RESERVE BANK OF INDIA

OCCASIONAL PAPERS

RESERVE BANK OF INDIA

RESERVE BANK OF INDIA

OCCASIONAL PAPERS

VOL. 31 NO. 2 **MONSOON 2010**

Articles

Special Notes

Book Reviews

Published by Deepak Mohanty for the Reserve Bank of India and printed by him at Alco Corporation, Gala No. 72, A-2, Shah and Nahar Industrial Estate, Lower Parel (W), Mumbai - 400 013.

Reserve Bank of India Occasional Papers
Vol. 31, No.2, Monsoon 2010

Global Crisis, Fiscal Response and Medium-term Risks to Inflation in India

Jeevan Kumar Khundrakpam
Sitikantha Pattanaik*

Contagion from the global crisis necessitated use of fiscal stimulus measures in India during 2008-10 in order to contain a major slowdown in economic growth. Given the usual downward inflexibility of fiscal deficit once it reaches a high level, as has been experienced by India in the past, there could be medium-term implications for the future inflation path, which must be recognised while designing the timing and speed of fiscal exit. Inflation, at times, may become effectively a fiscal phenomenon, since the fiscal stance could influence significantly the overall monetary conditions. As highlighted in this paper, fiscal deficit could be seen to influence the inflation process either through growth of base money created by the RBI (*i.e.* net RBI credit to the Government) or through higher aggregate demand associated with an expansionary fiscal stance (which could increase growth in broad money). Empirical estimates of this paper conducted over the sample period 1953-2009 suggest that one percentage point increase in the level of the fiscal deficit could cause about a quarter of a percentage point increase in the Wholesale Price Index (WPI). The paper emphasises that the potential inflation risk should work as an important motivating factor to ensure a faster return to the fiscal consolidation path in India, driven by quality of adjustment with appropriate rationalisation of expenditure, rather than waiting for revenue buoyancy associated with sustained robust growth to do the job automatically. The importance of fiscal space in the India specific context needs to be seen in terms of not only the usual output stabilisation role of fiscal policy but also the occasional need for use of fiscal measures to contain such inflationary pressures that may arise from temporary but large supply shocks.

JEL Classification : B21, E31, E62.
Keywords : Crisis, Fiscal, Inflation.

---

* Shri Jeevan Kumar Khundrakapam and Shri Sitikantha Pattanaik are Directors in Monetary Policy Department and Department of Economic and Policy Research, respectively. The earlier version of the paper was presented in the 12th Conference on Money & Finance organised by IGIDR, Mumbai during March 11-12, 2010. The authors are grateful to the anonymous referee for useful comments. The paper reflects the personal views of the authors.

Introduction

Fiscal stimulus emerged as the key universal instrument of hope in almost every country around the world, when the financial crisis in the advanced economies snowballed into a synchronised global recession. Borrowing as much at as low a cost as possible to stimulate the sinking economies necessitated unprecedented coordination between the fiscal and monetary authorities. It is the fiscal stance of the Governments that had to be accommodated without any resistance by the monetary authorities so as to minimise the adverse effects of the crisis on output and employment, while also saving the financial system from a complete breakdown. Given the deflation concerns in most countries –rather than the fear of inflation – monetary authorities had no reasons to resist. The universal resort to fiscal stimulus, however, has now led to significant increase in deficit and debt levels of the advanced economies, which may operate as a permanent drag for some time, vitiating the overall macroeconomic outlook, including inflation. OECD projections indicate that OECD level fiscal deficit may reach 60 year high of about 8 per cent of GDP in 2010, and public debt may exceed 100 per cent of GDP in 2011, which will be 30 percentage points higher than the comparable pre-crisis levels in 2007. In the process of managing the financial crisis, fiscal imbalances have been allowed to reach levels that could trigger fiscal crisis in several countries. The market perception of sovereign risk has changed significantly in 2010, particularly since the time that the fiscal crisis in Greece has surfaced and contaminated the Euro-area. The same private sector that was bailed out at the cost of fiscal excesses will now perceive Government papers as risky and fiscal imbalances as the harbinger of the next crisis.

In India, the fiscal response to the global crisis was swift and significant, even though India clearly avoided a financial crisis at home and also continued to be one of the fastest growing economies in the World in a phase of deep global recession. Despite the absence of any need to bailout the financial system, it is the necessity to partly offset the impact of deceleration in private consumption and investment demand on economic growth, which warranted adoption of an expansionary fiscal stance. One important consequence of this, though, was the significant

deviation from the fiscal consolidation path, and the resultant increase in the fiscal deficit levels over two consecutive years (2008-10).

The immediate impact of the higher levels of fiscal deficit on inflation in India could be seen as almost negligible, since: (a) the expansionary fiscal stance was only a partial offset for the deceleration in private consumption and investment demand, as the output-gap largely remained negative, indicating no risk to inflation in the near-term; and (b) despite large increase in the borrowing programme of the Government to finance the deficit, there was no corresponding large expansion in money growth, since demand for credit from the private sector remained depressed. Thus, neither aggregate demand nor monetary expansion associated with larger fiscal deficits posed any immediate concern on the inflation front. The usual rigidity of deficit to correct from high levels to more sustainable levels in the near-term, however, entails potential risks for the future inflation path of India, which may become visible when the demand for credit from the private sector reverts to normal levels and if the revival in capital flows turns into a surge again over a sustained period, that may require sterilised intervention. The major risk to future inflation would arise from how the extra debt servicing could be financed while returning to sustainable levels through planned consolidation. Revenue buoyancy associated with the recovery in economic activities to a durable high growth path would only contribute one part; the major important part, however, has to come either from a combination of higher taxes, withdrawal of tax concessions and moderation in public expenditure, which could weaken growth impulses or from higher inflation tax, suggesting higher money growth and associated pressure on future inflation.

Conceptually, the risk to inflation from high fiscal deficit arises when fiscal stimulus is used to prop up consumption demand, rather than to create income yielding assets through appropriate investment, which could have serviced the repayment obligations arising from larger debt. As highlighted by Cochrane (2009) in the context of the US, "...If the debt corresponds to good quality assets, that are easy...If the new debt was spent or given away, we're in more trouble. If the debt will be paid off by higher future tax rates, the economy can be set up for

a decade or more of high-tax and low-growth stagnation. If the Fed's kitty and the Treasury's taxing power or spending-reduction ability are gone, then we are set up for inflation." It may be worth recognising that all over the world, at some stage, the risk of active anti-inflationary policy conflicting with inflexible fiscal exit cannot be ruled out. As highlighted by Davig and Leeper (2009) in this context for the US, "...as inflation rises due to the fiscal stimulus, the Federal Reserve combats inflation by switching to an active stance, but fiscal policy continues to be active....In this scenario, output, consumption and inflation are chronically higher, while debt explodes and real interest rates decline dramatically and persistently".

The future risks to inflation in India from fiscal stimulus, thus could arise from the downward inflexibility of the deficit levels, and with revival in demand for credit from the private sector and consolidation of growth around the potential, the fiscal constraint could be manifested in the form of pressures on both aggregate demand and money supply. Surges in capital flows could complicate the situation further. This paper recognises the possible policy challenge arising from higher money growth on account of persistent fiscal constraint, revival in private credit demand and surges in capital flows, on the one hand, and higher policy interest rate chasing higher inflation on the other. Possible crowding-out effects associated with the fiscal constraint may also lead to a situation where high inflation and high nominal interest rates co-exist. Since much of these possibilities could be empirically validated over time depending on what outcome actually may materialise in the future, this paper not only recognises the potential risks to the future inflation path, but also aims at unravelling the relevance of the perception by studying the relationship between fiscal deficit and inflation in India over the sample period 1953 to 2009.

Macroeconomic variables are generally interrelated in a complex manner. Therefore, a deeper understanding of inflation dynamics would involve analysing its relationship with macroeconomic variables such as deficit, money supply, public debt, external balance, exchange rate, output gap, global inflation and commodity prices, and interest rates. In the literature, particularly in the developing country context, simple

models are, however, often used to analyse the inflationary impact of fiscal deficit. This largely reflects the role of fiscal dominance, which has often been a phenomenon in many developing countries. Thus, fiscal-based theories of inflation are more common in the literature of developing countries (for example, Aghevli and Khan (1978), Alesina and Drazen (1978) and Calvo and Vegh (1999)). On the other hand, for developed countries, fiscal policy is often considered to be unimportant for inflation determination, at least on theoretical grounds, as the desire to obtain seigniorage revenue plays no obvious role in the choice of monetary policy (Woodford, 2001).

In the Indian context also, there are several studies analysing the nexus between government deficits, money supply and inflation. The findings of these studies generally point to a self perpetuating process of deficit-induced inflation and inflation-induced deficit, besides the overall indication that government deficits represent an important determinant of inflation (for example, Sarma (1982), Jhadav (1994) and Rangarajan and Mohanty (1998)). The above results have been on the expected lines given that till the complete phasing out of the *ad hoc* treasury bills in 1997-98, a sizable portion of the government deficit which could not be financed through market subscription was monetised. However, extending the period of analysis further beyond the automatic monetisation phase, Ashra *et al* (2004) found no-long relationship between fiscal deficit and net RBI credit to the Government and the latter with broad money supply. Thus, they concluded that there is no more any rationale for targeting fiscal deficit as a tool for stabilisation. On the other hand, Khundrakpam and Goyal (2009), including more recent data and adopting ARDL approach to cointegration analysis, found that government deficit continues to be a key factor causing incremental reserve money creation and overall expansion in money supply, which lead to inflation.

In this paper, we use a simple model to study the inflationary potential of fiscal policy in India by estimating the long-run relationship and the short-run dynamics between fiscal deficit, seigniorage and inflation. The motivation is that fiscal deficit can lead to inflation either directly by raising the aggregate demand (demand pull inflation), or

indirectly through money creation, or a combination of both. Against this background, Section-II presents the challenges associated with fiscal exit for advanced economies as well as EMEs, and highlights the issues that are particularly important for India. Section III explains briefly the analytical framework employed in the paper. In section IV, the estimation procedures are explained. The data and empirical results are analysed in section V. Section VI contains the concluding observations.

Section II
The Challenge of Fiscal Exit – What is Important for India?

The unprecedented stimulus that was used across countries to avert another Great Depression is widely believed to have shown the seeds of the next crisis. Public debt levels in the advanced economies are projected to explode to levels never seen during peace-time, leaving almost no fiscal space for managing other shocks to the economies in future, besides significantly constraining normalisation of overall macroeconomic conditions. Some of the projected debt figures look uncomfortably high – revealing in true sense the trade-offs involved in policy options. A better today ensured through policy interventions could enhance risks for the future. In the case of sub-prime crisis, the impact on the world economy will be permanent and is expected to persist over several decades through the channel of high public debt.

What then is the dimension of the challenge we are facing today? IMF projections indicate that in the G-20 advanced economies, Government debt would reach 118 per cent of GDP in 2014, which will be 40 per cent higher than the pre-crisis levels. Consolidating the level to about 60 per cent of GDP by 2030 would require raising the average structural primary balance by 8 per cent of GDP, which is not easy, though not impossible. But this order of adjustment will involve other costs. One could first see why the adjustment options may not be easy, and then, what other costs could result from sustained high levels of public debt.

Why Debt Normalisation could be Difficult?

Many of the advanced economies were preparing their fiscal conditions to face the challenges associated with demography when the

crisis unfolded. The pressure from demography on the fiscal conditions in terms of social security needs and aging population will increase over time, whereas the crisis will leave behind additional pressure arising from the impact of lower potential output and patchy recovery on revenues and from high unemployment and jobless recovery on expenditure. Collapse in asset prices also seems to have affected the funded part of the social security systems. The plausible options for debt normalization include higher taxes, higher economic growth and the associated revenue buoyancy, lower expenditure or use of inflation tax. Many of the advanced economies already have higher tax/GDP ratios, and future increases in tax rates may also affect growth. Moreover, in a globalised world, higher taxes could shift economic activities to other parts of the world. Lower expenditure, given the constraint of aging population and high unemployment, and higher debt servicing associated with the higher debt, could be difficult. Higher economic growth, thus, could be the best possible option. Search for new sources of growth would be a key policy challenge, which has to be also seen in relation to the rising prominence of EMEs in the global economy and the competition they would provide in the search for higher productivity.

The Costs of Sustained High Levels of Public Debt

A critical part of the policy challenge associated with high public debt is to recognize upfront the costs for the economy, without being too alarmist. Some of the costs seem obvious, even though because of the non-linearity in the relationships between key evolving macroeconomic variables, it may not be easy to quantify them. Some of these obvious costs could be:

(a) Lack of fiscal space to deal with future shocks, including future downturns in business cycles.

(b) Pressure on interest rates and crowding-out of resources from the private sector. This effect is not visible as yet because of weak private demand and expansionary monetary policies. As private demand recovers and monetary policy cycles turn around, potential risks will materialize. Three specific channels could exert pressure on the interest rate: (i) larger fiscal imbalances would imply lower

domestic savings, (ii) increase in risk premia, as market would differentiate between debt levels and expect a premium in relation to the perceived risk, which is already evident after the experience of Dubai World and Greece, and (iii) higher inflation expectations that would invariably result from high levels of debt, which will be reflected in the nominal interest rates.

(c) Pressure on central banks to dilute their commitment to and focus on price stability. In this context, one may see the inflation tolerance levels of central banks rising. The IMF's argument that raising the inflation target in advanced economies from 2 per cent to 4 per cent may not add significant distortions to the economies should also be carefully examined by central banks. One must recognise why some feel that return to pre-crisis levels of central bank independence with focus on price stability would be critical to improve the future macroeconomic conditions, given the large debt overhang. Price stability will be critical to ensure high growth, which in turn can effectively contribute to debt consolidation without imposing costs of adjustments through other options. The extent of dilution of central bank independence may also increase if financial stability is made an explicit mandate of central banks.

How then to Approach Fiscal Exit?

In planning the approach to fiscal exit, the scope for any complacency based on some misplaced arguments must be avoided. One such argument could be "no threshold level of debt could be risky", given the experience of Japan, which has been operating with very high levels of debt for quite some time. One cannot ignore the fact that in Japan private demand has remained depressed for more than a decade, and much of the debt of the government is held internally as part of domestic savings. The second flawed argument could be that Dubai and Greece type shocks cannot cause any systemic global concern since these shocks are too insignificant for the global economy. The most dangerous argument, though, could be to support "inflation tax" as a means to reduce the real debt burden, on the ground that the alternative option of higher taxes could be equally distortionary. IMF estimates

indicate that higher inflation in advanced economies at about 6 per cent maintained over five years could reduce the real debt burden by about 25 per cent (IMF, 2009).

The fiscal exit plans, thus, must involve clarity and commitment. The broad contours of such strategies may have to emphasise: (a) medium-term fiscal framework, (b) credible commitment, (c) adoption of fiscal rules – with scope for deviations to deal with future shocks, including cyclical slowdowns, and (d) clarity in communication.

Why Fiscal Exit in EMEs Could be Different?

EMEs entered the global crisis with much better fiscal space, as fiscal discipline was seen generally as a critical aspect of sound macroeconomic environment to support higher growth. Since the financial sector of the EMEs did not require any official bailout, the magnitude of fiscal support needed during the global crisis was also not as high as in the advanced economies. More importantly, with stronger recovery ahead of the advanced economies, EMEs can implement fiscal exit faster without creating concerns for growth. Stronger recovery in growth will also improve revenue buoyancy. EMEs have to be particularly careful about fiscal exit, unlike in advanced economies, since fiscal indiscipline has conventionally created other problems such as high current account deficit, pressures on inflation, crowding-out concerns and even capital outflows. The fiscal exit challenges in EMEs, thus, will be different from those in the advanced economies.

Fiscal Exit in India

India was on a sustained path of fiscal consolidation prior to the global crisis, conditioned by the discipline embodied in the Fiscal Responsibility and Budget Management (FRBM) Act, 2003. The FRBM rules required phased reduction in fiscal deficit to 3 per cent of GDP by end March-2009, with commitment to also eliminate revenue deficit by that time. The progress on fiscal consolidation turned out to be faster than initially expected, as high growth during the five year period 2003-08 ensured better revenue buoyancy. Fiscal deficit as percentage of GDP fell from 4.5 per cent in 2003-04 to 2.6 per cent in 2007-08,

leading to attainment of the target one year before what was initially set under the FRBM rules in 2004. Revenue deficit also declined from 3.6 per cent of GDP to 1.1 per cent of GDP during the corresponding period. The FRBM, thus, had created considerable fiscal space, led by revenue buoyancy, when the impact of the global recession on domestic activities warranted introduction of anti-crisis fiscal response. Some have viewed the fiscal consolidation as a favourable macroeconomic condition that contributed to India's shift to the higher growth trajectory, even though it is a fact that fiscal consolidation resulted primarily because of high growth.

When the global crisis started to spread, despite perceptions of decoupling and a sound financial system at home, there was a clear risk of slowdown in Indian growth, which had to be arrested through the appropriate policy response. Because of the heightened uncertainty, and the "black swan" nature of the series of adverse developments that unfolded after the bankruptcy of Lehman Brothers, the Indian policy response had to be swift and significant, with a heavy accent on adequate precaution. Two major fiscal decisions that were taken earlier, *i.e.*, the farm debt waiver scheme and the Sixth Pay Commission award, worked like expansionary stimulus, where the decision lag was almost zero, since the decisions had been taken and partly implemented even before the crisis-led need for fiscal stimulus was recognised. The subsequent crisis related fiscal stimulus was delivered in the form of tax cuts as well as higher expenditure, dominated by revenue expenditure, as the deceleration in private consumption expenditure turned out to be significant, which needed to be partly offset by higher government expenditure. Reflecting the expansionary fiscal stance – involving a deliberate deviation from the fiscal consolidation path – the fiscal deficit of the Central Government rose from 2.6 per cent of GDP in 2007-08 to 5.9 percent in 2008-09 and further to 6.7 per cent in 2009-10. Even the State Governments, which were progressing well on fiscal consolidation – driven partly by the incentives from the Twelfth Finance Commission – experienced a setback to the process, resulting primarily from pressures on revenues and central transfers associated with the economic slowdown as well as the compelling demand to match the

pay revision already announced for Central Government employees. Gross fiscal deficit of the states, which had improved to 1.5 per cent of GDP by 2007-08, expanded to 3.2 per cent of GDP in 2009-10.

The role of the expansionary fiscal stance adopted by both the Central and the State Governments has to be seen in the context of the fact that private consumption demand, which accounts for close to 60 per cent of aggregate demand, exhibited sharp deceleration in growth, from 9.8 per cent in 2007-08 to 6.8 per cent and 4.1 per cent in the subsequent two years. Government consumption expenditure, which accounts for just about 10 per cent of aggregate demand, had to be stepped up significantly to partially offset the impact of the sharp deceleration in the growth of private consumption demand. Reflecting the fiscal stimulus, growth in government consumption expenditure was as high as 16.7 per cent in 2008-09, as a result of which the contribution of government expenditure to the overall growth in aggregate demand rose almost three fold – from 10.4 per cent in 2007-08 to 33.6 per cent in 2008-09. The fiscal stance, thus, had a clear role in arresting sharper slowdown in economic growth.

Given the possibility of a weak fiscal position operating as a drag on economic growth in the medium-run – through crowding-out pressures, besides the scope for causing higher inflation – the need for faster return to fiscal consolidation path was recognised quite early in India, which was articulated and emphasised by the Reserve Bank in its policy statements, as signs of stronger recovery in growth started to emerge. By the time the Budget for 2010-11 was announced in February 2010, better evidence on broad-based momentum in recovery created the space for gradual roll back of some of the fiscal measures that were taken in response to the crisis. At the macro level, while gross fiscal deficit has been budgeted lower at 5.5 per cent of GDP, net market borrowing programme has also been scaled down by more than 10 per cent. In terms of specific measures, some of the stimulus-led tax cuts have been rolled back, greater non-tax revenue from disinvestments and auction of 3-G/BWA spectrum has been realised and growth in non-plan expenditure has been significantly curtailed to 4.1 per cent in 2010-11 from 26.0 per cent in the previous year, much of which will result from

rationalisation of subsidies. More importantly, indicating the resolve to return to the fiscal consolidation process, a Medium Term Fiscal Policy Statement (MTFPS) has been issued along with plans for tax reforms, both direct and indirect. As per the MTFPS, there will be annual rolling targets for revenue deficit and gross fiscal deficit so as to reach 2.7 per cent and 4.1 per cent of GDP, respectively, by 2012-13. Goods and Services Tax (GST) and Direct Tax Code (DTC), to be implemented in 2011-12, will be critical components of the fiscal consolidation, which could help in improving the tax to GDP ratio from 10.8 per cent in 2010-11 to 11.8 per cent in 2012-13. Reflecting the planned fiscal consolidation, total debt liabilities of the Central Government could also be expected to moderate from 51.5 per cent of GDP in 2009-10 to 48.2 per cent of GDP in 2012-13. The Indian approach to fiscal exit – in terms of both adoption of specific fiscal consolidation measures in sync with the recovery and announcement of medium-term targets for phased consolidation – reflects the recognition in the sphere of policy-making of the importance of a disciplined fiscal environment for sustainable high growth.

The quality of fiscal adjustment, however, must receive greater attention, given the medium-term double digit growth objective. Like the previous phase of fiscal consolidation during 2004-08, stronger recovery in growth will improve revenue buoyancy. Moreover, given the fact that a large part of the government borrowing (excluding the part invested by FIIs) is financed domestically, the sovereign risk concerns would also remain contained. These favourable aspects, however, should not dilute the focus on consolidation from the expenditure side. Even if gross fiscal deficit for 2010-11 has been budgeted to decline to 5.5 per cent of GDP from 6.7 per cent in the previous year, that may not signal any major move in the direction of structural consolidation, if one removes the one-off components from the revenue and expenditure sides. Adjusted for disinvestment and 3-G/BWA auction proceeds on the revenue side, and farm debt waiver and Sixth Pay Commission arrears on the expenditure side, the reduction in gross fiscal deficit as per cent of GDP would be much less, *i.e.* by 0.3 percent as against 1.2 percent envisaged in the Budget. The magnitude and quality of fiscal

adjustment could have a significant conditioning influence on India's medium-term growth prospects.

In the absence of faster and better quality fiscal adjustment, at least four major risks to macroeconomic conditions could be envisaged: (a) the decline in domestic savings, led by the fall in public sector savings, which will lower the potential output path, (b) higher overall interest rates, when the revival in demand for credit from the private sector starts competing with the borrowing programme of the government, (c) limit the capacity to manage the exchange rate and the domestic liquidity impact of possible surges in capital flows, since the use of sterilisation options like the MSS could exert further pressures on the interest rates, and thereby lead to even higher inflows, and (d) may even force reversal of reforms, such as use of higher SLR requirements for banks or even introduction of SLR for non-banking entities in the financial system to create a captive market for the government borrowing programme. These possible potential implications signify why fiscal discipline is so critical in a market based economy. Often, in the search for easy solutions, direct or indirect monetisation could be preferred, which in turn could give rise to higher inflation. This paper primarily highlights the inflation risks to India from the fiscal imbalance, and argues that fiscal space is as critical for managing inflation as for stabilising the output path.

Section III
The Analytical Framework

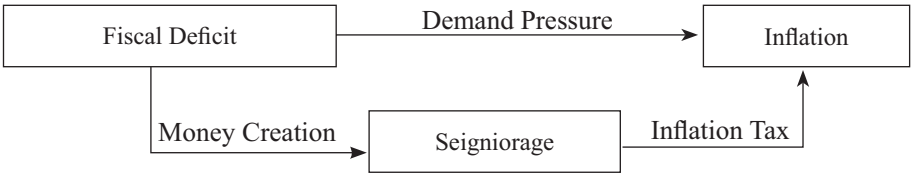
Inflation, according to monetarists, is always and everywhere a monetary phenomenon. Following the seminal contribution by Sargent and Wallace (1981), however, it is viewed that fiscally dominant governments running persistent deficits would sooner or later finance those deficits through creation of money, which will have inflationary consequences. Fischer and Easterly (1990), thus, argue that rapid monetary growth may often be driven by underlying fiscal imbalances, implying that rapid inflation is almost always a fiscal phenomenon. Historical evidences have shown that governments often resorted to seigniorage (or inflation tax) during times of fiscal stress, which

had inflationary consequences. Thus, contemporary macroeconomic literature, while trying to explain inflationary phenomenon has also focussed on the fiscal behaviour, particularly in the developing country context. This is because fiscally dominant regimes are often seen as a developing country phenomenon, due to less efficient tax systems and political instability, which lead to short-term crisis management at the cost of medium to long-term sustainability. As noted by Cochrane (2009), "...Fiscal stimulus can be great politics, at least in the short-run." Furthermore, more limited access to external borrowing tends to lower the relative cost of seignorage in these countries, increasing their dependence on the inflation tax while delaying macroeconomic stabilisation (Alesina and Drazen, (1991) and Calvo and Vegh (1999)).

The relationship between government deficit and inflation, however, is more often analysed from a long-term perspective. This is because borrowing allows governments to allocate seignorage inter-temporally, implying that fiscal deficits and resort to inflation tax need not necessarily be contemporaneously correlated. The short-run dynamics between inflation and deficit is also complicated by the possible feedback effect of inflation on the fiscal balance (Catao and Terrones, 2001). In the short-run, the government might also switch to alternative sources of financing in relation to seigniorage so that the correlation between inflation, deficit and seigniorage is weakened.

A popular method for analysing the inflationary potential of fiscal deficit in India is through its direct impact on reserve money, which *via* the money multiplier leads to increase in money supply, that in turn leads to inflation (for example, Khundrakpam and Goyal, 2009). In this paper, we analyse the inflationary potential of fiscal deficit by hypothesising that either: (i) there can be a direct impact on inflation through increase in aggregate demand; or (ii) through money creation or seigniorage; or (iii) a combination of both. The causality is described in the following flow chart. In essence, though, one has to recognise that the increase in demand financed by fiscal deficit would automatically lead to higher money supply through higher demand for money. In a Liquidity Adjustment Facility (LAF) framework, increase in money demand associated with higher government demand has to

be accommodated, in order to keep the short-term interest rates in the system, in particular the overnight call rate, within the LAF (repo – reverse repo) corridor of interest rates. In a LAF based operating procedure of monetary policy, thus, money supply is demand driven, and hence endogenous. To the extent that fiscal deficit leads to expansion in money supply, associated inflation risk must be seen as a fiscal, rather than a monetary phenomenon.



In this paper, fiscal deficit (D) is defined as total expenditure of the central government less the revenue receipts (including grants) less other non-debt capital receipts. In the literature, primary deficit, which is fiscal deficit less interest payments, is also often considered in analysing the inflationary impact of government deficit in order to remove any possible endogeneity bias resulting from the reverse impact of inflation on nominal interest rate.

Seigniorage, which is often referred to as the inflation tax, could be defined for simple empirical analysis as the change in reserve money scaled by the price level. The price level is measured by the wholesale price index. Thus, seigniorage 'S' is defined as,

$$S = \{RM - RM_{(-1)}\}/P$$

Where, RM is the reserve money or base money and P is the index of price level.

So, we essentially empirically test the following:

i) $P = f(D)$

ii) $P = f(S)$

iii) $S = f(D)$

iv) $P = f(D,S)$

It is important to note here that ΔRM could be driven by increase in net foreign assets (NFA) of the RBI as well as net RBI credit to the government. Under fiscal dominance, much of the increase in RM could be because of increase in net RBI credit to the government. Under an exchange rate policy that aims at avoiding excessive volatility, surges in capital flows and the associated increase in NFA of the RBI could drive the growth in RM from the sources side. As a result, inflation may still exhibit a stronger relationship with money growth, but the underlying driving factors behind money growth could be the fiscal stance and the exchange rate policy.

Section IV
The Empirical Framework

We employ bounds test or ARDL approach to cointegration analysis developed by Pesaran, Shin and Smith (2001) to examine the stated empirical hypotheses above. The advantages of this approach are that, first, it can be applied to variables integrated of different order. Second, unlike residual based cointegration analysis, the unrestricted error correction model (UECM) employed in bounds test does not push the short-run dynamics into the residual terms. Third, the bounds test can be applied to small sample size. Fourth, it identifies the exact variable to be normalised in the long-run relationship. A limitation of bounds test, however, is that it is not appropriate in situations where there may be more than one long-run relationship among the variables. In other words, the test is appropriate only when one variable is explained by the remaining variables and not the *vice versa*.

This test involves investigating the existence of a long-run relationship among the variables using an unrestricted error-correction model (UECM). In the case of two variables, the UECM would take the following form:

$$\Delta X_t = a_x + \sum_{i=1}^{n} b_{ix}\Delta X_{t-i} + \sum_{i=0}^{n} c_{ix}\Delta Y_{t-i} + \beta_x X_{t-1} + \gamma_x Y_{t-1} + \varepsilon_t \quad (1)$$

$$\Delta Y_t = a_y + \sum_{i=1}^{n} b_{iy}\Delta Y_{t-i} + \sum_{i=0}^{n} c_{iy}\Delta X_{t-i} + \beta_y Y_{t-1} + \gamma_y X_{t-1} + \varepsilon_t \quad (2)$$

Δ is the first difference operator. The bounds test for the presence of long-run relationship can be conducted using F-test. The F statistic tests the null hypothesis that the coefficients of the lagged levels of the variables are jointly equal to zero, against the alternative that they are jointly different from zero. In (1), where 'X' is the dependent variable, F-test for the null hypothesis for cointegration between the two variables with 'Y' as the long-run forcing variable is (H_0: $\beta_x = \gamma_x = 0$) against the alternative hypothesis (H_1 : $\beta_x \neq \gamma_x \neq 0$), denoted by F_x(X/Y). Where 'Y' is the dependent variable in (2), the null hypothesis is (H_0: $\beta_y = \gamma_y = 0$) against the alternative hypothesis (H_1: $\beta_y \neq \gamma_y \neq 0$), denoted by F_y(Y/X).

In the case of three variables, UECM would take the following form:

$$\Delta X_t = a_x + \sum_{i=1}^{n} b_{ix}\Delta X_{t-i} + \sum_{i=0}^{n} c_{ix}\Delta Y_{t-i} + \sum_{i=0}^{n} d_{ix}\Delta Z_{t-i} + \alpha_x X_{t-1} + \beta_x Y_{t-1} + \gamma_x Z_{t-1} + \varepsilon_t \quad (3)$$

$$\Delta Y_t = a_y + \sum_{i=1}^{n} b_{iy}\Delta Y_{t-i} + \sum_{i=0}^{n} c_{iy}\Delta X_{t-i} + \sum_{i=0}^{n} d_{iy}\Delta Z_{t-i} + \alpha_y Y_{t-1} + \beta_y X_{t-1} + \gamma_y Z_{t-1} + \varepsilon_t \quad (4)$$

$$\Delta Z_t = a_z + \sum_{i=1}^{n} b_{iz}\Delta X_{t-i} + \sum_{i=0}^{n} c_{iz}\Delta Y_{t-i} + \sum_{i=0}^{n} d_{iz}\Delta Z_{t-i} + \alpha_z Z_{t-1} + \beta_z X_{t-1} + \gamma_z Y_{t-1} + \varepsilon_t \quad (5)$$

When 'X' is the dependent variable, F-test for the null hypothesis for cointegration amongst the three variables, with 'Y' and 'Z' as the long-run forcing variables, is (H_0 : $\alpha_x = \beta_x = \gamma_x = 0$) against the alternative hypothesis (H_1 : $\alpha_x \neq \beta_x \neq \gamma_x \neq 0$), denoted by F_x(X/Y,Z). Where 'Y' is the dependent variable, the similar null hypothesis, with the 'X' and 'Z' as the long-run forcing variable, is (H_0 : $\alpha_y = \beta_y = \gamma_y = 0$) against the alternative hypothesis (H_1 : $\alpha_y \neq \beta_y \neq \gamma_y \neq 0$), denoted by F_Y(Y/X,Z). With 'Z' as the dependent variable, the similar hypothesis is the null of (H_0 : $\alpha_z = \beta_z = \gamma_z = 0$) against ($H_1$: $\alpha_z \neq \beta_z \neq \gamma_z \neq 0$), denoted by F_Z(Z/X,Y). However, as mentioned above, for this approach to be valid, there must be only one unique cointegrating relationship among the variables *i.e.*, only one of the variables should be explained by the remaining variables without any reverse causal relationships.

The F-test has a non-standard distribution which depends upon: (i) whether variables included in the ARDL model are I(1) or I(0); (ii) whether the ARDL model contains an intercept and/or a trend. There

are critical bound values of both the statistics set by the properties of the regressors into purely I(1) or I(0), which are provided in Pesaran, Shin and Smith (2001) for large sample size. The critical bound values for F-test in the case of small sample size are estimated in Narayan (2005). If the absolute value of the estimated F-statistics: (i) lie in between the critical bounds set by I(1) and I(0), cointegration between the variables is inconclusive; (ii) in absolute value lower than set by I(0), cointegration is rejected; and iii) in absolute value higher than set by I(1), cointegration is accepted.

For the equation which shows cointegrating relationship, the conditional long-run relationship is estimated by the reduced form solution of the following ARDL equations. If 'X' is the explained variable the specification takes the form:

$$X_t = a_0 + \sum_{i=1}^{n} b_1 X_{t-i} + \sum_{i=0}^{n} b_2 Y_{t-i} + \sum_{i=0}^{n} b_3 Z_{t-i} + \varepsilon_t \quad (6)$$

The short dynamics are obtained from the following ARDL specifications

$$\Delta X_t = a_0 + \sum_{i=1}^{n} b_1 \Delta X_{t-i} + \sum_{i=0}^{n} b_2 \Delta Y_{t-i} + \sum_{i=0}^{n} b_3 \Delta Z_{t-i} + ECT_{t-1} + \varepsilon_t \quad (7)$$

The ECT term in (7) is the error obtained from the long-run relationship in (6).

The error correction model described by (7) can be used to generate dynamic forecast of the explained variable based on the past and current values of the independent variables. The accurateness of the dynamic forecast could indicate the robustness of the estimated model.

Section V
Data and Empirical Results

We cover the time period 1953 to 2009. The relevant data on price (wholesale price index) and reserve money are obtained from Monetary Statistics and Handbook of Statistics on Indian Economy, RBI. Data on Central Government fiscal deficit from 1971 onwards are obtained from Handbook of Statistics on Indian Economy, while

that for the earlier period was taken from Pattnaik *et al* (1999). Two time periods were considered, mainly with the purpose of generating dynamic forecast and checking the robustness of the model. The first time period is from 1953 to 2005, which excludes the post-FRBM period when direct lending to Government by the RBI was discontinued under the FRBM Act.

Unit Root Tests

To gauge the appropriateness of the ARDL cointegration analysis, two unit root tests *viz.*, ADF test and PP test were conducted for the two sample periods. It was found that there are contradictions in the unit root properties based on the alternative tests for the price variable and between the two sample periods on government deficit. On the other hand, seigniorage is indicated to be a stationary series by both the tests and for both the sample periods. The overall picture that emerged was that the three variables considered are not necessarily integrated of the same order (Table 1). In view of this, we used bounds tests, which are valid when variables are integrated of different order (Pesharan, Shin and Smith, 2001).

Bounds Tests

Bounds test results are extremely sensitive to the presence of serial correlation and the lag length selected. In order to remove the

Table 1: Unit Root Tests

Variable (X)	ADF		PP	
	X	ΔX	X	ΔX
1953 to 2005				
LogP	-3.21(t)	-5.20*	-4.94(t)*	-6.22*
LogS	-5.59(t)*	-8.93*	5.60(t)*	-24.4*
LogD	-3.10(t)	-6.96*	-3.16(t)	-6.98*
1953 to 2009				
LogP	-2.93(t)	-6.43*	-4.36(t)*	-6.44*
LogS	-5.50(t)*	-9.09*	5.53(t)*	-24.6*
LogD	-3.58(t)**	-6.82*	-3.63(t)**	-6.69*

Note: * and ** denote statistical significance at 1% an d 5% levels, respectively, 't' in parentheses denote that the tests included a trend along with the constant.

possible presence of serial correlations, dummies were included to remove outliers. With price as the explained variable, the outliers were found in 1974 and 1975 coinciding with the after affects of oil price shock of 1973. Fiscal deficit outliers were found in 1955 and 2009, coinciding with the initiation of the Second Five Year Plan and the recent fiscal stimulus measures following economic slowdown due to the global financial crisis, respectively. The outliers with respect to seigniorage were found during the years of 1975, 1976 and 1977, which were the years of extreme volatility in prices and money growth. Given the use of annual data, the maximum lag length was set at 2 and the appropriate lag length was selected based on SBC criterion.[1] This was considered appropriate since the sample size is small (in the statistical sense) and therefore including too many lags may lead to loss of explanatory power.

The bounds test results among the variables during both the sample periods reported in table-2 reveal the following:

(i) Between price and seigniorage, the F-statistics are above the 95% critical bound values (9.74 and 7.18 for the two sample periods) and significant at 99% critical level only when price is explained by seigniorage. The F-statistics for the reverse relationships (3.13 and 2.67) are statistically insignificant. In other words, there exists a long-run cointegrating relationship between price level in the economy and government resorting to seignorage to finance its deficits, but with the former only being caused by the latter;

(ii) Between price and government deficit, the F-statistics for the two sample periods are 6.17 and 7.96 and statistically significant only when price is explained by government deficit. In the case of the reverse relationship, the F-statistics are 3.34 and 2.27 and are lower than 95% critical bound values and hence not significant. Thus, in the long-run, government deficit has an impact on price level in the economy, but the reverse impact is insignificant;

(iii) Seigniorage is also explained by government deficit with F-statistics of 8.14 and 5.32 for the two sample periods, but the

reverse relationships are not statistically significant, given the corresponding F-statistics of 0.39 and 0.48. The implication is that government resorts to seigniorage to finance its deficit in the long-run, but there is no significant reverse impact.

(iv) When all the three variables are combined, only price is explained by seigniorage and government deficit with F-statistics of 6.42 and 5.83 for the two sample periods. None of the reverse relationships are statistically significant. The respective F-statistics for the two sample periods are 2.51 and 1.85 with government deficit as the explained variable and 0.83 and 0.56 with seigniorage as the explained variable. In other words, *ceteris paribus*, price level in the economy in India, in the long-run, is significantly influenced either directly by deficit itself or through the creation of money via deficit financing, or a combination of both. In other words, inflation is indicated to be explained by government deficit either directly or through seigniorage indirectly or through a combination of both the factors. Further, the results that there is only one cointegrating relationship between the variables in all the alternative combinations clearly indicates that the ARDL approach to cointegration can be used for estimation of the long-run relationships and the short-run dynamics.[2]

Long-run Coefficients

In estimating the long-run coefficients a trend component was included in the price equations as a proxy to capture the impact of other macroeconomic variables on price. The results presented in table-3 reveal some interesting features. While the signs of the coefficients are as expected *a priori* in all the equations, some of them are not statistically significant. Specifically, the coefficients of fiscal deficit in the price equations are insignificant in the shorter sample period (column 2 and 4), but turn significant in the full sample period (column 6 and 8). Conversely, the coefficients of seiniorage which are significant in the shorter sample period (column 1 and 4) turn insignificant in the full sample period, particularly with the inclusion of fiscal deficit as the other explanatory variable (column 5 and 8).

Table 2: Bounds test for Cointegration

Functional Relationship	1952-2005			1952-2009		
	F-Statistics	95% critical Values	Dummy variables	F-Statistics	95% critical Values	Dummy variables
Bivariates						
F_p (P/S)	9.74*	4.44	1974 & 1975	7.18*	4.393	1974 & 1975
F_s(S/P)	3.13	4.44		2.67	4.393	
F_p (P/D)	6.71*	4.44	1974 & 1975	7.96*	4.393	1974 & 1975
F_d(D/P)	3.34	4.44	1955	2.27	4.393	1955 & 2009
F_s(S/D)	8.14*	4.44	1975, 1976 & 1977	5.32**	4.393	1975, 1976 & 1977
F_d(D/S)	0.39	4.44		0.48	4.393	2009
Trivariates						
F_p (P/S,D)	6.42*	4.178	1974 & 1975	5.83*	4.10	1974 & 1975
F_d(D/S,P)	2.51	4.178		1.85	4.10	2009
F_s(S/D,P)	0.83	4.178	1959 & 1997	0.56	4.10	1959 & 1997

Note: * and ** denote statistical significance at 99% and 95% critical levels, respectively. The critical bound values for F-statistics are from Narayan (2005).

This could indicate that till the ban on direct government borrowing from the RBI, the inflationary impact of fiscal deficit worked primarily through money creation and overshadowed the direct impact, if any. However, in recent years, with limited scope for direct monetisation, the inflationary impact of fiscal deficit is generated more directly perhaps via the channel of increase in aggregate demand.

Individually, one percent increases in seigniorage leads to about one-third of a percent increase in the price level in both sample periods, though the level of statistical significance declines (column 1 and 5). With regard to fiscal deficit, one per cent increase in it leads to about

Table 3: Long-run Coefficients

	1954-2005				1954-2009			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	LogP	LogP	LogS	LogP	LogP	LogP	LogS	LogP
Constant	4.50 (21.6)*	3.30 (5.4)*	-3.01 (-12.8)*	3.75 (6.4)*	4.53 (17.6)*	3.0 (5.1)*	-3.18 (-10.7)*	3.23 (5.3)*
LogS	0.31 (2.1)**			0.23 (1.8)***	0.32 (1.7)***			0.2 (1.3)
LogD		0.19 (1.5)	0.483 (19.3)*	0.13 (1.2)		0.25 (2.1)**	0.51 (16.6)*	0.24 (2.1)**
Trend	0.06 (6.1)*	0.05 (3.3)*		0.05 (3.4)*	0.05 (4.0)*	0.04 (2.9)*		
DumP	0.71 (0.71)**	0.79 (2.6)*		0.67 (2.5)**		0.90 (2.64)**		0.93 (2.2)*
DumS1			-.97 (-3.2)*				-1.25 (-2.85)*	

Note: *, ** and *** denote statistical significance at 1%, 5% and 10% levels, respectively. Dummy as indicated in the bounds test.

one-fifth to one-quarter of a per cent increase in the price level, which though is statistically significant only for the full sample period (column 2 and 6).

The above estimated elasticities, however, ignore the interaction between seigniorage and government deficit. It is seen from column (3) and (7) that to finance one percent of fiscal deficit in the long-run, seigniorage increased by about 0.48 to 0.51 percent, with other things remaining the same.

Combining both government deficit and seigniorage,one percent increase in seigniorage was found to cause inflation by about one-fifth of a percent in both the sample periods, but is not statistically significant for the full period. With regard to one per cent increase in government deficit, the impact which was small (0.13) and not statistically significant in the shorter sample period, increased in the full sample period to a statistically significant level of about a quarter of a percent increase in the price level. It may, thus, be interpreted that, in the more recent years, the direct long-run inflationary impact

of seigniroage has declined while that of government deficit through aggregate demand channel has increased. However, the long-run impact of government deficit on seigniorage revenue appears to have not declined.

Short-run Dynamics

The short-run dynamics presented in Table-4 reveal that all the equations are stable i.e., they converge to the long-run equilibrium as indicated by the negative sign of the error correction term. The explanatory powers are reasonable and the problem of serial correlation is within the tolerable level in general. There, however, seems to be some decline in the explanatory power after the inclusion of more recent periods.

The inflationary impact of seigniorage in the short-run is neglisible, irrespective of whether it is considered alone or taken together with government deficit in the model in both the sample periods (columns 1, 4, 5 and 8). The speed of convergence following a shock is also very slow, about 16 to 17 percent in a single year when considered alone and about 16 to 20 percent when deficit is also included.

Government deficit, on the other hand, has a positive impact on inflation even in the short-run for the full sample period indicating that the direct inflationary impact of government deficit could have become more prominent in the more recent years.

With regard to the impact of government deficit on seigniorage, there is a strong positive impact even in the short-run. The impact was larger in the shorter sample period and the speed of convergence was also higher with about 92 per cent of the divergence from the long-run equilibrium following a shock being corrected in a single time period. Both the short-run impact and speed of convergence decline in the full sample period, indicating that government may have switched over to alternative source of financing its deficit in the short-run given the restriction on direct borrowing from the RBI since the beginning of fiscal 2006.

Table 4: Short-run Dynamics

	1954-2005				1954-2009			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	ΔLogP	ΔLogP	ΔLogS	ΔLogP	ΔLogP	ΔLogP	ΔLogS	ΔLogP
Constant	0.79 (3.1)*	0.62 (2.7)*	-2.78 (-5.3)*	0.75 (3.1)*	0.73 (2.8)*	0.52 (2.5)**	-2.38 (-4.26)*	0.51 (2.2)**
$\Delta LogP_{-1}$					0.33 (2.4)**			
ΔLogS	0.00 (0.01)		0.29 (2.6)**	-0.00 (-0.2)	-0.01 (0.61)		0.24 (1.96)***	-0.00 (-0.6)
ΔLogD		0.04 (1.5)	0.45 (5.9)*	0.03 (1.1)		0.04 (2.2)**	0.38 (4.8)*	0.04 (1.9)***
Trend	0.01 (2.0)**	0.01 (2.2)**		0.01 (1.9)***	0.01 (1.6)	0.01 (1.9)***		0.00 (1.1)
DumP	0.12 (4.6)*	0.15 (4.5)*		0.13 (4.7)*		0.16 (5.0)*		0.15 (5.2)*
DumS1			-0.90 (-4.0)*				-0.94 (-3.8)*	
ECM(-1)	-0.17 (-2.76)*	-0.19 (-3.4)*	-0.92 (-4.93)*	-0.20 (-2.97)**	-0.16 (-2.43)*	-0.127 (-3.27)*	-0.75 (-5.17)*	-0.16 (-2.42)**
R-bar Square	0.52	0.40	0.57	0.52	0.27	0.40	0.46	0.47
DW-Statistics	1.75	1.65	1.88	1.73	2.02	1.64	1.82	1.64

Note: *, ** and *** denote statistical significance at 1%, 5% and 10% levels, respectively. Dummy as indicated in the bounds test.

As mentioned above, dynamic forecasts of inflation for the period 2006 to 2009 were generated from the models estimated for the period 1953 to 2005 and then compared with the actual change. The forecast results are presented in Table-5. It could be seen that the direction of actual inflation are correctly predicted irrespective of whether seigniorage and government deficit are combined or considered individually. However, the inflation rates in each of the four years are over-predicted The root mean square errors of predictions for the forecast period are also marginally higher than for the estimation period, except when government deficit is considered as the only explanatory variable. However, root mean square errors are about or less than 5.0 per cent, indicating that the forecast performance may be reasonable.

Table 5: Dynamic Forecasts for 2006 to 2009

(in per cent)

	Change in P due to change in S and D		Change in P due to change in S		Change in P due to change in D	
	Actual	Predicted	Actual	Predicted	Actual	Predicted
2006	4.28	8.8	4.28	9.67	4.28	8.1
2007	5.28	8.7	5.28	9.97	5.28	7.5
2008	4.65	9.4	4.65	11.2	4.65	6.7
2009	8.01	13.0	8.01	12.6	8.01	9.7
Root mean square	Estimation Period	Forecast period	Estimation Period	Forecast period	Estimation Period	Forecast period
	3.3	4.4	3.3	5.3	3.9	2.6

Section VI
Concluding Observations

The fiscal response in India to the severe contagion from the global crisis was conditioned by the need to minimize the adverse impact on the domestic economy. In the process, however, India's fiscal deficit expanded again to the pre-FRBM level. Given India's past experience, in terms of fiscal consolidation resulting only over a number of years, downward inflexibility of the post-crisis high fiscal deficit level could emerge as a potential source of risk to India's future path of inflation.

During 2008-10, when the fiscal stimulus led to increase in the fiscal deficit level, India's inflation environment remained highly volatile, reaching a peak in 2008-09 under the influence of the global oil and commodity prices shock, and coming under pressure again in 2009-10 from another supply shock, but from within the country, in the form of significant increase in food prices resulting from the deficient monsoon. In this inflation process over these two years, however, fiscal deficit did not have much of a contributing role, since: (a) the overall private demand remained depressed, and fiscal expansion only aimed at partially offsetting the impact of deceleration in the growth of private consumption and investment demand on economic growth, (b) large borrowing programme of the Government did not lead to high money growth, since the growth in demand for credit from the private sector exhibited significant deceleration, and (c) certain fiscal measures like cuts in indirect tax rates in fact helped in lowering the prices of specific goods and services to some extent. Thus, the usual

two channels through which fiscal deficit could cause inflation - *i.e.* by exerting pressure on aggregate demand in relation to potential output and by leading to excessive expansion in money growth - were almost absent. As demand for credit from the private sector has revived, and if capital inflows remain strong on a sustained basis, the usual downward inflexibility in fiscal deficit and its implications for the future inflation path will start to emerge over time.

In this context, this paper examined the empirical relationship between fiscal deficit and inflation over the pre-FRBM period 1953-2005 as well as the full sample period of 1953-2009. The direct impact of fiscal deficit through primary expansion in reserve money was studied by using a concept of 'seigniorage', proxied by the annual change in reserve money deflated by WPI inflation.Net RBI credit to the government and RBI's increase in net foreign assets are the two key determinants of growth in reserve money on the sources side, and hence, only part of the increase in reserve money could be ascribed to the fiscal stance at any point of time. The overall impact of the fiscal deficit on inflation, in turn, could operate through both increases in aggregate demand as well as associated growth in broad money. In both direct as well as overall analysis, thus, the role of money in inflation becomes obvious, but that process could be significantly conditioned by the fiscal stance.

Bounds test results presented in the study suggest that: (a) there is a cointgrating relationship between the price level and seigniorage financing of deficit; (b) fiscal deficit and price level also exhibit a similar relationship, and in both cases the price level appears to be determined by seigniorage or fiscal deficit, not the other way round; (c) the role of seigniorage in the inflation process may be declining over time, particularly in recent years, even though the impact of fiscal deficit on inflation through aggregate demand channel might have increased; (d) one percentage point increase in the level of fiscal deficit is estimated to cause as much as a quarter of a percentage point increase in WPI; and (e) as per the analysis of short term dynamics through which fiscal deficit may get transmitted to inflation, fiscal deficit appears to have a positive impact on inflation even in the short-run, though modest. These empirical findings suggest that while the fiscal stance in India

was appropriate in the context of the economic slowdown that followed in response to the global crisis, it may have medium-term potential ramifications for the inflationary situation. This possibility, in turn, highlights the significance of return to fiscal consolidation path at the earliest, with an emphasis on the quality of fiscal adjustment, driven by rationalisation of expenditure rather than revenue buoyancy from stronger growth. Build up of adequate fiscal space is important not only for ensuring stability to the high growth objective but also for enhancing the ability to deal with such inflationary pressures that may originate from temporary supply shocks, as experienced in recent few years.

Notes:

[1] It was, however, found that increasing the maximum lag length to 3 or 4 hardly affected the results.

[2] As mentioned above, for Bounds test to be valid, the long-run relationship between the variables should be only in one direction.

References:

Aghevli, B.B., and Khan, M. (1978), "Government Deficits and the Inflationary Process in Developing Countries," *IMF Staff Papers, 25,* 383-416.

Alesina, Alberto and Drazen, Allan (1991), "Why are Stabilisations Delayed?", American Economic Review, Vol. 81, 1170-1188.

Ashra, S., Chattopadhyay, S., and Chaudhuri, K. (2004), "Deficit, Money and Price – the Indian Experience", *Journal of policy Modeling, 26,* 289-99.

Calvo, Guillermo and Vegh, Carlos (1999), "Inflation Stabilisation and BOP Crisis in Developing Countries," in John Taylor and Michael Woodford (Ed)., Handbook of Macroeconomics, Volume C, North Holland.

Catao Luis and Marco Terrones (2001), "Fiscal Deficits and Inflation: A New Look at the Emerging Market Evidence", IMF Working Paper WP/01/74.

Cecchetti, Stephen G, M. S. Mohanty and Fabrizio Zampolli (2010), "The Future of Public Debt: Prospects and Implications", BIS Working Papers No. 300, March.

Fischer Stanely and William Easterly (1990), "The Economics of the Government Budget Constraint", World Bank Research Observer, Vol. 5(2), 127-142.

Cochrane, John H. (2009), "Fiscal Stimulus, Fiscal Inflation, or Fiscal Fallacies?", University of Chicago Booth School of Business, February 27..

Davig, Troy and Erie M. Leeper (2009), "Monetary-Fiscal Policy Interactions and Fiscal Stimulus", NBER Working Paper Series 15133, July.

IMF (2009), " The State of Public Finances Cross-Country Fiscal Monitor", IMF Staff Position Note (SPN/09/25), November.

Jadhav, N. (1994). *Monetary Economics for India.* Delhi: Macmillan India Limited.

Khundrakpam J.K. and Rajan Goyal (2009), "Is the Government Deficit in India Still Relevant for Stabilisation?," RBI Occasional Papers, Vol.29 (3), Winter 2008.

Narayan, P.K. (2005), "The Saving and Investment Nexus for China: Evidence from Co-integrating Tests", Applied Economics, 35, 1979-1990.

Pattnaik, R.K., Pillai, S.M., and Das, S. (1999), "Budget Deficit in India: A Primer on Measurement", *RBI Staff Studies*, Reserve Bank of India.

Pesaran, M. H., Shin, Y. and Smith, R.J. (2001), "Bound Testing Approaches to the Analysis of Level Relationships", *Journal of Applied Econometrics,* 16, 289-326.

Rangarajan, C., and Mohanty M.S. (1998), "Fiscal Deficit, External Balance and Monetary Growth", *Reserve Bank of India Occasional Papers*, 18, 635-653.

Reserve Bank of India (2006), Handbook of Monetary Statistics of India.

Reserve Bank of India (2009), Handbook of Statistics of the Indian economy, 2008-09.

Sarma , Y.S.R. (1982), "Government Deficits, Money Supply and Inflation in India", *Reserve Bank of India Occasional Papers.* Mumbai, India.

Sargent, Thomas J. and Neil Wallace (1981), "Some Unpleasant Monetarist Arithmetic", Federal Reserve Bank of Minneapolis Quarterly Review, Vol. 5(3), 1-17.

Vinals, Jose and Paolo Mauro (2010), "A Strategy for Renormalising Fiscal and Monetary Policies in Advanced Economies", KDI/IMF Workshop, Seoul Korea, February 25, 2010.

Woodford, Michael (2001), "Fiscal Requirements for Price Stability", National Bureau of Economic Research, Working Paper, 8072.

Reserve Bank of India Occasional Papers
Vol. 31, No.2, Monsoon 2010

Forecasting Inflation and IIP Growth: Bayesian Vector Autoregressive Model

Dipankar Biswas, Sanjay Singh and Arti Sinha*

Maintaining low and stable inflation with sustainable growth is the prime objective of any monetary authority. To achieve the prime goal, reliable forecast of macroeconomic variables play an important role. In this paper, the authors tried to develop a forecasting model for inflation as well as IIP growth in a multivariate time series Bayesian framework, known as Bayesian Vector Autoregressive (BVAR) Model. The main advantage of using this model is the incorporation of prior information which may boost the forecasting performance of the model. Using the quarterly data on WPI, M1 and IIP during the period of first quarter of 1994-95 (Q1: 1994-95) to last quarter of 2007-08 (Q4: 2007-08), a VAR was developed and subsequently using Minnesota prior or Litterman's prior proposed by Litterman in 1980, a BVAR model was developed. Based on the comparison of forecasting performance of VAR and BVAR model, measured in terms of out-of-sample percentage root mean square error, it is found that BVAR model performed better than VAR model in case of inflation as well as IIP growth forecast.

JEL Classification : C1, C3, E2, E3.
Keywords : Inflation, Output, VAR, Bayesian VAR, Minnesota prior.

Introduction

Undoubtedly, maintaining inflation at low and stable rate which bust production environment without hearting common people is primary goal of any monetary authority at the globe. In the process of achieving this prime goal, while making monetary policy, a lot of information on monetary and fiscal variables are required. Along

* Authors are working as Research Officers in the Department of Statistics and Information Management, Reserve Bank of India. The views expressed in the paper are those of authors and do not necessarily represent those of the RBI. Erros and omissions, if any, are the sole responsibility of the authors.

with these inputs, the reliable forecasts of macro-economic variables undoubtedly have significant policy implications. It is therefore, the search for better forecasting techniques to get reliable forecast is always vital. To access the general price situation, which is likely to be appeared in the next coming few months, the frequently used forecasting models are univariate time series models like autoregressive model, moving average model, autoregressive moving average model, etc. or multivariate times series model. The merit of using multivariate time series model is, along with incorporating past information of the target variable, it allows to incorporate inter-temporal interdependence of other variables for improving the forecasting performance. The commonly used multivariate time series model is vector autoregressive (VAR) model. But, the major setback of this model is the problem of overparameterisation. By the nature of the model, it requires to estimate large number of parameters which leads to large standard error. So, if some restriction can be imposed on the parameters then the performance of the model should be improved.

The facility of imposing restrictions is available in Bayesian Statistics by the way of prior information on parameters/coefficients. As, the name itself says about prior information, it is the information about the parameters which come before the experiment, by the way of other experiments, personal belief of the forecaster, etc., and then assigning probability distribution to each coefficients of the model. This Bayesian VAR (BVAR) approach provides more accurate forecasts (Litterman (1980), Kinal and Ratner (1986)). BVAR is also superior to VAR since it is robust to the choice of national variables, even when misspecified national variables are included (Shoesmith, 1990). Hence, a modified VAR restricting certain parameters is sometimes preferred. In general, the prior being used for BVAR is Minnesota prior or Litterman's prior proposed by Litterman in 1980. Some important studies being done using Bayesian VAR are for Minnesota (Litterman, 1980), New York state (Kinal and Ratner 1986), Texas (Gruben and Long 1988), Louisiana (Gruben and Hayes 1991), Iowa (Otrok and Whiteman 1998) and Philadelphia Metropolitan Area (Crone and McLaughlin 1999).

In this project, the idea is to develop a Bayesian Vector Autoregressive (BVAR) model for Indian Economy by allowing possibility of interactions between the important macroeconomic variables. Here, at the first stage, we have developed a VAR model for the two most important macroeconomic variables *viz.* industrial output growth and inflation of the economy. Next, the VAR model is modified to make a BVAR model. Lastly, a comparative study between the VAR and BVAR models is done based on the out-of-sample forecasting performance.

The rest of the paper is organized as follows. Section I gives the literature review. A short description on VAR process and BVAR process and on Litterman's prior is given in Section II. Section III presents the data, variables used and period of study. Section IV describes the empirical results. Finally, the concluding remarks are presented in Section V.

Section I
Literature Review

The comparative analysis of short-run forecasting methods used in this present work has been recurrent in the econometric literature. Three main trends were then distinguished. In the 1950s, the first forecasts were released to analyze business cycles and enlighten public decisions. As these were successfully used in the '60s and the '70s, forecasting developed later mainly through macroeconometric models, which were carried out by many economists (Mincer and Zarnowitz (1969), Makridakis & Hibon (1979), Fair (1979), Fonteneau (1982), Bodkin, Klein & Marwah (1990)). However, critics arose in the late '70s, (Lucas (1970), Kydland & Prescott (1977), Sims (1980)), saying that the forecasts were inaccurate and unable to anticipate the big crises of seventh and eighth decades of twentieth century. This period put an end to the golden age of forecasting based on econometric models and favoured the emergence of new methodological approaches.

Some works broke up with the traditional approach by offering diverse methods to study time series data (Kaman filter, Box-Jenkins methodology, the VAR modelling, state-space models). At the end of the '80s, empirical studies on these methods flourished, questioning their effectiveness and performances faced with the macroeconomic models (Kling and Blesser (1985), McNees (1986), Makridakis (1986), Wallis (1989), Aoki (1990). In short, this second trend showed that the methods based on time series data gave comparable or even superior results to the traditional macreconometric models.

The third trend corresponds to the present time. It started with questions about the non-stationarity of the series and their long-run evolution. The answers to these questions aroused a tremendous interest in econometric research. It consequently led to a large diversity of works on economic variables in 1990s. It is however too soon to measure the effectiveness and significance of these current methods, which remain to be improved.

The use of VAR models has been recommended by Sims (1980) as an efficient alternative to verify causal relationships in economic variables and to forecast their evolution. On the theoretical level, this approach has its foundation in the work of Wold (1938), Box and Jenkins (1980) and Tiao and Box (1981). Given the vector of variables, the classical VAR model explains each variable by its own past values and the past values of all other variables by a well-defined relation. For macroeconomic forecasting, VAR has become a standard tool. VARs produce dynamic forecasts that are consistent across equations and forecast horizons.

The issue which has entailed for a long time the controversy between the supporters and detractors of the Bayesian procedure is the estimation of the parameters of a model, either by using the statistical inference techniques or, on the contrary, by taking into account the previous knowledge of the economic system. The application of this procedure implies that an a priori probability has to be chosen and it can only be applied to models with a finite number

of parameters. Yet, since most of the macroeconomic variables are from stochastic tendencies, the specification of their distribution turns out to be necessary. Usually, the hypothesis of normality for the coefficients is adopted since, in most cases, the underlying economic theory has little influence on the distribution of errors. In the field of multivariate modelling, Litterman suggested the use of the Bayesian procedure (1980) as an efficient way of avoiding some of the problems posed by Sims VAR models. The over-parametrisation is mainly the cause of these problems. Indeed, even if the reduced-size systems are involved, too many parameters have to be considered, which turns out to be non-significant after applying the hypothesis tests. Thus, it is necessary to put forward that the out-of-sample forecasts obtained by means of a standard VAR model depend a lot on the number of lags, even though the values observed and calculated are very close on the estimation period. In order to bypass these difficulties, Litterman (1980) introduces some a-priori knowledge in the formulation of his model by means of a distribution of probabilities.

The primary focus of monetary policy, both in India and elsewhere, has traditionally been the maintenance of a low and stable rate of aggregate price inflation along with sustainable economic growth. The underlying justification for this objective is the widespread consensus supported by numerous economic studies that inflation is costly insofar as it undermines real, wealth-enhancing economic activity. If anything, this consensus is probably stronger today than it ever has been in the past. Indeed, it could be argued that much of the improvement in Indian living standards which has taken place over the last two decades would not have been achieved without the establishment of a credible low inflation environment.

This paper focuses mainly on BVAR models. Over the past twenty years, the BVAR approach has gained widespread acceptance as a practical tool to provide reasonably accurate macroeconomic forecasts when compared to conventional macroeconomic models or alternative time series approaches.

Section II
Methodology: An Overview

Vector Autoregressive Model:

In notational form, mean-adjusted VAR(p) model (VAR model of order p) can be written as

$$y_t = A_1 y_{t-1} + ... + A_p y_{t-p} + u_t \text{ ; t=0,1,2,3,....}$$

Where, $y_t = (y_{1t}, ..., y_{Kt})$ is a (K×1) random vector, the A_i are fixed (K×K) coefficient matrices and $u_t = (u_{1t}, ..., u_{Kt})$ is a K-dimensional white noise or innovation process, i.e., E(u_t)=0, $E(u_t u_t^{'}) = \Sigma_u$ and $E(u_t u_s^{'}) = 0$ for s≠ t.

The same can be written for t=1,……,T, compactly as

$$Y = AX + U$$

or $y = (X^{'} \otimes I_K)\beta + u$

where,

$$Y = (y_1, ..., y_T)_{(K \times T)}$$

$$A = (A_1, ..., A_p)_{(K \times Kp)}$$

$$X = (Y_0, ..., Y_{T-1})_{(Kp \times T)}$$

$$Y_t = \begin{bmatrix} y_t \\ . \\ . \\ . \\ y_{t-p+1} \end{bmatrix}_{(Kp \times 1)}$$

$$y = vec(Y)_{(KT \times 1)}$$

$$\beta = vec(A)_{(K^2 p \times 1)}$$

$$U = (u_1, ..., u_T)_{(K \times T)}$$

$$u = vec(U)_{(KT \times 1)}$$

Under the standard VAR, coefficient vector β is unknown but fixed which has to be estimated.

Bayesian Vector Autoregressive(BVAR) Model:

On the other hand, in BVAR model the coefficients β's are considered as variables which some known distribution known as prior distribution. The parameter of prior distribution is known as hyperparameter. In this project, we have used Minnesota prior or Litterman's prior proposed by Litterman in 1980. Under this prior, parameter vector β has a prior multivariate normal distribution with known mean β* and covariance matrix V_β, hence the prior density is written as

$$f(\beta) = (\frac{1}{2\pi})^{K^2 p} \left|V_\beta\right|^{-1/2} \times \exp[-\frac{1}{2}(\beta - \beta^*)V_\beta^{-1}(\beta - \beta^*)']$$

Whereas, the likelihood function for the Gaussian process becomes

$$l(\beta | y) = (\frac{1}{2\pi})^{KT/2} \left|I_T \otimes \Sigma_u\right|^{-1/2} \times$$

$$\exp[-\frac{1}{2}(y - (X \otimes I_K)\beta)(I_T \otimes \Sigma_u)^{-1}(y - (X \otimes I_K)\beta)']$$

Therefore, using Bayes' theorem,

$$f(\beta / y) = \frac{l(\beta / y) f(\beta)}{\int l(\beta / y) f(\beta) d\beta}$$

the posterior density is written as

$$l(\beta | y) \propto \exp[-\frac{1}{2}(\beta - \overline{\beta})\overline{\Sigma_\beta}^{-1}(\beta - \overline{\beta})']$$

where the posterior mean is

$$\overline{\beta} = [V_\beta^{-1} + (X'X \otimes \Sigma_u^{-1})]^{-1}[V_\beta^{-1}\beta^* + (X' \otimes \Sigma_u^{-1})y]$$

and the posterior covariance matrix is

$$\overline{\Sigma_\beta} = [V_\beta^{-1} + (X'X \otimes \Sigma_u^{-1})]^{-1}$$

In practice, the prior mean β* and the prior variance V_β need to be specified. According to Litterman, the prior variance can be given by

$$\upsilon_{ij}(l) = \begin{cases} (\lambda / l)^2 & \text{if i=j} \\ (\lambda\theta\sigma_{ii} / l\sigma_{jj})^2 & \text{if i}\neq\text{j} \end{cases}$$

where $\upsilon_{ij}(l)$ is the prior variance of the $(i,j)^{th}$ element of A_l, λ is the prior standard deviation of the diagonal elements of A_l, θ is a constant in the interval (0,1), and σ_{ii}^2 is the ith diagonal element of Σ_u .

Section III
Selected of Variables and Time Period of the Study

In India, the measurement of general price situation of the country as a whole is based on Wholesale price Index (WPI), we have used following variables in our study:

- Wholesale Price Index (WPI)
- Index of Industrial Production (IIP), and
- Narrow Money (M1).

We have used quarterly data during the period of first quarter of 1994-95 (Q1: 1994-95) to last quarter of 2007-08 (Q4: 2007-08). The model is fitted based on data till Q4: 2006-07, whereas, data for remaining period is being used for testing the model performance.

Before developing the model logarithmic transformation has been used. Whereas, to adjust with seasonality, seasonal dummies are used.

Section IV
Empirical Analysis

Stationary: The Augmented Dickey Fuller test is used for testing stationarity at the level and at first difference. Based on the results of the test statistics (Appendix 1), it can be observed that the variables are seems to be stationary at first difference.

Selection of Order of VAR: For the purpose of selecting order of VAR, the Minimum Information Criteria as well as Univariate Model White Noise Diagnostics are being used and based on these criteria, the order of VAR is found to be two.

The results of VAR(2) is given in the Appendix 2. Based on these results, it can be observed that the diagnostics results of this model are appears to be satisfactory. And out of sample percentage root mean

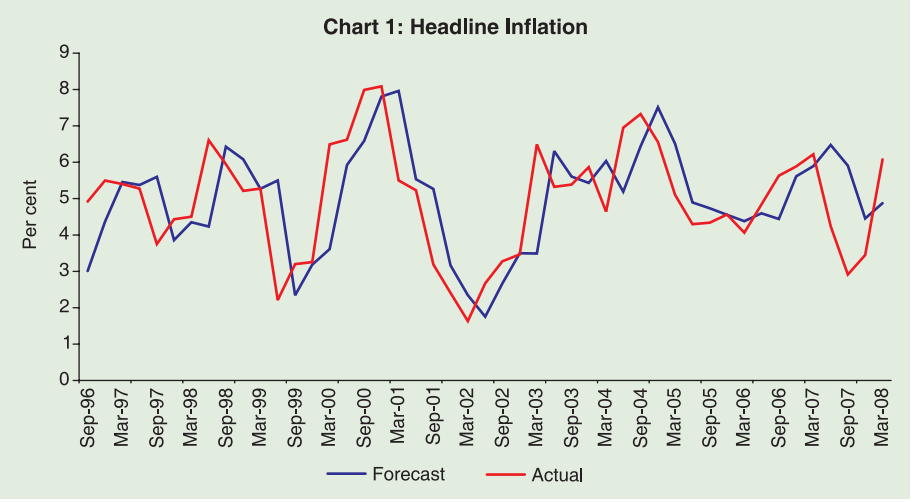
Table 1: Comparison of the Models

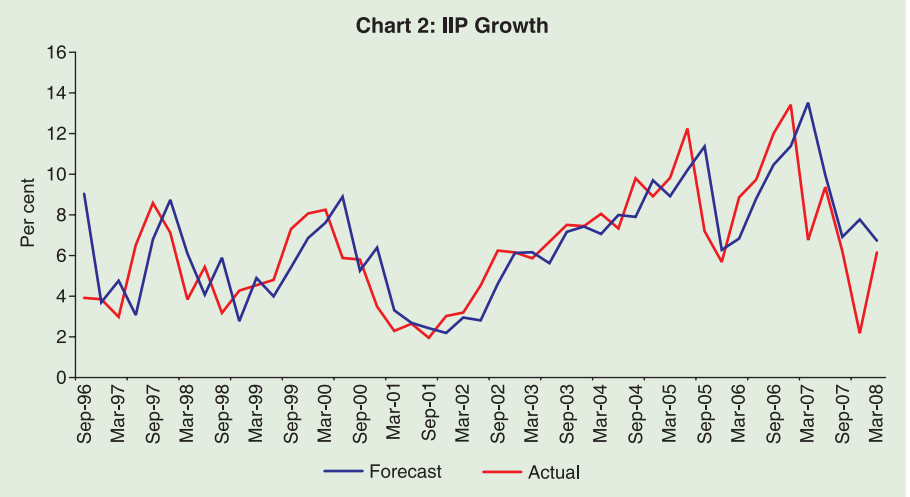
Model	Out of Sample PRMSE	
	WPI	IIP
VAR(2)	1.4932	4.2508
BVAR(2)	1.4400	3.6055

square error (PRMSE) for WPI for four quarters is 1.4932 per cent, whereas, for IIP, it is 4.2508 per cent.

Selection of values of lambda and theta in Litterman prior: Here, since the VAR model is developed at difference of the variables, therefore, the absolute value of the parameters would be less then one and hence mean of prior distribution is taken as zero, whereas, the degree of closeness of parameters to the prior mean can be controlled by suitable values of lambda and theta. Further, for selecting the a suitable values for lambda and theta, we have tried various combination for these parameters between 0 to 1 and based on PRMSE (Appendix 3), we found that lambda=0.3 and theta=0.9 are suitable values for BVAR(2). Therefore, BVAR(2) with lambda=0.3 and theta=0.9 was fitted and results of the model is given in Appendix 4.

From the results, given in the table 1, it can be observed that, out of sample PRMSE has been reduced while using BVAR in both the cases i.e. for WPI as well as IIP.





Section V
Concluding Remarks

In this project, with the objective of getting better forecast of inflation as well as IIP growth, quarterly data on WPI, IIP and M1 since first quarter of 1994-95 to fourth quarter of 2007-08 were used and we developed a VAR as well as Bayesian VAR (BVAR) model for forecasting the target variables. Further, based on the comparison of performance of these two models, it is found that the forecasting performance, measured in terms of out-of-sample percentage root mean square error of VAR model being used for forecasting inflation as well as IIP growth, has improved by applying Bayesian technique.

Appendix 1: Unit Root Test

Augmented Dickey-Fuller Unit Root Tests (Level)

Variable: lwpi

Type	Lags	Rho	Pr < Rho	Tau	Pr < Tau
Zero Mean	1	0.1238	0.7069	5.23	0.9999
	2	0.1205	0.7060	5.55	0.9999
	3	0.1175	0.7052	5.63	0.9999
	4	0.1118	0.7038	4.08	0.9999
Single Mean	1	-0.3863	0.9315	-0.86	0.7923
	2	-0.2066	0.9428	-0.62	0.8555
	3	-0.1395	0.9466	-0.56	0.8704
	4	0.0838	0.9581	0.31	0.9765
Trend	1	-44.0181	<.0001	-4.98	0.0010
	2	-42.7256	<.0001	-4.01	0.0148
	3	-34.3860	0.0005	-3.27	0.0827
	4	-82.5674	<.0001	-3.24	0.0892
Variable: liip					
Type	Lags	Rho	Pr < Rho	Tau	Pr < Tau
Zero Mean	1	0.1238	0.7069	5.23	0.9999
	2	0.1205	0.7060	5.55	0.9999
	3	0.1175	0.7052	5.63	0.9999
	4	0.1118	0.7038	4.08	0.9999
Single Mean	1	-0.3863	0.9315	-0.86	0.7923
	2	-0.2066	0.9428	-0.62	0.8555
	3	-0.1395	0.9466	-0.56	0.8704
	4	0.0838	0.9581	0.31	0.9765
Trend	1	-44.0181	<.0001	-4.98	0.0010
	2	-42.7256	<.0001	-4.01	0.0148
	3	-34.3860	0.0005	-3.27	0.0827
	4	-82.5674	<.0001	-3.24	0.0892
Variable: lm1					
Type	Lags	Rho	Pr < Rho	Tau	Pr < Tau
Zero Mean	1	0.1374	0.7101	6.13	0.9999
	2	0.1319	0.7087	7.19	0.9999
	3	0.1262	0.7073	8.90	0.9999
	4	0.1222	0.7062	3.28	0.9996
Single Mean	1	0.3323	0.9688	0.73	0.9917
	2	0.4188	0.9719	1.47	0.9990
	3	0.4760	0.9737	3.33	0.9999
	4	0.5584	0.9762	2.55	0.9999
Trend	1	-9.3281	0.4442	-1.57	0.7891
	2	-0.5215	0.9915	-0.14	0.9927
	3	2.9137	0.9999	1.73	0.9999
	4	1.0159	0.9985	0.35	0.9984

Augmented Dickey-Fuller Unit Root Tests (Difference=1)

Variable: lwpi

Type	Lags	Rho	Pr < Rho	Tau	Pr < Tau
Zero Mean	1	-16.6621	0.0028	-2.95	0.0040
	2	-9.9214	0.0245	-2.19	0.0285
	3	-3.4208	0.1989	-1.57	0.1090
	4	-2.2352	0.3006	-1.20	0.2062
Single Mean	1	-99.6940	0.0004	-6.79	0.0001
	2	-1124.78	0.0001	-6.42	0.0001
	3	-114.865	0.0001	-4.43	0.0008
	4	-316.520	0.0001	-3.93	0.0036
Trend	1	-100.378	0.0001	-6.75	<.0001
	2	-1321.11	0.0001	-6.37	<.0001
	3	-106.584	0.0001	-4.29	0.0072
	4	-241.817	0.0001	-3.84	0.0232
Variable: liip					
Type	Lags	Rho	Pr < Rho	Tau	Pr < Tau
Zero Mean	1	-244.186	0.0001	-11.26	<.0001
	2	623.2370	0.9999	-7.67	<.0001
	3	-2.7100	0.2542	-1.23	0.1977
	4	-3.4941	0.1940	-1.64	0.0946
Single Mean	1	-389.858	0.0001	-14.13	0.0001
	2	115.7601	0.9999	-18.48	0.0001
	3	-20.2941	0.0053	-2.61	0.0973
	4	-38.5153	0.0004	-3.23	0.0241
Trend	1	-388.594	0.0001	-13.97	<.0001
	2	116.0946	0.9999	-18.38	<.0001
	3	-21.3430	0.0283	-2.67	0.2548
	4	-39.1565	<.0001	-3.43	0.0602
Variable: lm1					
Type	Lags	Rho	Pr < Rho	Tau	Pr < Tau
Zero Mean	1	-21.4662	0.0005	-3.06	0.0029
	2	-10.7733	0.0187	-2.12	0.0336
	3	-1.0953	0.4525	-0.77	0.3787
	4	-0.4935	0.5672	-0.51	0.4905
Single Mean	1	-157.578	0.0001	-8.26	0.0001
	2	216.4850	0.9999	-8.91	0.0001
	3	-33.0310	0.0004	-3.03	0.0387
	4	-14.4477	0.0321	-2.12	0.2388
Trend	1	-166.277	0.0001	-8.48	<.0001
	2	181.8394	0.9999	-10.19	<.0001
	3	-77.2359	<.0001	-4.01	0.0148
	4	-41.7384	<.0001	-3.37	0.0680

Appendix 2: VAR (2)

Estimation Method: Least Squares Estimation

Seasonal Constant Estimates				
Variable	Constant	Season 1	Season 2	Season 3
dlwpi	0.01394	-0.01258	-0.01463	-0.00450
dliip	0.04654	-0.00519	0.00039	-0.13780
dlm1	0.01144	0.03351	0.05328	0.00301

Model Parameter Estimates

Equation	Parameter	Estimate	Standard Error	t Value	Pr > |t|	Variable
dlwpi	CONST1	0.00158	0.00961	0.16	0.8698	1
	SD_1_1	0.00144	0.01299	0.11	0.9124	S_1t
	SD_1_2	-0.00197	0.01170	-0.17	0.8671	S_2t
	SD_1_3	0.00613	0.01194	0.51	0.6096	S_3t
	AR1_1_1	0.22639	0.10926	2.07	0.0426	dlwpi(t-1)
	AR1_1_2	0.05563	0.08592	0.65	0.5199	dliip(t-1)
	AR1_1_3	0.08854	0.06744	1.31	0.1943	dlm1(t-1)
	AR2_1_1	-0.16897	0.09405	-1.80	0.0775	dlwpi(t-2)
	AR2_1_2	0.05573	0.07045	0.79	0.4321	dliip(t-2)
	AR2_1_3	0.11449	0.05616	2.04	0.0460	dlm1(t-2)
dliip	CONST2	0.02409	0.01212	1.99	0.0515	1
	SD_2_1	0.00772	0.01653	0.47	0.6422	S_1t
	SD_2_2	0.03394	0.01469	2.31	0.0244	S_2t
	SD_2_3	-0.09845	0.01499	-6.57	0.0001	S_3t
	AR1_2_1	-0.41799	0.13353	-3.13	0.0027	dlwpi(t-1)
	AR1_2_2	0.20349	0.10809	1.88	0.0647	dliip(t-1)
	AR1_2_3	0.13000	0.08384	1.55	0.1264	dlm1(t-1)
	AR2_2_1	-0.00292	0.11195	-0.03	0.9793	dlwpi(t-2)
	AR2_2_2	-0.06808	0.09121	-0.75	0.4584	dliip(t-2)
	AR2_2_3	0.15537	0.06984	2.22	0.0299	dlm1(t-2)
dlm1	CONST3	0.00490	0.01588	0.31	0.7589	1
	SD_3_1	0.03024	0.02122	1.42	0.1595	S_1t
	SD_3_2	0.05074	0.01916	2.65	0.0104	S_2t
	SD_3_3	0.05399	0.01948	2.77	0.0075	S_3t
	AR1_3_1	-0.17080	0.17574	-0.97	0.3351	dlwpi(t-1)
	AR1_3_2	0.07945	0.14032	0.57	0.5734	dliip(t-1)
	AR1_3_3	-0.27610	0.11252	-2.45	0.0171	dlm1(t-1)
	AR2_3_1	-0.06520	0.14718	-0.44	0.6594	dlwpi(t-2)
	AR2_3_2	-0.14172	0.11526	1.23	0.2237	dliip(t-2)
	AR2_3_3	0.11877	0.09635	1.23	0.2226	dlm1(t-2)

Schematic Representation of Cross Correlations of Residuals

Variable/													
Lag	0	1	2	3	4	5	6	7	8	9	10	11	12
dlwpi	+..	...	...	...	...	...	...	...	...	...	...	...	...
dliip	.+.	...	...	...	...	...	...	...	...	...	...	...	...
dlm1	..+	...	...	...	...	...	...	...	...	...	...	...	...
	+ is > 2*std error, - is < -2*std error, . is between												

Portmanteau Test for Cross Correlations of Residuals

Up to Lag	DF	Chi-Square	Pr > ChiSq
3	9	18.81	0.0269
4	18	23.92	0.1576
5	27	30.92	0.2743
6	36	44.60	0.1540
7	45	50.23	0.2738
8	54	64.52	0.1547
9	63	72.96	0.1832
10	72	78.00	0.2940
11	81	87.64	0.2876
12	90	96.86	0.2919

Univariate Model ANOVA Diagnostics

		Standard		
Variable	R-Square	Deviation	F Value	Pr > F
dlwpi	0.4808	0.00914	4.01	0.0011
dliip	0.9561	0.01752	94.43	<.0001
dlm1	0.7564	0.02028	13.46	<.0001

Univariate Model White Noise Diagnostics

	Durbin	Normality		ARCH	
Variable	Watson	Chi-Square	Pr > ChiSq	F Value	Pr > F
dlwpi	2.04045	7.33	0.0256	0.92	0.3413
dliip	2.18189	1.19	0.5502	1.01	0.3208
dlm1	1.99207	0.83	0.6607	0.11	0.7423

Appendix 3: Percentage Root Mean Square Error (PRMSE) for WPI based on different combination of lambda and theta

		lambda									
		1	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1
theta	0.9	1.4796	1.4770	1.4736	1.4691	1.4633	1.4560	1.4474	***1.4400***	1.4446	1.4897
	0.8	1.4772	1.4741	1.4704	1.4656	1.4597	1.4525	1.4450	1.4407	1.4510	1.4990
	0.7	1.4739	1.4705	1.4666	1.4615	1.4555	1.4491	1.4435	1.4434	1.4603	1.5091
	0.6	1.4697	1.4660	1.4617	1.4566	1.4514	1.4465	1.4442	1.4497	1.4732	1.5195
	0.5	1.4640	1.4603	1.4561	1.4518	1.4481	1.4462	1.4489	1.4611	1.4900	1.5300
	0.4	1.4571	1.4540	1.4510	1.4488	1.4484	1.4515	1.4607	1.4799	1.5108	1.5399
	0.3	1.4511	1.4501	1.4503	1.4526	1.4580	1.4681	1.4844	1.5078	1.5345	1.5486
	0.2	1.4562	1.4607	1.4672	1.4765	1.4890	1.5051	1.5239	1.5434	1.5578	1.5555
	0.1	1.5099	1.5199	1.5307	1.5419	1.5532	1.5637	1.5725	1.5775	1.5756	1.5599

Appendix 4: BVAR(2)

Estimation Method **Maximum Likelihood Estimation**
Prior Lambda **0.3**
Prior Theta **0.9**

Seasonal Constant Estimates				
Variable	Constant	Season 1	Season 2	Season 3
dlwpi	0.01506	-0.01268	-0.01328	-0.00170
dliip	0.04363	0.02134	0.00649	-0.13811
dlm1	0.00979	0.02926	0.06049	0.01558

Model Parameter Estimates

Equation	Parameter	Estimate	Standard Error	t Value	Pr > |t|	Variable
dlwpi	CONST1	-0.01287	0.01307	-0.98	0.3295	1
	SD_1_1	0.01495	0.01824	0.82	0.4162	S_1t
	SD_1_2	0.01601	0.01596	1.00	0.3209	S_2t
	SD_1_3	0.01869	0.01541	1.21	0.2308	S_3t
	AR1_1_1	0.27226	0.13315	2.04	0.0463	dlwpi(t-1)
	AR1_1_2	-0.01495	0.10841	-0.14	0.8909	dliip(t-1)
	AR1_1_3	0.13876	0.08431	1.65	0.1062	dlm1(t-1)
	AR2_1_1	-0.31337	0.13668	-2.29	0.0262	dlwpi(t-2)
	AR2_1_2	0.08893	0.10384	0.86	0.3959	dliip(t-2)
	AR2_1_3	0.21975	0.08622	2.55	0.0140	dlm1(t-2)
dliip	CONST2	0.01950	0.01624	1.20	0.2357	1
	SD_2_1	0.00006	0.02267	0.00	0.9980	S_1t
	SD_2_2	0.03717	0.01984	1.87	0.0669	S_2t
	SD_2_3	-0.10122	0.01915	-5.29	0.0001	S_3t
	AR1_2_1	-0.53137	0.16548	-3.21	0.0023	dlwpi(t-1)
	AR1_2_2	0.21896	0.13473	1.63	0.1106	dliip(t-1)
	AR1_2_3	0.21129	0.10478	2.02	0.0492	dlm1(t-1)
	AR2_2_1	0.03900	0.16987	0.23	0.8194	dlwpi(t-2)
	AR2_2_2	-0.14044	0.12905	-1.09	0.2818	dliip(t-2)
	AR2_2_3	0.31351	0.10715	2.93	0.0052	dlm1(t-2)
dlm1	CONST3	-0.00311	0.02139	-0.15	0.8850	1
	SD_3_1	0.04310	0.02985	1.44	0.1552	S_1t
	SD_3_2	0.06106	0.02612	2.34	0.0235	S_2t
	SD_3_3	0.05923	0.02522	2.35	0.0229	S_3t
	AR1_3_1	-0.21334	0.21793	-0.98	0.3324	dlwpi(t-1)
	AR1_3_2	0.05611	0.17744	0.32	0.7532	dliip(t-1)
	AR1_3_3	-0.29889	0.13799	-2.17	0.0352	dlm1(t-1)
	AR2_3_1	-0.14122	0.22371	-0.63	0.5308	dlwpi(t-2)
	AR2_3_2	0.24353	0.16995	1.43	0.1582	dliip(t-2)
	AR2_3_3	0.17355	0.14112	1.23	0.2246	dlm1(t-2)

Schematic Representation of Cross Correlations of Residuals Variable

Lag	0	1	2	3	4	5	6	7	8	9	10	11	12
dlwpi	+..	...	...	...	...	...	...	...	...	...	...	...	...
dliip	.+.												
dlm1	..+												
+ is > 2*std error, - is < -2*std error, . is between													

Portmanteau Test for Cross Correlations of Residuals

Up to Lag	DF	Chi-Square	Pr > ChiSq
3	9	18.36	0.0312
4	18	22.65	0.2045
5	27	29.51	0.3366
6	36	43.71	0.1766
7	45	49.10	0.3123
8	54	62.21	0.2071
9	63	68.45	0.2976
10	72	73.81	0.4188
11	81	82.72	0.4259
12	90	91.71	0.4301

Univariate Model ANOVA Diagnostics

Variable	R-Square	Std. Deviation	F Value	Pr > F
dlwpi	0.4768	0.00818	3.95	0.0012
dliip	0.9542	0.01596	90.31	<.0001
dlm1	0.7499	0.01833	12.99	<.0001

Univariate Model White Noise Diagnostics

		Normality		ARCH	
Variable	Durbin Watson	Chi-Square	Pr > ChiSq	F Value	Pr > F
dlwpi	2.10694	6.85	0.0326	0.56	0.4564
dliip	1.99104	0.17	0.9202	0.84	0.3647
dlm1	2.02638	0.99	0.6106	0.14	0.7105

Select References

Artis, M. J. and W. Zhang (1990), "BVAR Forecasts for the G-7", International Journal of Forecasting, Vol. 6, pp. 349-362.

Geoff Kenny, Aidan Meyler and Terry Quinn (1998), "Bayesian VAR Models for Forecasting Irish Inflation", Economic Analysis, Research and Publications Department, Central Bank of Ireland.

Helmut Lütkepohl, 2006, " New Introduction to Multiple Time Series Analysis". Springer.

Litterman, Robert B. 1980. "A Bayesian Procedure for Forecasting with Vector Autoregressions". Federal Reserve Bank of Minneapolis.

Litterman, Robert B. 1984a, "Forecasting and Policy Analysis with Bayesian Vector Autoregression Models". Federal Reserve Bank of Minneapolis Quarterly Review.

Litterman, Robert B. 1984b. "Specifying Vector Autoregressions for Macroeconomic Forecasting". Federal Reserve Bank of Minneapolis Staff Report 92.

Shawn Ni, Dongchu Sun, "Bayesian Estimates for Vector-Autoregressive Models", University of Missouri, Columbia, MO 65211, USA.

Reserve Bank of India Occasional Papers
Vol. 31, No.2, Monsoon 2010

Profitability of Foreign Banks vis-à-vis Other Bank Groups in India – A Panel Data Analysis

Rakhe P.B.*

The paper analysed the financial performance of foreign banks in comparison with other bank groups in India. The study assumes importance in the context of the on-going preparation of roadmap for the presence of foreign banks in India by the Reserve Bank. The results of the study indicate that access to low cost funds, diversification of income, adequate other income to fully finance the operating expenses are the important factors leading to the higher profitability of foreign banks vis-à-vis other bank groups in India. The results of the panel data regression also indicate that efficiency of fund management is the most important factor determining profitability in the banking system followed by generation of other income. However, with regard to the foreign banks policy, a holistic view may be taken by considering factors such as global financial inter-linkages, financial performance of parent banks as also the pursuit of social objectives by these banks.

Introduction

Scheduled Commercial Banks (SCBs), with their wide geographical coverage and large volume of banking business, is the most important segment of the Indian financial system. After the implementation of the first Narasimham Committee (1991) recommendations, which enabled the entry of new private sector banks and allowed for more liberal entry of foreign banks, SCBs have become a heterogeneous group of institutions in terms of their ownership and risk taking appetite[1]. Presently, with a credit-deposit ratio of 73.9 per cent at end-March 2009, SCBs play an important role in the financial intermediation of the economy. Public sector banks

* Ms. Rakhe P.B. is a Research Officer in the Banking Research Division (BRD) of the Department of Economic and Policy Research (DEPR), Central Office, Mumbai. The author is grateful to Dr. Himanshu Joshi, Director, DEPR, RBI and Smt. Pallavi Chavan, Assistant Adviser, DEPR, RBI for their insightful comments on an earlier draft of the paper. The author is also thankful to Shri Paul D'mello, Shri R. Pimputkar and Smt. K. Nandakumar for data support.

(PSBs) are the biggest segment of SCBs comprising about 72 per cent of total assets of SCBs followed by private sector banks (PrSBs) (20 per cent) and foreign banks (FBs) (8 per cent) as at end-March 2009. After the liberalisation policies adopted in India since 1991, in terms of interest rate liberalisation, reduction in reserve requirements, entry deregulation, credit policies and prudential supervision, these banks acquired considerable commercial freedom to pose themselves as profit making entities in the whole industry. As at end-March 2009, PSBs account for 65.2 per cent of the total net profits of SCBs followed by PrSBs (20.6 per cent) and FBs (14.2 per cent).

The positive dividends on account of higher profitability in the banking sector are many: First, it would enable banks to attract more resources (equity capital) from the market, Second, it would equip banks to absorb the risk of non-performing assets and third, it would facilitate the implementation of aggressive written off policy for non-performing loans (Chaudhuri, 2002). Healthy profits are also desired for the development activities of banks such as branch expansion in the rural areas and the fulfillment of priority sector advances (Mittal and Aruna, 2007). Thus, a profitable banking system is a necessary condition for a pro-development financial intermediation.

In India, the profitability of various bank groups as well as banks considerably varies and foreign banks operating in the country report higher profitability than others, *viz*., public sector banks and private sector banks. It may be noted that FBs with 8 per cent of the total assets of SCBs, generated 14.2 per cent of the total net profits of SCBs as at end-March 2009. This raises the question what determines profitability in the banking sector or what explains the higher profitability of FBs *vis-à-vis* other bank groups.

An analysis of financial performance of FBs assumes added importance in the context of the preparation of roadmap for FBs by the Reserve Bank. The Reserve Bank released the roadmap for the presence of FBs in February 2005. The roadmap had two phases. First phase from March 2005 to March 2009 and second phase would begin after reviewing the experience in the first phase.

However, after the completion of the first phase, the Reserve Bank continued with the existing policies with regard to FBs because the global financial system was experiencing turbulence. Later on, in the Annual Monetary Policy Statement announced in April 2010, the Reserve Bank proposed to prepare a discussion paper on the mode of presence of FBs through branch or wholly owned subsidiary by September 2010. In this background, this paper is an attempt to analyse the financial performance of FBs *vis-à-vis* other banks in detail by examining the data in 2000s on the banking sector of India.

The paper is organised in the following sections. Followed by introduction the previous studies on profitability of Indian banks are discussed in Section II. Conceptual framework in presented in Section III. Section IV analyses the profitability of FBs *vis-à-vis* other bank groups in India during the recent years based on financial ratios. Section V presents the determinants of profitability based on results of the panel regressions and Section VI draws broad conclusions.

Section II
Review of Literature

There have been many attempts in the past to analyse the profitability of banks in general and also to compare the performances of different bank groups. Most of these studies tried to study the performance of banks during the post-liberalisation period. During the pre-liberalisation period, the Indian banking sector was characterised by state ownership and administered interest rates. Thus, the performance of banks during this period was dependent to a great extent on policies undertaken in the banking sector. One of the earlier studies (Verghese, 1983) found that changes in the interest rate were the most important factor determining profitability of banks during the post-nationalisation but pre-deregulation period. The trend has changed after the adoption of the liberalisation policies. Banks have gained considerable commercial freedom within the broad regulatory framework.

There is a difference of opinion among previous studies with regard to the performance of banks during the post liberalisation period. A study that covers the time period from 1991-92 to 1999-2000 (Ram Mohan, 2002) revealed that the performance of PSBs improved

during the post-liberalisation period both in absolute and relative terms. The study analysed the performance of PSBs by taking a number of indicators, *viz*., net profits, net interest margin, intermediation cost and non-performing assets. However, another study (Chaudhuri, 2002) pointed out that during the period from 1997-98 to 2000-01, the PSBs witnessed a decline in their profitability, mainly owing to the thinning down of net interest margin.

Similarly, with regard to the performance of FBs in comparison with other bank groups, some of the studies have come to the conclusion that there is convergence in the performances of different bank groups in India. Some other studies concluded that public and private sector banks continue to be more efficient than foreign banks. To illustrate, Mittal and Aruna (2007) compared the profitability of various bank groups using ratio analysis during the period 1999-00 to 2003-04. The study found that FBs were the most profitable bank group in India followed by PrSBs and PSBs. The study also noted that the profitability of the PSBs have witnessed improvement over the last five years. A study by Das (1999) also opined that there is convergence in the performances of different bank groups in India. The Report on the Committee on Financial Sector Assessment (CFSA) noted that 'the relatively higher productivity ratios of new PrSBs and FBs in terms of business per employee could be due to increased mechanisation, lower staff strength and increased outsourcing activities as compared to PSBs. PSBs have a legacy of labour-intensive work procedures and greater penetration in rural areas, which also result in comparatively low business per employee' (RBI, 2009).

Another study by Sensarma (2006), however, opined that foreign banks are less cost efficient as compared with other bank groups in India. This study compared the performances of different bank groups for the period from 1986 to 2000.

A study by Reddy (2002) pointed out that reduction in employee strength through voluntary retirement schemes and reduction in non-performing assets mainly through write-off schemes were the two major developments in the banking sector of India during the post-

liberalisation period which had a positive impact on the profitability of banks.

Section III
Profitability – The Analytical Framework

This section documents the analytical framework in which the profitability of banking institutions is determined.

The net interest income, other income, operating expenses and provisioning are the factors which get into the direct calculation of net profits.

NP = (NII + OI) – (OE +Pr)

Where NP – Net Profits, NII – Net Interest Income, OI – Other Income, OE – Operating Expenses, Pr – Provisioning.

The net interest income is the difference between interest income and interest expenses. The interest income is dependent on the return on funds and the interest expenses depend upon the cost of funds. While the cost of funds indicates the efficiency of resource mobilisation by a bank, the return on funds indicate how profitably the bank has deployed its funds. Thus, the capability to raise low cost resources and the ability to design profitable asset creating strategy are the keys to increase the net interest income of a bank.

Apart from interest income, banks also have income from other sources such as commission, exchange and brokerage, profit on sale of investments, and profit on exchange transactions. Those banks which make conscious efforts to increase income from other sources would register higher net profits than others. On the expenditure side, apart from interest expenses, *i.e.*, interest paid on deposits and borrowings, another major expenditure category is the operating expenses. The operating expenses mainly consists of payments to and provisions for employees, rent, taxes, printing and stationary, advertisement and publicity, law charges and insurance, among others. Savings in these expenses through austerity measures would increase net profits of banks.

Provisioning including those for non-performing assets, standard assets, depreciation on investment and floating provisions, is another major item which has a bearing on net profits of banks. Banks are required to keep aside a portion of their operating profit as provisions. Thus, as NPA increases or the value of investment decreases due to adverse market movements, banks have to increase the amount kept aside as provisions[2], which will reduce their net profits. Thus, quality of loans and investment strategies will have a strong bearing on profitability of banks. Further, it is observed that some of the sectors in the economy are more prone to NPAs. Accordingly, if a bank has more exposures to such sectors, it is likely to impact the profitability of those banks adversely.

While factors discussed above such as net interest income, other income, operating expenses and provisioning, would get into the direct calculation of net profits, there could be other factors in the second line which would influence these first line factors and through them, net profits. For example, if macroeconomic growth momentum is conducive in a particular economy, it would have a positive impact on the banking sector as well through reduction in NPAs and good growth in banking business. Further, the credit risk undertaken by a bank as reflected in the NPA generation would impact the profitability negatively. Further, banks' profitability would also move in tandem with business cycles in the economy owing to the pro-cyclical behavior of banks. Thus, the profitability of banks would increase during an economic upturn and decrease during an economic downturn. The inflationary pressures in the economy would tighten the interest rate environment in the economy, thus, making banking services less attractive to customers. This also will have a negative impact on the profitability of the banking sector.

Section IV
Profitability of Foreign Banks *vis-à-vis* Other Bank Groups: An Analysis of Financial Ratios

Net profit to total assets ratio (return on assets (ROA)) across the bank groups showed that the ratio hovered around 1 per cent for SCBs during the period 2002-03 to 2008-09. While PSBs and PrSBs witnessed

a ratio of 0.9 per cent and 1.1 per cent, respectively at end-March 2009, FBs reported a higher ratio of 1.7 per cent during the same year. It may be noted that the net profit to total assets ratio of FBs hovered around 1.6 per cent and were considerably higher than other bank groups during the period 2002-03 to 2008-09 (Chart 1).

On the income side, the interest income was the major component of the total income of SCBs comprising more than 80 per cent of the total income. The bank group wise data depicted that in case of FBs the percentage of interest income in total income declined during the recent years. This is in contrast to the trend observed in case of other bank groups. As at end-March 2009, while SCBs as a whole raised 83.8 per cent of their total income through interest, FBs raised only 67.1 per cent of their total income through interest (Table 1).

The net interest income (NII) (difference between interest income and interest expenses) as a ratio to total assets is observed to be higher for foreign banks than the other bank groups, though the interest income as a per cent of total income was witnessing a declining trend in case of them. At end-March 2009, FBs as a group registered a NII to total asset ratio of 3.9 per cent as compared with the ratio of 2.4 per cent for SCBs as a whole. The higher NII for FBs indicated that either they were able to access sufficiently low cost funds or were able to deploy funds with higher returns or both.

Chart 1: Net Profit to Total Assets

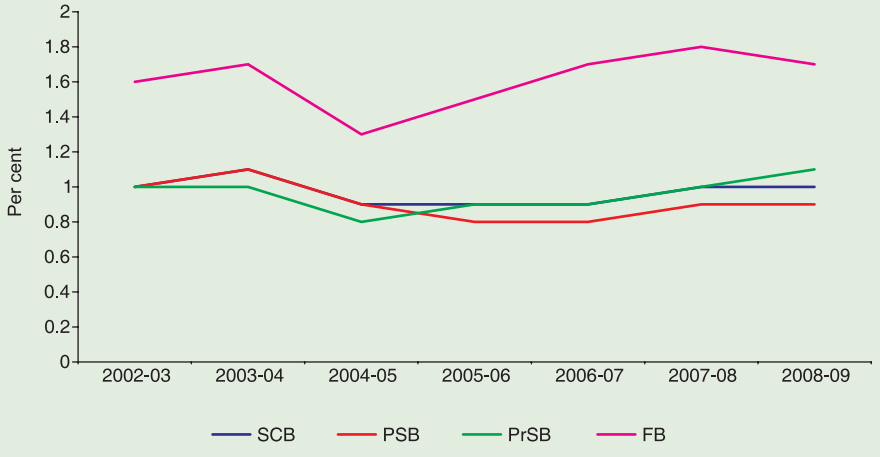


Table 1: Interest Income as a per cent to Total Income

(per cent)

Year	FBs	PSBs	New PrSBs	Old PrSBs	SCBs
2002-03	74.4	83.5	76.0	79.1	81.7
2003-04	70.2	79.6	76.2	78.9	78.5
2004-05	70.3	82.7	76.9	88.1	81.9
2005-06	69.6	86.3	78.3	89.5	84.0
2006-07	71.8	87.4	78.0	88.0	84.3
2007-08	69.8	86.7	79.2	87.0	83.6
2008-09	67.1	86.6	81.4	87.1	83.8

FBs – Foreign Banks, PSBs – Public Sector Banks, PrSBs – Private Sector Banks, SCBs – Scheduled Commercial Banks.

Source: The Report on Trend and Progress on Banking in India, various issues.

An analysis of return on funds indicated that the return on funds for FBs was higher than other bank groups. As at end-March 2009, FBs registered a return on funds at 9.9 per cent as compared with the ratio of 8.5 per cent registered by SCBs. However, it is important to note that new PrSBs as well as old PrSBs did have higher return on funds which was close to FBs (Table 2).

This pointed to differences in cost of funds faced by different bank groups. Trends in cost of funds faced by the different bank groups indicated that the cost of funds was considerably lower for FBs as compared with other bank groups. While the cost of funds was 4.2 per cent for FBs at end-March 2009, it was 5.5 per cent for SCBs as a whole.

Table 2: Return on Funds

(per cent)

Year	FBs	PSBs	New PrSBs	Old PrSBs	SCBs
2003-04	8.4	8.2	7.7	8.5	8.2
2004-05	7.3	6.9	7.3	8.0	7.1
2005-06	7.6	7.5	6.6	7.7	7.4
2006-07	8.2	7.5	7.4	8.0	7.6
2007-08	8.7	8.0	8.7	8.5	8.2
2008-09	9.9	8.2	9.5	9.1	8.5

Note: Return on funds is calculated as (interest on advances + interest on investments)/(total advances + total investments).

FBs – Foreign Banks, PSBs – Public Sector Banks, PrSBs – Private Sector Banks, SCBs – Scheduled Commercial Banks.

Source: The Report on Trend and Progress on Banking in India, various issues.

Notably, new PrSBs as well as old PrSBs registered considerably higher cost of funds at end-March 2009 (Table 3).

The decomposition of cost of funds of SCBs indicated that FBs had the lowest cost of deposits of 4.3 per cent as at end-March 2009 as compared with the cost of deposits of SCBs at 5.7 per cent during the same year. It may be noted that PrSBs registered the highest cost of deposits of 6.3 per cent at end-March 2009. However, deposits were costlier than borrowings for all bank groups including FBs. In this context, it is interesting to note that the dependence of FBs on costly funds, *viz*., deposits was relatively less. In contrast, deposits were the major source of funds for other SCBs. Thus, it is clear that the lower dependence on deposits as well as access to low cost deposits enabled FBs to register higher profits than other bank groups in India (Table 4).

Accordingly, FBs gained on account of the higher difference between cost of funds and return on funds, *i.e*., higher spread (Chart 2). This point was also noted in an earlier study by Mittal and Aruna (2007).

Apart from net interest income, other income was the second source of income for banks. As at end-March 2009, the other income constituted 32.9 per cent of the total income of FBs, whereas for SCBs as a whole, it constituted only 16.2 per cent. Old PrSBs recorded the lowest other

Table 3: Cost of Funds

(per cent)

Year	FBs	PSBs	New PrSBs	Old PrSBs	SCBs
2003-04	3.8	5.0	3.7	5.3	4.8
2004-05	3.1	4.2	3.0	4.6	4.0
2005-06	3.2	4.2	3.5	4.5	4.0
2006-07	3.5	4.4	4.5	4.8	4.3
2007-08	3.9	5.3	5.5	5.7	5.3
2008-09	4.2	5.5	6.0	6.1	5.5

Note: Cost of funds is calculated as (interest on deposits + interest on borrowings)/(total deposits + total borrowings).

FBs – Foreign Banks, PSBs – Public Sector Banks, PrSBs – Private Sector Banks, SCBs – Scheduled Commercial Banks.

Source: The Report on Trend and Progress on Banking in India, various issues.

Table 4: Details of Sources of Funds of SCBs as at end-March 2009

(per cent)

Year	FBs	PSBs	PrSBs	SCBs
Cost of deposits	4.3	5.6	6.3	5.7
Cost of borrowings	3.9	4.0	4.4	3.9
Share of deposits in total funds	75.3	95.2	88.6	92.6
Share of borrowings in total funds	24.7	4.8	11.4	7.4

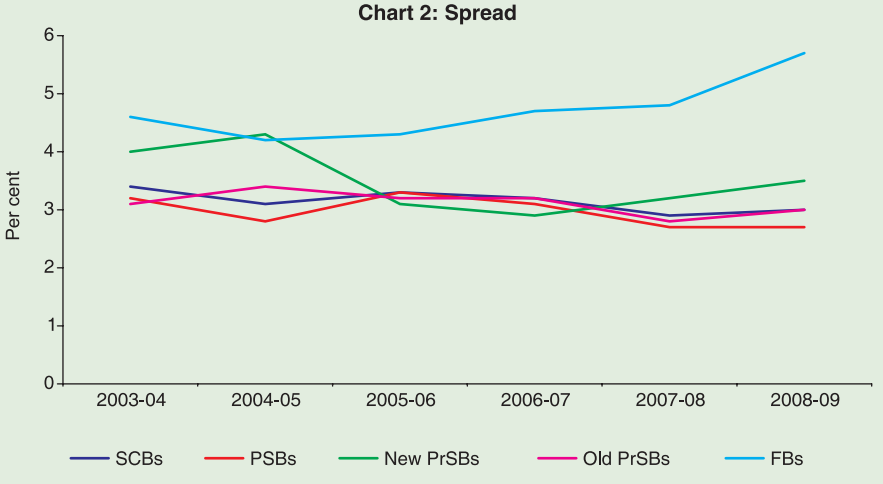
FBs – Foreign Banks, PSBs – Public Sector Banks, PrSBs – Private Sector Banks, SCBs – Scheduled Commercial Banks.

Note : 1. Cost of deposits is calculated as interest paid on deposits/total deposits.
2. Cost of borrowings is calculated as interest paid on borrowings/total borrowings.

Source : 1. The Report on Trend and Progress on Banking in India, various issues.
2. Statistical Tables Relating to Banks in India.

income to total income ratio of 12.9 per cent followed by PSBs (13.4 per cent) and new PrSBs (18.6 per cent) during the same year. Thus, it is clear that the dependence of FBs on other income was relatively high in comparison with other bank groups in India. Or in other words, this indicated that FBs had diversified their sources of income during the recent years. One factor which enabled FBs to diversify their income was the higher foreign exchange transactions undertaken by them. It is interesting to note that FBs raised considerable amount of income through net profit on exchange transaction (12.9 per cent of the total income) and net profit on sale of investments (3.2 per cent of the total

Chart 2: Spread

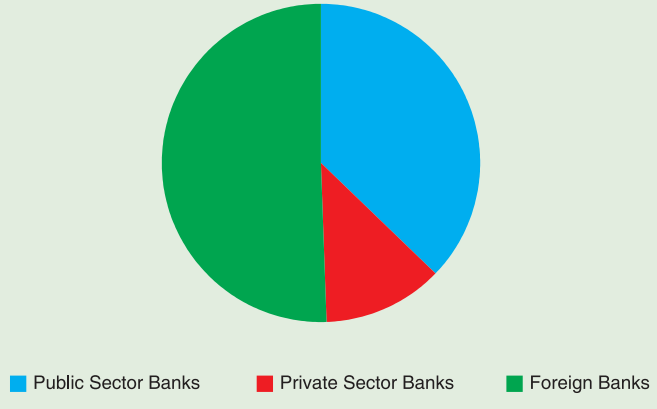


income) at end-March 2009. In this context, it may also be noted that as at end-March 2009 out of the total income raised through net profit on exchange transaction by all SCBs, FBs accounted for 50.2 per cent (Chart 3).

On the expenditure side, the operating expenses to total assets ratio of FBs was 2.8 per cent as at end-March 2009. In contrast, the ratio was lower for both PSBs and PrSBs at 1.5 per cent and 2.1 per cent, respectively during the same year. It is interesting to note that FBs incurred relatively higher expenditure than other bank groups for managing their assets. The possible reason for these high operating expenses of FBs as documented in literature is that these banks generally spend more for technology up-gradation, and also for advertisement and publicity. Though this spending may impinge upon their profits in the short run, it may yield a high dividend in the long run (Mittal and Aruna, 2007). Another study by Sensarma (2006) also opined that higher operating expenses of FBs reflect higher expenditure incurred by them on costly real estate, salaries and expenditure for technology up-gradation. The higher operating expenses of FBs led some of the earlier studies to conclude that FBs were not cost efficient as compared with other bank groups in India (ibid.).

Wage bills as a per cent of total assets was the highest in the case of FBs at 1.1 per cent as compared with 0.8 per cent for PrSBs and 0.9 per cent for PSBs as at end-March 2009. However, as a percentage of

Chart 3: Net Profit on Exchange Transaction by SCBs
as at end-March 2009



total operating expenses, the wage bills constituted only 39.7 per cent in case of FBs as at end-March 2009. In contrast, for SCBs as a whole, as at end-March 2009, wage bills constituted 53.4 per cent of the total operating expenses. The relatively lower percentage of wage bills in the total operating expenses of FBs may be due to the relatively higher operating expenses incurred by these banks (Chart 4).

A detailed analysis of the operating expenses of FBs indicated that though wage bills as a per cent of operating expenses was low, wage bills was the biggest item of expenditure in the total operating expenses of FBs. Further, it is interesting to note that FBs spent almost 9 per cent of the total operating expenses on advertisement and publicity[4].

FBs, however, were able to finance the entire operating expenses through other income. This is in contrast to the trend observed in case of other bank groups. At end-March 2009, for SCBs as a whole, the other income was sufficient to finance only 84.0 per cent of the operating expenses, whereas in the case of FBs, other income was more than the operating expenses (121.1per cent). Old PrSBs financed only 70.8 per cent of the operating expenses through other income at end-March 2009 followed by PrSBs (76.4 per cent) and new PrSBs (85.0 per cent) (Table 5).

Chart 4: Wage Bills as a per cent to Operating Expenses

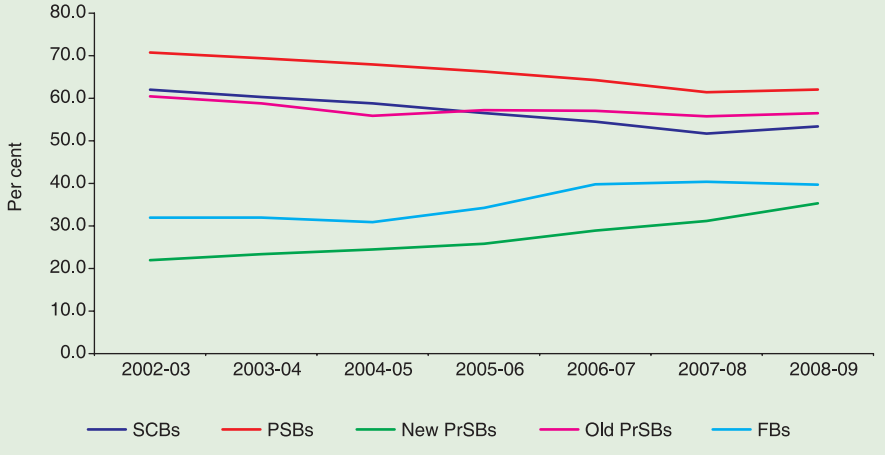


Table 5: Other Income as a per cent to Operating Expenses

(per cent)

Year	FBs	PSBs	New PrSBs	Old PrSBs	SCBs
2002-03	94.6	73.5	130.7	109.9	83.0
2003-04	103.1	86.2	102.8	102.3	90.4
2004-05	87.5	82.5	84.4	47.9	68.7
2005-06	91.8	53.0	76.8	39.5	59.7
2006-07	90.9	54.8	87.0	52.8	64.9
2007-08	102.3	70.3	87.0	67.5	78.1
2008-09	121.1	76.4	85.0	70.8	84.0

FBs – Foreign Banks, PSBs – Public Sector Banks, PrSBs – Private Sector Banks, SCBs – Scheduled Commercial Banks.

Source: The Report on Trend and Progress on Banking in India, various issues.

Provisioning are made by banks against loan assets including standard assets and non-performing assets. These provisioning are made out of operating profits and thus, get reflected in the calculation of net profits. SCBs as a whole kept aside 7.6 per cent of their income as provisioning for NPAs as at end-March 2009. FBs made provisioning of 7.7 per cent of their total income against NPAs. It is important to note that the PSBs kept aside the lowest portion (7.1 per cent) of their income as provisioning.

Section V
Determinants of Profitability: A Panel Data Analysis

In this section, we examine determinants of profitability in the Indian banking sector using panel data regression analysis. We used a sample of 59 banks, which include 14 FBs, 14 old PrSBs, 5 new PrSBs and 26 PSBs. The criterion for inclusion in the sample is the consistent availability of data for the period 2000-2009. These 59 banks together account for 94 per cent of the total assets of all SCBs as at end-March 2009. The bank-wise data used in the study have been taken from the *Statistical Tables Relating to Banks in India*.

Net profits to total asset ratio was taken as the dependant variable. We have taken efficiency of fund management, operating expenses to total assets, other income to total assets, credit risk, cyclical output and inflation as the explanatory variables of net profits of the banking sector.

Thus, symbolically, the model used in the study can be written as:

$$\pi_{it} = c + \sum_{k=1}^{K} \beta_k X_{it}^k + \varepsilon_{it}$$

Where

$$\varepsilon_{it} = v_i + u_{it}$$

Π_{it} is the profitability of bank *i* at time *t*, with *i = 1,…,N; t = 1,…, T*, *c* is a constant term, X_{its} are k explanatory variables and ε_{it} is the disturbance with v_i the unobserved bank-specific effect and u_{it} the idiosyncratic error.

The efficiency of fund management is calculated as the amount of interest expenses required for generating one rupee interest income. The primary function of banks is to accept deposits on which they are liable to pay interest and lend the mobilised funds to earn interest income. Banks also mobilise funds through borrowings on which they pay interest and make investments on which they earn interest income. Thus, the net interest income of banks is dependent on how efficiently they are deploying the costly funds mobilised by them. The efficiency of fund management was calculated by the ratio – interest expenses/interest income. A decrease in this ratio, *i.e.*, the interest expenses required for generating one rupee interest income comes down, implies an improvement in the fund management. Accordingly, profitability would increase, with the decrease in this ratio. Thus, the expected sign of the coefficient is negative.

Operating expenses to total assets ratio would have a negative impact on profits, as profits come down with the increase in operating expenses. Thus, we expect a negative coefficient for this variable. Income from sources other than net interest income, *i.e.*, other income, is expected to impact the profitability positively. Thus, we expect a positive coefficient for this variable.

Credit risk is calculated by the ratio provisions to total advances of banks. An increase in this ratio indicates that the credit risk

involved in the lending activities of banks is higher. Or in other words, an increase in this ratio indicates the deterioration in the quality of credit origination. As the quality of credit origination comes down the amount of non-performing assets increases, thus, impacting upon the profitability negatively, first through the increased requirement for provisioning and second through the reduction in the interest income. Thus, we expect a negative coefficient for this variable.

The cyclical output has been calculated using the Hodrick-Prescott (HP) Filter method. We expect a positive coefficient for this variable as the profits of the banking sector tend to move along with cycles. It is documented in the literature that during an upturn of the cycle, with increased economic activity, banks also tend to lend more. The generation of non-performing assets will also be low during an upturn as the economy is performing well. However, during a downturn, with the decelerating economic growth, the bank lending would come down and also the generation of non-performing assets would pick up. This would reduce the profitability of banks during a downturn. Thus, according to the theoretical expectations, we expect a positive coefficient for this variable.

We have taken the whole sale price index as a proxy for inflation. Higher inflation indicates a tighter interest rate scenario, in which the bank lending would slow down due to inadequate response from the real sector to the high cost loans. Thus, as inflation increases the profitability of the banking system would come down. Accordingly, we expect a negative coefficient for this variable.

The Hausman test statistic was significant at 5 per cent level indicating that there are unobserved bank specific effects determining the profitability of individual banks. Hence, we have reported results of the fixed effects model in this study.

The regression results are presented in Table 6.

The regression result shows that efficiency of fund management is the most important factor determining profitability in the banking

Table 6: Determinants of Profitability in the Banking Sector

Explanatory Variables	Coefficients	t-value
Intercept	4.8227	15.25140*
Efficiency of Fund Management	-4.8085	-14.34199*
Credit Risk	-0.0993	-12.08159*
Cyclical Output	8.18E-07	5.539659*
Other Income	0.7783	17.96789*
Operating Expenses	-0.6715	-11.30420*
Inflation	-0.0452	-2.360831*
R-Squared : 0.66		
Adjusted R-Squared: 0.62		
DW Statistic: 1.62		

*: Significant at one per cent level.

sector. We have noted in the previous section that FBs have the least cost deposits as compared with other bank groups. Further, borrowings were cheaper than deposits and unlike other bank groups, FBs have diversified their sources of funds with relatively low dependence on deposits and correspondingly higher dependence on borrowings. Thus, FBs report very low cost of funds alongside a high return on funds. Thus, FBs gain on account of their efficient fund management.

Income from sources other than net interest income also determine profits to a large extent. As alluded to earlier, foreign banks raise considerable portion of income through other sources, especially net profit on exchange transactions.

The operating expenses is another factor which has a bearing on the profitability of the banking sector. As noted in the previous section, FBs report the highest operating expenses to total assets ratio among the bank groups in India. Thus, we found that even with the highest operating expenses to total assets ratio, FBs report higher profits than the other bank groups. However, when we assess the operating expenses in terms of income, FBs are well placed than the other bank groups in India. Further, as noted in the previous section, not only the income of FBs is high but also well diversified with a considerable portion of income coming from sources other than net interest income.

Generally, non-performing assets are high in foreign banks implying that foreign banks take higher credit risk than other banks, which has a negative impact on their profitability. However, it may be noted that the impact of this factor is less as compared with other determinants.

The positive coefficient of the cyclical component of GDP indicates that the profitability of the banking sector moves in tandem with the business cycles, however, the impact is low as compared with other determinants. We also found that with the increase in inflation, the profitability of the banking sector decreases.

Section VI
Concluding Observations

The present study probed the question: why FBs are more profitable than other bank groups in India? The analysis in the study indicates that the access to low cost funds by FBs is the most important factor which is making a difference to the profitability of FBs *vis-à-vis* other bank groups in India. The cost of deposits for FBs is the lowest among the bank groups in India. However, the deposits were costlier in comparison with borrowings for all the bank groups including FBs. In this context, it is important to note that the dependence of FBs on deposits is relatively lower than the other bank groups. Another major factor determining the profitability of FBs is diversification of income achieved by them. The other income to total income ratio is higher for FBs than other bank groups. FBs raised almost 9 per cent of their total income through net profit on exchange transactions. As a result, FBs are able to meet their entire operating expenses through their other income. To ascertain the determinants of profitability in the banking sector, the study has done a panel data regression analysis. The regression results showed that efficiency of fund management measured as the amount of interest expenses required for generating one rupee interest income determined profits to a large extent. The operating expenses and other income are other important factors determining profitability in the banking sector. In terms of fund management and other income,

FBs were well ahead of domestically owned banks in India, thus, providing a cue about the higher profitability of FBs in comparison with domestically owned banks. However, profitability is only one factor which is important while preparing the roadmap for the presence of FBs in India. The roadmap may take a holistic view by considering aspects such as soundness of FBs, financial performance of their parent banks, global financial inter-linkages and also their contribution in achieving social objectives of banking in India.

Notes

[1] SCBs consist of public sector banks, old private sector banks, new private sector banks and foreign banks.

[2] These provisions up to the ceiling of 1.25 per cent of risk weighted assets can form a part of the total capital of the bank.

[3] Since the Statistical Tables Relating to Banks classify a considerable portion of expenditure (29.4 per cent) under 'others', it was impossible to make a detailed analysis of the composition of operating expenses of foreign banks.

Select References

1. Chaudhuri, S.2002.'Some Issues of Growth and Profitability in Indian Public Sector Banks', Economic and Political Weekly, June 1.

2. Das, A.1999.'Profitability of Public Sector Banks: A Decomposition Model', Reserve Bank of India Occasional Papers 20,1.

3. Demirguc, Kunt and Harry Huizinga.1998. 'Determinants of Commercial Bank Interest Margins and Profitability: Some International Evidence', World Bank.

4. Mittal, Manish and Aruna Dhade.2007.'Profitability and Productivity in Indian Banks: A Comparative Study', AIMS International, Volume 1, Number 2, May, 137-152.

5. Panayiotis P. Athanasoglou.2005.'Bank Specific, Industry Specific and Macroeconomic Determinants of Bank Profitability', Working Paper No.25, Bank of Greece, June.

6. RamMohan, T.T.2002.'Deregulation and Performance of Public Sector Banks', February 2.

7. Reddy, K., (2002), A comparative study on NPLs in India in the Global Context [online]Available:http://www.crisil.com/youngthoughtleader/winners/2002/topic3-Prashanth-Reddy-IIM-AHM.PDF

8. Sensarma, R. 2006. 'Are Foreign Banks always the best? Comparison of State-Owned, Private and Foreign Banks in India', Economic Modelling, April 7, 717-735.

9. The Reserve Bank of India, 'Statistical Tables Relating to Banks in India', Various years.

10. The Reserve Bank of India. 2009. 'The Report of the Committee on Financial Sector Assessment'.

11. The Reserve Bank of India, 'The Report on Trend and Progress of Banking in India', Various years.

12. Verghese, S.K.1983.'Profits and Profitability of Indian Commercial Banks in Seventies', Review of Management, November.

Reserve Bank of India Occasional Papers
Vol. 31, No.2, Monsoon 2010

Macroeconomic Forecasting using Dynamic Factor Models

Sanjib Bordoloi, Dipankar Biswas, Sanjay Singh Ujjwal K. Manna and Seema Saggar*

During the recent period, dynamic factor modelling is gaining importance as one of the key forecasting tools exploiting the information contained in large datasets. The major advantage with the factor modelling approach is that, it can cope with many variables without running into scarce degrees of freedom that often arise in regression analysis. This technique allows forecasters to summarize the information contained in large datasets and extract a few common factors from them. This study attempts to develop a dynamic factor model (DFM) to forecast industrial production and price level in India. For this purpose, domestic as well as external economic indicators, that appear to contain information about the movement of industrial production/ price level, were used. Based on empirical analysis, it is found that the out-of-sample forecast accuracy of DFM, as measured by root mean square percentage error, is better than the OLS regression.

JEL Classification : C3, E2, E3.
Keywords : Dynamic Factor Model, Forecast, Inflation, Output

Introduction

Reliable forecast of key macro economic indicators plays an important role for the formulation of monetary and fiscal policies of a country. Academic work on macroeconomic modeling and economic forecasting historically has focused on models with only a handful of variables. In contrast, economists in business and government, whose

* Authors are working in the Department of Statistics and Information Management, Reserve Bank of India. The views expressed in the paper are those of authors and do not necessarily represent those of the RBI. Errors and Omission, if any, are the sole responsibility of the authors.

job is to track the swings of the economy and to make forecasts that inform decision-makers in real time, have long examined a large number of variables. Practitioners use many series when making their forecasts, and despite the lack of academic guidance about how to proceed, they suggest that these series have information content beyond that contained in the major macroeconomic aggregates. But if so, what are the best ways to extract this information and to use it for real-time forecasting? In the same line, Stock and Watson (2006) had focused on the case of United States, where, literally thousands of potentially relevant time series were available on a monthly or quarterly basis.

During the recent period, one of the key forecasting tools, which is gaining importance for dealing with large datasets, is dynamic factor modelling. The major advantage with the factor modelling approach is that, it can cope with many variables without running into scarce degrees of freedom that often arise in regression analysis. Besides this, by using factor models, the idiosyncratic movements, which possibly include measurement error and local shocks, can be eliminated. Through factor analysis, one can extract the unobserved factors that are common to the economic variables and these can be used for real time dynamic forecasting. For instance, Stock and Watson (1989) used a single factor to model the co-movements of four main macroeconomic aggregates. DFM plays an important role in the theory of Capital Asset Pricing Model (CAPM) also, as asset returns are often modeled as a function of market risk, where market risk is a common factor explaining the returns of many assets. Similarly in Arbitrage Pricing Theory (APT), returns are considered as function of other indicators like market return, inflation risk, liquidity risk etc as well as of some idiosyncratic component. This gives a more reliable signal for policy makers and prevents them from reacting to idiosyncratic movements. The uses of dynamic factor models have been improved by recent advances in estimation techniques [Stock and Watson (2002); Forni, Hallin, Lippi and Reichlin (2005) and Kapetanios and Marcellino (2004)].

These techniques allow forecasters to summarize the information contained in large datasets and extract a few common factors from

them. All or a subset of the estimated factors are then entered into simple regression models to forecast the economic indicators.

The co-movement of contemporaneous economic variables may be due to the fact that they are driven in part by common shocks. This allows parsimonious modeling while corresponding to the notion of binding macroeconomic comovement. To overcome the problem of degrees of freedom for estimation of an economic system, reduction of dimensions has gained importance in the recent period. Factor analysis allows for dimension reduction and has become a standard econometric tool for both measuring comovement and forecasting macroeconomic variables.

The primary objective of the study is to forecast the inflation and output growth using dynamic factor models. The complete list of indicators that have been considered for empirical analysis is provided in the Annexure. The indicators cover the various sectors of the economy, *viz.,* monetary and banking, financial, price, real and external. Also the performance of the dynamic factor model has been compared with alternative methods like the time series and econometric techniques.

The remainder of the study is divided into three sections. Section I describes briefly the methodology of Dynamic Factor Model (DFM). The empirical results related to DFM and assessment of the forecast performance are discussed in Section II. Finally, Section III concludes.

Section I
Methodology of the Dynamic Factor Model

Factor models have a long history of use in cross-sectional settings, and their generalization to dynamic environments is due to Sargent and Christopher (1977), Geweke (1977) and Watson and Engle (1983). Important recent contributions include Stock and Watson (1989, 1991, 1993) and Quah and Sargent (1993), among others. The dynamic factor model of Stock and Watson (1991) was developed as a modern statistical framework for computing a composite index of coincident indicators.

Given a data set, one can divide it into a common part, which captures the comovements of the cross section and a variable specific idiosyncratic part. A vector of *N* variables is represented as the sum of two unobservable orthogonal components, *viz.* a common component, driven by few (fewer than N) common factors, and an idiosyncratic component, driven by N idiosyncratic factors. If we have only one common factor, affecting only contemporaneously all of the variables, such a factor can be interpreted as the reference cycle (Stock and Watson, 1989). These models imply that the economic activity is driven by some few latent-driving forces, which can be revealed by the estimation of the dynamic factors. However, it may be noted that the factors, their loadings, as well as the idiosyncratic errors are not observable.

In one-factor model, movements in the N macroeconomic variables of interest, $\underset{\sim t}{X}$, are determined by changes in the unobserved common factor, $\underset{\sim t}{F}$ and by the N-dimensional idiosyncratic component, $\underset{\sim t}{e}$:

Let x_{it} be the observed data for the i[th] cross-section unit at time t, for i = 1, . . . ,N, and t = 1, . . ,T. Consider the following model:

$$x_{it} = \underset{\sim i}{\lambda'} \underset{\sim t}{F} + e_{it} \quad \text{.....(1)}$$

where $\underset{\sim t}{F}$ is a vector of common factors, $\underset{\sim i}{\lambda}$ is a vector of factor loadings associated with $\underset{\sim t}{F}$, and e_{it}, is the idiosyncratic component of x_{it}. The product $\underset{\sim i}{\lambda'} \underset{\sim t}{F}$ is called the common component of x_{it}. Equation (1) is then the factor representation of the data.

Consider the forecasting equation for a scalar series,

$$y_{t+1} = \underset{\sim}{a'} \underset{\sim t}{F} + \underset{\sim}{b'} \underset{\sim t}{W} + e_t$$

Where the set of variables $\underset{\sim t}{W}$, are observable. Although $\underset{\sim t}{F}$ is not observable, we observe x_{it} , i = 1,. . . ,N. Suppose x_{it}, bears relation with ***F,*** as defined in (1), then (1) can be interpreted as the reduced-form representation of X_i, in terms of the unobservable factors. Let us

denote the estimate of $\underset{\sim}{F}_t$ by $\underset{\sim}{\hat{F}}_t$. Then one can regress y_t on $\underset{\sim}{\hat{F}}_{t-1}$, and $\underset{\sim}{W}_{t-1}$ to obtain the coefficients $\hat{a}$ and $\hat{b}$ from which a forecast can be generated. Stock and Watson (1998, 1999) showed that this approach of forecasting outperforms many competing forecasting methods.

Alternatively, in the frequency domain, the dynamics among a number of important economic variables can be characterized by high pairwise coherences at the lower business cycle frequencies. Dynamics in frequency domain can be observed through cross spectral density function, which presents the same dynamic information. The cross spectral density matrix decomposes variation and covariation among variables by frequency, permitting one to concentrate on the dynamics of interest (e.g. the business-cycle dynamics correspond to periods of roughly 2-8 years). Transformations of both the real and imaginary parts of the spectral density matrix have immediate interpretation in business-cycle analysis - the *coherence statistic* between any two economic variables effectively presents the strength of their relationship at different frequencies, while the *phase statistic* presents the lead/lag relationships at different frequencies.

However, a factor model must have two characteristics. First, it must be dynamic to capture the structural changes in the economy. Secondly, it must allow for cross-correlation among idiosyncratic components, since orthogonality is an unrealistic assumption for most applications. The model we propose to use in this project has both the characteristics. It encompasses as a special case of the static 'approximate factor model' of Chamberlain (1983) and Chamberlain and Rothschild (1983), which allows for correlated idiosyncratic components. It also generalizes the factor model of Sargent and Sims (1977) and Geweke (1977), which is dynamic in nature, but has orthogonal idiosyncratic components. An important feature of this model is that the common component is allowed to have an infinite Moving Average (MA) representation, so as to accommodate for both autoregressive (AR) and MA responses to common factors. In this respect, it is more general than a static factor model where lagged factors are introduced as additional static factors, since in such model AR responses are ruled out.

Analysis of co-movement in dynamic settings typically makes use of two nonparametric tools, *viz.,* the autocorrelation function and the spectral density function. In the time domain, one examines multivariate dynamics through the autocorrelation function, which estimates the correlations of each variable with its own past as well as with the past of other economic variables in the system. As an example, one can characterize the dynamics of output, consumption, investment, net exports, money and prices across different countries over the years.

The basic difference between the classical factor analysis and dynamic factor analysis is that, in the former, the factors are identified by multiplying by a nonsingular $(r \times r)$ matrix, whereas, in the later, the factors are identified by multiplying by a nonsingular $(r \times r)$ matrix lag polynomial. The theory of dynamic factor model is that the covariation among a set of economic variables at leads and lag can be traced to a few underlying unobserved factors. DFMs express observed variables in terms of distributed lag of a small number of unobserved common factors, plus idiosyncratic disturbance, which may be serially correlated:

$$Y_{it} = \lambda_i(L)F_t + u_{it}, i = 1,2,---,n$$

where F_t is an $(r \times 1)$ vector of unobserved factors, $\lambda_i(L)$ is a $(r \times 1)$ vector lag polynomial, known as the *dynamic factor loadings* and u_{it} is the idiosyncratic disturbance. The factors and idiosyncratic disturbance are assumed to be uncorrelated at various leads and lags, *i.e.,*

$$E(F_t u_{is}) = 0 \text{ for all } i, s$$

The unobserved factors are modeled as a linear dynamic process,

$$\Gamma(L)F_t = \eta_t$$

where $\Gamma(L)$ is a matrix lag polynomial and η_t is a $(r \times 1)$ disturbance vector.

Consider a single forecasting equation for Y_t, so that,

$$Y_t = \lambda_Y(L)F_t + u_{Yt}$$

where $\{u_{Yt}\}$ is distributed independently of $\{F_t\}$. Further, assume that $\{u_{Yt}\}$ follows the autoregressive process,

$$\Delta_Y(L)u_{Yt} = v_{Yt}$$

Then,

$$\Delta_Y(L)Y_{t+1} = \Delta_Y(L)\lambda_Y(L)F_{t+1} + \Delta_Y(L)u_{Y,t+1}$$
$$\Rightarrow Y_{t+1} = \Delta_Y(L)\lambda_Y(L)F_{t+1} + \gamma(L)Y_t + v_{t+1}$$

where $\gamma(L) = L^{-1}(1-\Delta_Y(L))$

Thus,

$$E[Y_{t+1}/Y_t, F_t, Y_{t-1}, F_{t-1}, ---] = E[\Delta_Y(L)\lambda_Y(L)F_{t+1} + \gamma(L)Y_t + v_{t+1}/Y_t, F_t, Y_{t-1}, F_{t-1}, ---]$$
$$= \beta(L)F_t + \gamma(L)Y_t$$

where $\beta(L)F_t = E[\Delta_Y(L)\lambda_Y(L)F_{t+1}/F_t, F_{t-1}, ---]$

Setting, $Z_t = Y_t$, we have,

$$Y_{t+1} = \beta(L)F_t + \gamma(L)Z_t + \varepsilon_{t+1}$$
$$\textit{where } \varepsilon_{t+1} = v_{t+1} + [\Delta_Y(L)\lambda_Y(L)F_{t+1} - \beta(L)F_t]$$
$$= v_{t+1} + [\Delta_Y(L)\lambda_Y(L)F_{t+1} - E[\Delta_Y(L)\lambda_Y(L)F_{t+1}/F_t, F_{t-1}, ---]]$$

has conditional mean zero given F_t, Y_t and their lags. The notation Z_t generalizes the equation so that observable predictors other than lagged Y_t can be included in the regression. As an illustration, Z_t may incorporate an observable variable that may be valuable to forecast Y_{t+1} even after its inclusion of the factors and lags of the dependent variable.

The parameters of the DFM can be estimated by maximum likelihood using the Kalman filter and the dynamic factors can be estimated using the Kalman smoother [Stock and Watson (1989, 1991)].

h-step ahead forecast:

Multi-step ahead forecast can be estimated based on two alternative ways – the iterated or the direct method. The iterated h-step ahead forecast is computed by solving the full DFM forward through the Kalman filter. On the other hand, the h-step ahead forecast, by the direct method, is done by projecting Y_{t+h}^{h} onto the estimated factors and observables, *i.e.,* by estimating $\beta_h(L)$ and $\gamma_h(L)$ in the equation,

$$Y_{t+h}^{h} = \beta_h(L)F_{t/t} + \gamma_h(L)Z_t + \varepsilon_{t+h}^{h}$$

utilizing data through the period (t-h). Consistent estimates of $\beta_h(L)$ and $\gamma_h(L)$ can be obtained by OLS as the signal extraction error $(F_{t-i} - F_{t-i/t})$ is uncorrelated with $F_{t-j/t}$ and Y_{t-j} for $j \geq 0$. The forecast for period $T+h$ is then $\hat{\beta}_h(L)F_{t/t} + \hat{\gamma}_h(L)Z_t$.

Section II
Empirical Estimates

The study uses monthly data covering the period from April 1994 to March 2008 consisting 168 sample points. The list of variables with description and sources are provided in the Annexure. To test the forecasting performance of the alternative methods, the whole sample period is divided into two sub-samples, *viz.,* in-sample and out-of-sample. The in-sample, covering the period from April 1994 to March 2007, is used to estimate the parameters, while the last twelve points from April 2007 to March 2008, were used to test for the out-of-sample forecasting performance.

2.1. Model for Industrial Production

2.1.1. Estimates of the model

For developing a dynamic factor model to forecast the monthly industrial production in India, thirteen economic indicators were selected. The estimates cover the sample from April 1994 to March 2007. Table-1 presents the list of selected indicators.

Table 1: List of economic indicators selected to forecast IIP

Indicator Name	Abbreviation
Cargo Handled at Major Ports	CARGO
Production of Cement	CEMENT
Production of Commercial Motor Vehicles	CMV
Demand Deposits	DD
Euro Area IIP	EURO_IIP
Exports	EXPORT
IIP Capital Goods	IIP_CAP
Non-Food Credit	NFC
Non-Oil Imports	NONOIL
Rs. Dollar Exchange Rate	RSDOLLAR
Steel Production	STEEL
USA IIP	US_IIP
WPI Manufactured Products	WPIMAN

Based on these selected thirteen indicators, factor analysis has been performed and obtained thirteen factors. Table-2 presents the estimates of the initial eigen values along with the percentage of total variance explained corresponding to these eigen values. For determining the number of factors that to be retained for further analysis, we have applied the rule based on eigen values-greater-than-one. The factors with eigen values greater than 1.0 are considered significant, explaining an important amount of the variability in the data, while eigen values less than 1.0 are considered too weak, not explaining a significant portion of the data variability. Based on this rule, the first six eigen values were selected, which together explained 62.7 percent of the total variation. The selected first six factors were than rotated through the application of Varimax method. The Component Score Coefficient Matrix is presented in Table-3.

Table 2: Factors Extraction – Industrial Production

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.0	15.1	15.1	2.0	15.1	15.1	1.7	12.9	12.9
2	1.6	12.0	27.1	1.6	12.0	27.1	1.6	12.4	25.3
3	1.3	9.9	37.0	1.3	9.9	37.0	1.3	10.2	35.5
4	1.2	8.9	45.9	1.2	8.9	45.9	1.2	9.4	44.9
5	1.1	8.5	54.4	1.1	8.5	54.4	1.2	9.1	54.0
6	1.1	8.3	62.7	1.1	8.3	62.7	1.1	8.7	62.7
7	1.0	7.3	70.1						
8	0.8	6.4	76.4						
9	0.8	5.9	82.3						
10	0.8	5.8	88.1						
11	0.6	4.4	92.5						
12	0.6	4.3	96.8						
13	0.4	3.2	100.0						

Table 3: Component Score Coefficient Matrix

	Components					
	Factor-1	**Factor-2**	**Factor-3**	**Factor-4**	**Factor-5**	**Factor-6**
CARGO	0.308	0.283	0.211	-0.013	0.192	-0.007
CEMENT	0.178	-0.103	0.066	-0.497	0.027	0.114
CMV	-0.054	0.026	-0.118	0.014	0.682	0.137
DD	-0.095	0.533	0.062	-0.071	-0.079	0.018
EURO_IIP	-0.024	0.106	-0.269	0.130	-0.457	0.255
EXPORT	0.509	-0.107	0.000	-0.079	-0.036	0.111
IIP_CAP	0.185	0.015	-0.193	0.273	0.335	-0.066
NFC	0.011	0.464	0.027	-0.010	0.041	-0.005
NONOIL	0.392	-0.010	-0.065	0.089	-0.098	-0.200
RSDOLLAR	-0.053	0.035	0.556	0.288	-0.038	-0.183
STEEL	0.064	0.086	0.511	-0.089	-0.058	0.180
US_IIP	-0.035	0.011	-0.010	0.053	0.038	0.795
WPIMAN	0.125	-0.150	0.196	0.623	-0.022	0.190

2.1.2. Out-of-sample forecasting

As mentioned earlier, the last twelve data points covering the sample from April 2007 to Mach 2008, has been used to test for the out-of-sample forecasting performance of the model. A comparison has been made between the out-of-sample forecasting performances of the DFM with a simple equation based on the ordinary least square (OLS) regression of the estimated factors. Table-4 presents the forecast errors (measured as percentage of actual industrial production), based on the two alternative methods, along with the Root Mean Square

Table 4: Forecast errors (as percentage of industrial production) of alternative models

Month	**DFM**	**OLS**
Apr-07	0.4	3.4
May-07	1.4	2.8
Jun-07	2.0	3.4
Jul-07	3.0	4.0
Aug-07	2.1	3.1
Sep-07	2.9	4.4
Oct-07	2.8	4.0
Nov-07	2.8	4.5
Dec-07	2.2	3.2
Jan-08	2.7	3.7
Feb-08	2.9	4.2
Mar-08	2.7	5.2
RMSPE	2.45	3.87

Table 5: List of economic indicators selected to forecast WPI

Indicator Name	Abbreviation
BSE Sensex	BSE
Food Stock	FOODSTOCK
International Edible Oil Price	IEDIBLE
IIP Manufacturing	IIPMAN
International Metal Price	IMP
Industrial Raw Material Price	INDRM
Narrow Money	M1
Oil Price - Indian Basket	OIL_INDIA
Rs Dollar Exchange Rate	RSDOLLAR

Percent Error (RMSPE). The RMSPE of the DFM is found to be 2.45 percent, which is significantly lower than 3.87 percent based on the OLS regression, indicating better explanatory power of the DFM than the OLS method.

2.2. Model for Price Level / Inflation

2.2.1. Estimates of the model

For developing a dynamic factor model to forecast the monthly inflation in India, nine economic indicators were selected. Table-5 presents the list of selected indicators.

Based on these selected nine indicators, factor analysis has been performed and accordingly nine factors were extracted initially. Table-6 presents the estimates of the initial eigen values along with

Table 6: Factors extraction – WPI

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	1.9	21.0	21.0	1.9	21.0	21.0	1.6	18.0	18.0
2	1.2	13.6	34.6	1.2	13.6	34.6	1.3	14.9	32.9
3	1.2	13.0	47.6	1.2	13.0	47.6	1.2	13.9	46.8
4	1.1	12.5	60.1	1.1	12.5	60.1	1.2	13.3	60.1
5	0.9	9.8	69.9						
6	0.8	9.4	79.4						
7	0.7	7.6	87.0						
8	0.6	6.9	93.9						
9	0.5	6.1	100.0						

Table 7: Component Score Coefficient Matrix

	Component			
	Factor-1	**Factor-2**	**Factor-3**	**Factor-4**
BSE	-0.46	-0.04	0.06	-0.08
FOODSTOC	0.30	0.02	0.48	0.23
IEDIBLE	-0.11	0.10	0.14	0.66
IIPMAN	0.14	0.63	-0.34	0.06
IMP	-0.17	0.42	0.10	0.18
INDRM	0.09	-0.03	-0.12	0.48
M1	-0.05	-0.05	0.58	-0.06
OILINDIA	0.11	0.43	0.26	-0.26
RSDOLLAR	0.52	0.10	0.12	-0.11

the percentage of total variance explained corresponding to these eigen values. For determining the number of factors to be retained for further analysis, eigen values-greater-than-one rule has been applied as done previously. Based on this rule, the first four eigen values were selected, which together explained 60.1 percent of the total variation. The selected first four factors were than rotated through the application of Varimax method. The Component Score Coefficient Matrix is presented in Table-7.

2.2.2. Out-of-sample forecasting

As done earlier, the out-of-sample forecasting performance of the DFM has been compared with that of a simple OLS regression based on the selected four factors. Table-8 presents the forecast

Table 8: Forecast errors (as percentage of WPI) of alternative models

Month	**DFM**	**OLS**
Apr-07	0.1	0.1
May-07	0.6	0.8
Jun-07	1.0	1.3
Jul-07	1.0	1.2
Aug-07	1.1	1.5
Sep-07	1.6	2.0
Oct-07	1.5	1.9
Nov-07	1.2	1.8
Dec-07	0.2	1.0
Jan-08	-0.6	0.3
Feb-08	-0.9	0.1
Mar-08	-2.1	-0.7
RMSPE	1.14	1.24

errors (measured as percentage of actual WPI), based on the two alternative methods, along with the Root Mean Square Percent Error (RMSPE). The RMSPE of the DFM is found to be 1.14 percent which is marginally lower than that of the OLS regression based estimate. This supports the better explanatory power of the DFM than the OLS method.

Section III
Conclusion

This study explores to develop dynamic factor models (DFM) to forecast industrial production and price level in India. For this purpose, economic indicators that contain information about the future movement of industrial production/ price level are selected. These indicators chosen represent both domestic as well as external factors. Based on empirical analysis, it appears that the performances of DFM are quite encouraging. It is found that the out-of-sample forecast accuracy of DFM, as measured by root mean square percentage error, is better than the OLS regression.

References

Chamberlain, G. (1983). "Funds, factors and diversification in Arbitrage Pricing Models", *Econometrica*, **51**,1305-1324.

Chamberlain, G., and M. Rothschild (1983). "Arbitrage factor structure, and mean variance analysis of large asset markets", *Econometrica*, **51**,1281-1304.

Forni M., Hallin M., Lippi M. and Reichlin L.(2005). 'The generalized dynamic factor model: one-sided estimation and forecasting', *Journal of the American Statistical Association,* **100**, 830 – 840.

Geweke, J. (1977) "The Dynamic Factor Analysis of Economic Time-Series Models," in D.J.Aigner and A.S. Goldberger *(eds.)*, *Latent Variables in Socioeconomic Models,* (Amsterdam: North-Holland), 365-383.

Kapetanios G. and Marcellino M. (2004). 'A parametric estimation method for dynamic factor models of large dimensions', *Queen Mary University of London Working Paper,* No. 489.

Quah, D. and Sargent, T. (1993) "A Dynamic Index Model for Large Cross Sections", Centre for Economic Performance Discussion Paper No. 132, London School of Economics.

Sargent, T.J., and Christopher S. (1977), "Business Cycle Modeling Without Pretending to Have Too Much a Priori Theory," in C. Sims (ed.), *New Methods of Business Cycle Research* (Minneapolis: Federal Reserve Bank of Minneapolis, 1977).

Stock, J. H., and Watson, M. W., (1989) "New Indexes of Coincident and Leading Economic Indicators," in O. Blanchard and S. Fischer (eds.), *NBER Macroeconomics Annual* (Cambridge, Mass.: MIT Press, 1989), 351-394.

---------- (1991) "A Probability Model of the Coincident Economic Indicators," in K. Lahiri and G.H. Moore (eds.), *Leading Economic Indicators: New Approaches and Forecasting Records* (Cambridge: Cambridge University Press, 1991), 63-89.

---------- (1993), "A Procedure for Predicting Recessions with Leading Indicators: Econometric Issues and Recent Experience," in J.H. Stock and M.W.

Watson (eds.), *Business Cycles, Indicators and Forecasting* (Chicago: University of Chicago Press for NBER, 1993), 255-284.

---------- (1998), "Median unbiased estimation of coefficient variance in a time varying parameter model", *Journal of the American Statistical Association,* 93,349-358.

---------- (1999), "Forecasting Inflation", *Journal of Monetary Economics*, **44**, 293-335.

---------- (2002), 'Forecasting using principal components from a large number of predictors', *Journal of the American Statistical Association,* **97,** 1167 – 1179.

---------- (2006), 'Forecasting with Many Predictors', *Handbook of Economic Forecasting,* **1**, 515-554

Watson, M. W., and Engle, R. F. (1983), "Alternative Algorithms for the Estimation of Dynamic Factor, Mimic and Varying Coefficient Models," *Journal of Econometrics,* **15**, 385-400.

Annexure

List of Indicators for Inflation and Output

Indicator	Source	Definition
Monetary and Banking Indicators		
M1	RBI	Narrow Money (in Rupee Crore)
M3	RBI	Broad Money (in Rupee Crore)
CWP	RBI	Currency with the Public (in Rupee Crore)
BCCS	RBI	Bank Credit to the Commercial Sector (in Rupee Crore)
BCSCB	RBI	Bank Credit – Scheduled Commercial Banks (in Rupee Crore)
NFC	RBI	Non-Food Credit (in Rupee Crore)
ADSCB	RBI	Aggregate Deposits– Scheduled Commercial Banks (in Rupee Crore)
DDSCB	RBI	Demand Deposits – Scheduled Commercial Banks (in Rupee Crore)
TDSCB	RBI	Time Deposits – Scheduled Commercial Banks (in Rupee Crore)
Financial sector Indicators		
CHEQUE	RBI	Cheque Clearance – All India (in Rupee Crore)
SENSEX	BSE	Bombay Stock – 30 price Index, monthly average of the daily closing prices
S&P CNX Nifty	NSE	S&P CNX – 50 price Index, monthly average of the daily closing prices
NET_FII	SEBI	Total value of the net foreign investment inflows during the month (in Rupee Crore)
Rs_Dollar	RBI	The Indian Rupee per US Dollar exchange rate
FORWARD6	RBI	Inter-Bank Forward Premia of US Dollar (6-months)
Price Indicators		
WPI_INR	OEA	Index of Industrial Raw Material prices – WPI based
WPI_MP	OEA	Index of Manufactured Product prices – WPI based
WPI_FA	OEA	Index of Food Articles prices – WPI based
WPI_MIN	OEA	Index of Mineral Oils prices – WPI based
WPI_ALL	OEA	Index of All Commodity prices – WPI based
Real Sector Indicators		
CMV	CMIE	Production of Commercial Motor Vehicles
RAIL	CMIE	Railway Revenue Earning Freight Traffic in Million tonnes
CEMENT	CMIE	Cement Production in Million tonnes
IIP_BASIC	CSO	Index of Industrial Production – Basic Goods
IIP_CAP	CSO	Index of Industrial Production – Capital Goods
IIP_INT	CSO	Index of Industrial Production – Intermediate Goods
IIP_CONG	CSO	Index of Industrial Production – Consumer Goods
IIP_CD	CSO	Index of Industrial Production – Consumer Durables
IIP_CND	CSO	Index of Industrial Production – Consumer Non-Durables
IIP_METAL	CSO	Index of Industrial Production – Basic Metal and Alloy Industries
IIP_ELEC	CSO	Index of Industrial Production – Electricity
IIP	CSO	Index of Industrial Production – General Index
NAGDP	CSO	Non-agriculture GDP at factor cost (1999-00 prices)
External Sector Indicators		
EXPORT	DGCI&S	Total value of exports in terms of US$ million
IMPORT	DGCI&S	Total value of imports in terms of US$ million
NIMPORT	DGCI&S	Total value of non-oil imports in terms of US$ million
CARGO	CMIE	Cargo handled at major ports in Million tonnes
USGDP	BEA	USA Gross Domestic Product
USA_LI	OECD	Index of USA Leading Indicator
EURO_LI	OECD	Index of Euro Area Leading Indicator
CHINA_IIP	OECD	Index of Industrial Production in China
INT_OIL	IMF	International Crude Oil Prices in US$ per barrel
INT_EDIBLE	IMF	International Edible Oil Prices
INT_METAL	IMF	International Metal Prices

Reserve Bank of India Occasional Papers
Vol. 31, No.2, Monsoon 2010

The Economic Crisis and The State of Economics edited by Rober Skidelsky and Christian Westerlind Wigstrom, Palgrave-Macmillan, The United States of America, 2010. US$ 55, pp 123.

'…Good economists are scarce because the gift of using 'vigilant observation' to choose good models, although it does not require a highly specialized intellectual technique, appears to be a very rare one...'

J M Keynes

The Telegraph from London reported on November 5, 2008 "… during a briefing by academics at the London School of Economics on the turmoil on the international markets the British Queen asked: 'Why did nobody notice it ?'..." '..if these things were so large how come everyone missed it..." These questions have been harping in the minds of millions across the globe. A sense that the economists failed to see the financial crisis brewing has led to soul searching among many economists around the world, ever since the global financial crises exploded. While some did warn that home prices were forming a bubble, others confess to a widespread failure to predict the damage the bubble would cause when it burst. Some economists are arguing that a free-market bias in the profession, coupled with outmoded and simplistic analytical tools, blinded to the danger. Dahlem report condemned as growing reliance over the past three decades on mathematical models that improperly assume markets and economies are inherently stable, and which disregard influences like differences in the way various economic players make decisions, revise their forecasting methods and are influenced by social factors. There are strong views that standard analysis also failed, in part, because of the widespread use of new financial products that were poorly understood, and because economists did not firmly grasp the workings of the increasingly interconnected global financial system. Allen F (2009) is of the opinion that '…economists used mathematical models that failed to account for the critical roles that banks and other financial institutions play in the economy…' Further, he stated that they

simply didn't believe the banks were important. Likewise, the global financial crises, not only kicked up a lot of debate on the international financial crisis *per se*, there are stronger views on market economy stating as 'moral crisis of capitalism' and others often compared the crises with the 'Great Depression'. Predictably scores of conferences, symposiums were conducted by different forums across the world to seek explanations. This book is an outcome of collection of papers presented in one such symposium organised in February 2009, partly inspired by the general dissatisfaction with the silence of economics profession on the causes of and the remedies for current economic distress. The participants in the symposium were world reknown economists, who came out with divergent views not only on the causes of crises but also on the very subject 'economics'. This book is neatly edited and presented with all the conference papers in the form of separate chapters.

The book is extremely interesting to read, scintillating and thought provoking as well. There are ten chapters in all, which the editors have aptly grouped under three broad heads, viz., Part I : Risk and Uncertainty in Economics, Part II : Macro-Economics and the Current Crisis and Part III: Models, Metaphors and Morals. Besides the above, the editors eminently summarized the entire presentations of papers and the discussion in the conference in the form of Chapter 1: Introduction. According to the editors, the three main themes emerged from the papers and the discussions that followed are 'the question of whether future events are a matter of uncertainty rather than risk; the impact of global macroeconomic imbalances; and the role of economic models. These three main themes clearly emerges out of the papers presented.

Paul Davidson in his paper 'Risk and Uncertainty' strongly advocates a view of the future as irreducibly uncertain. Unlike in the "hard sciences" such as physics or astronomy, in economics, there is no foundation on which to base any probabilities about future events. While astronomers can be reasonably confident that a planet will appear in a predicted place at a predicted time the same cannot be said about many subjects of interest to economists. Probabilities calculated on past and current market data cannot be taken to hold about future

events since, as he argues, there is no way of knowing what social and economic events will occur in the future. Thus, the future is not "ergodic" - it is not predetermined. Yet, the ergodic axiom is at the heart of key theories such as the efficient-market hypothesis which states that markets determine price of the assets correctly based on all available past and present information. Without the possibility of assigning actuarial probabilities to future events, the value of assets cannot be efficiently established. In effect, the efficient-market hypothesis assumes that all uncertainty can be reduced to calculable risk. The failure to recognize this fallacy has led to the bankruptcy of major financial institutions such as AIG as well as a false sense of security which paved the way for panic once the foundations trembled. Therefore, Davidson makes a case for the introduction of a "market maker" an institution that takes up responsibility for keeping the market liquid in the face of unforeseeable events, in order to lessen the effects of uncertainty. Sujoy Mukerji in his paper "Ambiguity and Economic Activity Implications for the Current Crisis in Credit Markets" reinforces Davidson's view on irreducible uncertainty as an explanation for the crisis. In situations of uncertainty it is often the case that the decision maker's knowledge about the probability of contingent events is consistent with more than one possibility. Under such conditions it is rational not to act. In financial markets this leads to a situation in which more ambiguity results in less trade and lending. In the words of the author : "…the uncertainty is triggered by unusual events and untested financial innovations that lead agents to question their worldview..." In the sense that, rather subjecting investments to incalculable risks no investments are made at all and instead, people hoard cash - an idea conforming to "Keynes's liquidity preference theory". Therefore, the author concludes that the present crisis can be understood as having erupted because of increasing uncertainty amidst rapid financial innovation. Significantly, this also corroborates an idea related to the discussion in Richard Bronk's chapter : Models and Metaphors. At some point investors and banks withdrew their capital and credit, leaving consumers and companies in lurch and ultimately themselves too. This suggests that a policy promoting transparency and other uncertainty-reducing objectives could mitigate the financial downturn and ease credit markets.

Therefore, we are in need of qualitative rather than quantitative easing. Marc Potters, on the other hand, in his chapter on 'Lessons from Finance' did not strongly dismiss the ability of economic modeling to assign accurately probabilities to future events. He opines that, the future is not exclusively characterised by irreducible uncertainty. Potters further argues that, rather than facing a principal problem with uncertainty, influential pricing models have typically relied on assumptions too simple to have any relation to the reality they seek to predict. For instance, the Gaussian process assumed in the Black- Scholes option pricing model imply a disregard for the relative frequency of extreme fluctuations observed in the empirical data. In contrast to the assumptions of this model, volatility is not constant. The invalidity of these assumptions implies that there can be no zero-risk options as the model predicts. In other words, "option trading involves some irreducible risk." Moreover, conventional wisdom in mathematical finance treats prices as "god-given," yet feedback loops indicate that this is fundamentally wrong. Large purchases of assets increase their price thereby prompting further purchases, or conversely decreasing prices result in investors selling thereby further lowering the price. In effect, the financial crisis can be explained by means of such a positive feedback loop. Under such circumstances the degree of correlation among instruments changes, however, such a consideration seldom included in financial mathematical models. In practice, mathematical tractability and methodological consistency have made these models attractive, despite their flaws. Significantly, Potters also cautioned stating that 'diversified portfolios do not reduce risk as soon price movements are correlated'. However, if the models were better understood and improved there is scope for modeling to reduce the degree of uncertainty in the economy. The problem is that a lot of people can make huge amounts of money by *not* understanding the models they are using. This draws similar opinions of Christopher Bliss in his chapter 'Globalisation and the Current Crisis' who emphasised on asymmetric information. He blamed bankers provide credit to investment projects they have only very limited information about. Rating agencies and diversification of asset portfolios are intended to reduce the risk associated with asymmetric information, yet the rating agencies have incentives to

award higher ratings than deserved. Thus, according to Bliss, "market function poorly, if they function at all, in situations characterized by asymmetric information" and this problem is exacerbated when the distinction between investment and retail banks is blurred and "safe" deposits end up being used for speculation. It is significant to note that, once the bubble bursts the crisis migrates quickly from finance to the real economy. However, asymmetric information only explains the speculative side of the crisis and does not explain how consumers in the West could enjoy low inflation, cheap money and high profits at the same time, all of these fuelled an unprecedented growth in credit.

Bliss argues further, that competition from East Asia, predominantly China, was responsible for the present crisis. A Chinese "saving glut" in the form of enormous investments in American Treasury Bills kept the Chinese currency artificially low and made Chinese companies super competitive. Cheap imports kept prices low while cheap Chinese labor stifled the increase in Western real wages. In effect, the resulting imbalances led to a situation in which East Asia financed Western current account deficits. Vijay Joshi in his paper titled 'Global Imbalances' takes a similar stand but of the view that the origins of the Asian saving glut by referring to two projects; the creation of foreign currency reserves as a precautionary buffer, the value of which the East Asian countries understood after the 1997 financial crisis: and the policy decision of these states to pursue export-led growth as a means to economic development. Both of these missions were facilitated by keeping their own currencies low relative to the reserve currency, i.e. the dollar. Further, this was achieved by investing heavily in the American credit markets. The ensuing macroeconomic imbalances were not sustainable in the long run. Joshi further argued that if the American house prices had not fallen, an adjustment process would have started with a fall of the dollar. As a suggestion, Joshi advised that in order to forestall similar bubbles appearing in future, central banks, must look beyond consumer price indices as key indicators of the health of the economy and need to look at asset and credit price movements too. He also called for strengthening of key financial institutions such as the IMF to prevent the creation of unsustainable imbalances on an international level. The world needs a "neutral" reserve currency and agreements on exchange rate regimes. Although

macroeconomic theory cannot be blamed for global imbalances, it shows weakness in its inability to foresee these consequences. In part, this weakness stems from reliance on inappropriate models.

John Kay in his chapter "Knowledge in Economics" emphasized that 'the test of an economic model is whether it is useful rather than whether it is true'. He stated that one should not be concerned about whether the efficient-market theory is true or not and in fact, he said it is neither. Markets are often efficient but economists take this to mean that they are always efficient. Information is included in prices but it is not necessarily correctly weighted. The same goes for views on risk as well. The 'theory of subjective expected utility' is neither true nor false. Economic theories are metaphors and models and not realistic descriptions. We need to be able to choose when to use which metaphor. "The skill of the economist is in deciding which of many incommensurable models one should apply in a particular context." Keynesian uncertainty which considers confidence, narratives and degrees of belief in those narratives has all but become extinct and yet Keynes's perception of risk is no less important than the dominant classical risk paradigm. He advised that economists need to be more eclectic in the set of models they use. Otherwise will end up in the situation described by Charles Goodhart in his chapter 'Macro-Economic Failures' which describes how Dynamic Stochastic General Equilibrium (DSGE) models work well in good times when default rates on loans are low but badly in bad times. In part, he attributes this weakness to the transversality condition which stipulates that an economic agent has used all his resources and paid all his debts by the time he dies. Further, he observed, that it hardly corresponds to the reality. He underscored that amongst economists, a flawed but rigorous theory often beats a correct but literary exposition and this has led to an over confidence in markets based on rigorous but incorrect theories such as the efficient market theory. However, there is a large difference between what academic economists think and what businessmen do. Given that economists and financial practionars accept that prices can move away from fundamentals, it is absurd to count on the efficient 'market theory'. Consequently, our standard macroeconomic models which virtually everybody has been using, tell us absolutely nothing

about our present problems. This was also the strongest contest by Richard Bronk's paper : Models and Metaphors. Despite rapid innovation which imparted dynamism and uncertainty, economists and the businessmen rely heavily on equilibrium models. He concluded with the remarks that world as we see it is to some extent, a creation of our minds. Likewise models that we use structures the way we analyze and interpret what we observe. In simple words 'ones perspective affects one's view' the tendency of the contemporary models to treat uncertainty as risk has had huge consequences for the world economy into crisis. This is similar to what Davidson and Mukherjee also stated. Thus, Bronk concluded that there was something absurd in relying so completely on risk models based on past data when bankers going ahead with innovating newer products on weekly basis.

Lord Meghnad Desai in his Chapter : 'Hayek : Another Perspective' suggested that we should look at the ideas of Hayek to get better inkling of the unfolding of recent events. Hayek combined Walras and Money to explain business cycles. Credit creation by the banking system produces overinvestment in relation to voluntary saving. The overinvestment can be kept going only at the cost of increasing inflation. In such a situation any increase in interest rates forces the banks stop lending and cut down the existing loan sanctions. Which in turn makes the investment projects to collapse and the economy contracts. According to Hayek, as pointed out by Desai, there should not be build up of the credit by the banks at the first count. Desai pointed out further, Hayek was trying to talk about a crisis in terms of the banking system being the principal source of trouble. The resent crisis was much in line with what was visualized by Hayek long back. He suggest that there are more models than just the Walrasian and Keynesian. Even in the case of Keynes, there used to be multiple models out of Keynes, more than we have today. Therefore, he suggests that it is time for practioners and thinkers to dig out and ponder over Hayek's philosophy.

The last chapter titled 'Economics and Morals' by Robert Skidelsky is very interesting to read and it traces the subject 'Economics' from the days of F Y Edgeworth 1881 who wrote that the first principle of economics is that every agent is actuated by only 'self interest'. With varied definition of economics coming into existence Skidelsky

argued that what was mentioned as self interest by Edgeworth is interpreted as 'egoism' according to him. Egoism remain implicit in the method of economics, even if it no longer features explicit as a first premise and it permeates the whole range of human purposes right upto 'spiritual'. In the sense, economists tend to treat all ends as 'measureable' and unfortunately assess them along single dimension. In the process the diversity of human goods reduced to a series of benefits of varying degrees of magnitude. In this context, he stated Robbins is disingenuous in claiming that economics has 'outgrown its hedonistic origins'. However maintained that '…the Pig-Philosophy may have proved all-embracing, but pig-philosophy it remains…'. Ultimately the Author is of the view that the economic approach cannot be valid as a general theory of human behavior.

In sum, the book is extremely interesting and a necessity for reading by all students of economics, professional economists and practicing policy makers. Those who believe strongly on the power and utility of models and those who strongly question the utility of such propositions, both need to read and understand where the fault lies. The book as s whole is scintillating and thought provoking. I must quote '…the beauty of General Theory of Employment, Interest and Money was that it was 'general' enough to accommodate a variety of "models" applicable to different states of expectations…'. Therefore, it is absolutely necessary to choose the right models to the right situation rather than rejecting the usefulness of models in macroeconomics and finance.

Given their pre-eminence position in the field of economics, the authors could have made more explicit suggestions/ precautions as to how to prevent such crises of monstrous magnitude in future as that would help for the readers and policy makers to take precaution.

A Karunagaran*

* Shri A. Karunagaran is Assistant Adviser in the Department of Economic and Policy Research of the Bank.