997 to April 1998 are set out below:

- With a view to reducing arbitrage opportunities between forex market and the domestic rupee markets, and thereby reducing the demand for dollars, the interest rate on fixed rate 'repos' was raised to 5 per cent from 4.5 per cent,
- The CRR requirement of scheduled commercial banks was raised by 0.5 percentage point.
- Incremental CRR of 10 per cent on NRERA and NR(NR) deposits were removed with effect from the fortnight beginning December 6, 1997.
- The interest rate on post-shipment export credit in rupees for periods beyond 90 days and up to six months was raised from 13 per cent to 15 per cent,
- In respect of overdue export bills, a minimum interest rate of 20 per cent per annum was prescribed,
- An interest rate surcharge of 15 per cent on lending rate (excluding interest tax) on bank credit for imports was introduced..

On Jan 6/16, 1998, more measures were taken, which included

- Raising of cash reserve ratio requirement for banks from 10 per cent to 10.5 per cent,

- Raising Bank Rate from 9 per cent to 11 per cent,
- Raising interest rate on fixed rate repos from 7 per cent to 9 per cent,
- Reducing access of banks to export and general refinance facility from RBI and
- Prohibiting banks from taking any overnight currency position from January 6, 1998.

C. Outcome: As a result of these measures, stability returned in the foreign exchange market and more importantly, the expectations of the market participants about further depreciation in the exchange rate of rupee were contained and also reversed to a certain extent. The exchange rate of rupee, which had depreciated to Rs. 40.36 per US dollar as on January 16, 1998, appreciated to Rs. 39.50 per dollar on March 31, 1998. The exchange rate moved in a narrow range around Rs.39.50 per US dollar in March-April 1998. The six month forward premia, which reached a peak of around 20 per cent in January 1998, came down to 7.0 by the end of March 1998. Forward liabilities of the Reserve Bank declined from a peak of US $ 3.2 billion at the end of January 1998 to US $ 1.4 billion by April 1998.

II. May-August 1998: Renewed Volatility due to Spread of Asian Crisis

A. Backdrop: In May 1998 there were again uncertainties in market expectations due to the spread of the South –East Asian crisis to Brazil and Russia, nuclear weapon testing in Pokhran (India), which resulted in economic sanctions being imposed by the US and certain other industrialized countries, suspension of fresh multilateral lending (except for certain specified sectors), downgrading of country rating by international rating agencies and reduction in investment by Foreign Institutional Investors (FIIs). As a result of these developments, the forex market experienced increased pressure during the period May-August 1998. The exchange rate of the rupee, which was Rs 39.74 at the end of April 1998, depreciated to Rs 41.50 by the end of May 1998 and further

to around Rs 42.47 by the end of June 1998, and continued to remain at these levels till mid August 1998 when it crossed Rs 43 mark for a brief period prompting RBI to take certain measures.

B. Actions taken: Some important measures announced by the RBI during the period have been set out below:

- Export credit denominated in foreign currency was made cheaper and banks were advised to charge a spread of not more than 1.5 per cent above LIBOR as against the earlier norm of not exceeding 2-2.5 per cent over LIBOR.
- Exporters were also allowed to use their balances in EEFC accounts for all business related payments in India and abroad at their discretion,
- Withdrawal of the facility of rebooking of cancelled forward contracts for trade related transactions including imports, etc.
- As a measure of abundant precaution and also to send a signal to the world regarding the intrinsic strength of the economy, India floated the **Resurgent India Bonds (RIBs)** in August 1998, which was very well received by the Non Resident Indians(NRIs)/ Persons of Indian Origin (PIOs) and subscribed to the tune of US$ 4.2 billion.

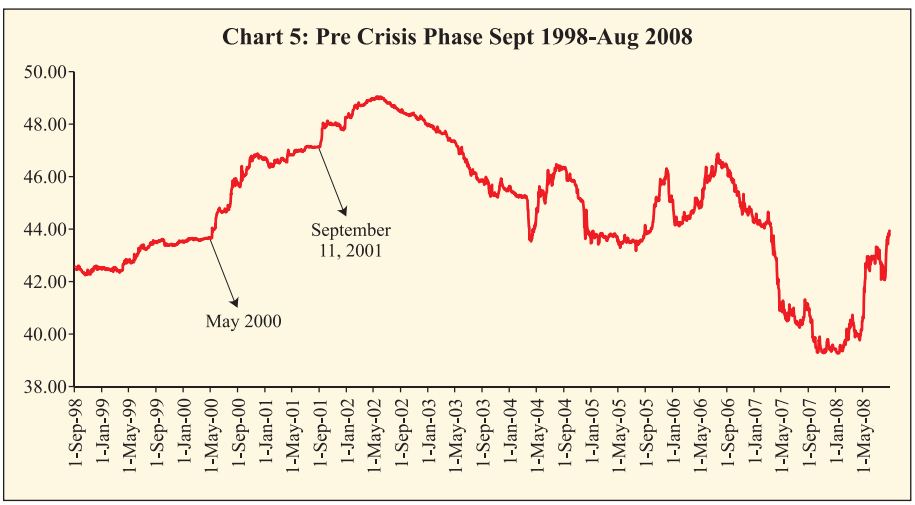
C. Outcome: As a result of the measures announced by the RBI in August 1998, the rupee, which crossed Rs 43 mark for a brief period in August 1998, climbed back to Rs 42.50 level by end-August 1998. The rupee remained range bound after that and hovered around 42.50 per US dollar up to March 1999 but depreciated a bit and crossed the Rs. 43 per US dollar mark in the subsequent months.

D. Lessons learnt from the Asian Crisis: On hindsight, one could say that India was successful in containing the contagion effect of the Asian crisis due to swift policy responses to manage the crisis and favourable macroeconomic conditions. During the period of crisis, India had a low CAD, comfortable foreign exchange reserves amounting to import cover of over seven months, a market determined exchange rate, low level of short-term debt,

and absence of asset price inflation or credit boom. Apart from prudent policies pursued over the years, sound capital controls also helped in insulating the economy from contagion effect of the East Asian crisis. Thus, sound macro-economic fundamentals, especially sustainable level of CAD, and prudent capital controls helped India to escape from the contagion effect of the Asian crisis

Section V
The Pre Crisis Phase (September 1998 till August 2008)

In the fourth phase, starting from September 1998 onwards (i.e., till the advent of global financial crisis in 2008), the forex markets generally witnessed stable conditions with brief phases of volatility caused due to certain domestic and international events like the Indo-Pak border tension in June 1999, terrorist attack on the World Trade Centre, New York on September 11, 2001 and the attack on Iraq by America which resulted in a oil price shock, etc. (Chart 5) The periods of volatility were managed mainly by intervention in the spot and swap markets, floatation of the India Millennium Deposit (IMD) in September/October 2000, which helped in mobilizing US$ 5.5 billion, and appropriate monetary /administrative measures. Due to continuous excess supply of dollars in the period from April 2002 to May 2008 and intervention by RBI to maintain the stability and external competitiveness of the rupee, the



foreign currency assets of the RBI rose from US$ 51.0 billion as at end-March 2002 to US$ 305 billion as at end-May 2008.

Two specific instances of volatility (i) during 2000 on higher imports and reduced capital flows and (ii) after the terrorist attack at World Trade Centre (WTC) on September 11, 2001 and RBI's response have been detailed below:

I. Episode of Volatility in 2000: Higher imports and Reduced Capital Flows

A. Background: The stability in the foreign exchange market exhibited during the latter part of 1999 was carried over to the month of April 2000 with the rupee hovering within a narrow band of 43.4 – 43.7 per US dollar. However, there was a sudden change in market perception on the rupee from the second week of May 2000 due to higher import payments and reduced capital inflows. The exchange rate depreciated from Rs.43.64 per US dollar during April 2000 to Rs.44.28 on May 25, 2000 as the market was characterised by considerable uncertainty.

B. Actions taken: Apart from intervention (net sales of US$ 1.9 billion during May-June 1998), the RBI under Governor Jalan took a number of administrative measures to contain volatility in the forex market, which had a salutary impact. The measures taken on May 25, 2000 included:

(i) an interest rate surcharge of 50 per cent of the lending rate on import finance was imposed with effect from May 26, 2000, as a temporary measure, on all non-essential imports,

(ii) it was indicated that the Reserve Bank would meet, partially or fully, the Government debt service payments directly as considered necessary;

(iii) arrangements would be made to meet, partially or fully, the foreign exchange requirements for import of crude oil by the Indian Oil Corporation;

(iv) the Reserve Bank would continue to sell US dollars through State Bank of India in order to augment supply in the market or intervene directly as considered necessary to meet any temporary demand-supply imbalances;

(v) banks would charge interest at 25 per cent per annum (minimum) from the date the bill fell due for payment in respect of overdue export bills in order to discourage any delay in realisation of export proceeds;

(vi) authorised dealers acting on behalf of FIIs could approach the Reserve Bank to procure foreign exchange at the prevailing market rate and the Reserve Bank would, depending on market conditions, either sell the foreign exchange directly or advise the concerned bank to buy it in the market; and

(vii) banks were advised to enter into transactions in the forex market only on the basis of genuine requirements and not for the purpose of building up speculative positions.

Subsequently, the exchange rate of the rupee, which was moving in a range of Rs. 44.67-44.73 per US dollar during the first half of July 2000 touched a low of Rs 45.07 per US dollar on July 21, 2000, the day on which RBI announced certain monetary measures, which have been set out below:

- Raising of CRR by 0.5 percentage points to 8.5 per cent from 8.0 per cent;
- Raising of bank rate by one percentage point from 7 per cent to 8 per cent and
- Reduction of 50 per cent in refinance facilities including collateralised lending facility available to the banks.

C. Outcome: As a result of these measures, stability was restored with the forex market remaining relatively quiet during September-October 2000. During the months of November and December 2000, the exchange rate of the rupee displayed appreciating trend in the midst of positive sentiments in the foreign exchange market created by inflows coming from India Millenium Deposits (IMDs). After opening the month of November 2000 at Rs. 46.85 per US dollar, the rupee appreciated to the levels of Rs.46.53 per US dollar before closing the month at Rs. 46.84 per US dollar, almost close to the opening level of the month. The rupee closed the month of December 2000 at Rs. 46.67 per US dollar. The orderly conditions in the forex market continued in the last quarter of 2000-01 as well.

II. Episode of Volatility in 2001: September 11, 2001 Terrorist Attacks

A. Background: The stability in the forex market witnessed during the first five months of financial year 2001-02 (April-August) with the rupee depreciating marginally from 46.64 at end-March 2001 to 47.15 per US dollar at end-August, 2001 could not be sustained in September 2001. The unprecedented attacks by terrorists at strategic locations in New York and Washington on September 11, 2001 brought international financial markets into turmoil. The Indian financial markets also experienced repercussions of the horrifying events. As a result, the exchange rate of Indian rupee, which stood at 47.41 per US dollar on September 11, 2001 touched the level of 48.43 on September 17.

B. Actions Taken: The Reserve Bank tackled the situation through quick responses in terms of net sales in the forex market to the tune of US$ 894 million in September 2001 and package of measures, which have been set out below:

The measures taken by the Reserve bank under Governor Jalan included:

- Reiteration by the Reserve Bank to keep interest rates stable with adequate liquidity;
- Assurance to sell foreign exchange to meet any unusual supply-demand gap;
- Opening a purchase window for select Government securities on an auction basis;
- Relaxation in FII investment limits upto the sectoral cap/statutory ceiling;
- A special financial package for large value exports of six select products;
- Reduction in interest rates on export credit by one percentage point, etc.

C. Outcome: The above measures coupled with announcement of the mid-term review of monetary and credit policy on October 22, 2001, which brought in easy liquidity conditions and softer

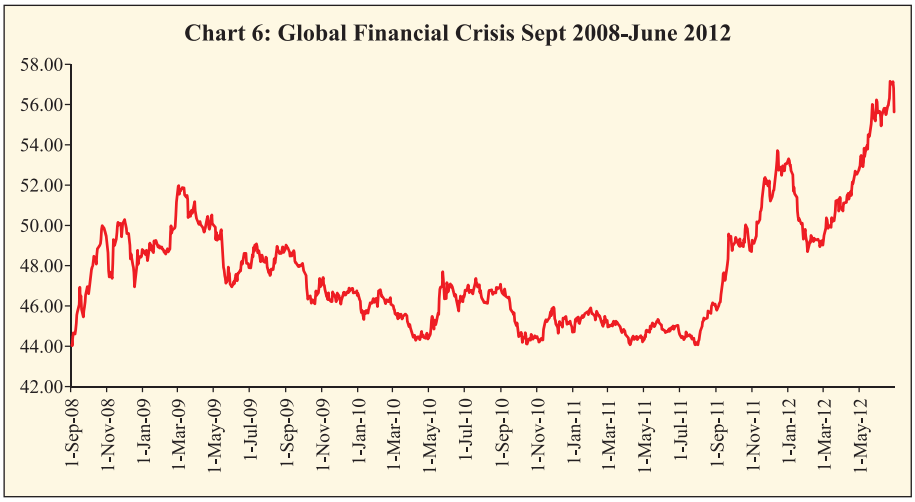
interest rate regime and aided the market sentiment, helped in restoring stability to the forex market quickly. During the last quarter of 2001 (October-December), the forex market generally witnessed stable conditions with the exchange rate of the rupee hovering around Rs. 48 per US dollar amidst steady supply of dollars and modest corporate demand. The benign macroeconomic environment also helped in achieving stability quickly with GDP growth accelerating from 4.3 per cent in 2000-01 to 5.5 per cent in 2001-02. The current account was in surplus at 0.7 per cent of the GDP. WPI inflation was also quite low at 3.6 per cent in 2001-02 (7.2 per cent in 2000-01). However, GFD increased from 5.7 per cent in 2000-01 to 6.2 per cent in 2001-02.

Section VI
The Global Financial Crisis (2008-09 To 2011-12)

I. Volatility in 2008-09: Collapse of Lehman Brothers

A. Background: Prior to the advent of global financial crisis in 2008, external sector developments in India were marked by strong capital flows, which resulted in the exchange rate of the Indian rupee witnessing appreciating trend up to 2007-08. The robust macro-economic environment with GDP expanding at over 9 per cent during 2006-07 and 2007-08, CAD standing at 1.3 per cent of GDP in 2007-08 (1.0 per cent in 2006-07) and WPI inflation standing at a comfortable 4.7 per cent during 2007-08 also facilitated strong capital inflows. However, there was a sudden change in the external environment following the Lehman Brothers' failure in mid-September 2008. The global financial crisis and deleveraging led to reversal and/ or modulation of capital flows, particularly FII flows, ECBs and trade credit. Large withdrawals of funds from the equity markets by the FIIs, reflecting the credit squeeze and global deleveraging, resulted in large capital outflows during September-October 2008, with concomitant pressures in the foreign exchange market across the globe, including India.

After Lehman's bankruptcy, the rupee depreciated sharply from around Rs. 48 levels, breaching the level of Rs.50 per US dollar on October 27, 2008 (Chart 6). The Reserve Bank scaled up its intervention operations



during the month of October 2008 (record net sales of US$ 18.7 billion during the month). Despite significant easing of crude oil prices and inflationary pressures in the second half of the year, declining exports and continued capital outflows led by global deleveraging process and the sustained strength of the US dollar against other major currencies continued to exert downward pressure on the rupee. With the spot exchange rates moving in a wide range, the volatility of the exchange rates increased during this period.

B. Actions Taken: The Reserve Bank under Governor Subbarao took a number of measures to control volatility, which included:

- Announcement in mid-September 2008 by the Reserve Bank about its intentions to continue selling foreign exchange (US dollar) through agent banks to augment supply in the domestic foreign exchange market or intervene directly to meet any demand-supply gaps.
- A rupee-dollar swap facility for Indian banks was introduced with effect from November 7, 2008 to give the Indian banks comfort in managing their short-term foreign funding requirements. For funding the swaps, banks were also allowed to borrow under the LAF for the corresponding tenor at the prevailing repo rate. The forex swap facility, which was originally available till June 30, 2009, was extended

up to March 31, 2010; however, this was discontinued in October 2009.

- The Reserve Bank also continued with Special Market Operations (SMO) which were instituted in June 2008 to meet the forex requirements of public sector oil marketing companies (OMCs), taking into account the then prevailing extraordinary situation in the money and foreign exchange markets; these operations were largely (Rupee) liquidity neutral.
- Finally, measures to ease forex liquidity also included those aimed at encouraging capital inflows, such as, an upward adjustment of the interest rate ceiling on foreign currency deposits by non-resident Indians, substantially relaxing the ECB regime for corporates, and allowing non-banking financial companies and housing finance companies to access foreign borrowing.

C. Outcome: As a result of the Reserve Bank's actions in the foreign exchange market, the pressure eased from December 2008 as liquidity conditions in the foreign exchange market returned to normal. With the return of some stability in international financial markets and the relatively better growth performance of the Indian economy, the rupee generally appreciated against the US dollar during 2009-10 on the back of significant turnaround in FII inflows, continued inflows under FDI and NRI deposits, better-than expected macroeconomic performance in 2009-10 and weakening of the US dollar in the international markets. The volatility in the foreign exchange market declined after the introduction of the forex swap facility. Additionally, the outcome of the general elections, which generated expectations of political stability, buoyed market sentiment and contributed towards the strengthening of the rupee, especially from the second half of May 2009. As a result of these developments, the rupee, which depreciated sharply by 21.5 per cent from 39.99 as at end-March 2008 to 50.95 at end-March 2009 in the aftermath of the global financial crisis, staged a smart turnaround and appreciated by around 12.9 per cent in 2009-10 to 45.14 per US dollar as at end-March 2010.

II. Volatility in 2011-12: Deepening of Euro Zone Debt Crisis & Weak Fundamentals

A. Background: After being largely range bound in the first four months of the financial year 2011-12, rupee depreciated by about 17 per cent during August to mid-December of 2011, reflecting global uncertainties and domestic macro-economic weakness. The S&P's sovereign rating downgrade of the US economy, deepening euro area crisis and lack of credible resolution mechanisms led to enhanced uncertainty and reduced risk appetite in global financial markets for EME assets, which resulted in a flight to US dollar, as it was considered a safe asset *vis-à-vis* the riskier EME assets by investors, notwithstanding the economic woes of the US, as US dollar is considered numero uno currency at the time of uncertainty and crisis. With US dollar appreciating as a result, most currencies, including the Indian rupee came under pressure.

B. Actions Taken: Considering the excessive pressures in the currency markets, the Reserve Bank under Governor Subbarao intervened in the foreign exchange market through dollar sale. It also took several capital account measures to stabilise rupee that included:

- Deregulation of interest rates on rupee denominated NRI deposits and enhancing the all-in-cost ceiling for ECBs with average maturity of 3-5 years.
- Ceilings for FIIs' investment in government securities and corporate bonds were raised by US$ 5 billion each to US$ 15 billion and US$ 45 billion, respectively.

Additionally, the Reserve Bank initiated various administrative steps to curb speculation, which included:

- Withdrawing the facility of cancellation and rebooking of contracts available under contracted exposure to residents and FIIs;
- Reducing the limit under past performance facility for importers to 25 percent of the limit available at that time;
- Making the past performance facility available to exporters and importers only on a delivery basis, mandating that all

cash/ tom/ spot transactions by ADs on behalf of clients were to be undertaken for actual remittances/ delivery only and could not be cancelled/ cash settled;

- Reducing the net overnight open position limit (NOOPL) of ADs across the board;
- Mandating that the intra-day position/ daylight limit of ADs should not exceed the existing NOOPL approved by the Reserve Bank.
- The taking of position by banks, in the currency futures segment, was also curbed, because it was rampantly used for arbitrage between the OTC and the currency futures, which exacerbated the volatility in the forex market.

C. **Outcome:** As a result of the series of measures undertaken to improve dollar supply in the foreign exchange market as also to curb speculation, the rupee appreciated by 11 per cent from 54.24 per US dollar on December 15, 2011 to 48.68 by February 6, 2012, before weakening again. The renewed pressure on rupee was mainly due to widening trade deficit, drying up of capital flows, particularly FII flows and apprehension about the exit of Greece from the euro.

Measures taken in May-June 2012

In order to improve the inflows as also to reduce the volatility in the rupee, the Reserve Bank under Governor Subbarao took additional measures in May-June, 2012.

The measures in May 2012 included increase in interest rate ceiling on FCNR(B) deposits, deregulation of ceiling on interest rate for export credit in foreign currency, and requirement to convert 50 per cent of the balances in the EEFC accounts to rupee balances.

Additional measures were taken In June 2012, in consultation with the government, which included, *inter alia*, allowing ECB for Indian companies for repayment of outstanding rupee loans towards capital expenditure under the approval route, enhancing the limit for FII investment in G-secs by US$ 5 billion to US$ 20 billion, rationalisation of FII investment in infrastructure debt in

terms of lock in period and resident maturity, allowing Qualified Foreign Investors (QFIs) to invest in mutual funds that held at least 25 per cent of their assets in infrastructure under the sub-limit for investment in such mutual funds and broadening the investor base for G-Secs to include certain long-term investor classes, such as, Sovereign Wealth Funds, insurance funds and pension funds.

Outcome: The measures during May-June 2012 helped in stabilizing the rupee, which moved in a range-bound fashion in the subsequent months.

Some lessons from Various Past Episodes of volatility in the Forex Market

An important aspect of the policy response in India to the various episodes of volatility has been market intervention combined with monetary and administrative measures to meet the threats to financial stability while complementary or parallel recourse has been taken to communications through speeches and press releases. Empirical evidence in the Indian case has generally suggested that in the present day managed float regime of India, intervention has served as a potent instrument in containing the magnitude of exchange rate volatility of the rupee and the intervention operations do not influence as much the level of rupee (Pattanaik and Sahoo, 2001; Kohli, 2000; RBI, 2005-06).

The message that comes out from this discussion of various episodes of volatility of exchange rate of the rupee and the policy responses thereto is clear: flexibility and pragmatism have been the cornerstone of exchange rate policy in developing countries, rather than adherence to strict theoretical rules. It also underscores the need for central banks to keep instruments/policies in hand for use in difficult situations. Thus, availability of sufficient tools in the toolkit of a central bank is also a necessary condition to manage crisis.

India was able to escape the contagion effect of various currency crises in the second half of the nineties mainly because of prudent forex and reserve management policies and also, to an extent, because of relatively closed nature of its economy on account of sound capital controls. Indian rupee is fully convertible so far as current account

transactions are concerned, but the process of opening up of the capital account has been gradual though a number of capital account liberalization measures have been taken over the years. The capital controls have worked well in the Indian case as they have helped in insulating the economy, to an extent, from the vagaries of international capital flows. India has consciously tried to reduce debt-creating flows, especially those which are essentially short-term in nature.

The Asian crisis and the more recent global financial crisis have underscored the importance of having certain necessary capital control in place (even international financial institutions like the IMF have revised their stance in this regard) as unfettered capital account liberalization is no longer considered the most desirable thing. Additionally, the various crises of the past two decades have highlighted the need for the EMEs to maintain a healthy forex reserve cover as this helps in inspiring confidence of the market in the ability of the central bank to contain volatility at the time of any crisis. Since EMEs are especially vulnerable to reversals and sudden stops in capital flows, this issue assumes paramount significance for ensuring financial stability of the EMEs. Even the debate surrounding the optimal level of reserves, based on various yardsticks, such as, import cover of reserves, Guidotti-Greenspan rule, liquidity-at-risk rule, *etc.*, is inconclusive and, recent developments have established that having a large quantum of reserves has turned out to be beneficial for EMEs in dealing with various episodes of crises, notwithstanding the costs associated with holding large reserves, as the quasi-fiscal costs are miniscule in comparison with the benefits in terms of financial stability and confidence.

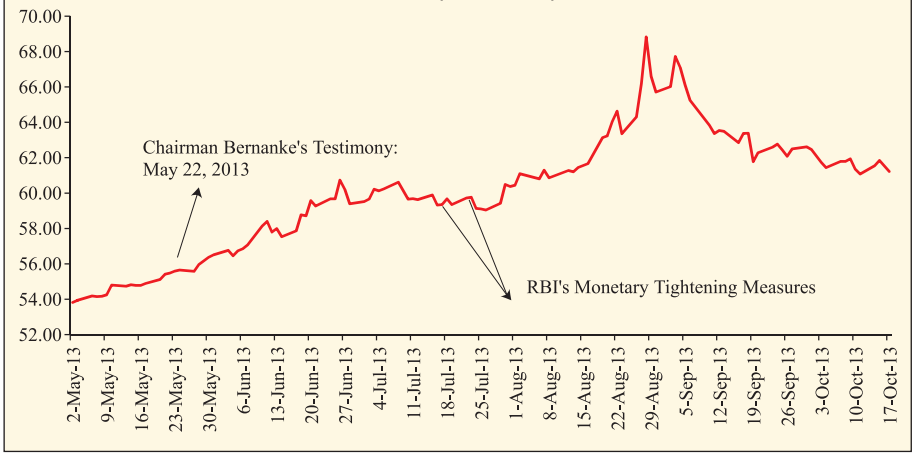
It is noteworthy that most of the measures taken by the RBI during the period of analysis aimed at curbing speculation and essentially related to the external sector/entities and were not general in nature. The measures, including the increase in fixed rate repo twice at the time of Asian financial crisis, were basically aimed at curbing arbitrage opportunity between money and forex market and not specifically as a tool to induce greater capital flows for which a number of other measures, including hike in NRI deposit rates to increase their attractiveness and easing of ECB norms were taken.

Section VII
Episode of Volatility Post Chairman Bernanke's Testimony on May 22, 2013

A. Backdrop to the Recent Episode of Volatility

In the aftermath of the global financial crisis and the Euro zone debt crisis, EMEs have faced enhanced uncertainty. Capital flows to EMEs have become extremely volatile with excessive capital inflows to EMEs in search of better yields, resulting from massive quantitative easing (QE) undertaken by the advanced economies to pump prime their economies, followed by sudden stops and reversals as witnessed in the post May 22, 2013 period on fears of tapering of the QE programme. As a result of substantial slowdown in capital inflows, the rupee experienced significant depreciating pressure from the second half of May 2013 with the rupee depreciating sharply by around 19.4 per cent against the US dollar between May 22, 2013 when it stood at 55.4 per US dollar and August 28, 2013 when it touched historic low of 68.85 per US dollar on the back of sharp reversals in capital inflows and unsustainable level of CAD (4.8 per cent of GDP in 2012-13) coupled with weak macroeconomic environment in the form of sharp deceleration in GDP growth rate (4.5 per cent in 2012-13 and 4.4 per cent in Q1 of 2013-14), high inflation (WPI inflation of 7.4 per cent in 2012-13), large fiscal deficit (4.9 per cent of GDP in 2012-13), etc (Chart 7). Though the rupee was generally

Chart 7: Volatility- Post May 22, 2013



depreciating in line with economic fundamentals even prior to Chairman Bernanke's testimony on May 22, 2013, his testimony, which led to overarching concern about possibility of early tapering of QE programme by the US Fed as signs of US recovery emerged, triggered large selloffs by the FIIs in most EMEs, including India, leading to heightened volatility in financial markets in the EMEs and sharp depreciation of EME currencies, including the Indian rupee, which was one of the worst performers during the period from the second half of May 2013 to August 2013. The hardening of long-term bond yields in the US and other advanced economies increased their attractiveness prompting foreign investors to pull funds out of riskier emerging markets, which received large capital inflows in search of better yield, as a recovery in the US made the EME fixed income assets less attractive *vis-a-vis* the US, especially in the absence of large quantities of cheap money to invest in the event of QE tapering. The sharp depreciation of the rupee was not unique to India. A number of other emerging market currencies, such as, South African rand, Brazilean real, Turkish lira, Indonesian rupiah *etc.*, witnessed similar trends. Many of the EMEs, including India, resorted to forex market intervention coupled with other policy measures, such as, hike in interest rates, import compression of non-essential items, incentivisation of capital inflows, removal of bottlenecks to inflows, *etc.*, to stabilise their currencies, which yielded mixed results.

B. Measures taken by the RBI to contain volatility

In view of the increased exchange rate volatility in the domestic forex market, especially after Chairman Bernanke's testimony on May 22, 2013, the Reserve Bank under Governor Subbarao announced a number of monetary policy measures on July 15, 2013. The measures, though intended to stem the volatility in the forex market, primarily operated through their effect on liquidity in the banking system by making it relatively scarce, thereby reducing demand for foreign currency. The measures included:

- Recalibration in MSF rate with immediate effect to 300 basis points above the repo rate, i.e., the MSF rate was increased to 10.25 per cent from the earlier 8.25 per cent,

- Limiting overall allocation of funds under LAF to 1.0 per cent of NDTL of the banking system reckoned at Rs. 75,000 crore with effect from July 17, 2013 and
- Announcement to conduct open market sales of government securities of Rs. 12,000 crore on July 18, 2013.

While the above set of measures had a restraining effect on volatility with a concomitant stabilising effect on the exchange rate, based on a review of these measures, and an assessment of the liquidity and overall market conditions going forward, it was decided on July 23, 2013 to modify the liquidity tightening measures.

- The modified norms set the overall limit for access to LAF by each individual bank at 0.5 per cent of its own NDTL outstanding as on the last Friday of the second preceding fortnight effective from July 24, 2013.
- Moreover, effective from the first day of the fortnight beginning from July 27, 2013, banks were required to maintain a minimum daily CRR balance of 99 per cent of the average fortnightly requirement.

However, with the return of stability in the forex market, in the mid-quarter review of Monetary Policy on September 19, 2013, a calibrated unwinding of exceptional measures of July 2013 was undertaken, Accordingly, MSF rate was reduced by 75 bps to 9.5 per cent and the requirement of maintenance of minimum daily CRR balance by the banks was reduced to 95 per cent along with a 25 bps increase in repo rate to 7.5 per cent. In continuation with the calibrated unwinding, MSF rate was reduced further by 50 bps to 9.0 per cent on October 7, 2013 along with introduction of 7 days and 14 days term repo facility and liquidity injection to the tune of Rs. 99.74 billion through OMO purchase auction.

Apart from the monetary measures, the Reserve Bank made net sales to the tune of US$ 10.8 billion in the forex market during the period May-August 2013 (around US$ 6.0 billion in July 2013 and US$ 2.5 billion in August 2013). The Reserve bank also intervened in the forward market with RBI's outstanding net forward sales nearly

doubling to US$ 9.1 billion as at end-August 2013 from US$ 4.7 billion in July 2013. The Reserve Bank also took a number of administrative/ other measures to ease pressure on the rupee. Some of the key measures included:

- On July 8, 2013, banks were disallowed from carrying proprietary trading in currency futures/exchange traded options
- To moderate the demand for gold for domestic use, measures were taken to restrict import of gold by nominated agencies on consignment basis on May 13 and June 4, 2013. On July 22, revised guidelines regarding import of gold by nominated agencies was issued according to which at least 20 per cent of every import of gold needs to be exclusively made available for the purpose of export.
- Special dollar swap window was opened for the PSU oil Companies on August 28, 2013
- Norms relating to rebooking of cancelled forward exchange contracts for exporters and importers were relaxed on September 4, 2013
- A separate concessional swap window for attracting FCNR(B) dollar funds was opened on September 4, 2013
- Overseas borrowings limit was hiked from 50 per cent to 100 per cent of Tier I capital of the banks and concessional swap facility with the Reserve Bank for borrowings mobilized under the scheme was provided on September 4, 2013.

C. Outcome

The various measures taken by the RBI, both monetary as well as administrative, lent some stability to the rupee with the rupee exhibiting greater two way movements and stabilizing around the level of 62 - 63 per US dollar in the second half of September 2013 and around 61-62 level during October 2013. The rupee has been range-bound since then and has exhibited some strengthening bias in the recent period, especially in March 2014. The stability of the

rupee in the medium-term will depend on both external as well as internal developments. The initial set of monetary tightening measures taken on July 15, 2013 led to some strengthening of the rupee *vis-à-vis* the US dollar. However, despite additional set of monetary measures taken on July 23, 2013, the rupee continued with its depreciating trend and touched historic lows during August 2013. The rupee, based on RBI reference rate, appreciated marginally by 0.6 per cent from 60.05 on July 15, 2013 to 59.69 per US dollar on September 23, 2013. However, despite RBI's monetary measures, the rupee depreciated continuously and touched historic low of 68.85 per US dollar on August 28, 2013, a sharp depreciation of around 13.3 per cent between July 23 and August 28, 2013. However, opening of dollar swap window for oil PSUs on August 28, 2013 and announcement of additional measures by the new Governor, Dr. Raghuram Rajan on September 4, 2013, which *inter alia* included relaxation in rebooking of cancelled forward contracts, concessional swap window for attracting FCNR (B) deposits and enhancement in overseas borrowing limits of ADs buoyed the market sentiment and reduced pressure on the rupee. Positive domestic factors, such as, significant narrowing of trade deficit in August 2013 on the back of rising exports, aided to some extent by the sharp depreciation of the rupee against the US dollar, and fall in imports, especially gold imports, turnaround in industrial production for July 2013, improvement in CPI inflation rate, *etc.*, coupled with positive external developments like deferment of QE tapering by the US Fed in its FOMC meeting on September 18, 2013, easing of geopolitical tension over Syria and resolution of the US budget impasse also aided the market sentiment, as a result of which the rupee made a smart turnaround and appreciated by 11.4 per cent to 61.81 per US dollar on September 27, 2013 from its historic low of 68.85 per US dollar on August 28, 2013, indicating significant improvement in market sentiments.

The rupee has been range-bound and has exhibited strengthening bias in the recent period on the back of sustained capital inflows. The rupee has moved in the range of 59.65 and 63.65 per US dollar during the period from mid-September 2013 to April

2, 2014. Despite the announcement on December 18, 2013 of commencement of tapering by the US Fed starting from January 2014 and the subsequent announcements about the increase in its pace, the rupee has generally remained stable, which indicates that the markets have shrugged off QE tapering fears. The rupee has remained relatively stable as compared to other major EME currencies like Brazilian real, Turkish lira South African rand, Indonesia rupiah and Russian rouble. The contagion effect of sharp fall in Argentina peso against the US dollar in the second half of January 2014 and the recent crisis in Ukraine also did not have any major impact on the rupee.

Recent economic developments, such as, continued FII inflows to the domestic equity markets and resumption of FII flows to debt market as well, especially since December 2013 coupled with substantial reduction in gold imports and increase in exports leading to significant reduction in current account deficit to 0.9 per cent of GDP in Q3 of 2013-14 have buoyed the market sentiment and contributed to the stability of the rupee in the recent months. As per RBI's estimates, CAD narrowed to 1.7 per cent of GDP in 2013-14 from 4.7 per cent in 2012-13. The forex swap facilities extended by the Reserve Bank along with enhancement in banks' overseas borrowing limit, which led to forex inflows in excess of US$ 34 billion, have bolstered forex reserves and aided the stability of the rupee. Thus, a host of factors have led to the stability of the rupee in the recent months.

The measures taken by the RBI, aided undoubtedly by both external as well as internal positive developments, have had a stabilizing impact on the forex market and have been successful in reversing the unidirectional expectations of rupee's depreciation.

Efficacy of Measures to contain the Recent Bout of Exchange Rate Volatility and the Way Forward

The measures taken by the Reserve Bank have helped in stabilizing the financial markets, in general, and the forex market, in particular. The measures have been successful in countering the all pervasive negative sentiment, which afflicted the markets during the period end-May to

August 2013. The rupee staged a sharp turnaround in September 2013, which continued in the subsequent months and also in Q1 of 2014. The measures taken by the RBI (swap window for attracting FCNR (B) and enhancement of overseas borrowing limits of banks) led to forex inflows to the tune of US$ 34 billion, which helped in bridging the CAD during 2013-14. The measure to open special dollar swap window for oil PSUs helped in removing a major chunk of demand from the forex market, which went a long way towards stabilizing the rupee as bulk dollar demand from oil PSUs is a major source of pressure on the rupee. These measures buoyed the market sentiment, which got reflected in the sharp turnaround made by the rupee from September 2014 onwards. Even the monetary tightening measures taken by the RBI on July 15 and 23, 2013, which were subsequently relaxed in the mid-quarter review of Monetary Policy on September 20, 2013, helped in reducing volatility to an extent by making rupee expensive, thereby reducing speculation in the forex market. Though monetary policy measures like hike in policy rate is used by many central banks to attract capital, flows, its efficacy in attracting greater capital flows is quite debatable. In this context, an RBI Working Paper (May 2011) on 'Sensitivity of capital flows to interest rate differential' has concluded that from the point of view of monetary policy, FDI and FII flows are not impacted by interest rate changes as they are primarily determined by growth prospects of the Indian economy and returns on equities, respectively. During 2009-10, these two, on a net basis, accounted for about 96 per cent of total net capital inflows to India while for the 10-year period from 2000-01 to 2009-10, they accounted for around 76 per cent of the total net capital flows. The empirical results, however, corroborated the expectation that ECBs and NRI deposits are interest sensitive, though policy interventions by authorities do tend to reduce interest rate sensitivity. Thus, monetary policy needs to take cognizance of the fact that debt flows like ECBs and NRI deposits are impacted both by interest rate as well as exchange rate movements, while sensitivity of capital flows like FDI and FII is relatively less to interest rate changes.

The kind of intense volatility witnessed in the forex market during May-August 2013 when the rupee experienced sharp depreciating pressure is unlikely to recur anytime soon as the situation has improved

significantly in the last 7 months. All the macro-economic parameters, viz., current account deficit, fiscal deficit and inflation, which contributed to the sharp depreciation of the rupee, have shown marked improvement in the recent months. The stability of the rupee despite the commencement of QE tapering and sharp depreciation in many EME currencies bears testimony to the fact that the recent improvement in fundamentals has stood the rupee in good stead. However, downside risks in the form of still elevated retail inflation, continued weak economic performance, uncertainty surrounding global economic recovery, uncertainty surrounding capital flows to EMEs once QE is completely withdrawn, *etc.*, remain, which can cause intermittent turbulence in the forex market.

Additionally, despite a sharp decline in CAD to a sustainable level of 1.7 per cent of GDP in 2013-14 from 4.7 per cent in the previous year, it remains to be seen if the positive momentum could be sustained in the medium-to long-term, as this significant decline in CAD during 2013-14 has been mainly effected through a sharp compression in gold imports through exceptional policy measures, including import duty hike, taken by both the Government and the RBI, which may need to be rolled back in due course. Thus, the need to bring the CAD down to a sustainable level consistently for maintaining stable conditions in the forex market needs no reiteration.

In this context, domestic structural factors, such as, inelastic demand for POL and gold imports, which together account for a major chunk of India's imports coupled with large and increasing coal imports despite India being one of the largest producers of coal in the world are some of the important problems facing India's external sector. Efforts are already underway to reduce gold imports, deregulate POL pricing, especially diesel prices, find new ways of increasing supply of POL domestically through exploration and better use of existing facilities, increase coal output in order to reduce imports, etc., which will have a positive impact on CAD and, hence, on the exchange rate of the rupee in the long-term. There is a need to increase and diversify India's exports and also to increase total factor productivity growth of India's exports in order to increase its competitiveness. A number of measures

to address these important issues pertaining to structural transformation of India's external sector are already underway. The government and the RBI have already taken a number of steps, such as, removal of procedural bottlenecks, speedy clearance of FDI proposals, provision of various incentives, pruning of negative list, etc., to facilitate FDI flows to various sectors like FDI in retail, civil aviation, pension, insurance, infrastructure sector, etc. All these measures, keeping in view the sound economic fundamentals of the economy, should help in reducing the CAD to sustainable levels in the medium-to long-term, thereby adding significant strength to India's external sector with concomitant stability on the exchange rate front.

Apart from the measures that have already been taken, there are talks about promoting invoicing of trade in domestic currency, which has hitherto not been very successful. In this context, negotiating bilateral currency swaps arrangements using domestic currencies with a number of countries in the Asian region will give fillip to regional trade and preclude the use of dollar for trade settlement purposes though such a move will lead to internationalisation of the rupee, with its attendant costs and benefits. India at present has swap arrangement with Japan to the tune of US$ 50 billion, but that involves the use of dollar. China has been aggressively internationalising renminbi since the onset of global financial crisis and has successfully put in place swap agreements involving local currencies with a number of countries (over 20 in number) in the recent years and India can learn from their experience. Governor Rajan in his statement on taking office on September 4, 2013 stated the following in regard to internationalization of the rupee: "As our trade expands, we will push for more settlement in rupees. This will also mean that we will have to open up our financial markets more for those who receive rupees to invest it back in. We intend to continue the path of steady liberalisation." Thus, the issue of internationalisation of the rupee in a careful and gradual manner needs to be taken up proactively.

Section VIII
Concluding Observations

This paper has attempted to identify the major episodes of volatility in Indian forex market in the past two decades, caused either by exogenous or endogenous factors, or a combination of both. The paper has attempted to capture the broad gamut of measures the Reserve Bank has taken to effectively manage various episodes of volatility in the past two decades. An analysis of the various episodes of volatility in the Indian forex market reveals that there has been a significant increase in exchange rate volatility in the aftermath of the global financial crisis, signifying the greater influence of volatile capital flows on exchange rate movements. An important aspect of the policy response in India to the various episodes of volatility has been market intervention combined with monetary and administrative measures to meet the threats to financial stability while complementary or parallel recourse has been taken to communications through speeches and press releases.

In the end, structural problems present in India's external sector, especially the persistence of large trade and current account deficits, will need to be addressed for a sustainable solution to the problem of exchange rate volatility, as significant reliance on hot money in the form of portfolio flows to bridge the large CAD is, at best, a temporary solution and reversals can be quick, necessitating painful adjustments in exchange rate and asset prices and, consequently, in the real sector as well because of inflationary consequences of large exchange rate adjustments. Thus, increase in India's exports of both goods and services through improvements in their competitiveness by enhancing their total factor productivity (TFP) growth coupled with enhanced FDI flows on the back of appropriate policy initiatives are the way forward in the medium to long-term in the absence of which the vulnerability of India's external sector to sudden stops and reversals in capital flows will continue.

References

Dua P & R. Ranjan (2010), "Exchange Rate Policy and Modelling in India", RBI DRG Study No. 33, February.

Government of India (1993), ''Report of the High Level Committee on Balance of Payments'', April.

International Monetary Fund (2013), ''Global Financial Stability Report", October.

International Monetary Fund (2013), ''Pilot External Sector Report", August.

Kohli, R. (2001), "Real Exchange Rate Stabilisation and Managed Floating: Exchange Rate Policy in India," 1993-99, ICRIER Working Paper 59, October.

Patra Michael Debabrata & Sitikantha Pattanaik (1998), ''Exchange Rate Management in India : An Empirical Evaluation'' Occasional Papers, Reserve Bank of India.

Pattanaik, S. and S. Sahoo (2001), ''The Effectiveness of Intervention in India: An Empirical Assessment'', RBI Occasional Papers, Volume 22.

Rangarajan, C. (1991), ''Exchange Rate Adjustment: Causes and Consequences'', Reserve Bank of India Bulletin, September.

Reserve Bank of India (2005), Report of the Internal Technical Group on Forex Markets.

Reserve Bank of India, Report on Currency and Finance, 2002-03.

Reserve Bank of India, Report on Currency and Finance, 2005-06.

Reserve Bank of India, Annual Report, (Various years).

Reserve Bank of India, Handbook of Statistics on Indian Economy (various years).

Reserve Bank of India. Bulletin (various issues).

Verma R & A. Prakash (2011), "Sensitivity of Capital Flows to Interest Rate Differentials: An Empirical Assessment for India", RBI Working Papers, May.

Reserve Bank of India Occasional Papers
Vol. 33, No. 1 & 2: 2012

The Offshore Renminbi: The Rise of the Chinese Currency and its Global Future, Robert Minikin and Kelvin Lau; John Wiley & Sons Singapore Pte. Ltd., 2013. Price: US $49.95.

During the previous two decades, world witnessed considerable increase in China's share in the global merchandise trade and global output. It maintained a huge surplus in its current account on sustained basis, while during the same period some advanced economies, in particular, the US, maintained higher deficit. This led to consistent pressures on China from global stakeholders to increase flexibility in its currency management regime and sharing the burden of adjustment of the global financial imbalances. In addition, there was consistent demand from global investors community for access to more and more Chinese currency denominated assets. Along with above two, a geo-political debate for a multi-polar world order is going on, where China is expected to play a more proactive role, particularly among the emerging market and developing economies.

Amidst above background, in order to reform its currency regime without losing control in the domestic market, the Chinese authorities took initiatives to internationalise Chinese currency in a controlled manner. In a unique experiment in purely Chinese style, they allowed free deliverability of renminbi in the offshore market, while maintaining policy determined exchange rate regime in the onshore market. Due to its 'one country two systems' administrative structure, Hong Kong emerged as a natural hub for the global trading and clearing of the offshore renminbi. Here, it may be noted that at present, Hong Kong operates as a special administrative region of the People's Republic of China and enjoys a high degree of autonomy in all matters except for external affairs and defense. Chinese and Hong Kong Special Administrative Region authorities exploited this unique dual status of Hong Kong for internationalisation of the Chinese renminbi.

In order to support internationalisation of Chinese currency, authorities encouraged invoicing of international trade in renminbi. As China has imposed strict curbs on capital account of balance of payments, for development and maintaining of adequate liquidity in the offshore renminbi market, the People's Bank of China (PBC) has sought to promote RMB trade settlement by signing bilateral local currency swap agreements with 19 Central Banks – including the Bank of China, Hong Kong (BOCHK) – with a key objective to provide market participants confidence that liquidity in the offshore RMB market will be sufficient to meet RMB denominated payment obligations. Activation of these agreements resulted in the PBC depositing RMB into the foreign central bank's account at the PBC in exchange for the foreign central bank depositing their local currency into the PBC's account at the foreign central bank. The BOCHK provides clearing service between the onshore and offshore markets. It is permitted to undertake cross-border transactions subject to specified controls and functions as a clearing bank for offshore renminbi.

Chinese authorities permitted Hong Kong based commercial banks to accept deposits and lend advances denominated in renminbi. They also permitted floatation of the offshore renminbi denominated bonds. In addition to Hong Kong, subsequently the Chinese authorities signed memorandum of understanding with financial authorities in London and New York for issuance of renminbi denominated bonds. Since the exchange rate of onshore renminbi is policy determined and that of the offshore renminbi is determined purely by the market forces, differences in offshore and onshore exchange rates arose, which led to assigning of CNH symbol to the offshore renminbi. Assigning a new symbol RMB-CNH for offshore renminbi, symbolises an important step towards internationalisation of Chinese official currency.

A recent book titled as "**The Offshore Renminbi: The Rise of Chinese Currency and Its Global Future**" written by Robert Minikin and Kelvin Lau, dissects various facets of the offshore renminbi such as its micro-structure, policy rationale, global linkage, impact on the onshore renminbi and future consequences for Hong Kong and its

financial markets, *etc.* in a lucid manner. At the broader level, this book has attempted to answer some important questions such as (i) how the offshore renminbi is different than other currencies or why we never discuss about offshore US dollar?, (ii) what are the developments related to international use of the offshore renminbi so far and its future prospects?, (iii) what are the investment and hedging opportunities in the new market created by renminbi internationalisation project? and finally last but not the least it examines (iv) what would be the consequences of internationalisation of renminbi and opening of Chinese onshore financial system for the financial system of Hong Kong? Under above broader framework, the book is divided in seven chapters. The first Chapter, the New Global Role of Chinese Renminbi sets the background and context of the book.

According to the authors, the Chinese authorities who hitherto were taking baby-steps for internationalisation of renminbi took a 'Big Bang' decision in that direction in July 2010, by launching sale of the offshore renminbi (i.e., RMB-CNH) denominated Chinese government bonds in Hong Kong. Rationale for the launch of the offshore renminbi was two-fold - economic and geo political. A more flexible currency can play some role in shielding China from imported inflation. On political front, the increasing share of Chinese economy in global output demands that China should take a more active role in global economic affairs.

In Chapter 2 titled 'Linking the Offshore and Onshore Renminbi Markets', the authors address policy and theoretical issues related to the subject. They argue that in order to internationalise the renminbi, China has to move towards full capital account convertibility, even if it moves gradually and takes longer time. Authors have claimed that in order to transform the renminbi from a purely national currency to a fully global currency, Chinese banks and financial markets need to become fully engaged in the global financial system just as Chinese exporters / importers have become integrated in the global trading system. The pole position, which the US dollar has attained in present global financial system, is due to a host of factors including the US's willingness to deregulate its financial markets and allow high degree of

integration with global markets. Hence, unrestricted deliverability of renminbi becomes a necessary condition for its internationalisation.

Authors point out that for deliverability of the renminbi, it is global interbank transactions which are important. According to Bank of International Settlements' survey of global forex market, China's share in the global banking assets and liabilities is less than two per cent. This share is marginal in comparison with China's role in the global trade which has expanded multifold over the years. Authors say that if the US is taken as a benchmark then Chinese share in global banking assets and liabilities has to increase by around eleven times from its present levels, and even if it has to reflect China's share in the global trade then its share has to increase by about six times. Hence, authors foresee a considerable scope for scaling up of renminbi investability.

The book argues that there is a huge difference between full renminbi convertibility and investability. The essence of full capital account convertibility is losing control while investability calls for scaling up of portfolio flows between China and overseas. According to authors, scaling up of portfolio flows can be done in very controlled manner. Offshore renminbi is one such controlled experiment. It enables Chinese authorities to push forward the internationalisation of renminbi while maintaining a close control in the onshore market.

In the next chapter, 'the Birth and Evolution of the Offshore Renminbi Market in Hong Kong' the authors have outlined the micro-structure of offshore renminbi in chronological order. The 'RMB trade settlement scheme' is the main channel through which RMB has been able to flow between the Mainland China and the offshore RMB market. The renminbi trade settlement scheme facilitates offshore renminbi in three distinct ways, namely, a) by bringing overseas corporations and financial institutions on board riding on China's extensive trade linkages, b) generating offshore renminbi liquidity and c) spurring the demand for complementary financial instruments and markets for offshore renminbi.

Although the trade settlement scheme is quite complex in design and still opaque in functioning, it has witnessed various expansions,

fine tunings and iterations since its launch. Initially, under this scheme, cross border trade of Shanghai and four cities of Guangdong province with Hong Kong, Macau and ASEAN were covered. Subsequently, geographical coverage of scheme was increased to entire mainland and enterprise restrictions were removed. Presently, money can enter to and exit from China as long as it is backed by genuine trade documents.

Evolution of offshore renminbi has led to emergence of a very complex financial engineering. It has witnessed development of many new instruments and entities, such as agent banks (onshore entities to facilitate renminbi trade settlement) and non-resident account (a new onshore financial account), *etc.* Similarly, trading in derivatives has also witnessed evolution of a plethora of products. Corporate bonds, denominated in offshore renminbi are known as 'dim sum' bonds, have been issued in Hong Kong and other global financial centres. The characteristics and liquidity aspect of these instruments are discussed in the Chapter 4, 'New Markets – Jargon, New Opportunities'. It is argued that as long as China does not go for capital account convertibility, the divergence between onshore and offshore renminbi rate will continue to exist. Nevertheless, freedom to deliver the renminbi in Hong Kong without trade documentation has led to emergence of new currency derivative products. Recent studies have pointed out that corporates have increased uses of derivative products denominated in offshore renminbi and reduced their exposure to products denominated in non-deliverable forwards (NDFs) of renminbi.

Global financial centres such as London and New York are making special efforts to promote development of 'dim sum' bonds. In chapter 5, the authors discuss the growing presence of offshore renminbi beyond Hong Kong. The authors look into some of the channels which enabled the offshore renmibi market to grow in size and build scalability geographically. It is argued that Hong Kong has played a major role in internationalising the Chinese renminbi. It has played the role of a gatekeeper by controlling and monitoring cross-border flows of renminbi from China. In fact, as part of efforts towards promoting offshore renminbi market, the HKMA and the UK Treasury announced

a joint initiative to focus on development of clearing and settlement system, improving CNH liquidity in overseas markets and developing CNH products. Presence of global financial institutions in London has helped it to amass renminbi denominated deposits.

Chapter 6, 'Drivers for Internationalisation' has given micro details of globalisation of renminbi. Authors point out that role of Chinese renminbi as international reserve currency is disproportionately low. However, the history of reserve currencies tells that change in global reserve currency status happens in abrupt and sudden manner. In present global economic circumstances, Chinese renminbi has every right attribute to become a global reserve currency. It would give grater diversification to the global investor class and reduce the burden on the US dollar. Recent studies have pointed out the growing influence of Chinese renminbi in Asia Pacific region. Here, however, it is important to understand that if recent episodes of movement of exchange rate of Chinese currency are any precursor to exchange rate policy of China then it can be inferred that it is the Chinese authorities who are more sceptical on the global role of Chinese renminbi as a reserve currency. However, the authors have not analysed this issue in the present book.

On the issue of use of renminbi as a global reserve currency or its inclusion in special drawing rights (SDRs) of international monetary fund, authors are of the view that it will depend on the pace of internationalisation of Chinese currency. Authors argue that if emerging market economies' share in the global trade and global output is used as a criterion, then in the present global monetary system, their currencies are under-represented. However, IMF's decision about inclusion of renminbi in SDR calculations will depend on reforms in the capital account of China and depth and size of global renminbi denominated financial system. In present circumstances, the use of renminbi in SDR is still a substantial time away.

Chapter 7, 'the Rise of the Renminbi and its Policy Implications' has posed and attempted to answer some forward looking questions, such as whether rise of renminbi is threat to the Hong Kong dollar, use of renminbi as global reserve currency and rise of renminbi and role of

the US dollar in a multipolar world, *etc.* On the role of US dollar and renminbi in a multipolar world, authors have argued that with rising share of emerging market economies in global output and trade and fall in the share of advanced economies, dominance of the US dollar will shrink and that of renminbi will go up. Nevertheless, this does not mean that Chinese currency will eclipse the US dollar and will attain the dominating position in the global financial structure. The authors perceive that the rise of China will be challenged by emergence of other emerging economies (*e.g.* India) and the US will also be able to maintain a sizable share in the global output. Hence, going forward global financial system will be more a mutlipolar sort of system rather than dominated by a single currency.

The book covers quite interesting aspects of growing presence of Chinese renminbi in the offshore market. The book mainly focuses on evolution of offshore deliverable segment of the market. However, analysis of book would have been more enriching if it would have discussed linkages between offshore reniminbi and non-deliverable forward (NDF) segment. NDF segment of renminbi market is operational since much earlier in the 1990s. The book concludes that progressive opening of renminbi to international use has to be seen as a complement to the mainland's financial sector reform, not as a substitute. The book has given a multifaceted overview of emerging scenario in the Chinese offshore currency market. The authors have concluded that in coming years the Chinese renminbi will play an important role in global financial structure as a reserve currency and vehicle of global trade. However, as all forward looking conclusions in any economic literature are based on certain strong assumptions, many of the conclusions of this book are also based on the premise that China would be able to maintain its high growth trajectory. To a large extent, output growth of China is dependent on its share in the global trade. Thus for sustainable economic growth, matching reforms in the domestic economy are equally important. There is no chapter on domestic economic reforms. A chapter on domestic reforms would have made book more complete. That is the only minor lacuna of this book.

References

Lynne Cockerell and Michael Shoory, (2012). "Internationalising the Renminbi." Reserve Bank of Australia, Bulletin, June Quarter.

Alexander Ballantyne, Megan Garner and Michelle Wright, (2013). "Developments in Renminbi Internationalisation." Reserve Bank of Australia Bulletin, June Quarter.

Robert McCauley, Chang Shu and Guonan Ma, (2014). "Non-deliverable forwards: 2013 and beyond." BIS Quarterly Review, March.

Chang Shu, Dong He and Xiaoqiang Cheng (2014). "One currency, two markets: the renminbi's growing influence in Asia-Pacific," BIS Working Papers No 446, April.

Avdhesh K. Shukla*

* Author is Assistant Adviser in the Division of Financial Markets of the Department of Economic and Policy Research of the Reserve Bank. He may be contacted at akshukla@rbi.org.in.