MONOGRAPH 41/2018

MEDIUM TERM MACRO ECONOMETRIC MODEL OF THE INDIAN ECONOMY

D.K. Srivastava
K.R. Shanmugam

MADRAS SCHOOL OF ECONOMICS
Gandhi Mandapam Road
Chennai 600 025
India

June 2018

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April 2018

MONOGRAPH 41/2018

June 2018

Rs.200/-

MADRAS SCHOOL OF ECONOMICS
Gandhi Mandapam Road
Chennai 600 025
India

Phone: 2230 0304/ 2230 0307/2235 2157
Fax : 2235 4847 /2235 2155
Email : info@mse.ac.in
Website: www.mse.ac.in

Acknowledgement

We are thankful the Reserve Bank of India for partial funding support of this study. Beginning October 2008, the RBI team and the MSE team started collaborating for building a Macro Econometric Model of the Indian Economy. This project was guided by an Advisory Committee headed by Dr. C. Rangarajan. The main aim of the project was to build a Core Model (annual as well as quarterly models) and a number of models for different sectors of the economy. This annual model was an extended version of RBI-MSE macro-econometric annual data model build by the MSE team. Unfortunately the project was given up as many members from both RBI side and MSE side moved to other departments/other places. The authors thank the advisory committee members for their valuable comments and suggestions.

D.K. Srivastava
K. R. Shanmugam

Chapter 1

INTRODUCTION

Macroeconomic modeling has the capacity to capture complex and dynamic interrelationships among economic variables. It is a useful and powerful analytical tool for central and state governments, central bank, and other major stakeholders in the economy.[1] It also provides a suitable analytical vehicle for addressing contemporary issues like tackling inflation, growth prospects in the medium to long term, examining inflation-growth trade-offs, impact of inflationary expectations, managing public debt and deficit at sustainable levels, and determining permissible levels of seigniorage, taking into account both internal and international trends.

Macroeconomic modeling techniques including specification, estimation, and theoretical underpinnings have been evolving at a rapid pace. While there has been a tradition of building models going back to about five decades in India, most models have remained one-time exercises. That is, macro modeling has not been undertaken at the level of institutions as on-going exercises and the forecast evaluation has not been undertaken on a regular basis with some exceptions.

In the western world, the initial wave of constructing large macro econometric models in the sixties and the seventies was followed, in the eighties and the nineties, with disenchantment with these due to poor forecasting performance and usability for policy formulation following the Lucas (1976) critique. In recent years, with the emergence of powerful non-structural methods of forecasting (e.g., VAR model) and new strategies for constructing structural models moving away from the 'system-of-equations' approach to micro foundations and modeling approaches like dynamic stochastic general equilibrium (DSGE) modeling, Vector error correction models (VECM) and structural co-integrating VAR models, there has been a resurgence of modeling for forecasting and policy analysis.[2]

[1] It is useful for other stakeholders including business and investors domestic and foreign and institutions handling inter governmental fiscal transfers.

[2] Other approaches to macro modeling are: State space models with dynamically changing parameters, Delphi and survey based methods and Eclectic approaches to exploiting information for forecasting.

MACRO MODELING: RECENT THEORETICAL PERSPECTIVES

Structural Macroeconomic Models

Origin of structural macro-modelling dates back to after World War II when the Cowles Commission attempted and the Keynesian Revolution was at the centre-stage. Those associated with the Commission were: Koopmans, Arrow, Haavelmo, Anderson, Klein, Debreu, Hurwitz, Morkowitz, Marschak, Modigliani etc. While Tinbergen constructed first model in 1939, extensive research was initiated after US Econometric Model by Klein and Goldberger (1955). Since then empirical Keynesian model has been refined, its properties expanded, alternative specifications has been made.

A few important large scale structural macro-econometric models (MEMs) developed are: Federal Reserve Board's Models, Fair's model of the US economy (and world economy), Murphy's Model of the Australian economy (1988, 1992), London Business School Model (LBS), National Institute of Economic and Social Research (NIESR), HM Treasury (HMT) models of the UK economy, CANDIDE model for Canada, EPA model for Japan and Link project Multi-country model.

The popularity and usability of structural large scale MEMs waned during the seventies and the eighties. Part of this decline was due to growing dissatisfaction with the Keynesian theoretical underpinnings of these models, including poor micro foundations and inadequate expectational specifications. Partly, the disenchantment arose due to their poor forecasting performance where small non-structural models like VAR routinely gave superior forecasting performance. Many predictive failures were due to structural changes and regimes shifts.

Four important methodological critiques are worth noting.[3] First, following the Lucas (1976) critique, also known as the policy irrelevance doctrine, the usability of MEMs as a guide to policy formulation was seriously questioned.[4] Most models were built on the assumption of a given structure and stability of parameters. In so far as economic agents were able to revise their expectations based on information including the model

[3] Other limitations are: (i) Estimation, specification involves a lot of subjective judgments; (ii) Forecasting performance is not yet robust to attain public credibility; (iii) They project future from past data. If no business cycle in the past, model can not predict any cyclical behavior in future; (iv) They can not forecast outcome of any non economic event; (v) They are based on theories that are not independent of time and space; and (vi) Even with correct in sample forecast, structural changes can nullify the forecast in out sample period.

[4] "Under alternative policy formulations, because of all the economic agents base their decisions on the full information, any change in policy will systematically alter the structure of econometric models" (Lucas, 1976, p41).

forecasts, and adjusted their behavior accordingly, leading to changes in model parameters, model forecasts were belied as a logical outcome of their own predictions. While the Lucas critique is theoretically appealing, its empirical relevance has since been questioned (see, for example, Eriksson and Irons, 1994 and Fair, 2004) and the results on its importance at best give mixed evidence (VanBergeijk and Berk, 2001). The Lucas critique remains a milestone in macro modeling literature and more and more models have started incorporating adequate mechanisms for forming expectations including rational expectations.

Secondly, Sims (1980) raised serious doubts about the traditional modeling of behavioral relations, which had been based on extremely restrictive assumptions. Sims called these as 'incredible' restrictions on the short-term dynamics of the model. Sims' alternative modeling strategy led to the Vector Auto Regressive (VAR) models. While VAR models usually produce unconditional forecasts that might outperform, under certain conditions, forecasts generated from large macro economic models or other univariate models, their usability for policy analysis is limited.

Thirdly, greater attention was paid to the treatment of non-stationarity in macro variables. This led to modeling techniques involving co-integration and provided a framework for model dynamics to evolve around long term equilibrium relationships. This new emphasis followed from the work of Nelson and Plosser (1982), who showed that many important macroeconomic variables in the US economy contained unit roots. Some of the pioneering works regarding co-integration and error correction models came from Engle and Granger (1987).

Finally, large econometric models also suffered from what is known as the 'curse of dimensionality'. By including too many variables, often accidental or irrelevant data features are embodied into the model. The chances of including features that are not likely to remain similar to the sample period increase, and errors multiply due to cross-equation linkages. Further, parameter estimates may be poorly determined due to large number of variables and high probability of correlation. Clements and Hendry (1995) observe: ".. parameter estimates may be poorly determined in-sample due to the sheer number of variables, perhaps exacerbated by the high degree of collinearity manifest in the levels of integrated data." As such, parsimony is considered a desirable feature of macro modeling. It is worth recognizing, however, that one of the foremost experts on macro modeling, namely, Klein, continues to put faith in large size models arguing (e.g., Klein, 1999) that small models cannot capture the complex nature of an economy and that this may lead to misleading policy conclusions.

One response to the criticism of the Keynesian system-of-equations approach was to incorporate rational expectations in the econometric models. Notable efforts of this genre were by Fair (1984, 1994) and Taylor (1993) who also undertook rigorous assessment of the model fit and forecast performance. Models in the Fair-Taylor mould are now in use at a number of leading policy organizations (see, e.g. Diebold, 1998).

In spite of their failures, these large models left a rich analytical, methodological, and empirical legacy. They spurred the development of powerful identification and estimation theory, computational and simulation techniques. As observed by Clements and Hendry (1995): " Formal econometric systems of national economies fulfill many useful roles others than just being devices for generating forecasts; for example, such models consolidate existing empirical and theoretical knowledge of how economies function, provide a framework for a progressive research strategy, and help explain their own failures".

One outcome of the critique was the recognition for the need for separating models that could be used for unconditional forecasting vis-à-vis others that can be used for policy analysis. Clements and Hendry (1995) suggest that it is useful to distinguish between characteristics of models that are to be used for forecasting alone as compared to those that may be used for policy analysis. In the case of forecasting, parsimony may help by excluding those relations that are not likely to persist in the forecast period. Sometimes models focused on forecasting exclude long-term relations that may be crucial for policy formulation.

The *ex-ante* desirability of any policy depends on its effects and on the baseline forecasts prior to its implementation. The timing of important policy changes can be improved by using such models. Stringent conditions must be satisfied to support policy analysis based on econometric models. First, it should be possible to specify the policy change in the model and policy variable should be 'super exogenous' in the terminology of Engle and Hendry (1993). In the case of weak exogeneity, the Lucas critique may yet apply if the expectation of policy change changes the behavior of the economic agents. In such cases, the effect of anticipated changes should also be modeled.

Non-structural Forecasting Models

The non-structural models had roots in works of Slutsky (1927) and Yule (1927). Slutsky and Yule had argued that simple linear difference equations, driven by purely random stochastic shocks, provide a powerful tool for forecasting economic and financial time series. While autoregressive processes modeled current value of a variable as weighted average of its own past values plus a random shock, Slutsky and Yule also studied moving average processes where the current value could be expressed as weighted average of current and lagged random shocks only. In more recent times, work on autoregressive moving average (ARMA) and autoregressive integrated moving average (ARIMA) modeling developed at a rapid pace with the pioneering work of Box and Jenkins (1970).

Although Box-Jenkins framework dealt primarily with univariate modeling, many extensions of the Box-Jenkins models involved multi-variate modeling and notably Sims advocated the use of Vector Autoregression (VAR) models as a less restrictive alternative to structural econometric modeling. Sims (1972) had argued that the division of variable into endogenous and exogenous variables, as done in the structural models, was arbitrary and VAR models could avoid that by treating all variables as endogenous. In the VAR model, cross variable effects are automatically included as each variable is regressed on its own lagged values and lagged values of all other variables. It is straightforward to estimate VAR systems as one equation at a time as estimation using OLS is efficient. These models can be taken as unrestricted reduced-form models. More recent variants allow for symmetric and asymmetric variants. Bayesian VAR models allow for prior restrictions.

Non-structural models have been used as a powerful tool for forecasting. These are also convenient, as no independently predicted values of exogenous variables are needed to generate forecasts as in the case of structural models. As these models produce unconditional forecasts, these are not directly useful for policy analysis.

A REVIEW OF MACRO-ECONOMETRIC MODELING IN INDIA

India has a long history of macro econometric model building. [5] The earliest work dates back to the mid fifties when Narasimham (1956) estimated a short term planning model for India for his Ph.D dissertation. This was followed by a number of similar attempts. The earlier Indian models were constrained considerably because of (i) absence of comprehensive and empirically feasible theoretical framework relevant to developing countries, (ii) weak and inadequate data base, and (iii) lack of perspective as regards the role of such models in developing economies.

[5] Extensive surveys of the model building endeavor in India have been undertaken from time to time. Some examples are Bhaduri (1982), Chakrabarty (1987), Jadhav (1990), Krishna, Krishnamurty, Pandit, and Sharma (1991), Pandit (1999), Pandit (2001), and Krishnamurty (2002,2008).

Over the years, there has been considerable progress in the process of model building in India. These models have been broadly grouped into four distinct phases: (i) Models up to sixties, (ii) models developed in the seventies, (iii) models prepared in the eighties, and (iv) models prepared after the eighties. Each of the successive phase/generation of models benefited from the earlier models by avoiding pitfalls of the earlier ones and gaining from the advances made earlier even if such advances were only incremental in character (Krishnamurty, 2008). The evolution of macroeconomic modelling in India in terms of these four phases is highlighted below.

First Phase: Models up to Sixties

A good number of models belong to this phase. But most of them were estimated for Ph.D dissertations. Notable among them are: Narasimham (1956), Chaudhry (1963), Krishnamurty (1964), Mammen (1967), UNCTAD (1968), Marwah (1963, 1972) and Agarwala (1970). As these models were severely constrained by a variety of problems including non availability of data, and time/resource constraints, obviously these were small, simple linear, highly aggregate and often close to the macroeconomic text books. Estimation was carried out using the annual data series and the single equation method.

Nevertheless, these models served well as explorations of specification for the economic relationship valid for the Indian Economy. They uncovered the weaknesses of the existing data base. [6]

Second Phase: Models Prepared in the Seventies

Most of the second phase models were also undertaken as doctoral dissertations. Amongst them, the most popular models are: Pandit (1973), Bhattacharya (1975), Pani (1977), Chakrabarty (1977) and Ahluwalia (1979). The important features of these models are: (i) they are more disaggregated than the first phase models; (ii) they are mainly focused on policy issues and (iii) they also allow for lagged and more complex adjustment process.

Third Phase: Models Prepared in the Eighties

Several models were estimated in the eighties. Most of them were constructed by independent model builders including Srivastava (1981), Bhattacharya (1982, 1984,

[6] Despite considerable odds, each model had a specific focus. For instance, Marwah (1963) focused on price behaviour; Krishnamurty (1964) examined the investment behaviour and endogenous population growth; Chaudhry (1963) and Dutta (1964) concentrated on external trade while Agarwala (1970) analyzed the growth in a dualistic economy.

1987), Ghose, Lahiri, Madhur and Roy (1983), Pani (1984), Krishnamurty (1984), Pandit (1984, 1985a, 1985b, 1986a, 1986b, 1989), Ahluwalia and Rangarajan (1986), Bhattacharya and Rao (1986), and Pandit and Bhattacharya (1987). In addition, there were many sectoral studies. For instance, Rangarajan, Basu and Jadhav (1989) analyzed the interaction between government deficit and domestic debt; Kannan (1985) examined the external sector; Rangarajan and Singh (1984) focused on reserve money multiplier and Pradhan, Ratha and Sharma (1990) studied the interrelationship between public and private sectors. Interesting features of these models are: (i) they are larger in size, (ii) better disaggregated and (iii) they seek to carry forward the analysis of policy issues (simulations) initiated by the Second Phase model builders.

Fourth Phase: Models Prepared after the Eighties

A few popular models in this category include Anjaneyulu (1993), Bhattacharya and Guha (1992), Bhattacharya, Barman and Nag (1994), Chakrabarty and Joshi (1994), Rangarajan and Mohanty (1997), Klein and Palanivel (1999), and Bhattacharya and Kar (2007). They all address issues relevant to new policy regime (after reform) and carry out many "what if" policy scenario simulations. Obviously, these models are larger in size, highly disaggregated and considering inter-links and trade-offs between sectors.

A large number of models covering the period at least until the eighties were based on estimates where proper testing of unit roots and stationarity of series was not undertaken. Even now, very few structural models have been specified and estimated using co-integration and error correction mechanisms if the relevant series are considered difference-stationary. Similarly, a comprehensive analysis of the structural breaks and the impact of economic reforms has also not been an integral part of most of the Indian macro models. Some of the data constraints, however, are now less restrictive with many important macro time series stretching over 55 years. Most models that incorporated policy analysis also became methodologically dated because of inadequate specifications of the impact of expectations regarding policy changes on parameter values. [7]

In the initial years, there were also major data problems. No meaningful quarterly or sub annual series were available except for a few sectors. Even in the case

[7] In spite of this rich heritage of macroeconomic modeling, most of these remain structural models in the Keynesian tradition and therefore subject to almost all the criticisms of the structural models discussed above.

of annual data, there were periodic reviews of the base year and estimation methodology making comparability extremely difficult.

New attempts at modeling the Indian economy should ensure that stationarity of variables is properly tested. If these are non-stationary then model specifications should recognize co-integration among variables and use error-correction models for forecasting short-term variations around long-term trends around equilibrium values. Macro models can be represented as Vector Error Correction Models (VECM) or structural co-integrating VAR models. Most existing models in India lack co-integration and error correction specifications. Alternatively, if the series are trend-stationary with structural beaks, then structural breaks need to be carefully identified. In this context, it is also important to recognize that the Indian economy has undergone major structural changes since the reform years. These require to be suitably incorporated within the model. Most of the existing models do not adequately provide for structural changes. It is also important to carry out detailed analysis of forecasting errors so that diagnostic checks are carried out and is properly validated.

Given the growing integration of the Indian economy with the world economy, this interface of the Indian economy with the world economy should be incorporated in adequate detail in respect of both capital account and current account flows. Particular care should be taken for policy modeling taking care to ascertain that policy changes are either strongly exogenous with respect to the model or the impact of the policy changes on the behavior of the economic agents should also be modeled.

Models by Srivastava (1981) and Rangarajan, Basu and Jhadav (1989, 1994) recognized the importance of the government budget constraint and the differential impact of financing government fiscal deficit that is monetized or based on borrowing from domestic markets or external sources. Later, Krishnamurty and Pandit, in the several versions of modeling efforts at the IEG/ DSE, have analyzed the government sector in detail. Issues of debt sustainability and strategies of supporting aggregate government demand financed by government borrowing are some of the critical and contemporary policy issues that require to be addressed through a macro model.

Since many of the modelling exercises in India have been the result of efforts of individual researchers, none of them were maintained and serviced on a sustained basis for policy analysis and forecasting. Therefore, a few reputed institutions have been attempting to build and maintain comprehensive models incorporating complexities on an ongoing basis and are these models regularly used for forecasting. They have a number of advantages over the one-time models as they regularly add new information by the way of data, policy changes and developments in theory and estimation techniques. An effort in this direction was initiated jointly by the Institute of Economic Growth (IEG) and Delhi School of Economics (DSE) in the early 1990s. At present the NCAER model, the IEG model and the DSE model are present. Two of the prominent international efforts at modeling the global economy through joining individual country models are Project LINK and Fair's multi-country model, both include a country model of the Indian economy.

NEW WAVE OF STRUCTURAL MODELING

As part of the new wave of structural modeling, some of the techniques that are now emerging address some of the basic difficulties noted with the Keynesian type system-of-equations models. In particular, those models were criticized for not catering to basic behavioral determinants like taste and technology and based on postulated decision rules. As such, although called structural models, these lacked depth in their structural specification. One of the first such efforts was made by Lucas (1972) based on a dynamic stochastic model that provided for fully articulated preferences, technologies and rules of the game. This type of modeling was given the name of dynamic stochastic general equilibrium (DSGE) modeling. These models avoid the Lucas critique as these are based on fully specified stochastic dynamic optimization as opposed to any reduced-form decision rules that had characterized the earlier genre of Keynesian type structural models. The new generation of models was developed for direct practical applications.

One well-known example is that of Kydland and Prescott (1982), which used DSGE modeling to argue that a neo-classical model driven by technology shocks could explain a large fraction of US business cycle fluctuations. These models, also initially called real business cycle models, are combinations of preferences and technologies. In general, in the DSGE models, while preferences are quadratic and yield tractable optimizing decisions, technologies are linear, thereby giving rise to linear-quadratic models. Optimizing behavior such as those of consumers and investors under quadratic preferences yields decision rules that are stochastic and linear functions of other variables. As such the decision rules conform to the VAR type of specifications subject to restrictions that arise from theory.

Kydland and Prescott (1982) used non-linear quadratic models so that non-linearity in technologies can be accommodated. Although solving these models is not a straightforward exercise, in most cases these are approximated by vector auto-regressions. In estimating the DSGE models, formal estimation is often combined with calibration methods, a good description of which is available in Kydland and Prescott (1996). More recent arguments favor formal estimation of the DSGE models and search for best fitting parameters. Maximum likelihood estimators have been the most preferred estimators. Current work on DSGE modeling aims at accommodating heterogeneity in agents using representative agents and suitable aggregator functions. The analysis has to be developed to a level that it can suitably address the Lucas critique. One characteristic of DSGE models is their parsimony.

Another important modeling strategy is referred to as 'Structural Cointegrating VAR Approach' (SVAR). This approach also has transparent theoretical foundations in regard to the underlying behavioral relationships. It is based on log-linear VAR model estimated subject to long run relationships based on economic theory. In the presence of unit root in different macro time series, the long-term relationship is derived on the basis of cointegrating relationships among variables, which provide the relevant restrictions on the VAR.

Making an assessment of the future of macroeconomic modeling and forecasting, Diebold (1996) writes: "The hallmark of macroeconomic forecasting over the next 20 years will be a marriage of the best of nonstructural and structural approaches, facilitated by advances in numerical and simulation techniques that will help macroeconomics to solve, estimate, simulate, and yes, *forecast* with rich models".

It is clear that while macro modeling has had a rich history in India, considerable new effort is required in the context of the development of new modeling techniques and also focus on modeling that can direct and provide for practical policy applications.

MACRO-ECONOMETRIC MODELING STRATEGIES

Macroeconomic modeling requires specification of the key relationships in terms of equations and identities, estimation of the stochastic equations, solution of the model, validation of the model, forecasting, and simulations. As stated earlier, new strategies for constructing structural models by supplementing the 'system-of-equations' (SOE) approach have emerged emphasizing micro foundations and extraction of predictive power of information through time series and vector error correction models (VECM) as well as structural co-integrating vector auto-regression (SVAR) models.

There are five major approaches to macroeconomic modeling in the literature: the traditional Cowles Commission structural equations approach, unrestricted and Bayesian VARs, structural VARs, linear rational expectations models, and the calibration approach associated with real business cycle models. Many models are eclectic using a combination of elements drawn from different approaches (Pesaran and Wickens, 1995). These new strategies need to be considered in the modeling.

As most macroeconomic series are non-stationary, appropriate estimation strategies need to be considered. There is now also an extensive debate as to whether macro-variables are difference-stationary or trend-stationary with or without structural breaks. If macro variables are trend stationary with structural breaks, then structural breaks in the history of time series must be carefully studied and modeled as they lead to changes in parameters like mean, variance and auto correlations. Therefore, the model is build for providing a medium term perspective on the movement of key economic variables. It is not meant for capturing short term movements.

As stated earlier, large econometric models often suffer from what is known as the 'curse of dimensionality'. Inclusion of too many variables often leads to irrelevant data features into the model. The chances of including features that are not likely to remain similar to the sample period increase, and errors multiply due to cross-equation linkages. Further, parameter estimates may be poorly determined due to large number of variables and high probability of correlation among them. Parsimony is considered a desirable feature of macro modeling and depending on the issues that are examined, a medium-sized model may be more robust.

It is also important to incorporate expectations in the modeling framework. Following the Lucas (1976) critique, also known as the policy irrelevance doctrine, the usability of macro econometric models (MEMs) as a guide to policy formulation requires new strategies as discussed above.

It is useful also to distinguish between characteristics of models that are to be used for forecasting alone as compared to those that may be used for policy analysis. In the case of forecasting, parsimony may help by excluding those relations that are not likely to persist in the forecast period. Sometimes models focused on forecasting exclude long-term relations that may be crucial for policy formulation.

Chapter 2

MACRO TIME SERIES IN INDIA: UNIT ROOTS, CO-INTEGRATION AND STRUCTURAL BREAKS

Introduction

This Chapter discusses the time series properties of major macroeconomic variables in India. The literature argues that the presence of either unit root(s) or deterministic trend (or both) would lead to non-stationarity in the economic time series. If the former is present, the series will reduce to stationary by differencing (integration) and the series is known as "difference stationary". If the latter is present, the series will reduce to stationary by de-trending and the series in this case is called as "trend stationary".[8]

If a series is trend-stationary, the conventional methodology of specification and estimation would be relevant. If a series is difference stationary, the appropriate modeling methodology would be co-integration with error correction. In the presence of unit roots, two or more variables may move together in a long run relationship and if the residual of this long run or co-integrating relationship is stationary, there would be an error correction process that forces the short run relationship, estimated in terms of first differences to return to the long run relationship.

Recent literature adds another important dimension namely trend stationary with structural breaks. [9] Studies by Perron (1989), Lumsdaine and Papell (1997), Bai, Lumdsdaine and Stock (1998) found that most macroeconomic series are trend stationary with one or more structural breaks. Some studies in the Indian context have also reported structural breaks in GDP growth (e.g., Rodrick and Subramanian (2004), Panagariya (2004), Sinha and Tejani (2004), Virmani (2004), Wallack (2003)) and savings and investments (Verma, 2007) and demand for money (Singh and Pandey, 2009). As the presence of structural breaks leads to the changes in the parameters-mean, variance or trend, it has serious implications for estimation of relationships among

[8] De-trending is done simply by regressing the given series on a constant and trend variable and then using the residual of this regression (which is stationary) in the subsequent analyses. Alternatively, the trend variable is included in the regression in which the given series is the dependent variable.

[9] Structural changes may happen in the time series due to economic crisis, policy changes, and changes in the institutional arrangements and regime shifts.

economic variables and their use in macro models.[10] Therefore, identifying the timing of such structural breaks becomes quite important.

Using a single (exogenously determined) break in the specification of the unit root test, Perron (1989) rejects the null of unit root for many of the US macroeconomic series and concludes that if potential structural breaks are not allowed for, the unit root tests may be biased towards a mistaken non-rejection of the non-stationarity hypothesis.

Christiano (1992) and others have criticized the usage of a known exogenous structural breaks, arguing that this invalidates the distribution theory underlying conventional testing (Vogelsang and Perron, 1998). In response to this criticism, a number of studies have proposed different ways of estimating the time of break endogenously, which lessen the bias in the usual unit root tests. These studies include Zivot and Andrews (1992), Perron (1994, 1997), and Lumsdaine and Papell (1997). They endogenize one structural break in the intercept and the trend of the time series.[11] Bai and Perron (1998, 2003) have developed formal tests for multiple structural changes in the case of single equations.

The macro model builders in India have generally not taken into account the structural breaks in testing for unit roots in various time series. However, there are several papers that seek to establish structural breaks in economic growth in India since Independence (Delong (2003), Verma (2007), Rodrick and Subramanian (2004), Panagariya (2004), Sinha and Tejani (2004), Virmani (2004), and Wallack (2003).

In this chapter, we test for stationarity of selected macroeconomic variables in India. We perform both unit root test and structural break test. The sample period for this exercise is 1950-51 to 2009-10. For identifying the structural breaks we employ the

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[10] Let $y_t = \alpha + \rho\ y_{t-1} + e_t$ and $Ee^2 = \sigma^2$. If y_t is stationary (i.e., $y_t \sim I(0)$), the parameters α, ρ and σ^2 are constant overtime. Structural change means that at least one of these parameters has changed at some date. Changes in α mean changing intercept; changes in ρ reflect change in the serial correlation in y_t and changes in σ^2 imply change in the volatility of the series.

[11] For example, in Zivot and Andrews (1992) model, the null hypothesis is, H_0: $y_t = \mu + y_{t-1} + e_t$ and the alternative hypothesis is, H_a: $y_t = \mu + \theta\ DU_t\ (T_b) + \beta\ t + \gamma\ DT_t\ (T_b) + \alpha\ y_{t-1} + \sum_{j=1}^{k} c_j\ \Delta y_{t-j} + e_t$. The time of break T_b is chosen to minimize the one sided t statistics for α=1. The null is rejected if α is statistically significant. The time of break is endogenously determined by running the model sequentially (allowing for T_b to be any year within a five percent trimming region) and selecting the most significant t-ratio for α. The dummy variable DU_t captures a break in the trend occurring at time T_b where DU_t=1 if t (trend) >T_b and 0 otherwise. DT_t captures a break in the trend occurring at time T_b (where DT_t is equal to (t-T_b) if (t>T_b) and 0 otherwise.

Bai and Perron (2003) procedure and the GAUSS computer program (to run their tests) provided by them at: http://econ.bu.edu/perron.

Tests for Multiple Breaks in a Single Equation Framework

The classical test for structural break is developed in Chow (1960). The Chow test typically splits the sample into two sub-periods and estimates parameters of each sub sample period. Then, it uses an F-statistic in order to test the equality of the sets of parameters. An important limitation of the Chow test is that the break point must be known a priori. Otherwise, researchers will choose arbitrary dates and reach different conclusions. The solution is to treat "break date" as an unknown. Quandt (1960) proposed taking the largest Chow statistics over all possible break dates.[12] Later studies such as Christiano (1992), Banerjee *et al*. (1992), Zivot and Andrews (1992), and Perron (1994) incorporate an endogenous break point into the model specification.

Various alternative approaches have been developed in the literature. Yao (1988), and Yao and Au (1989) study the estimation of the number of shifts in the mean of variables using Bayesian information criterion. Liu, Wu, and Zidek (1997) consider multiple changes in a linear model estimated by least squares and suggest an information criterion for the selection of the number of structural breaks. Their results are generalized by Bai and Perron (1998) who consider the problem of estimation and inference in a linear regression model allowing for multiple shifts. Bai and Perron (2003) have developed some useful tests for endogenously determining multiple structural breaks.

Bai and Perron (1998, 2003) have provided for (i) methods to select the number of breaks, (ii) tests for structural changes and (iii) efficient algorithms to compute the estimates. The multiple regression model with m breaks (m+1 regimes) can be specified as:

$$Y_t = \sum_p \beta_p X_p + \sum_{qi} \delta_{qi} Z_{qi} + u_t \;\; ; \;\; t = 1,\ldots, T \qquad (1)$$

where Y is the dependant variable, X and Z are vectors of covariates and u is the regular residual. δs are subject to change (and i= 1,…,m+1). Since βs are not subject to shift, this is a partial structural change model. If βs are also allowed to shift or set at zero, it is a pure structural change model (i.e., all coefficients are subject to change). Using matrix notations, (1) can be written as:

[12] Quandt (1960) also considered that y_t is subject to a one time change in mean at some unknown date T_b, i.e., $y_t = \mu_1 + \mu_2\, l(t>T_b) + e_t$ where $e_t \sim$ iid $(0, \sigma_e^2)$ and l(.) denotes the indictor function. He also introduced the Sup F test (assuming normally distributed errors). It is basically a likelihood ratio test for a change in parameter evaluated at the break date that maximized the likelihood function (Perron, 2005).

$$Y = X\beta + Z^{*}\delta + U \qquad (2)$$

where Z^{*} is the matrix that diagonally partitions Z at $T_1,\ldots,T_m$. The Ts' are indices or break points which are treated as unknowns. The unknown regression coefficients together with the break points can be estimated using OLS method.

For each m partition, the least square estimates of βs and δs can be obtained by minimizing the sum of squared residuals (SSRs), $S_T(T_1,\ldots,T_m)$. Since the break points are discrete parameters and can only take a finite number of values, they can be estimated using an efficient algorithm based on the principle of dynamic programming that allows the computation of estimates of break points as global minimizers of the SSRs.

With a sample size of T, the total number of possible segments is at most W [=T(T+1)/2]. Imposing a minimum distance between each break such that $h \geq k$ will reduce the number of segments to be considered to $(h-1)T - (h-2)(h-1)/2$. When the segment starts at a date between 1 and h, the maximum length of this segment is T – hm when m breaks are allowed. This will further reduce the possible number of segments to $h^2 m(m+1)/2$. Finally a segment cannot start at dates 2 to h as otherwise no segment of minimal length h could be inserted at the beginning of the sample. This will further reduce to $T(h-1) - mh(h-1) - (h-1)^2 - h(h-1)/2$ segments.

In the case of a pure structural change model (by letting $\beta_p = 0$, which is relevant in our case), the estimates of $\hat{\delta}, \hat{u}_t$ and $S_T(T_1,..,T_m)$ can be obtained using OLS segment by segment. The dynamic programming approach is then used to evaluate which partition achieves a global minimization of the overall SSRs. This method proceeds via a sequential examination of optimal one break (or 2 segments) partitions. Let SSR $(T_{r,n})$ be the SSRs associated with the optimal partition containing r breaks using first n observations. The optimal partition solves the following recursive problem:

$$SSR(T_{m,T}) = \min\,[SSR(T_{m-1,j}) + SSR(j+1, T)] \qquad (3)$$

where, $mh \leq j \leq T - h$. The procedure involves the following steps:

(i) Evaluating the optimal one break partition for all sub samples that allow a possible break ranging from observations h to T – mh. That is, the first step is to store a set of T – (m+1)h + 1 optimal one break partitions along with their associated SSRs. Each of the optimal partitions correspond to sub samples ending at dates ranging from 2h to T – (m-1)h.

(ii) Then, searching for optimal partitions with 2 breaks. Such partitions have ending dates ranging from 3h to T – (m-2) h. For each of these possible ending dates the procedure looks at which one break partition can be inserted to achieve a minimal SSR. The outcome is a set of T–(m+1)h + 1 optimal two breaks partitions. The method continues sequentially until a set of T – (m+1) h + 1 optimal m-1 breaks partitions are obtained ending dates ranging from (m-1) h to T – 2h.

(iii) Finally, verifying which of the optimal m-1 breaks partitions yields an overall minimal SSR, when combined with an additional segment. That is, it is sequentially updating T – (m+1) h + 1 segments in to optimal one, two and up to m-1 breaks partitions and create a single optimal m breaks partition.

To select the dimension of a model, Bai and Perron (1998) suggested the sequential application of the supF_T $(\ell+1|\ell)$ test.[13] This amounts to the application of ($\ell+1$) tests of the null hypothesis of no structural change versus the alternative hypothesis of a single change. It is applied to each segment containing the observations T_{i-1} to T_i (i= 1,….., $\ell+1$). That is, it is based on the difference between the SSR obtained with ℓ breaks and that obtained with $\ell+1$ breaks. One can reject the model with $\ell+1$ breaks if the overall minimal value of SSR (overall segments where an additional break is included) is sufficiently smaller than the SSR from ℓ breaks model. Asymptotic critical values are provided in Bai and Perron (2003a) for a trimming ε equals to 0.05, 0.1, 0.2 and 0.25 for q ranging from 1 to 10.

Bai and Perron (1998) also provided two tests of the null hypothesis of no structural break against an unknown number of breaks given some upper bond M. These are called "Double Maximum Tests". The first one is UD max F_T test while the other on is called WD max F_T test.

[13] Other information criteria proposed in the literature are: the Bayesian Information Criterion (BIC) by Yao (1988) and a modified Schwarz Criterion by Liu et al., (1977).

Indian Macro Series: Testing for Stationary and Structural Breaks

In a macro-economic modeling exercise, the first step is to examine the stationary properties of variables (endogenous as well as exogenous) under consideration. That is, we need to test whether the time series is stationary or trend stationary with or without structural beaks. The first step involves the testing for unit root hypothesis. The popular Augmented Dickey-Fuller (ADF) is used for this purpose. The next step involves the application of Bai and Perron's (2003) methodology and identify the timing of structural breaks if exists. The sequential procedure at 5 percent level of significance is used to select the optimal number of breaks. Assuming a pure structural change model (i.e, X=0), Z in the equation (2) is specified as: $Z_t = \{1, Trend\}$. In this case both intercept and trend vary in different regimes. With identified structural breaks from this second step above, we use the following regression in order to de-trend: [14]

$$Y_t = \mu_i + \beta_i t + e_t \tag{4}$$

In the equation (4), the term μ_i indicates that the intercepts change due to the presence of i number of structural breaks and term β_i indicates that trend parameters also vary accordingly.

Alternatively, the above equation is specified as:

$$Y_t = \sum SD_i + \sum \beta_i t^*SD_i + e_t \tag{5}$$

where SD_i's are structural dummies. After estimating this equation using OLS, the ADF test is performed on its residuals. If the residual is stationary then it is concluded that the series is a trend stationary with structural breaks.[15]

In our analysis below, variables in general are transformed into their log (L) values. Therefore, a variable name preceded by 'L' below refers to its logarithmic transformation with natural base. A variable entering after 'D' in parenthesis means first-difference of the variable.

Although both ADF test and multiple breaks test are used to examine the stationary properties of all variables under considerations, we report the summary results relating to a few major (and selective) variables (during 195051 to 2009-10) in Table 2.

[14] Intercepts are allowed to change the structural break dummies. Suppose that there are two breaks. Then we need to introduce three structural break dummies to represent three regimes without the overall intercept term in order to avoid the dummy variable trap. The trend parameters are allowed to change by introducing trend-structural dummies interaction terms.

[15] One can also directly test whether the series is trend stationary with structural breaks by modifying the ADF test equation (15) as: $\Delta y_t = \mu_i + \delta\, y_{t-1} + \Sigma\ \alpha_i\, \Delta\, y_{t-i} + \beta_i\, t + e_t$

If $\delta = 0$, then the series y_t contains unit root. Otherwise, y_t is stationary.

The detailed results corresponding to these variables are given in Appendix Table A4. Results relating to the full set of variables are available with the authors.

The selective variables are:

(i) Output Variables

(1) YAR: Agricultural output (GDP Agriculture and allied activities at factor cost at 2004-05 prices); (2) YIR: Industrial output (GDP Industry at factor cost at 2004-05 prices); (3) YSR1: Services sector output 1 (GDP Services other than community, social and personal services at factor cost at 2004-05 prices); and (4) YSR2: GDP services-community social and personal services at factor cost at 2004-05 prices.

(ii) Fiscal Variables

(5) CBDTR: Combined direct taxes; (6) CBITR: Combined indirect tax revenue; (7) CBRE: combined revenue expenditure; and (8) CBDEBT: Combined debt

(iii) Investment Variables

(9) IHR: Household investment (at 2004-05 prices); (10) IPCR: Corporate private investment (at 2004-05 prices); (11) IGR: Government investment (at 2004-05 prices)

(iv) External Sector Variables

(12) EXPR: Exports in 2004-05 prices and (13) IMPR: Imports in 2004-05 prices

(v) Monetary Variables

(14) M0: Reserve money and (15) M3: Broad money

The summary results shown in Table 1 indicates that:

a. Most of the aggregate annual time series are found to have unit roots. That is, they are non stationary. They turn out to be difference stationary. However, if reasonable numbers of structural breaks are accounted for, several of these become trend-stationary with structural breaks.

b. Over the entire sample period, YAR has only one structural break in the year 1987-88. While YIR and YSR1 have four breaks each, YSR2 has three breaks.

Table 2.1: Testing for Stationarity with Structural Breaks

Selected Variables (Y_t)	Difference-stationarity (C-intercept, T-trend)	Trend-stationarity with Structural Breaks	Structural Break Dates
(i) Output Variables			
1. LYAR	$Y_t \sim I(1)$ with C; $Y_t \sim I(0)$ with C,T	I(0) with trend and 1 structural break	1987-88

2. LYIR	Y_t ~I(1) with C; DY_t)~I(0) with C,T	I(0) with trend and 4 structural breaks	1961-62, 1971-72, 1987-88, 2000-01
3. LYSR1	Y_t ~I(1) with C; D(Y_t)~I(0) with C,T	I(0) with trend and 4 structural breaks	1962-63, 1971-72, 1987-88, 2000-01
4. LYSR2	Y_t ~I(1) with C; D(Y_t)~I(0) with C,T	I(0) with trend and 3 structural breaks	1961-62, 1983-84, 1997-98
(ii) Fiscal Variables			
5. LCBDTR	Y_t ~I(1) with C; D(Y_t)~I(0) with C,T	I(0) with trend and 2 structural breaks	1972-73, 1984-85
6. LCBITR	Y_t ~I(1) with C; D(Y_t)~I(0) with C,T	I(0) with trend and 4 structural breaks	1958-59, 1967-68, 1984-85, 1997-98
7. LCBRE	Y_t ~I(1) with C; D(Y_t)~I(0) with C,T	I(0) with trend and 5 structural breaks	1958-59, 1967-68, 1984-85, 1991-92, 2000-01
8. LCBDEBT	Y_t ~I(1) with C; D(Y_t)~I(0) with C,T	I(0) with trend and 2 structural breaks	1980-81, 1992-93
(iii) Investment Variables			
9. LIHR	Y_t ~I(1) with C; D(Y_t)~I(0) with C,T	I(0) with trend and 2 structural breaks	1964-65, 1980-81
10. LICPR	Y_t ~I(1) with C; D(Y_t)~I(0) with C,T	I(0) with trend and 1 structural breaks	1974-75
11.LIGR	Y_t ~I(1) with C; D(Y_t)~I(0) with C,T	I(0) with trend and 3 structural breaks	1965-66, 1984-85, 1995-96
(iv) External Sector Variables			
12. LEXPR	Y_t ~I(1) with C; D(Y_t)~I(0) with C,T	I(0) with trend and 2 structural breaks	1969-70, 1987-88
13. LIMPR	Y_t ~I(1) with C; D(Y_t)~I(0) with C,T	I(0) with trend and 3 structural breaks	1977-78, 1989-90, 2000-01
(v) Monetary Variables			
14. LM0	Y_t ~I(1) with C; D(Y_t)~I(0) with C,T	I(0) with trend and 4 structural breaks	1957-58, 1968-69, 1976-77, 1998-99
15. LM3	Y_t ~I(1) with C; D(Y_t)~I(0) with C,T	I(0) with trend and 1 structural breaks	1966-67

c. The fiscal variables CBDTR and CBDEBT have two breaks. CBITR has four breaks and CBRE has five. The CBDEBT series contains two breaks: one in 1980-81 and another in 1992-93.

d. Of the three investment variables considered, IPCR contains one break (1974-75), IHR contains two breaks (1964-65 and 1980-81) and IGR with three breaks (1965-66, 1984-85 and 1995-96).

e. Export variable (EXPR) has two breaks (1969-70 and 1987-88) while import (IMPR) contains three breaks. M0 has four breaks while M3 has only one break in 1966-67.

It may be noted that there have been many external events like oil price shocks, policy changes like the opening-up of the economy in the mid-eighties, extensive economic reforms in the early nineties, which may account for some of the structural breaks. Sometimes these breaks in individual series may even be caused by revision in the data series reflecting changes in the base year or methodology of compilation of data or change in the relevant weights. For individual years or periods, some of the important economic events that may have a link with the observed structural breaks may be noted as below.

1966-67: start of the green revolution
1967: devaluation of the Indian rupee
1969: bank nationalization
1973, 1979, 1999, and 2002: oil price shocks
1956, 1973,1977,1980,1991: major change in industrial policy.
1986: partial introduction of modified value added tax (Modvat)
1993-94: extensive reforms in MODVAT
1997: East Asian crisis.
1997-98: conversion of Modvat into Central value added tax (Cenvat)
1985-87: Initiation of opening up of the economy
: Exchange rate: move from administered to managed exchange rate regime
: Interest rate deregulation
Early 1990s: in the context of the foreign exchange reserve crisis and pressures from external international agencies (IMF and World Bank), comprehensive economic reforms were initiated involving industrial and trade liberalization.
1993: Shift to market determined exchange rate.
1994: Reserve Bank of India (RBI) and Government of India agreed to limit borrowing from the RBI through issuance of 91 days ad-hoc Treasury bills only.
1994-95: service tax was introduced.
1997-98: Extensive reforms of direct taxes including reduction in tax rates
1998: RBI moved to multiple indicator approach for the conduct of monetary policy from a regime of monetary targeting approach.
1996-99 and 2006-2008: Implementation of pay revisions following 5th and 6th central pay commission recommendations by the central and state governments.
2002: The Negotiable Instruments Act (Amendments and Miscellaneous Provisions) 2002: provided a framework for the use of electronic money.

2003: central government enacted the Fiscal responsibility and Budget Management Act (FRBMA); enactment of the Securitization Act and enactment of Prevention of Money Laundering Act.
2003-07: State governments enacted their respective FRBMAs
2005-08: State governments adopt Statevat.
2006: RBI withdraws from participating in the primary issues of central government securities.

Some of important changes in national income accounting took place changing the base year from time to time. In particular, 1948-49, 1960-61, 1970-71, 1980-81, 1993-94, and 1999-00 have been used as base years. The changes of base years have involved changes in coverage, methodology of data compilation, sectoral weights, etc. The methodology of compilation of money supply series have also changed from time to time.

Co-integration and Structural Breaks

It is quite possible that the co-integrating (long run) relationship is itself characterized by structural breaks. In such a case, combining co-integration with structural breaks with error correction can be an effective of capturing both the short run dynamics and the long run relationship among macro-variables. Quite a number of recent studies have drawn attention to the relevance of modeling such a process.

Yang Baochen and Zhang Shiying (2002) distinguished between three types of co-integration with structural breaks. These are:

(a) co-integration with parameter changes: This means that the parameters of the co-integration equation happen to change at some time, but the co-integration relationship still exists;
(b) Part co-integration: Part co-integration means that the co-integration relationship exists before or after some time, but disappears in other periods.
(c) Co-integration with mechanism changes: This means that the former co-integration relationship is destroyed because new variables enter the system and they form a new type of co-integration relationship.

The conventional tests for co-integration assume that the co-integrating vector is constant during the period of study. In reality, since the long-run relationship between the underlying variables can change due to technological progress, economic crises, changes in the people's preferences and behaviour accordingly, policy or regime alteration, and organizational or institutional developments. This is especially likely to be the case if the sample period is long. To take this issue into account Gregory and Hansen (1996) have introduced tests for co-integration with one unknown structural break and Hatemi-J (2008) has introduced tests for co-integration with two unknown breaks. While many of the tests currently being developed to specialized cases, a more general approach has been suggested whereby the test can be based on the significance of the error correction term once the long run relationship with structural breaks has been identified.

The presence of a statistically significant error correction term in the short run equation implies the existence of a co-integrating long run relationship with structural breaks. We have followed this approach. Engle and Granger have shown that co-integration implies and is implied by the error correction representation thus clarifying when levels information could legitimately be retained in econometric equations (Hendry, 1986). From a practical point of view, this result is extremely appealing because it enables us to model both short and long run effects.

Summary

In this Chapter, we look at the relevance of determining whether a macro series is trend-stationary (with or without structural breaks) or difference-stationary. For his purpose, we have employed both ADF unit root test and methodology and algorithms proposed by Bai and Perron (2003). The Bai and Perron (2003) procedure has some useful features, viz. (i) endogenous determination, (ii) optimal number of break dates, (iii) identification of break dates, (iv) presence of other exogenous variables, etc.

Results indicate that although most series appear to be difference-stationary, when structural breaks are allowed for, these become trend-stationary with multiple structural breaks. Since the study variables are trend stationary with structural breaks, these variables may be used at their levels in the time series analysis, but on the other (right) side of the regression equation, the relevant structural break variables and their interactions with trend must enter in order to ensure the stationary properties. Finally, it may be best to use co-integrating relationship with structural breaks if a significant error corrections mechanism exists. This allows the use of data in levels as well as first differences.

Chapter 3

METHODOLOGICAL PRELIMINARIES

Introduction

The RBI-MSE modeling project envisages building a suite of macro models of the Indian economy for providing alternative and competing modeling frameworks that can guide decision making through generating periodic forecasts and results of policy simulations. The first model in this series is Medium term macro econometric model for the Indian Economy which is primarily based on the conventional Cowles Commission approach. This Chapter highlights some of the considerations in the specification of this model.

While the model is specified in the overall framework of a structural model, the individual estimated equations have often experienced structural breaks and variables are trend-stationary with structural breaks. Some of the basic features of the model specified here are:

(a) Considerations relevant for incorporating the structural breaks in macro model, extending the analysis of individual variables to estimated relationships between variables that are trend stationary with multiple structural breaks;
(b) Determining selected policy variables endogenously using Taylor type rules, applied particularly for RBI's policy interest rate, combined fiscal deficit relative to GDP by the central and state governments, and exchange rate determination;
(c) Determination of potential output using alternative methodologies but mainly using the production function approach; and
(d) Formulation of expectations.

Modeling with Structural Breaks: Some Basic Considerations

While there is now an extensive literature on identifying the presence of structural breaks for individual variables, and testing the stationarity in the presence of time trends with or without structural breaks, there is very limited literature on the role of structural breaks in multi-equation models. In the previous Chapter, we have applied the Bai and Perron's multiple break test and found that most series are trend-stationary with multiple breaks. The next step is to consider issues of handling structural breaks in a macro model.

Some of the important issues in this context

(a) practical ways of handling structural beaks represented by shifts in intercepts and coefficient of time-trend over different parts of the sample period, particularly when breaks occurs at different points of time in different equations;
(b) since there may be an excessive number of states or regimes, strategies for limiting the aggregate number of breaks considering all equations;

(c) timing of structural breaks in equations where on both sides of the equation, the break-date is common (co-breaking) and when these are different;
(d) the usefulness of imposing restrictions on parameters; and
(e) forecasting errors in the presence of structural beaks when unanticipated breaks occur in the forecast period or towards the end of the sample period.

These issues are discussed below.

Structural Breaks and Successive States/Regimes

For any stochastic equation in this model, given the overall sample, if there are n structural breaks, there will be n+1 'states' or 'regimes'. Hendry and Mizon (1998) emphasize the importance of distinguishing between structural breaks leading to different 'states' of parametric relationships and different 'regimes'. The former refers to shifts in parameters governing the relationship explained within the model whereas the latter refers to changes in the behavior of non-modeled variables like the exogenous policy variables. For individual equations, the parameters may be estimated separately for the different regimes. It is the last regime, which is relevant for the forecast period unless there is regime switching or exogenous information to change the regime. However, estimating parameters for different equations for latest regimes requires changing the sample period again and again.

A more general method is to use structural dummy variables including interaction terms with time trend or other determinants. To explain the historical evolution of any relationship, the entire sample period needs to be used. Each time a structural break is identified, a new intercept and set of coefficients can be obtained. There may be some coefficients that do not change over the entire period while others change. The relevant intercepts and coefficients for each regime can be identified using a combination of the overall intercept, structural dummies, and interaction (slope) dummies.

In the specifications of individual equations, structural breaks in the time trend are indicated by: C, D_i, S_i, TT, where C is the overall intercept, and Di's are intercept dummies at different points of structural breaks. The time trend is indicated by TT, with S_0 being its coefficient over the entire sample period and S_i is the interaction dummy ($S_i = D_i$*TT). If there are three regimes with two structural breaks in time trend, located at periods T_1 and T_2, say, then the intercept for the first regime will be C for period 1 to T_1-1, for the second, C+D_1 for period T_1 to T_2-1, and C+D_1+D_2 for regime 3 over the period from T_2 to n where n is the sample size. Similarly, if the coefficients for TT over the entire sample period and two break point interaction dummies are S_1, and S_2, the coefficients of the time trend will be for the three regimes respectively, S_0, S_0+S_1, and $S_0+S_1+S_2$. In a similar way shifts in coefficients of other determinants can be derived.

Number of Structural Breaks

Since breaks occur at different points of time in different equations, the task is to keep the overall number of breaks within manageable limits. For individual equations, the maximum number of structural breaks is determined by the overall sample size and the size of the interval or minimum number of observations needed for estimation of parameters in each regime. There are however tests for choosing between ℓ and $\ell+1$ breaks for individual variables. The chapter on structural breaks for individual variables has described the methodology in detail. For the model as a whole, it is also useful to relate structural breaks in estimated relationships with identified external events wherever feasible. This will also help in deciding whether there is reason to consider that the same state or regime is likely to continue in the forecast period.

Issues of Co-breaking: Timing and Sequencing Structural Breaks in Macroeconometric Systems

Hendry (1997) defines co-breaking as 'cancellation of structural breaks across linear combinations of variables, analogous to cointegration removing unit roots'. If two variables are trend stationary with structural breaks where the breaks occur at the same date, in an equation where one of the variables is the determinant, one would expect that the structural break will be at the same date in the equation relating the two variables. However, in the estimation of the relationship this may not turn out to be the case. Co-breaking therefore tends to reduce the number of structural breaks and affects the timing of the breaks when a relationship between two variables is considered compared to the identified break dates when these were considered individually.

Suppose for consumption [$C_t = f(T_1) + u_t$] and income [$Yt = g(T_1) + v_t$] where u_t and v_t are stationary. The function f(T1) and g(T1) can be linear functions of T or more complicated functions as discussed in the note on stationarity. The regression of u_t on v_t, say $u_t = \alpha + \beta v_t + e_t$ amounts to regressing C_t on Y_t. Since $u_t = C_t - f(T_1)$ and $v_t = Y_t - g(T_1)$, we have,

$$C_t - f(T_1) = \alpha + \beta\{Y_t - g(T_1)\} + e_t \quad (1)$$

$$C_t = f(T_1) + \alpha + \beta\{Y_t - g(T_1)\} + e_t$$

$$C_t = \alpha + \beta Y_t + \{f(T_1) - \beta g(T_1)\} + e_t \quad (2)$$

Illustratively, if $f(T_1)$ and $g(T_1)$ are simply $a_1 + a_2T_1$ and $b_1 + b_2T_1$, then this equation can be written as

$$C_t = (\alpha + a_1 - \beta b_1) + \beta Y_t + (a_2T_1 - \beta b_2T_1) + e_t \quad (3)$$

If the break in the two variables considered above should occur at the same point of time (T_1**),** since f (T_1**)** and g (T_1**)** have opposite signs, a structural beak in the relationship may not be observed at $T_{1.}$ The closer β is to 1 or βb_2 is to a_2, the less likely it would be to observe the structural break at $T_{1.}$ On the other hand, if the timing of break is at different points of time, say T_1 and T_2, it is difficult to say whether the structural break will occur at T_1, or T_2, or some where as net effect may be small.

Qu and Perron (2007) also consider another important aspect of the problem of multiple structural changes, which are labeled as "locally ordered breaks". They consider the case of a policy-reaction function along with another equation that may be a market-clearing equation whose parameters are related to the policy function. According to the Lucas critique, if a change in policy occurs, it is expected to induce a change in the market equation but the change may not be simultaneous and may occur with a lag. This could be because of some adjustments due to frictions or incomplete information. However, it is expected to take place soon after the break in the policy function. Here, the breaks across the two equations may be considered as "ordered" in the sense that the break in one equation occurs after the break in the other. The breaks are also "local" in the sense that the time span between their occurrences is expected to be short.

Structural Breaks and Restrictions on Coefficients

Qu and Perron (2007) approach the issues of multiple structural changes in a broader framework whereby arbitrary linear restrictions on the parameters of the conditional mean can be imposed in the estimation. The class of models considered is

$$y = Z^*\delta + u \quad (4)$$

where $R\delta = r$

where R is a $k \times (m+1)\,q$ matrix with rank k and r is a k dimensional vector of constants. In this framework, there is no need for a distinction between variables whose coefficients are allowed to change and those whose coefficients are not allowed to change. A partial structural change model can be obtained as a special case by specifying restrictions that impose some coefficients to be identical across all regimes.[16] Qu and Perron show that the limiting distribution of the estimates of the break dates are unaffected by the imposition of valid restrictions.

Bai (1997) and Bai and Perron (1998) have shown that it is possible to consistently estimate all break fractions sequentially, i.e., one at a time. When estimating a single break model in the presence of multiple breaks, the estimate of the break fraction will converge to one of the true or dominating break fractions that allows the greatest reduction in the sum of squared residuals. Then, allowing for a break at the estimated value, a second one break model can be applied, which will consistently estimate the second dominating break, and so on[17] .

Bai (1997) considers the limit distribution of the estimates and shows that they are not the same as those obtained when estimating all break dates simultaneously. In particular, except for the last estimated break date, the limit distributions of the estimates of the break dates depend on the parameters in all segments of the sample (when the break dates are estimated simultaneously, the limit distribution of a particular break date depends on the parameters of the adjacent regimes only). To remedy this problem, Bai suggested a procedure called 'repartition'. This amounts to re-estimating each break date conditional on the adjacent break dates[18].

Estimating Break-dates in a System of Equations

The problem of estimating structural changes in a system of regressions is relatively recent. Bai *et al* (1998) considered asymptotically valid inference for the estimate of a single break date in multivariate time series allowing stationary or integrated regressors as well as trends. They show that the width of the confidence interval decreases in an important way when series having a common break are treated as a group and

[16] This is a useful generalization since it permits a wider class of models. Thus, a model, which specifies a number of states less than the number of regimes (with two states, the coefficients would be the same in odd and even regimes). It could be also the case that the value of the parameters in a specific segment is known. Also, a subset of coefficients may be allowed to change over only a limited number of regimes.

[17] In the case of two breaks that are equally dominant, the estimate will converge with probability 1/2 to either break). Fu and Cornow (1990) presented an early account of this property for a sequence of Bernoulli random variables when the probability of obtaining a 0 or a 1 is subject to multiple structural changes (see also, Chong, 1995).

[18] For example, let the initial estimates of the break dates be denoted by ($T^{*a}_1, \ldots, \hat{}\, T^{*a}_m$). The second round estimate for the i^{th} break date is obtained by fitting a one break model to the segment starting at date $T^{*a}_{i-1} + 1$ and ending at date T^{*a}_{i+1} (with the convention that $T^{*a}_0 = 0$ and $\hat{}\, T^a_{m+1} = T$). The estimates obtained from this repartition procedure have the same limit distributions as those obtained simultaneously.

estimation is carried using a quasi maximum likelihood (QML) procedure. Also, Bai (2000) considers the consistency, rate of convergence and limiting distribution of estimated break dates in a segmented stationary VAR model estimated by QML when the breaks can occur in the parameters of the conditional mean, the covariance matrix of the error term or both. Hansen (2003) considers multiple structural changes in a cointegrated system, though his analysis is restricted to the case of known break dates[19].

Forecasting in the Presence of Structural Breaks and Policy Regime Shifts

In Hendry and Mizon (1999), three aspects of the relationship between statistical forecasting devices and econometric models in the context of economic policy analysis were estimated. First, whether there are grounds for basing economic-policy analysis on the 'best' forecasting system. Second, whether forecast failure in an econometric model precludes its use for economic-policy analysis. Finally, whether in the presence of policy change, improved forecasts can be obtained by using 'scenario' changes derived from the econometric model, to modify an initial statistical forecast. To resolve these issues, Hendry and Mizon analyzed the case when forecasting takes place immediately after a structural break (i.e., a change in the parameters of the econometric system), but before a regime shift (i.e., a change in the behavior of non-modeled, often policy, variables), perhaps in response to the break (see Hendry and Mizon, 1998, for discussion of this distinction). No forecasting system can be immune to unmodeled breaks that occur after forecasts are announced, whereas some devices are robust to breaks that occur prior to forecasting. These three dichotomies, between econometric and statistical models, structural breaks and regime shifts, and pre and post forecasting events, are critical for the use of forecasting models for policy analysis.

Hendry (1997) shows that when forecast failure results from an in-sample structural break induced by a policy-regime shift, forecasts from a statistical model which is robust to the structural break may be improved by combining them with the predicted

[19] The most general framework is given by Qu and Perron (2007) who consider models of the form

$$y_t = (I \otimes z0_t)S\beta_j + u_t$$

for $T_{j-1} + 1 \leq t \leq T_j$ ($j = 1, ..., m + 1$), where y_t is an n-vector of dependent variables and z_t is a q-vector that includes the regressors from all equations. The vector of errors u_t has mean 0 and covariance matrix Σj. The matrix S is of dimension nq by p with full column rank. Though, in principle it is allowed to have entries that are arbitrary constants, it is usually a selection matrix involving elements that are 0 or 1 and, hence, specifies which regressors appear in each equation. The set of basic parameters in regime j consists of the p vector β_j and of Σ_j. They also allow for the imposition of a set of r restrictions of the form g (β, vec (Σ)) = 0, where $\beta = (\beta0_1, ..., \beta0_{m+1})0$, $\Sigma = (\Sigma_1, ..., \Sigma_{m+1})$ and g (·) is an r dimensional vector. Both within- and cross-equation restrictions are allowed, and in each case within or across regimes.

response from an econometric model of an out-of-sample policy change[20]. Shifts in parameter of deterministic terms are equivalent to deterministic shifts, as are other factors that mimic deterministic shifts, such as mis-estimating or mis-specifying deterministic components in models.

Importantly, no methods are robust to unanticipated breaks that occur after forecasts are announced, and Clements and Hendry (1999) show that those same 'robustifying' devices do not offset post-forecasting breaks. However, policy changes that occur post-forecasting will induce breaks in any models that do not embody the appropriate policy links. Thus, such models lose their robustness in that setting. Conversely, despite possibly experiencing forecast failures from pre-forecasting breaks, econometric systems which do embody the relevant policy effects need not experience a post-forecasting break induced by the policy-regime shift. Consequently, when both structural breaks and regime shifts occur, neither class of model alone is adequate. Henry observes that the best estimate of the effects of an economic policy change should not be based on the model that is robust to the policy change-its very robustness to the policy change lessens its value for predicting the consequences thereof. Thus, even the existence of a procedure that in the presence of structural breaks and regime shifts systematically produces better forecasts need not invalidate the policy use of another model.

Any empirical policy model will be invalid when it embodies the wrong causal attributions, its target-instrument links are not autonomous, and when its parameters are not invariant to the policy change under analysis. These are distinct from the causes of forecast failure, though they could be a subset of the factors in any given situation. None of these problems need be revealed in-sample, but the failure of the policy to produce the anticipated results would do so.

Setting Values of Key Policy Variables

There are four policy variables where values are determined endogenously. In each case, however, the value can also be determined exogenously by suppressing the relevant equation. These policy variables are: (i) policy interest rate, (ii) money supply, (iii) fiscal deficit, and (iv) nominal exchange rate.

[20] Using the taxonomy of forecast errors in Clements and Hendry (1995), Hendry and Doornik (1999) establish that deterministic shifts are the primary source of systematic forecast failure in econometric models. Deterministic variables include intercepts and linear trends-variables whose future values are known with certainty. Deterministic shifts are viewed as any change in the unconditional expectation of the non-integrated transformations of the variables.

One key issue of model specification is whether values of some of the key policy variables are determined endogenously within the model. RBI follows a multiple targeting strategy intervening through important instruments under its control. It determines the policy interest rate (bank rate/repo rate), influences the exchange rate through foreign exchange buying and selling operations, and broad money supply growth through changes in the cash-reserve ratio. The monetary base, which is the reserve money, is also affected by government's borrowing programme and the method of its financing. The monetary transmission mechanism is affected by a number of rigidities and changes in the policy rates only partially translate to changes in lending/deposit rates after a lag. In this model, both for the policy interest rate and the fiscal deficit to GDP ratio a Taylor's rule is used.

In the case of the policy interest rate, real policy interest rate is a weighted sum of the output gap and inflation gap where the weights may be either estimated or pre-fixed according to the central bank's inclination to assign equal or different weights to departures of actual output from potential output and that of actual inflation rate from the potential inflation rate.

For determination of fiscal deficit, we derive the fiscal deficit to GDP ratio as a weighted sum of output gap and departure of actual fiscal deficit to GDP ratio from the target GDP ratio as specified in the FRBMAs. Alternatively, the departure of actual fiscal deficit to GDP ratio from the structural fiscal deficit to GDP ratio may be used.

For exchange rate reference is made to deviation of actual exports from target exports and actual exchange rate from target exchange rate.

Formulation of Expectations

In equations where expectations have to be formulated, several alternative strategies can potentially be used. Expectations are particularly important in investment decisions. Several alternative strategies may be followed to suit the Indian conditions, particularly taking into account availability of information to decision making economic agents. Some of these are considered below.

a. Model Consistent Expectations

In model consistent expectations we can set the expectation of variable as

$$y^e_t = y_{t+1} \qquad (5)$$

where y^e_t is expected value of y in period t and y_{t+1} is its predicted value in period t+1 as predicted by the model. This is consistent with rational expectations but presumes that economic agents have the same set of information available to them as has been used in the model and also visualize the same interrelationships. The costs of obtaining the large volume of information and an understanding of economic relationships, similar to that of the model builder seems quite unlikely in the Indian conditions.

b. Partial or Adaptive expectations

Adaptive expectations means that people form their expectations about what will happen in the future based on what has happened in the past. If inflation has been higher than expected in the past, people would revise expectations for the future. In this case

$$y^e_t = \lambda\ (y^e_{t-1} - y_{t-1}) \tag{6}$$

Since adaptive expectations can be applied to all previous periods, often the estimable equation can be written in a form that involves lagged dependent variable on the right hand side. An alternative is the partial adjustment model. Although economic behavior is governed by discrete and individual choices, the econometric partial adjustment models perform relatively well at the aggregate level[21].

c. Rolling Autoregressive Models

Many data explorations and research projects estimate the same basic equation or relationship among variables over multiple date ranges. In a rolling regression, least-squares techniques are used to fit a linear equation over successive time periods using partially overlapping subsamples from a larger set. This procedure is typically applied to time series data in a manner that keeps the sample length (window) fixed for each estimation step by increasing the beginning and ending dates by the same time or date increment. In rolling autoregressive regressions, information on the past values of a variable is to be used for formulating its expected value in period t.

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[21] The partial adjustment model comprises two parts, a static part to describe how the desired amount is determined and the dynamic partial adjustment process:

$$y_t^* = \alpha_0 + \alpha_1 x_t + u_t$$

$$y_t - y_{t-1} = \lambda(y_t^* - y_{t-1})$$

Where y* is the desired level of y. By substituting the expression for y* into the other equation we obtain the following estimating equation:

$$y_t = \alpha_0\lambda + (1-\lambda)y_{t-1} + \lambda\alpha_1 x_t + \lambda u_t$$

The partial adjustment model also results in an estimable form that has the lagged dependent term on the right hand side.

Thus $y^e_t = f(y_{t-1},\ldots,y_{t-j})$ (7)

where j refers to the lag length used in the rolling regression.

In implementing this method for generating expectations, since even a window of 10-15 observations is likely to be non-stationary a decision is to be taken as to how large should be the size of the window and a suitable method of reducing the series to stationarity. This requires assumptions regarding how economic agents formulate their expectations.

d. Rolling VAR models

In rolling VAR models, expectations are formulated on the basis of interactions among variables using the past values of a subset of variables. As compared to rolling autoregressive models that related to individual variables in rolling VAR models, information on past behavior of several variables and their interactions can be used at the same time. Thus,

$(Y^i)^e_t = f(y^1_{t-1,\ldots}y^1_{t-j};\ y^2_{t-1,\ldots}y^2_{t-j};\ \ldots;y^m_{t-1,\ldots,}y^m_{t-j,})$ (8)

In the rolling VAR models, similar issues of non-stationarity arises and structural breaks need to be determined. Given the size of the sample window, it may be possible to use only a limited number of breaks. In our exercises, expectations are generated through rolling VAR/VECM models. Two alternative sets of exercises have been undertaken. In one case a subset of only three variables, in first differences, is taken and a rolling models with a window of 20 years is used from 1950-51 to 2009-10. The variables are first difference of log of GDP at factor cost (DLYRR), and similarly for broad money (DLM3) and deflator of GDP at factor cost (DLPYR). In this case, a series f expectations become available from 1970-71. One year ahead forecasts are generated.

In the second exercise, a Vector Error Correction model with a larger number of variables is used with a window of thirty years. Variable are taken in logs and growth inflation rates are subsequently predicted from the model. Variables include logs of price deflator for GDP (LPYR), outputs from three sector (LYAR, YLIR, LYSR), and broad money (LM3). In this model, expectations have been generated for key variables like sectoral outputs, inflation rate (with respect to GDP at factor cost and broad money using rolling VECM approach with a rolling window of 30 years. The expectations are available for one-year ahead and five year-ahead forecasts. These are given in Appendix to this Chapter (Appendix Tables A1 and A2).

e. Survey-based Expectations

Survey based expectations are available on many important variables from various sources including one based on the RBI's own survey based report. The Reserve Bank of India has been conducting quarterly surveys of professional forecasters on major macroeconomic indicators of medium term economic developments. This information can however only be used for more recent years. Results of eight rounds are available with the latest issue of survey-based expectations for 2009-10. Done through a questionnaire responded by 20 forecasters who participated in this round, the survey covered component-wise detailed forecasts of GDP growth, inflation, savings, capital formation, consumption expenditure, export, import, interest rates, money supply, credit growth, stock market movements, corporate profit, etc. However, in the present context, it may be difficult to use it for a sample period that goes backwards compared to the period for which RBI's publication of survey-based expectations.

Estimating Potential Output

Potential output is the maximum output an economy could sustain without generating an increase in inflation. The situation of excess demand, when actual output is greater than the potential output, leads to inflationary pressures calling for contraction of excess demand through monetary and fiscal policy measures for reducing aggregate demand. The situation of excess supply is when the actual output is less than the potential output. This calls for expansionary monetary and fiscal policies. A number of alternative methodologies have been used in the literature for estimation of potential output.

Five main methods for determining potential output are (a) time trend with or without structural breaks as relevant, (b) Hodrick-Prescott (H-P) filter including generalized H-P filters, (c) unobserved component method, (d) vector autoregression method, and (e) production function approach. Studies indicate that often different results are obtained using different methods. In a forecasting context, the production function approach, which can be an endogenous part of the overall set of equations, seems to be a useful method. In this model, aggregate supply is derived by summing agricultural, industrial, and services sector outputs.

i. Time Trend

Fitting a time trend to isolate the cyclical component is the most straightforward method. In the present model, we can fit a time trend with structural breaks to account for regime shifts. Exponential weighted moving average (EWMA) in this regard may be considered as an alternative.

ii. Hodrick-Prescott Filter

The Hodrick-Prescott (HP) method (Hodrick and Prescott, 1997) is a smoothing procedure. In this method, given time series, say y_t (or output) is expressed as the sum of a growth component or trend y^*_t (potential output) and a cyclical component or output gap ct, that is

$$y_t = y^*_t + c_t \qquad (9)$$

The measure of the smoothness of y^*_t is the sum of the squares of its second difference. The average of the deviations of ct from y^*_t is assumed to be near zero over a long period of time. The programming problem is that of finding the growth components by minimizing the following expression

$$\text{Min } L = \Sigma c_t^2 + \lambda\Sigma\,(\Delta\, y^*_t - \Delta y^*_{t-1})^2 \qquad (10)$$

$$= \Sigma(y_t - y^*_t)^2 + \lambda\Sigma(y^*_t - y^*_{t-1}) - (y^*_{t-1} - y^*_{t-2})^2$$

(first term summation over t = 1 to n, and second term summation is over t = 2 to n, where n is the sample size). The parameter λ is a positive number, which penalizes variability in the growth component series. The larger the value of λ, the smoother is the solution series. Moreover, as λ approaches infinity, the limit of the solutions for equation is the least squares of a linear time trend model. As λ approaches zero, the function is minimised by eliminating the difference between actual and potential output that is making potential output equal to actual output.

There are several weaknesses of the HP method. First, it is sensitive to changing the smoothing weight (λ). Secondly, it has a high end-sample bias. To counter this problem however, researchers use output projections to augment the observations. Thirdly, for integrated or near-integrated series, arbitrary value of smoothing parameter could lead to spurious cyclicality and an excessive smoothing of structural breaks (Harvey and Jaeger, 1993).

iii. Structural Vector Autoregression Method

The structural vector autoregression (VAR) uses a set of macroeconomic variables to estimate potential output and output gap. Thus, it does not constrain the short-run dynamics of the permanent component of output to a simple random walk process. Dupasquier *et al* (1999) suggested that it will often be useful for researchers and policymakers to include the dynamics of permanent shocks in potential output since they are more likely to reflect the production capacity of the economy. This methodology was popularized by Blanchard and Quah (1989) where output was considered to be a linear combination of supply disturbances and demand disturbances. Blanchard and Quah assume that the first disturbances have a long-run effect on output while the other has only temporary effects on it. They used unemployment to identify the cyclical component of the output.

iv. Production Function Method

This approach relates the potential output to the availability of factors of production and technological change (see for example Denis *et al* 2002). Suppose that the output can be characterized as a Cobb-Douglas production function of the form

$$Y = L^{\alpha}K^{1-\alpha}.TFP$$

where Y is output, L is labour employed, K is capital stock, TFP is the total factor productivity and α is the labour share of income. TFP is defined as:

$$TFP = (E^{\alpha}{}_{L}E^{1-\alpha}{}_{K})(U^{\alpha}{}_{L}U^{1-\alpha}{}_{K}) \qquad (11)$$

which summarises both the degree of utilisation (U) of factor inputs as well as their technological level (E).

If inputs are equilibrium values, then equation provides an estimate of potential output. With the estimated value of parameter α, the TFP is given as:

$$\log(TFP_t) = \log(Y_t) - \alpha\log(L_t) - (1-\alpha)\log(K_t) \qquad (12)$$

where it is computed as a residual. A trend is then fitted to the residual, TFP, in order to obtain an estimate of trend productivity to be used in the estimation of potential output where a "normal" level of efficiency of factor inputs is assumed. The trend efficiency level is usually measured as the HP filtered Solow Residual.

To obtain the potential output, assumption on the potential employment needs to be made. Most studies have different assumptions on how to estimate the potential employment [see for example de Brouwer (1998), Cerra and Saxena (2000), and Dennis *et al* (2002)]. The main concern is to find the level of employment that is consistent with non-accelerating inflation or the NAIRU (non-accelerating inflation rate of unemployment). The potential employment can be generated from a smoothed labour force series. One method of obtaining this is to use the H-P filter on the participation rate and apply to the working age population figures. The smoothed participation rate leads to a less volatile labour force series. Then, the potential employment (L*) is computed to be the labour force (LF*) minus the NAIRU estimates, that is:

$$L^* = LF^*(1 - NAIRU) \qquad (13)$$

The potential output (Y*) can then be obtained as:

$$Y^* = TFP^*(L^*)^{\alpha}(K)^{1-\alpha} \qquad (14)$$

The production function approach can provide useful information on the determinants of potential growth and is widely used. It highlights the close relationship between the potential output and NAIRU concepts. Moreover, the production function approach provides the possibility of making forecasts, or at least building scenarios, of possible future growth prospects by making explicit assumptions on the future evolution of demographic, institutional and technological trends. However, given the significant amount of data requirement for this approach and a whole wide range of assumptions to derive variables, this method is difficult to use.

The production function method also has a number of weaknesses. Laxton and Tetlow (1992) point out that there have not been reliable model of estimating productivity. Estimates have been based on trend and potential output estimates are essentially exogenous time trends. Moreover, the problems of trend elimination for GDP are shifted to the trend estimates of the inputs. Also detrending techniques such as the H-P filter are used for smoothing the components of the factor inputs.

In the present context, there are two important considerations. First, a series on labour force is not available although attempts can be made to derive it from census figures and NSS data. Secondly, this also necessitates the use of an aggregate production function rather than sectoral production functions. The latter will require aggregating output of the sectors and allow for the possibility of substituting or shifting labour from one sector to another.

Chapter 4

SPECIFICATION AND ESTIMATION: REAL AND EXTERNAL SECTORS

Introduction

The specification of the model aims to capture the key features of inter-linkages between demand output, fiscal, monetary, and trade sectors of the economy. The following sectors are covered:

A. Real sector: Consumption
B. Real sector: Investment
C. Real sector: Output (GDP at factor cost)
D. External sector
E. Monetary sector
F. Prices
G. Fiscal sector

The first three sectors are covered in this chapter. Details of specification and estimation for the remaining sectors, model closures and other features of the model are presented in Chapter 5.

Different sectors are interlinked to each other in a number of ways. Private consumption expenditures depends on personal disposable income which depends on GDP at factor costs i.e., output of the real sector as well as direct taxes, transfer payments, and interest payment from the government to private sector. The private real investment depends on private disposable income where transfer payments are important. The income expenditure identity incorporates government consumption and investment expenditures apart from private consumption and investment expenditures.

The real sector and the monetary sectors are linked through interest rates. In particular, investment demand is a function of long-term interest rate which is linked to the short term interest rate through a lag structure. The short term interest rate is determined by the interaction of demand for and supply of money. The supply of money is linked to the monetary base, i.e. the reserve money which depends partly on net RBI credit to government, which in turn depends partly on government fiscal deficit.

The monetary transmission mechanism operates through several channels. Some of the important channels relate to interest rate channel, exchange rate channel, asset price channel, and credit channel. In the case of the interest rate channel, a policy-induced increase in the short term nominal interest rate would impact the long term rate, which will also affect the real interest rates. In turn, private investment decisions and consumption decisions particularly for durable goods will be affected. The exchange rate channel is important for open economies where increase in nominal interest rates above foreign interest rates adjusted for exchange rates affect foreign exchange movements. The asset price channel makes debt more attractive for the investors compared to equity following a policy induced increase in the short-term nominal interest rate. The credit channels affect investment when bank loans and bank deposits are closely related.

The real and external sectors are linked through the impact of income on import demand as well as the price of imports relative to domestic prices. The aggregate demand is determined using both domestic absorption and exports net of imports.

Prices are determined using money supply and real income variables, which in turn determine the unit value of imports as well as the unit value of exports.

The core model is specified below. It is specified in a manner such that the real, monetary, and external sectors are treated at a suitably aggregated level. For the fiscal sector, the focus is on the consolidated account of the central and state governments. The equations are estimated with two-stage least squares with a subset of instrument variables in the first stage. While the instruments may change from equation to equation, a common set of instruments are maintained in most equations. These are indicated below:

c tt drain10 lcbntr lcbpre crratio lbpr lcpr(-1) lipr(-1) lyar(-1) lyir(-1) lysr(-1) kar(-) kir(-1) d68 s68 d96 s96 d76 s76 limpr(-1) lpcrude lexpr(-1)

This model is being estimated over annual data with an overall sample period from 1960-61 to 2009-10. The National Income Accounts data pertain to the 2004-05 base series. Budgetary data are linked with the National Accounts data through suitable identities. In the model specification, natural log of variable is indicated by prefixing it by L. An error correction term (Actual minus long term value of a variable) is pre-fixed by Z. An expectation variable is prefixed by XX. Variables starting with D followed by a year indicate intercept dummies. Variables starting with S followed by a year indicate slope dummy i.e. product of intercept dummy with the time trend (tt). Variables starting with

‘DD’ followed by a year indicate specific year dummies, with value 1 for the concerned year and zero in all other years.

Real Sector: Aggregate Domestic Demand and Output

a. Consumption Demand

The aggregate demand reflects the expenditure side of the economy. For consumption demand, separate equations for private and government consumption expenditures are specified and estimated.

Private consumption expenditure

A1a. LCPR = f [LPDYR, LCPR(-1), {C, TT, D_i, S_i,}]

Private consumption expenditure (LCPR) depends on personal disposable income (PDYR). Under certain assumptions, the lagged dependent term can capture permanent income hypothesis or life-cycle hypothesis (Surrey, 1974).

Derivation of personal disposable income incorporates the following steps in the national income accounts. From GDP at factor cost, deduction of consumption of fixed capital provides net national product at factor cost. From this, deduction of net other current transfer from the rest of the world provides net national disposable income. In this, addition of net factor income from abroad provides net domestic product at factor cost. From this, reduction of income from entrepreneurship and property accruing to government administration department and saving of non-departmental enterprises provides income accruing to private sector from domestic product.

To this, addition of transfer payments consisting of interest on public debt and current transfers from government administrative departments along with other current transfers from rest of the world and net factor income from abroad provides private income. From this, deduction of saving of private corporate sector net of retained earnings of private companies and corporation tax gives personal income. From this, deduction of direct taxes paid by households and miscellaneous receipts of government administrative departments gives personal disposable income.

Table 4.A1a: Private Consumption Expenditure: Levels

Dependent Variable: LCPR		Long term equation		
Method: Two-Stage Least Squares				
Sample (adjusted): 1961 2010				
Included observations: 50 after adjustments				
Instrument specification: C TT DRAIN10 CBNTR CBPRE CRRATIO LBPR LCPR(-1) LYAR(-1) LYIR(-1) LYSR(-1) KAR(-) KIR(-1) D59 S59 D68 S68 D96 S96 D76 S76 LIMPR(-1) PCRUDE LEXPR(-1) DD80 DD108 DD79 DD103 DD78 DD104				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.330	0.145	9.196	0.000
LPDYR	0.470	0.045	10.437	0.000
LCPR(-1)	0.425	0.054	7.802	0.000
D81*LPDYR	0.003	0.000	6.854	0.000
D103*LPDYR	0.004	0.001	6.723	0.000
DD108	0.037	0.011	3.292	0.002
DD79	0.034	0.011	3.205	0.003
DD103	-0.058	0.011	-5.145	0.000
DD78	0.030	0.011	2.837	0.007
DD104	-0.041	0.011	-3.589	0.001
R-squared	1.00	Mean dependent var		13.64
Adjusted R-squared	1.00	S.D. dependent var		0.60
F-statistic	19631.9	Durbin-Watson stat		1.81

CPR: Private consumption expenditure

PDYR: Personal disposable income at 2004-05 prices

The estimation results of the private consumption expenditure equation for the long run relations are shown in Table 4.A1a. This equation shows two shifts in the coefficients of log of personal disposable income. Both of these show upward and significant impact on private consumption expenditure. The relevant years are 1980-81 (D81) and for 2002-03 (D103). We also find a significant error correction mechanism operating and the short run equation in first difference is shown in Table 4.A1b.

A1b. DLCPR= f [[DLPDYR, ZLCPR(-1), DLCPR(-1), {C, TT, D_i, S_i,}]

Table 4.A1b: Private Consumption: First Difference with Error Corrction

Short term equation
Dependent Variable: DLCPR
Method: Two-Stage Least Squares
Sample (adjusted): 1961 2010
Included observations: 50 after adjustments

Instrument specification: DLPCRUDE DRAIN10 DLCBEIR(-1) DLCPR(-1) DLIDR(-1) DLRSN(-1) DLYSR1(-1) DLYSR2(-1) DLCPR(-1 TO -2) DLIAR(-1) DLPYR(-1) DLUDR(-1) DLYIR(-1) ZLCPR(-1) DLCPR(-1) DLPDYR(-2) DD81 DD103 DD108 ZLCPR(-1) DD80 DD106

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.006	0.004	-1.327	0.192
DLPDYR	0.706	0.056	12.706	0.000
ZLCPR(-1)	-1.096	0.173	-6.335	0.000
DLCPR(-1)	0.300	0.060	5.039	0.000
DD81	0.054	0.011	5.024	0.000
DD108	0.043	0.009	5.033	0.000
DD80	0.030	0.011	2.611	0.013
DD106	0.016	0.009	1.816	0.077
R-squared	0.91	Mean dependent var		0.043
Adjusted R-squared	0.89	S.D. dependent var		0.025
F-statistic	47.3	Durbin-Watson stat		1.736

Government Consumption Expenditure at Constant Prices

A2. LCGR = f [LCBPRE, {C, TT, D_i, S_i}]

The government consumption expenditure (LCG) function is a linking equation that relates budgetary data to the national income account concept of government consumption. In particular, it links primary revenue expenditure (CBPRE) on the combined account of central and state government to government consumption expenditure. In addition, persistence is captured through the lagged dependent variable. There are structural breaks in a number of years (1980-81, 2006-08).

Table 4.A2: Government Consumption Expenditure: Levels

Dependent Variable: LCGR
Method: Two-Stage Least Squares
Sample (adjusted): 1961 2010
Included observations: 50 after adjustments

Instrument specification: C TT DRAIN10 CBNTR LCBPRE CRRATIO LBPR LCPR(-1 TO -2) LIPR(-1) LYAR(-1) LYIR(-1) LYSR(-1) KAR(-) KIR(-1) D68 S68 D96 S96 D76 S76 LIMPR(-1) LPCRUDE LEXPR(-1) LCGR(-1) D75 S75 D64 S64 D95 S95 DD74 DD100

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.084	0.705	7.214	0.000
LCBPRE	0.447	0.070	6.409	0.000
LCGR(-1)	0.182	0.113	1.608	0.116
D75	0.277	0.104	2.655	0.011
S75	-0.017	0.005	-3.330	0.002
D64	0.106	0.036	2.972	0.005
D95	-0.520	0.116	-4.472	0.000
S95	0.011	0.002	4.317	0.000
DD74	-0.089	0.037	-2.396	0.021
DD100	0.069	0.032	2.134	0.039
R-squared	1.00	Mean dependent var		11.75
Adjusted R-squared	1.00	S.D. dependent var		0.83
F-statistic	3964.10	Durbin-Watson stat		1.53

CBPRE	Combined primary revenue expenditure
CGR	Government consumption expenditure at constant prices

b. Investment

Household Investment at Constant Prices

B1a. LIHR = f [LPDYR, LRSN, {C, TT, D_i, S_i,}]

The household investment expenditure (LIHR) depends on personal disposable income (LPDYR) and short term interest rate. The former has a positive influence with an elasticity of about 1.2. Higher interest rate leads to lower investment. Although the estimated elasticity is small in magnitude but it is statistically significant. Structural breaks are seen in 1966-67, 1982-83, and 1990-91.

Table 4.B1a: Household Investment Expenditure: Levels

Dependent Variable: LIHR
Method: Two-Stage Least Squares
Sample (adjusted): 1961 2010
Included observations: 50 after adjustments

Instrument specification: C TT DRAIN10 LCBNTR LCBPRE CRRATIO LBPR LCPR(-1) LIPR(-1) LYAR(-1) LYIR(-1) LYSR(-1) KAR(-) KIR(-1) D68 S68 D96 S96 D76 S76 LIMPR(-1) LPCRUDE LEXPR(-1) LIHR(-1) D67 D83 S83 D91 S91

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-5.139	2.859	-1.797	0.080
LPDYR	1.192	0.223	5.332	0.000
LRSN	-0.062	0.019	-3.158	0.003
D67	0.612	0.101	6.085	0.000
D83	-3.351	0.818	-4.097	0.000
S83	0.089	0.023	3.810	0.000
D91	2.741	0.901	3.043	0.004
S91	-0.07	0.023	-3.216	0.00
R-squared	0.98	Mean dependent var		11.42
Adjusted R-squared	0.98	S.D. dependent var		0.96
F-statistic	342.64	Durbin-Watson stat		2.11

IHR	Investment by household sector at constant prices
PDYR	Personal disposable income at 2004-05 prices
RSN	Short term interest rate (1 to 3 years deposit rate)

Investment by Household: Short term equations

In this case also, an error correction process was found to be significant and a short term equation was estimated.

B1b. DLIHR = f [ZIHR(-1), {C, TT, D_i, S_i,}]

Table 4.B1b Investment by Household Sector: First Difference with Error Correction

Dependent Variable: DLIHR
Method: Two-Stage Least Squares
Sample (adjusted): 1961 2010
Included observations: 50 after adjustments

Instrument specification: DLPCRUDE DRAIN10 DLCBEIR(-1) DLCPR(-1) DLIDR(-1) DLRSN(-1) DLYSR1(-1) DLYSR2(-1) DLCPR(-1) DLIAR(-1) DLPYR(-1) DLUDR(-1) DLYIR(-1) ZLIHR(-1) DD67 DD83 S83 DD92

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.028	0.028	1.003	0.321
ZLIHR(-1)	-0.995	0.173	-5.767	0.000
DD67	0.673	0.146	4.625	0.000
DD83	-0.52	0.136	-3.826	0.00
S83	0.00	0.001	2.088	0.04
DD92	-0.27	0.140	-1.921	0.06
R-squared	0.59	Mean dependent var		0.06
Adjusted R-squared	0.55	S.D. dependent var		0.19
F-statistic	12.79	Durbin-Watson stat		1.76

Private Corporate Sector Investment at Constant Prices

B2a. LIPCR= f [LPVDYR, LRSN, LICPR(-1),{C, TT, D_i, S_i,}]

The private corporate sector investment (LIPCR) equation incorporates the private income (LPVDYR), short term interest rate and its own lagged term. The relevant coefficients have significant and expected signs. Structural breaks are incorporated in 1981-82 and 2000-01. The elasticity with respect to income is 0.61 and with respect to interest rate is 0.47.

Table 4.B2a: Private Corporate Sector Investment: Levels

Dependent Variable: LIPCR
Method: Two-Stage Least Squares
Sample (adjusted): 1961 2010
Included observations: 50 after adjustments

Instrument specification: C TT DRAIN10 LCBNTR LCBPRE CRRATIO LBPR LCPR(-1) LIPR(-1) LYAR(-1) LYIR(-1) LYSR(-1) KAR(-) KIR(-1) D68 S68 D96 S96 D76 S76 LIMPR(-1) LPCRUDE LEXPR(-1) D101 S101 D82

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-3.377	2.399	-1.408	0.166
LPVDYR	0.614	0.265	2.317	0.025
LRSN	-0.473	0.229	-2.063	0.045
LIPCR(-1)	0.609	0.146	4.179	0.000
D101	-3.386	1.685	-2.010	0.051
S101	0.059	0.031	1.871	0.068
D82	0.334	0.151	2.219	0.032

R-squared	0.97	Mean dependent var	10.98
Adjusted R-squared	0.96	S.D. dependent var	1.20
F-statistic	219.43	Durbin-Watson stat	2.06

IPCR	Investment by private corporate sector at constant prices
PVDYR	Private income at 2004-05 prices
RSN	Short term interest rate (1 to 3 years deposit rate)

An error correction process is found to be significant. The following equation in first differences is developed. In this case expected inflation in price deflator is also included. The error correction term indicates that nearly 42 percent of correction takes place in a year if the actuals deviates from the long run equilibrium level.

B2b. DLIPCR= f [ZLIPCR(-1), XXDLPYR, {C, TT, D_i, $S_{i,}$}]

Table 4.B2b: Private Corporate Investment: First Difference with Error Correction

Dependent Variable: DLIPCR
Method: Two-Stage Least Squares
Included observations: 40 after adjustments

Instrument specification: DLPCRUDE DRAIN10 DLCBEIR(-1) DLCPR(-1) DLIDR(-1) DLRSN(-1) DLYSR1(-1) DLYSR2(-1) DLCPR(-1) DLIAR(-1) DLPYR(-1) DLUDR(-1) DLYIR(-1) ZLIPCR(-1) DD101 DD82 DD88 XXDLPYR DD105

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.032	0.062	-0.525	0.603
ZLIPCR(-1)	-0.422	0.118	-3.563	0.001
DD101	-0.497	0.185	-2.681	0.011
DD82	0.568	0.186	3.054	0.004
DD88	-0.521	0.185	-2.815	0.008
XXDLPYR	1.792	0.747	2.399	0.022
DD105	0.338	0.188	1.799	0.081
R-squared	0.59	Mean dependent var		0.10
Adjusted R-squared	0.52	S.D. dependent var		0.26
F-statistic	7.96	Durbin-Watson stat		1.75

XXDLPYR Expected rate of inflation w.r.t GDPfc deflator

Government Investment Expenditure

B3. IGR = f [CBTR, {C, TT, D_i, S_i,}]]

Government investment responds positively to government resources although the extent of response is limited. The combined tax revenues of the central and state governments are included as the key determinant. The short term elasticity is only 0.11.

Table 4.B3: Government Investment Equation: Levels

Dependent Variable: LIGR
Method: Two-Stage Least Squares
Sample (adjusted): 1961 2010
Included observations: 50 after adjustments

Instrument specification: C TT DRAIN10 LCBNTR LCBPRE CRRATIO LBPR LCPR(-1) LIPR(-1) LYAR(-1) LYIR(-1) LYSR(-1) KAR(-) KIR(-1) D68 S68 D96 S96 D76 S76 LIMPR(-1) LPCRUDE LEXPR(-1) IGR(-1) D103 S103

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.594	0.931	3.858	0.000
LCBTR	0.119	0.034	3.442	0.001
LIGR(-1)	0.582	0.112	5.207	0.000
D103	-2.617	0.867	-3.019	0.004
S103	0.049	0.016	3.155	0.003
R-squared	0.99	Mean dependent var	11.57	
Adjusted R-squared	0.99	S.D. dependent var	0.66	
F-statistic	976.03	Durbin-Watson stat	1.78	

IGR: Government Investment at constant prices; CBTR: combined tax revenues

The investment undertaken by households, private corporate sector and government is taken in gross terms. From the gross domestic investment, investment in net fixed capital stock is derived by deducting consumption of fixed capital, investment in inventories, and investment in valuables. Sectoral investment is taken as an increase in net fixed capital stock.

Investment in the agricultural sector is explained by the following equation, where the main driver of investment in agriculture is the capital expenditure on the combined account of central and state governments.

B4a. IAR = f [CBKE, {C, TT, D_i, S_i,}]

Table 4.B4a: Investment in Agriculture

Dependent Variable: LIAR
Method: Two-Stage Least Squares
Sample (adjusted): 1970 2010
Included observations: 41 after adjustments

Instrument specification: C TT DRAIN10 LCBNTR LCBPRE CRRATIO LBPR LCPR(-1) LIPR(-1) LYAR(-1) LYIR(-1) LYSR(-1) KAR(-) KIR(-1) D68 S68 D96 S96 D76 S76 LIMPR(-1) LPCRUDE LEXPR(-1) DD90 D95 S95 DD75

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	9.259	0.285	32.488	0.000
LCBKE	0.087	0.031	2.795	0.009
DD90	-0.398	0.146	-2.735	0.010
DD91	0.454	0.181	2.504	0.017
D95	-3.647	0.424	-8.597	0.000
S95	0.078	0.009	9.009	0.000
DD75	-0.336	0.143	-2.343	0.025
R-squared	0.92	Mean dependent var		10.29
Adjusted R-squared	0.90	S.D. dependent var		0.44
F-statistic	63.05	Durbin-Watson stat		1.44

CBKE: Combined central and state government capial expenditure

For investment in agriculture, an equation in first differences is developed. In the model only the first difference equation is used as the error correction term was not found to be significant.

B4b. DIAR = f [DLPYAR, DLYAR(-1), {C, TT, D_i, S_i,}]

Table 4.B4b: Investment in Agriculture: First Differences with Error Correction

Dependent Variable: DLIAR
Method: Two-Stage Least Squares
Sample (adjusted): 1966 2010
Included observations: 45 after adjustments

Instrument specification: DLPCRUDE DRAIN10 DLCBEIR(-1) DLCPR(-1) DLIDR(-1) DLRSN(-1) DLYSR1(-1) DLYSR2(-1) DLCPR(-1) DLIAR(-1) DLPYR(-1) DLUDR(-1) DLYIR(-1) DLIAR(-1) DD91 DD100 DD67 D90 S90 DD104 DD75 DLYAR(-1)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.178	0.067	2.662	0.011
DLPYAR	-1.823	0.756	-2.411	0.021
DLYAR(-1)	-1.515	0.484	-3.133	0.003
DD91	0.899	0.185	4.849	0.000
DD100	0.390	0.186	2.094	0.043
DD67	0.627	0.204	3.075	0.004
R-squared	0.55	Mean dependent var		0.04
Adjusted R-squared	0.49	S.D. dependent var		0.25
F-statistic	10.61	Durbin-Watson stat		2.03

Investment in Industry

B5a. LIIR = f [LPVDYR, LRLN, {C, TT, D_i, $S_{i,}$}]

The estimated equation shows a positive response to both private income and long term interest rate.

Table B5a. Investment in Industries: Levels

Dependent Variable: LIIR
Method: Two-Stage Least Squares

Instrument specification: C TT DRAIN10 LCBNTR LCBPRE CRRATIO LBPR LCPR(-1) LIPR(-1) LYAR(-1) LYIR(-1) LYSR(-1) KAR(-) KIR(-1) D68 S68 D96 S96 D76 S76 LIMPR(-1) LPCRUDE LEXPR(-1) LIIR(-1) D72 DD102 D103 DD103 DD71

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-8.153	0.817	-9.979	0.000
LPVDYR	1.244	0.072	17.177	0.000
LRLN	1.038	0.159	6.513	0.000
D72	-0.403	0.086	-4.700	0.000
DD102	-0.476	0.168	-2.828	0.007
D103	0.482	0.141	3.429	0.001
DD103	-0.630	0.155	-4.058	0.000
DD71	-0.419	0.152	-2.756	0.009
R-squared	0.98	Mean dependent var		11.04
Adjusted R-squared	0.98	S.D. dependent var		0.97
F-statistic	316.85	Durbin-Watson stat		1.20

An equation in the first differences shows significant error correction to the extent of about 64 percent. In this equation, the expected level of price inflation is also found to be significant. The higher is the expected inflation in future, the higher is the increase in current industrial investment.

B5b. DLIIR = f [ZLIIR(-1), DLKIR, XXDLPYR, {C, TT, D_i, S_i,}]

The estimated equation shows a positive response to both private income and long term interest rate.

Table B5b: Investment in Industries: First Differences with Error Correction

Dependent Variable: DLIIR
Method: Two-Stage Least Squares
Sample (adjusted): 1971 2010
Included observations: 40 after adjustments

Instrument specification: DLPCRUDE DRAIN10 DLCBEIR(-1) DLCPR(-1) DLIDR(-1) DLRSN(-1) DLYSR1(-1) DLYSR2(-1) DLCPR(-1) DLIAR(-1) DLPYR(-1) DLUDR(-1) DLYIR(-1) ZLIIR(-1) D100 S100 DD104 DD105 DD107 DD80

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.651	0.109	-5.951	0.000
ZLIIR(-1)	-0.643	0.085	-7.529	0.000
DLKIR	9.128	1.680	5.435	0.000
D100	-1.535	0.489	-3.137	0.004
S100	0.028	0.009	3.130	0.004
DD104	0.459	0.069	6.647	0.000
DD105	0.535	0.068	7.895	0.000
XXDLPYR	0.960	0.389	2.469	0.020
DD107	0.212	0.076	2.802	0.009
DD80	-0.170	0.073	-2.326	0.027
R-squared	0.91	Mean dependent var		0.07
Adjusted R-squared	0.88	S.D. dependent var		0.18
F-statistic	27.27	Durbin-Watson stat		2.08

Gross investment is the sum of the three investment demands emanating from household, private corporate and government sectors.

B6. GGIR= IHR+IPCR+IGR

The difference between gross investment coming from these three sectors and the gross domestic capital formation derived from the income expenditure identity gives a residual indicating net investment from abroad.

B7. WGGIR=GGIR-GDCFR

From GDCFR, consumption of fixed capital, investment in valuables and inventories along with errors and omission are to be deducted to arrive at net investment in fixed capital stock (NIFCR). The sectoral investments like IAR etc. represent increases in the fixed capital stock of the respective sectors. The investment-net fixed capital stock identities are specified below.

Investment in net fixed capital stock
B8. NIFCR = GGIR - (CFCR + WNIFCR)

WNIFCR represents investment in valuables, inventories and errors and omissions and is taken as exogenous in the model. NIFCR is then divided into four sectoral investments. Three of these are to be determined separately. The fourth is determined residually. At present, investment in agriculture and industry are determined in the model, that in community, social and personal services is taken as exogenous and that in service sector 1(covering services other than community, social and personal services is derived residually.

Net fixed capital stock in agriculture
B9. KAR = IAR + KAR (-1)
Net fixed capital stock in industry
B10. KIR = IIR + KIR (-1)
Net fixed capital stock in services other than community, social and personal services
B11. KSR1 = ISR1 + KSR1 (-1)
Net fixed capital stock in community, social and personal services
B12. KSR2=ISR2+KSR2 (-1)
Total fixed capital stock at 1999-00 prices
B13. KR = KAR + KIR + KSR1+KSR2

Real Sector: Output

Agricultural Output

Aggregate output is divided into four sectors: agriculture, industry, services1 containing all services except community, social and personal services, which is called services2. The services 2 sector includes construction, trade, hotels, restaurants, transport, storage and communications, and financial, real estate and business services. The industrial sector includes mining and quarrying, manufacturing, electricity, gas and water.

In case of agricultural output, the long term equation is specified as below.

C1a. LYAR = f [LAREA, LFERT, DRAIN10,{C, TT, D_i, S_i,}] The agricultural output (LYAR) depends on gross cropped area (LAREA), and inputs like fertilizer consumption in agriculture (LFERT). Deficiency of rainfall beyond a certain threshold leads to a fall in agricultural output. The threshold is kept at 10 percent of normal rainfall (DRAIN10).

Table 4.C1a: Agricultural Output: Levels

Dependent Variable: LYAR
Method: Two-Stage Least Squares
Sample (adjusted): 1961 2010
Included observations: 50 after adjustments

Instrument specification: C TT DRAIN10 LCBNTR LCBPRE CRRATIO LBPR LCPR(-1) LIPR(-1) LYAR(-1) LYIR(-1) LYSR(-1) KAR(-) KIR(-1) D59 S59 D68 S68 D96 S96 D76 S76 LIMPR(-1) LPCRUDE LEXPR(-1) LACRE LFERT D67 S67 D80 S80

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	8.884	1.273	6.980	0.000
LACRE	0.637	0.255	2.498	0.017
LFERT	0.061	0.024	2.555	0.014
DRAIN10	-0.047	0.011	-4.200	0.000
D67	-0.282	0.048	-5.870	0.000
S67	0.015	0.003	5.282	0.000
D80	-0.321	0.063	-5.125	0.000
S80	0.009	0.002	4.052	0.000
R-squared	1.00	Mean dependent var		12.74
Adjusted R-squared	1.00	S.D. dependent var		0.40
F-statistic	1815.06	Durbin-Watson stat		2.03

ACRE	Area under cultivation
FERT	Fertilizer used in agriculture

DRAIN10: a dummy for years with less than normal rainfall by a margin at least of 10 percent.

As expected, area and fertilizers have positive impact on agricultural output. DRAIN10 has a negative and significant impact, indicating that the output declines significantly in the years with a deficient rainfall. Structural breaks are provided in 1966-67 (D67) and 1979-80.

The error correction process was found to be significant. The short term dynamics is given by the following equation.

C1b. DLYAR = f [DLACRE, ZLYAR(-1), DRAIN10,{C, TT, D_i, S_i,}]

Table 4.C1b: Agricultural Output: First Difference Equation with Error Correction

Dependent Variable: DLYAR
Method: Two-Stage Least Squares
Sample (adjusted): 1961 2011
Included observations: 51 after adjustments

Instrument specification: DLPCRUDE DRAIN10 DLCBEIR(-1) DLCPR(-1) DLIDR(-1) DLRSN(-1) DLYSR1(-1) DLYSR2(-1) DLCPR(-1) DLIAR(-1) DLPYR(-1) DLUDR(-1) DLYIR(-1) ZLYAR(-1) DLACRE DD80 DD77 D71 DLFERT DLYAR(-1)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.028	0.005	5.892	0.000
DRAIN10	-0.031	0.011	-2.902	0.006
ZLYAR(-1)	-0.899	0.167	-5.375	0.000
DLACRE	1.249	0.171	7.293	0.000
DD80	-0.092	0.028	-3.266	0.002
R-squared	0.81	Mean dependent var		0.026
Adjusted R-squared	0.79	S.D. dependent var		0.059
F-statistic	48.09	Durbin-Watson stat		1.535

Industrial output

C2a. LYIR = f [LKIR, LYIR (-1), {C, TT, D_i, S_i,}]

The industrial output is related to net fixed capital stock in industry (LKIR), own lagged term and an interaction term between them and some structural dummies. There is an identified slope shift in 1997-98 and an earlier break in 1970-71. Other dummy variables indicate specific characteristics of individual years. As expected the net fixed capital stock influences the industrial output positively and significantly. The lagged dependent variable also positively and significantly influences the current industrial output.

Table 4.C2a: Industrial Output: Levels

Dependent Variable: LYIR
Method: Two-Stage Least Squares
Sample (adjusted): 1961 2010
Included observations: 50 after adjustments

Instrument specification: C TT DRAIN10 LCBNTR LCBPRE CRRATIO LBPR LCPR(-1) LIPR(-1) LYAR(-1) LYIR(-1) LYSR(-1) KAR(-) KIR(-1) DD68 S68 D96 S96 D76 S76 LIMPR(-1) LPCRUDE LEXPR(-1) LYIR(-1) LYSR1(-1) D71 S71 DD79 DD92 DD96 DD107

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	8.623	0.393	21.938	0.000
LKIR	-0.232	0.072	-3.200	0.003
D98*LKIR	-0.002	0.001	-1.971	0.056
LKIR*LYIR(-1)	0.040	0.004	9.958	0.000
D71	-0.194	0.045	-4.304	0.000
S71	0.009	0.002	4.198	0.000
DD79	0.066	0.021	3.072	0.004
DD92	-0.053	0.022	-2.411	0.021
DD96	0.049	0.022	2.171	0.036
DD107	0.047	0.022	2.174	0.036

R-squared	1.00	Mean dependent var	12.24
Adjusted R-squared	1.00	S.D. dependent var	0.80
F-statistic	8102.50	Durbin-Watson stat	1.63

LKIR: net fixed capital stock in industry
LYIR: GDP at factor cost in industry

The short term dynamics is given by the following equation.

C2b. DLYIR = f [DLYIR(-1), DLYSR1(-1), ZLYIR (-1), {C, TT, D_i, S_i,}]
`

The equation in first differences shows that nearly 48 percent of deviation of actual from long equilibrium value is corrected in a year.

Table 4.C2b : Industrial Output: First Difference Equation with Error Correction

Dependent Variable: DLYIR
Method: Two-Stage Least Squares
Sample (adjusted): 1961 2011
Included observations: 51 after adjustments

Instrument specification: DLPCRUDE DRAIN10 DLCBEIR(-1) DLCPR(-1) DLIDR(-1) DLRSN(-1) DLYSR1(-1) DLYSR2(-1) DLCPR(-1) DLIAR(-1) DLPYR(-1) DLUDR(-1) DLYIR(-1) ZLYIR(-1) DLYSR1(-1) DLYIR(-1) DD79 DD80 DD96 DD92 DD107

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.023	0.007	3.203	0.003
ZLYIR(-1)	-0.472	0.090	-5.239	0.000
DLYSR1(-1)	0.363	0.122	2.969	0.005
DLYIR(-1)	0.168	0.105	1.605	0.116
DD79	0.060	0.018	3.284	0.002
DD80	-0.076	0.019	-3.975	0.000
DD96	0.054	0.019	2.915	0.006
DD92	-0.046	0.018	-2.511	0.016
DD107	0.052	0.019	2.737	0.009
R-squared	0.72	Mean dependent var		0.06
Adjusted R-squared	0.67	S.D. dependent var		0.03
F-statistic	13.69	Durbin-Watson stat		1.84

Output of Services other than Community and Social and Personal Services

C3a. LYSR1 = f [LCBPE, LPVDYR, LKSR1 (-1), {C, TT, D_i, S_i,}]

The output of services other than community, social and personal services depends on net fixed capital stock of that sector, agricultural output and some structural breaks.

Table 4.C3a : Output of Services other than Community, Social and Personal Services: Levels

Dependent Variable: LYSR1
Method: Two-Stage Least Squares
Sample (adjusted): 1961 2010
Included observations: 50 after adjustments

Instrument specification: C TT DRAIN10 LCBNTR LCBPRE CRRATIO LBPR LCPR(-1) LIPR(-1) LYAR(-1) LYIR(-1) LYSR(-1) KAR(-) KIR(-1) D68 S68 D96 S96 D76 S76 LIMPR(-1) LPCRUDE LEXPR(-1) DD67 DD87 DD76 D66 S66 D75 S75 DD102 DD77 DD84 DD64

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.713	0.862	-1.987	0.054
LKSR1	0.594	0.029	20.618	0.000
LYAR	0.460	0.070	6.595	0.000
D66	0.130	0.017	7.576	0.000
D75	-0.696	0.054	-12.860	0.000
S75	0.027	0.002	11.929	0.000
DD102	-0.055	0.025	-2.166	0.036
DD84	-0.042	0.025	-1.674	0.102
DD64	0.059	0.027	2.150	0.038
R-squared	1.00	Mean dependent var		12.88
Adjusted R-squared	1.00	S.D. dependent var		0.88
F-statistic	7989.09	Durbin-Watson stat		1.46

YSR1: Output in service sector 1
KSR1: Capital Stock in service sector 1
In this case only the equation in levels is used.

Output of Community and Social and Personal Services

For output of community, social and personal services, lagged dependent variable and industrial output are found to be significant

C4a. LYSR2 = f [LKSR2 (-1), LYIR, {C, TT, D_i, S_i,}]

The output of the community, social and personal services is dependent on its own value and industrial output.

Table 4.C4a: Output of Community, Social and Personal Services: Levels

Dependent Variable: LYSR2
Method: Two-Stage Least Squares
Sample (adjusted): 1961 2010
Included observations: 50 after adjustments

Instrument specification: C TT DRAIN10 LCBNTR LCBPRE CRRATIO LBPR LCPR(-1) LIPR(-1) LYAR(-1) LYIR(-1) LYSR(-1) KAR(-) KIR(-1) D68 S68 D96 S96 D76 S76 LIMPR(-1) LPCRUDE LEXPR(-1) LYSR2(-1) DD100 DD95

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.052	0.039	-1.332	0.190
LYSR2(-1)	0.799	0.050	16.007	0.000
LYIR	0.202	0.048	4.226	0.000
DD100	0.070	0.018	3.931	0.000
DD95	-0.044	0.018	-2.495	0.016
R-squared	1.00	Mean dependent var		11.85
Adjusted R-squared	1.00	S.D. dependent var		0.78
F-statistic	24516.51	Durbin-Watson stat		1.580558

LKSR2: net fixed capital stock in community, social and personal services
YIR: industrial output

C4a. DLYSR2 = f [DLCBPE, ZLYSR2(-1), DLYSR2 (-1), {C, TT, D_i, S_i,}]

In the equation in first differences, changes in government primary expenditure along with the error correction term and lagged dependent variable are found to be significant.

Aggregate Supply (output): GDP at factor cost at constant prices

C5. YRR = [YAR +YIR + YSR1+YSR2 + DADJ]

DADJ: residual providing for difference in aggregate series of GDP at factor cost at 2004-05 prices and the sum of the sectoral series as provided by the CSO. This difference is up to 1999-00.

GDP at current market price

C6. YN = (YRR* PYR)+ IDLS

Private income

C8. PVDYR = (YN - IDLS - CFC + IPPDEBT - WPVDYR) / PYR

Personal disposable income

C9. PDYR = PVDYR - (CBDTR + WPDYR) / PYR

Gross domestic capital formation

C10. GDCFR = YMR - (CPR + CGR) + (IMPR - EXPR) - WYMR

Table 4.C4b : Output of Community, Social, and Personal Services: First Difference Equation with Error Correction

Dependent Variable: DLYSR2				
Method: Two-Stage Least Squares				
Instrument specification: DLPCRUDE DRAIN10 DLCBEIR(-1) DLCPR(-1) DLIDR(-1) DLRSN(-1) DLYSR1(-1) DLYSR2(-1) DLCPR(-1) DLIAR(-1) DLPYR(-1) DLUDR(-1) DLYIR(-1) ZLYSR2(-1) DLYSR2(-1) DD100 D80 S80 DD90 DD95 D70 S70 DD107 DLCBPE				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.050	0.009	5.465	0.000
DLCBPE	0.164	0.037	4.410	0.000
ZLYSR2(-1)	-0.462	0.114	-4.039	0.000
DLYSR2(-1)	0.239	0.099	2.423	0.020
DD100	0.063	0.013	4.738	0.000
D80	-0.170	0.044	-3.858	0.000
S80	0.006	0.002	3.793	0.001
DD90	0.026	0.014	1.904	0.064
DD95	-0.036	0.013	-2.783	0.008
D70	0.089	0.037	2.403	0.021
S70	-0.005	0.002	-3.252	0.002
DD107	-0.044	0.013	-3.310	0.002
R-squared	0.77	Mean dependent var		0.06
Adjusted R-squared	0.71	S.D. dependent var		0.02
F-statistic	11.95	Durbin-Watson stat		1.63

External Sector

The external sector has two key equations pertaining to imports and exports. For the external sector exports and import function are written with export and import in 2004-05 rupees divided by the exchange rate as the dependent variable. This highlight the influence of exchange rate changes, the exports and imports at 2004-05 figures expressed in rupee terms are divided by the exchange rate for the estimation of export and import demand equations. Imports are a function of domestic income and relative price of imports. Exports are a function of world exports which is exogenous. World exports are determined outside the model as a function of world income. The current account surplus ensures a balance of payment through an identity where capital and current account flow are balanced.

Demand for Exports

The demand for exports in dollar terms (EXPR/ER=EXPRDD) is specified as follows:

D1. LEXPRDD= f [LWEXP, LER, {C, TT, D_i, S_i,}]

Table 4.D1: Demand for Exports: Levels

Dependent Variable: LEXPRDD Method: Two-Stage Least Squares				
Instrument specification: C TT DRAIN10 LCBNTR LCBPRE CRRATIO LBPR LCPR(-1) LIPR(-1) LYAR(-1) LYIR(-1) LYSR(-1) KAR(-) KIR(-1) D68 S68 D96 S96 D76 S76 LIMPR(-1) LPCRUDE LEXPR(-1) LWEXP LER D80 S80 D94 S94 DD66 DD107				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	7.672	0.121	63.324	0.000
LWEXP	0.450	0.026	17.209	0.000
LER	-1.022	0.079	-12.938	0.000
D80	-0.885	0.261	-3.390	0.002
S80	0.028	0.008	3.653	0.001
D94	-2.796	0.363	-7.704	0.000
S94	0.067	0.008	8.447	0.000
DD66	-0.250	0.070	-3.586	0.001
DD107	0.137	0.069	1.988	0.054
R-squared	0.99	Mean dependent var		8.67
Adjusted R-squared	0.98	S.D. dependent var		0.52
F-statistic	388.13	Durbin-Watson stat		1.56
EXPRDD	Demand exports; WEXP	Index of world	exports	
ER	Exchange rate			

Demand for Imports

The demand for imports is specified as below.

D2. LIMPRDD= f [LYRR, LER, LIMPDD(-1), {C, TT, D_i, S_i,}]

Table 4.D2: Imports: Levels

Dependent Variable: LIMPRDD				
Method: Two-Stage Least Squares				
Instrument specification: C TT DRAIN10 LCBNTR LCBPRE CRRATIO LBPR LCPR(-1) LIPR(-1) LYAR(-1) LYIR(-1) LYSR(-1) KAR(-) KIR(-1) D68 S68 D96 S96 D76 S76 LIMPR(-1) LPCRUDE LEXPR(-1) LER LIMPRDD(-1) DD85 DD92 DD106				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-4.639	1.338	-3.466	0.001
LYR	0.560	0.154	3.650	0.001
LER	-0.345	0.109	-3.155	0.003
LIMPRDD(-1)	0.754	0.074	10.142	0.000
DD85	-0.296	0.106	-2.788	0.008
DD92	-0.329	0.107	-3.073	0.004
DD106	0.185	0.109	1.699	0.097
R-squared	0.96	Mean dependent var		8.91
Adjusted R-squared	0.95	S.D. dependent var		0.49
F-statistic	173.81	Durbin-Watson stat		1.41
IMPRDD	Imports at current prices in rupee terms			
YR	GDP at factor cost at constant prices; ER-Exc.rate			

The equation for price deflators for imports and exports are also developed.

Unit Value of Exports

The equation for unit value of exports is given below.

D3. LPEXP= f [LPYR, LPEXP(-1), LIMPDD(-1), {C, TT, D_i, S_i,}]

Table 4.D3: Unit Value of Exports: Levels

Dependent Variable: LPEXP
Method: Two-Stage Least Squares

Instrument specification: C TT DRAIN10 LCBNTR LCBPRE CRRATIO LBPR LCPR(-1) LIPR(-1) LYAR(-1) LYIR(-1) LYSR(-1) KAR(-) KIR(-1) D68 S68 D96 S96 D76 S76 LIMPR(-1) LPCRUDE LEXPR(-1) LPEXP(-1) DD92 DD71

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.044	0.012	3.710	0.001
LPYR	0.296	0.074	3.998	0.000
LPEXP(-1)	0.704	0.072	9.789	0.000
DD92	0.157	0.049	3.195	0.003
DD71	-0.237	0.050	-4.739	0.000
R-squared	1.00	Mean dependent var		-1.41
Adjusted R-squared	1.00	S.D. dependent var		1.13
F-statistic	6699.16	Durbin-Watson stat		1.46
PEXP	Unit value of exports			
PYR	Implicit price deflator for agriculture and allied sectors			

Unit Value of Imports

Similarly, an equation for unit value of imports is also developed. It is linked to implicit price deflator of GDP at factor cost and international price of crude.

D4. LPIMP= f [LPYR, LPEXP(-1), LIMPDD(-1), {C, TT, D_i, S_i,}]

In the external account, on the receipts side, apart from receipts from exports, the other important items include compensation of employees from the rest of the world, property and entrepreneurial incomes from the rest of the world, and other current transfers from the rest of the world to resident sectors other than general government. On the payments side, apart from imports, the main items are compensation of employees to the rest of the world, property and entrepreneurial income to the rest of the world, and other current transfers to the rest of the world by resident sectors other than general government. The main items are exports and imports. Looking at the time profile of current account surplus, it may be noted that, in recent years, except for three years (2001-02 to 2003-04), India has generally shown a current account deficit (i.e, a negative value for CAS). Net invisibles are represented by the term 'NIB'.

Table 4.D4: Unit Value of Imports: Levels

Dependent Variable: LPIMP
Method: Two-Stage Least Squares

Instrument specification: C TT DRAIN10 LCBNTR LCBPRE CRRATIO LBPR LCPR(-1) LIPR(-1) LYAR(-1) LYIR(-1) LYSR(-1) KAR(-) KIR(-1) D68 S68 D96 S96 D76 S76 LIMPR(-1) LPCRUDE LEXPR(-1) LPIMP(-1) DD75 DD72 DD87

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.244	0.093	-2.619	0.012
LPYR	0.340	0.082	4.122	0.000
LPCRUDE	0.069	0.022	3.143	0.003
LPIMP(-1)	0.599	0.092	6.486	0.000
DD75	0.317	0.085	3.730	0.001
DD72	-0.175	0.078	-2.240	0.030
DD87	-0.189	0.076	-2.489	0.017
R-squared	1.00	Mean dependent var		-1.47
Adjusted R-squared	1.00	S.D. dependent var		1.13
F-statistic	1854.08	Durbin-Watson stat		2.02

PIMP	Unit value of imports
PCRUDE	International price for crude petroleum
PYR	Implicit price deflator for agriculture and allied sectors

Trade balance

D5. TBL = (EXPRDD).(ER).(PEXP) - IMPR.(ER).(PIMP)

Current account balance

D6. CAS = TBL + NIB

The RBI provides foreign exchange liquidity to meet the demand from importers and contain volatility in the foreign exchange market arising out of capital account outflows. The overall approach to the management of India's foreign exchange reserves takes into account the changing composition of the balance of payments and endeavors to reflect the 'liquidity risks' associated with different types of flows and other requirements. The conduct of monetary policy had to contend with the high speed and magnitude of the external shock and its spill-over effects through the real, financial and confidence channels. The evolving stance of policy has been increasingly conditioned by the need to preserve financial stability while arresting the moderation in the growth momentum.

Chapter 5

SPECIFICATION AND ESTIMATION: MONETARY AND FISCAL SECTORS AND PRICES

This chapter contains specification and estimation details of the monetary and fiscal sectors and prices. Combining the sectors discussed in Chapter 4, it completes the model closures and provides details about exogenous variables and other model features.

Monetary Sector

For the monetary sector, we develop an equation for broad money (M3) by using a money multiplier that links reserve money (M0) to M3. The main policy instruments that are used are RBI policy rate (repo rate)and the cash-reserve ratio. We also develop equations for demand deposits and time deposits. These serve as determinants in the money multiplier equation.

The policy interest rate (BPR) is defined as bank rate up to 2004 and repo rate after that. The monetary sector has two key monetary aggregates. M0 refers to reserve money and M3 refers to broad money. Supply of broad money is determined by a money multiplier linking M0 to M3 with a short run interest rate. In addition, the cash reserve ratio is a key policy instrument affecting the M0-M3 relationship. Components of reserve money are divided into two aggregate parts: net RBI credit to government and the residual of reserve money, which is taken as exogenous. Net RBI credit to government is linked to combined fiscal deficit of the government.

Reduction in the CRR can have three inter-related effects on reserve money. First, it reduces reserve money as bankers' required cash deposits with the Reserve Bank, fall. Second, the money multiplier rises. Third, with the increase in the money multiplier, M3 expands with a lag.

The efficacy of the monetary transmission mechanism hinges on the extent and the speed with which changes in the central bank's policy rate are transmitted through the term-structure of interest rates across markets. The response to policy changes by the Reserve Bank has been faster in the money and government securities markets. But changes in the policy rates have not been fully transmitted to banks' lending rates. The adjustment in market interest rates in response to changes in policy rates gets reflected with some lag. The transmission to the credit market is somewhat slow on account of several structural rigidities. The administered interest rate structure of small savings acts as a floor to deposit interest rates. Without reduction in deposit rates, banks find it difficult to reduce lending rates exclusively on policy cues. Further, while banks are allowed to offer 'variable' interest rates on longer-term deposits, depositors have a distinct preference for fixed interest rates on such deposits which results in an asymmetric contractual relationship. In a rising interest rate scenario, while depositors retain the flexibility to prematurely withdraw their existing deposits and re-deploy the same at higher interest rates, banks have to necessarily carry these high cost deposits till their maturity in the downturn of the interest rate cycle. Also during periods of credit boom, competition among banks for wholesale deposits often hardens deposit interest rates, thereby further increasing the cost of funds. Further, the linkage of concessional administered lending rates, such as for agriculture and exports, to banks' BPLRs make overall lending rates less flexible. The persistence of large volumes of market borrowing by the government also hardens interest rate expectations.

The changes in BPR do not fully reflect the changes in the effective lending rates. During the pre-policy consultations with the Reserve Bank, banks pointed out that lending rates should not be assessed only in terms of reduction in BPRs since as much as three-quarters of lending is at rates below BPR which includes lending to agriculture, export sector, and well-rated companies, including PSUs.

RBI's objective is to maintain a monetary and interest rate regime supportive of price stability and financial stability taking into account the emerging lessons of the global financial crisis.

a. Components of Money Demand

Demand for Time Deposits

E1a. LTTN = [LPVDYR, RLN, LPYN; {C, TT, D_i, S_i,}]

The demand for time deposits is linked to private disposable income, implicit price deflator of GDP at market prices and long-term interest rate. The first two have positive impact while the latter one has a negative impact on demand for time deposits. Structural breaks in 1964-65 and 1978-79 are observed.

Table 5.E1a: Demand for Time Deposits: Levels

Dependent Variable: LTTN
Method: Two-Stage Least Squares
Sample (adjusted): 1961 2010
Included observations: 50 after adjustments

Instrument specification: C TT DRAIN10 LCBNTR LCBPRE CRRATIO LBPR LCPR(-1) LIPR(-1) LYAR(-1) LYIR(-1) LYSR(-1) KAR(-) KIR(-1) D68 S68 D96 S96 D76 S76 LIMPR(-1) LPCRUDE LEXPR(-1) LTTN(-1) D65 S65 D79 S79 LRLN(-1)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-2.677	1.660	-1.613	0.114
LPVDYR	0.432	0.110	3.906	0.000
LRLN(-1)	0.067	0.024	2.783	0.008
LTTN(-1)	0.581	0.068	8.535	0.000
D65	-0.980	0.194	-5.041	0.000
S65	0.064	0.013	4.964	0.000
D79	0.742	0.096	7.705	0.000
S79	-0.020	0.003	-5.825	0.000
R-squared	1.00	Mean dependent var		10.92
Adjusted R-squared	1.00	S.D. dependent var		2.57
F-statistic	61893.12	Durbin-Watson stat		1.73

TTN Time deposits

The equation for the first differences is specified below. An error correction term is found to be significant. As per the estimates, nearly 67 percent of the difference between actual and long term equilibrium value is made up in a year.

E1b. DLTTN = F [ZLTTN(-1), DLTTN(-1), {C, TT, D_i, S_i,}]

Table 5.E1b : Time Deposits: First Difference Equation with Error Correction

Dependent Variable: DLTTN
Method: Two-Stage Least Squares
Sample (adjusted): 1961 2011
Included observations: 51 after adjustments

Instrument specification: DLPCRUDE DRAIN10 DLCBEIR(-1) DLCPR(-1) DLIDR(-1) DLRSN(-1) DLYSR1(-1) DLYSR2(-1) DLCPR(-1) DLIAR(-1) DLPYR(-1) DLUDR(-1) DLYIR(-1) ZLTTN(-1) DD79 D86 S86 D77 S77 D62 S62 DLTTN(-1) DLRLN(-1)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.035	0.020	-1.760	0.086
ZLTTN(-1)	-0.673	0.125	-5.395	0.000
DLTTN(-1)	0.298	0.070	4.247	0.000
DD79	0.210	0.027	7.634	0.000
D86	-0.362	0.113	-3.197	0.003
S86	0.011	0.004	3.160	0.003
D77	0.497	0.111	4.476	0.000
S77	-0.017	0.004	-4.844	0.000
S62	0.007	0.001	6.650	0.000
R-squared	0.86	Mean dependent var		0.16
Adjusted R-squared	0.83	S.D. dependent var		0.06
F-statistic	31.43	Durbin-Watson stat		2.07

Demand for Demand Deposits

E2a. LDDN = [LPVDYR, LDDN(-1); {C, TT , D_i, S_i,}]

The demand for demand deposits is associated positively with both private disposable income (LPVDYR) and its own lag. Two structural break variables for the years 1979-80 and 1996-97 are found to be significant along with their interactions with trend. One period shifts are significant in 1974-75 and 1978-79.

Table 5.E2a: Demand for Demand Deposits: Levels

Dependent Variable: LDDN
Method: Two-Stage Least Squares
Sample (adjusted): 1961 2010
Included observations: 50 after adjustments

Instrument specification: C TT DRAIN10 LCBNTR LCBPRE CRRATIO LBPR LCPR(-1) LIPR(-1) LYAR(-1) LYIR(-1) LYSR(-1) KAR(-) KIR(-1) D68 S68 D96 S96 D76 S76 LIMPR(-1) LPCRUDE LEXPR(-1) LDDN(-1) DD75 DD79 D80 S80 D97 S97

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-53.513	3.007	-17.794	0.000
LPVDYR	4.686	0.241	19.420	0.000
LRSN(-1)	-0.216	0.124	-1.736	0.090
DD75	0.239	0.114	2.099	0.042
DD79	-0.650	0.136	-4.767	0.000
D80	2.250	0.320	7.038	0.000
S80	-0.084	0.011	-7.395	0.000
D97	3.507	0.668	5.248	0.000
S97	-0.080	0.014	-5.580	0.000
R-squared	1.00	Mean dependent var		9.82
Adjusted R-squared	1.00	S.D. dependent var		1.98
F-statistic	2103.12	Durbin-Watson stat		1.57

LPVYDR: private income

The short term equation containing a significant error correction term is developed as indicated below.

E2b. DLDDN = [DLRSN, ZLDDN(-1); {C, TT , D_i, S_i,}]

Table 5.E2b: Demand Deposits: First Difference Equation with Error Correction

Dependent Variable: DLDDN
Method: Two-Stage Least Squares
Sample (adjusted): 1961 2010
Included observations: 50 after adjustments

Instrument specification: DLPCRUDE DRAIN10 DLCBEIR(-1) DLCPR(-1) DLIDR(-1) DLRSN(-1) DLYSR1(-1) DLYSR2(-1) DLCPR(-1) DLIAR(-1) DLPYR(-1) DLUDR(-1) DLYIR(-1) ZLDDN(-1) DD79 D71 DD95 DD83 DD96

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.104	0.012	8.473	0.000
ZLDDN(-1)	-0.095	0.051	-1.848	0.072
DLRSN	0.141	0.070	2.021	0.050
DD79	-0.473	0.036	-13.059	0.000
D71	0.047	0.014	3.447	0.001
DD95	0.089	0.037	2.417	0.020
DD96	-0.074	0.037	-2.023	0.049
R-squared	0.82	Mean dependent var		0.13
Adjusted R-squared	0.80	S.D. dependent var		0.08
F-statistic	32.46	Durbin-Watson stat		1.57

b. Money Multiplier

The equation linking M0 to M3 is given below.

E3a. LMMULT= F[CRRATIO, LCWPN, LDDN, LTTN, LMMULT(-1), {C,TT, D_i, S_i,}]

The money multiplier depends on cash reserve ratio (CRRATIO), currency held with public (LCWPN), demand for demand deposits (LDDN) and demand for time deposits (LTTN) and its own lag. The cash reserve ratio and currency held with public have a negative impact on money multiplier while demand for demand deposits and demand for time deposits have a positive impact. A structural break in 2004-05 is observed. Two individual year dummies in 1987-88 and 1994-95 are also found to be significant.

Table 5.E3a : Money Multiplier: Levels

Dependent Variable: LMM
Method: Two-Stage Least Squares
Sample (adjusted): 1961 2010
Included observations: 50 after adjustments

Instrument specification: C TT DRAIN10 LCBNTR LCBPRE CRRATIO LBPR LCPR(-1) LIPR(-1) LYAR(-1) LYIR(-1) LYSR(-1) KAR(-) KIR(-1) D68 S68 D96 S96 D76 S76 LIMPR(-1) LPCRUDE LEXPR(-1) MM(-1) DD95 D106 DD88

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.236	0.063	3.733	0.001
CRRATIO	-1.609	0.221	-7.291	0.000
LCWPN	-0.237	0.037	-6.411	0.000
LDDN	0.136	0.021	6.478	0.000
LTTN	0.154	0.030	5.179	0.000
LMM(-1)	0.358	0.088	4.042	0.000
DD95	-0.038	0.021	-1.826	0.075
D106	-0.061	0.014	-4.536	0.000
DD88	-0.057	0.020	-2.814	0.008
R-squared	1.00	Mean dependent var		1.11
Adjusted R-squared	1.00	S.D. dependent var		0.31
F-statistic	1494.33	Durbin-Watson stat		1.68

CRRATIO: Cash-reserve ratio
CPWN: Currency held with public
DDN: Demand deposits
TTN: Time deposits

Short term dynamics for the money multiplier relationship is developed as given in the following relations ship.

E3b. DLMMULT= F[DLCWPN, ZLMMULT(-1), {C,TT, D_i, S_i,}]

Table 5E3b: Money Multiplier: First Difference Equation with Error Correction

Dependent Variable: DLMM
Method: Two-Stage Least Squares
Sample (adjusted): 1961 2011
Included observations: 51 after adjustments

Instrument specification: DLPCRUDE DRAIN10 DLCBEIR(-1) DLCPR(-1) DLIDR(-1) DLRSN(-1) DLYSR1(-1) DLYSR2(-1) DLCPR(-1) DLIAR(-1) DLPYR(-1) DLUDR(-1) DLYIR(-1) ZLMM(-1) D62 S62 D77 S77 D88 S88 D97 S97 D107 S107 DD103

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.174	0.093	1.877	0.069
DLCWPN	-0.703	0.239	-2.936	0.006
ZLMM(-1)	-0.456	0.181	-2.522	0.016
LBPR	-0.083	0.061	-1.365	0.181
D62	-0.095	0.045	-2.096	0.043
S62	0.008	0.003	2.440	0.020
D77	0.195	0.093	2.093	0.043
S77	-0.007	0.003	-2.350	0.024
D88	-0.332	0.148	-2.245	0.031
S88	0.008	0.004	2.121	0.041
D97	1.089	0.313	3.480	0.001
S97	-0.023	0.007	-3.257	0.003
D107	-0.787	0.429	-1.833	0.075
S107	0.015	0.007	2.002	0.053
DD103	0.054	0.023	2.316	0.026
R-squared	0.71	Mean dependent var		0.019
Adjusted R-squared	0.60	S.D. dependent var		0.034
F-statistic	5.51	Durbin-Watson stat		1.795
MMM	Money multiplier (M3/M0)			
CWPN	Currency with public			
BPR	Bank policy rate (bank rate/repo rate)			

c. Interest Rates

Short term Interest Rate

A long term equation alongwith a short term dynamics is estimated for the short run interest rates.

The long run relations ship is given the following relationship.

E4a. RSN = f [BPR, LM3, RSN (-1,-2); {C, TT , D_i, S_i,}] The short term interest rate (RSN) is positively and significantly associated with policy interest rate (BPR) and supply of broad money (LM3). It is also significantly related to its first two years lagged terms (positively with first year lag and negatively with second year lag).

Table 5. E4a: Short Term Interest Rate: Levels

Dependent Variable: LRSN
Method: Two-Stage Least Squares
Sample (adjusted): 1961 2010
Included observations: 50 after adjustments

Instrument specification: C TT DRAIN10 LCBNTR LCBPRE CRRATIO LBPR LCPR(-1) LIPR(-1) LYAR(-1) LYIR(-1) LYSR(-1) KAR(-) KIR(-1) D68 S68 D96 S96 D76 S76 LIMPR(-1) LPCRUDE LEXPR(-1) LRSN(-1 TO -2) DD78 DD103 DD92

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.202	0.072	2.802	0.008
LBPR	0.225	0.062	3.656	0.001
LRSN(-1)	0.679	0.061	11.133	0.000
DD78	-0.317	0.075	-4.254	0.000
DD103	-0.447	0.075	-5.999	0.000
DD92	0.195	0.076	2.557	0.014
R-squared	0.94	Mean dependent var		2.01
Adjusted R-squared	0.94	S.D. dependent var		0.30
F-statistic	149.77	Durbin-Watson stat		1.72
RSN	Short term interest rate (1 to 3 years deposit rate)			
BPR	Bank policy rate (bank rate/repo rate)			

The short term relationship is given by the following equation. As per the estimated equation nearly 46 percent of adjustment takes place in a year when the actual value deviates from the long run equilibrium value.

E4b. DLRSN = f [DLBPR, DLRSN (-1), ZLRSN(-1); {C, TT , D_i, S_i,}]

Table 5. E4b: Short Term Interest Rates: First Difference with Error Correction

Dependent Variable: DLRSN
Method: Two-Stage Least Squares
Sample (adjusted): 1961 2010
Included observations: 50 after adjustments

Instrument specification: DLPCRUDE DRAIN10 DLCBEIR(-1) DLCPR(-1) DLIDR(-1) DLRSN(-1) DLYSR1(-1) DLYSR2(-1) DLCPR(-1) DLIAR(-1) DLPYR(-1) DLUDR(-1) DLYIR(-1) DLBPR ZLRSN(-1) DLRSN(-1) DD78 DD103 DD92 DD69 DD107

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.004	0.009	0.460	0.648
DLBPR	0.226	0.083	2.710	0.010
ZLRSN(-1)	-0.455	0.088	-5.188	0.000
DLRSN(-1)	0.236	0.078	3.035	0.004
DD78	-0.295	0.062	-4.794	0.000
DD103	-0.462	0.063	-7.335	0.000
DD92	0.193	0.064	3.027	0.004
DD69	0.108	0.063	1.699	0.097
DD107	0.199	0.063	3.160	0.003
R-squared	0.80	Mean dependent var		0.01
Adjusted R-squared	0.76	S.D. dependent var		0.12
F-statistic	20.47	Durbin-Watson stat		1.46
RSN	Short term interest rate (1 to 3 years deposit rate)			
BPR	Bank policy rate (bank rate/repo rate)			

Nominal long term interest rate

E5a. LRLN = F[LRSN, LRLN (-1), LRSN (-1) {C, TT, D_i, S_i,}]

The long term interest rate (RLN) is linked to the short term interest rate (RSN) through a term structure. Both RSN and its one year lag and one year lag of RLN are significantly influencing the long term interest rate.

Table 5.E5a: Long Term Interest Rate: Levels

Dependent Variable: LRLN
Method: Two-Stage Least Squares
Sample (adjusted): 1961 2010
Included observations: 50 after adjustments

Instrument specification: C TT DRAIN10 LCBNTR LCBPRE CRRATIO LBPR LCPR(-1) LIPR(-1) LYAR(-1) LYIR(-1) LYSR(-1) KAR(-) KIR(-1) D68 S68 D96 S96 D76 S76 LIMPR(-1) LPCRUDE LEXPR(-1) LRLN(-1) LRSN(-1) DD70 S80 DD65 DD69

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.055	0.073	0.751	0.457
LRSN	0.796	0.094	8.484	0.000
LRLN(-1)	0.583	0.088	6.616	0.000
LRSN(-1)	-0.348	0.100	-3.473	0.001
DD70	-0.277	0.064	-4.350	0.000
S80	-0.002	0.001	-3.809	0.000
DD65	0.169	0.064	2.638	0.012
DD69	-0.239	0.061	-3.896	0.000
R-squared	0.96	Mean dependent var		2.15
Adjusted R-squared	0.95	S.D. dependent var		0.28
F-statistic	140.87	Durbin-Watson stat		1.72

This also has short term dynamics.

E5b. DLRLN = F[DLRSN, ZLRLN (-1), {C, TT, D_i, S_i,}]

Table 5. 5b: Long-term Interest Rate: First Difference Equation with Error Correction

Dependent Variable: DLRLN
Method: Two-Stage Least Squares
Sample (adjusted): 1961 2010
Included observations: 50 after adjustments

Instrument specification: DLPCRUDE DRAIN10 DLCBEIR(-1) DLCPR(-1) DLIDR(-1) DLRSN(-1) DLYSR1(-1) DLYSR2(-1) DLCPR(-1) DLIAR(-1) DLPYR(-1) DLUDR(-1) DLYIR(-1) ZLRLN(-1) DD71 DD69 DD65

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.006	0.010	-0.646	0.521
DLRSN	0.993	0.148	6.716	0.000
ZLRLN(-1)	-0.553	0.152	-3.645	0.001

DD71	0.299	0.066	4.518	0.000
DD69	-0.242	0.066	-3.672	0.001
DD65	0.141	0.074	1.908	0.063
R-squared	0.75	Mean dependent var		0.01
Adjusted R-squared	0.72	S.D. dependent var		0.12
S.E. of regression	0.06	Sum squared resid		0.18
F-statistic	19.02	Durbin-Watson stat		1.74

d. Bank Credit

Demand for Agricultural Credit

E6. LBFC= f [LPYR(-1), LRSN, LAGCREDIT(-1), {C, TT , D_i, S_i,}]

Table 5.E6: Demand for Agricultural Credit: Levels

Dependent Variable: LAGCREDIT
Method: Two-Stage Least Squares
Sample (adjusted): 1973 2009
Included observations: 37 after adjustments

Instrument specification: C TT DRAIN10 LCBNTR LCBPRE CRRATIO LBPR LCPR(-1) LIPR(-1) LYAR(-1) LYIR(-1) LYSR(-1) KAR(-) KIR(-1) D68 S68 D96 S96 D76 S76 LIMPR(-1) LPCRUDE LEXPR(-1) LAGCREDIT(-1) DD100 DD108

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.692	0.365	-1.893	0.068
LPYR	-0.150	0.051	-2.944	0.006
LRSN	-0.094	0.027	-3.461	0.002
LAGCREDIT(-1)	1.088	0.029	37.931	0.000
DD100	0.256	0.036	7.016	0.000
DD108	-0.132	0.038	-3.488	0.002
R-squared	1.00	Mean dependent var		10.20
Adjusted R-squared	1.00	S.D. dependent var		1.47
F-statistic	14087.13	Durbin-Watson stat		1.85
AGCREDIT	Area under cultivation			
PYR	Implicit price deflator for agriculture and allied sectors			
RSN	Short term interest rate (1 to 3 years deposit rate)			

Demand for Non-Food Credit

E7. LBNFC= F [LPWFUEL, LBNFC(-1) , {C, TT , D_i, S_i,}]

Supply of broad money

E8. M3= MMULT*M0

Change in Reserve Money

E9. DM0 = DRBICG + DRBIFER + DNWM0

Reserve Money

E10. M0=Mo(-1)+DM0

Table 5.E7: Non-food Bank Credit: Levels

Dependent Variable: LBCNFOOD
Method: Two-Stage Least Squares
Sample (adjusted): 1981 2010
Included observations: 30 after adjustments

Instrument specification: C TT DRAIN10 LCBNTR LCBPRE CRRATIO LBPR LCPR(-1) LIPR(-1) LYAR(-1) LYIR(-1) LYSR(-1) KAR(-) KIR(-1) D68 S68 D96 S96 D76 S76 LIMPR(-1) LPCRUDE LEXPR(-1) LBCNFOOD(-1) DD89 DD106 DD95 DD94

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.366	0.125	2.931	0.008
LRSN	-0.117	0.037	-3.126	0.005
LBCNFOOD(-1)	1.004	0.006	171.098	0.000
DD89	0.074	0.042	1.775	0.089
DD106	0.134	0.043	3.096	0.005
DD95	0.102	0.042	2.415	0.024
DD94	-0.106	0.042	-2.537	0.018
R-squared	1.00	Mean dependent var		12.31
Adjusted R-squared	1.00	S.D. dependent var		1.44
F-statistic	6061.62	Durbin-Watson stat		2.27
BCNFOOD	Residual in GDPmp identity			
RSN	Short term interest rate (1 to 3 years deposit rate)			

Prices

The following price indices are included in the model: (i) implicit price deflator of GDP at market prices, (ii) implicit price deflator of GDP at factor cost, (iii) implicit price deflator of agriculture GDP, (iv) unit value of imports, (v) unit value of exports, (vi) implicit price deflator of investment. The key variable among these is the implicit price deflator of GDP at factor cost, which is driven by money supply and real output. The other price deflators are linked to this. In addition, wholesale price indices for different commodity groups and one consumer price index for industrial workers is also included.

Implicit price deflator of GDP at factor cost market prices is estimated in first differences.

F1. DLPYR= f [DLM3, DLYRR (-1), DLPYR(-1), {C, TT , D_i, S_i,}]

The implicit price deflator of GDP at market prices (LPYN) is positively associated with international crude oil price index (PCRUDE) and lag of money supply (LM3). But it is negatively related to lag GDP real at factor cost (LYR).

Table 5.F1: Implicit Price Deflator of GDP at Factor Cost: First Differences

Dependent Variable: DLPYR
Method: Two-Stage Least Squares
Sample (adjusted): 1961 2011
Included observations: 51 after adjustments

Instrument specification: DLPCRUDE DRAIN10 DLCBEIR(-1) DLCPR(-1) DLIDR(-1) DLRSN(-1) DLYSR1(-1) DLYSR2(-1) DLCPR(-1) DLIAR(-1) DLPYR(-1) DLUDR(-1) DLYIR(-1) DLPYR(-1) DD76 DD74 DD79 DD71 DD80

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.019	0.020	0.956	0.344
DLM3	0.274	0.140	1.958	0.057
DLYRR	-0.450	0.119	-3.798	0.001
DLPYR(-1)	0.541	0.083	6.528	0.000
DD76	-0.120	0.022	-5.573	0.000
DD74	0.057	0.020	2.789	0.008
DD79	-0.060	0.020	-2.916	0.006
DD71	-0.044	0.020	-2.204	0.033
R-squared	0.75	Mean dependent var		0.071
Adjusted R-squared	0.71	S.D. dependent var		0.036
F-statistic	16.53	Durbin-Watson stat		1.875

M3	Broad money
LYRR	Net fixed capital stock in trade, transport, communications, and storage
PYR	Implicit price deflator for agriculture and allied sectors

Implicit price deflator of GDP at factor cost is also estimated in first differences.

F2. DLPYN = f [DLPYR, {C, TT, D_i, S_i,}]

Table 5.F2: Implicit Price Deflator of GDP at Market Prices: First Differences

Dependent Variable: DLPYN
Method: Two-Stage Least Squares
Sample (adjusted): 1961 2011
Included observations: 51 after adjustments

Instrument specification: DLPCRUDE DRAIN10 DLCBEIR(-1) DLCPR(-1) DLIDR(-1) DLRSN(-1) DLYSR1(-1) DLYSR2(-1) DLCPR(-1) DLIAR(-1) DLPYR(-1) DLUDR(-1) DLYIR(-1) DD109 DD76

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.001	0.002	0.591	0.557
DLPYR	0.993	0.022	44.473	0.000
DD109	-0.013	0.004	-3.289	0.002
DD76	0.008	0.004	1.851	0.070

R-squared	0.99	Mean dependent var	0.071
Adjusted R-squared	0.99	S.D. dependent var	0.036
F-statistic	842.31	Durbin-Watson stat	1.411

PYN	Implicit price deflator for GDP at market prices
PYR	Implicit price deflator for agriculture and allied sectors

The implicit price deflator at market prices is a markup on the implicit price deflator of GDP at factor cost, which itself reflects influences of money supply changes and real output changes.

Price equations for various wholesale price indices for different groups of commodities are developed. In particular, relations are worked out for WPI relating to food-grains, food articles, primary articles, fuel and energy, and manufactured articles.

Wholesale price index for food-grains

F3. LPFOOD = f [LPYR, LPWFOOD(-1), {C, TT, D_i, S_i,}]

Table 5.F3: Wholesale Price Indices: Food-grains: Levels

Dependent Variable: LPWFOOD
Method: Two-Stage Least Squares
Sample (adjusted): 1961 2010
Included observations: 50 after adjustments

Instrument specification: C TT DRAIN10 LCBNTR LCBPRE CRRATIO LBPR LCPR(-1) LIPR(-1) LYAR(-1) LYIR(-1) LYSR(-1) KAR(-) KIR(-1) D68 S68 D96 S96 D76 S76 LIMPR(-1) LPCRUDE LEXPR(-1) LPWFOOD(-1) DD75 DD74

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.935	0.322	9.124	0.000
LPYR	0.639	0.071	8.987	0.000
DD68	0.174	0.042	4.157	0.000
LPWFOOD(-1)	0.375	0.070	5.339	0.000
DD75	0.151	0.034	4.425	0.000
DD74	0.094	0.035	2.708	0.010
R-squared	1.00	Mean dependent var		3.24
Adjusted R-squared	1.00	S.D. dependent var		1.12
F-statistic	10846.33	Durbin-Watson stat		1.76

PWFOOD	Wholesale price index foodgrains
PYR	Implicit price deflator for agriculture and allied sectors

Wholesale price for food articles

F3. LPWFA = f [LYAR, LYIR, LPWFA(-1), {C, TT, D_i, S_i,}]

Table 5.F3: Wholesale Price Index: Food Articles

Dependent Variable: LPWFA
Method: Two-Stage Least Squares
Sample (adjusted): 1961 2010
Included observations: 50 after adjustments

Instrument specification: C TT DRAIN10 LCBNTR LCBPRE CRRATIO LBPR LCPR(-1) LIPR(-1) LYAR(-1) LYIR(-1) LYSR(-1) KAR(-) KIR(-1) D68 S68 D96 S96 D76 S76 LIMPR(-1) LPCRUDE LEXPR(-1)DD74 DD75 D103 DD68

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.741	1.806	-0.964	0.341
LPWFA(-1)	0.738	0.071	10.328	0.000
LYAR	-0.367	0.187	-1.956	0.057
LYIR	0.599	0.127	4.697	0.000
DD74	0.144	0.049	2.922	0.006
DD75	0.198	0.050	3.946	0.000
D103	-0.143	0.035	-4.046	0.000
DD68	0.175	0.050	3.499	0.001
R-squared	1.00	Mean dependent var		3.24
Adjusted R-squared	1.00	S.D. dependent var		1.12
F-statistic	3767.49	Durbin-Watson stat		1.99
PWFA	Wholesale price index for all commodities			
YAR	Output (GDP at factor cost) in agriculture and allied sectors			
YIR	Output (GDP at factor cost) in industry			

Wholesale price for primary articles

F4. LPWPA = f [LYAR(-1), LYIR(-1), LPWPFA(-1), {C, TT, D_i, S_i,}]

Table 5.F4: Wholesale Price Index: Primary Articles

Dependent Variable: LPWPA
Method: Two-Stage Least Squares
Sample (adjusted): 1972 2010
Included observations: 39 after adjustments

Instrument specification: C TT DRAIN10 LCBNTR LCBPRE CRRATIO LBPR LCPR(-1) LIPR(-1) LYAR(-1) LYIR(-1) LYSR(-1) KAR(-) KIR(-1) D68 S68 D96 S96 D76 S76 LIMPR(-1) LEXPR(-1) LPCRUDE D75 S75 D84 S84 DD90 LIMPR(-1) LPWPA(-1) DD76 DD75 DD90

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.162	1.811	2.299	0.028
LYAR(-1)	-0.650	0.213	-3.053	0.005
LYIR(-1)	0.352	0.112	3.153	0.004
LPWPA(-1)	0.965	0.055	17.516	0.000
DD76	-0.175	0.050	-3.499	0.001
DD75	0.130	0.049	2.685	0.011
DD90	0.105	0.048	2.216	0.034
R-squared	1.00	Mean dependent var		3.62
Adjusted R-squared	1.00	S.D. dependent var		0.92
F-statistic	2455.90	Durbin-Watson stat		1.68

PWPA	Wholesale price index for primary articles
YAR	Output (GDP at factor cost) in agriculture and allied sectors
YIR	Output (GDP at factor cost) in industry

Wholesale price for fuel and energy

F5. LPWFUEL = f [LPCRUDE, LER, {C, TT, D_i, S_i,}]

Table 5.F5: Wholesale Price Index: Fuel and Energy

Dependent Variable: LPWFUEL
Method: Two-Stage Least Squares
Sample (adjusted): 1961 2010
Included observations: 50 after adjustments

Instrument specification: C TT DRAIN10 LCBNTR LCBPRE CRRATIO LBPR LCPR(-1) LIPR(-1) LYAR(-1) LYIR(-1) LYSR(-1) KAR(-) KIR(-1) LPCRUDE D93 S93 DD74 DD87 DD66 DD93 DD89 DD88 DD65

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.152	0.103	-11.212	0.000
LPCRUDE	0.421	0.017	24.361	0.000
LER	1.032	0.056	18.548	0.000
D93	-0.664	0.241	-2.756	0.009
S93	0.016	0.005	3.571	0.001
DD74	0.377	0.087	4.316	0.000
DD87	0.344	0.088	3.897	0.000
DD66	0.270	0.090	2.989	0.005
DD93	-0.216	0.096	-2.243	0.031
DD89	0.285	0.090	3.172	0.003
DD88	0.257	0.088	2.909	0.006
DD65	0.187	0.090	2.073	0.045

R-squared	1.00	Mean dependent var	2.78
Adjusted R-squared	1.00	S.D. dependent var	1.34
F-statistic	1112.38	Durbin-Watson stat	1.20

PWFUEL	Wholesale price index for fuel and energy
PCRUDE	International price for crude petroleum
ER	International price for crude petroleum

F6. LPWMAN = f [LPWFUEL, LER, {C, TT, D_i, S_i,}]

Table 5.F6: Wholesale Price Index Manufactured Articles

Dependent Variable: LPWMAN
Method: Two-Stage Least Squares
Sample (adjusted): 1961 2010
Included observations: 50 after adjustments

Instrument specification: C TT DRAIN10 LCBNTR LCBPRE CRRATIO LBPR LCPR(-1) LIPR(-1) LYAR(-1) LYIR(-1) LYSR(-1) KAR(-) KIR(-1) D68 S68 D96 S96 D76 S76 LIMPR(-1) LPCRUDE LEXPR(-1) DD68 DD80 DD74 DD78 LPWMAN(-1) LPWMAN(-1) LPWFUEL(-1) DD73 DD80 D103 S103

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.944	0.055	17.231	0.000
LER	0.271	0.041	6.588	0.000
LPWFUEL(-1)	0.655	0.024	27.870	0.000
DD73	0.227	0.054	4.223	0.000
DD74	0.301	0.053	5.666	0.000
D96	2.421	0.482	5.023	0.000
S96	-0.052	0.010	-5.294	0.000
DD80	0.205	0.054	3.809	0.001
D103	-2.730	0.670	-4.073	0.000
S103	0.051	0.013	3.985	0.000
R-squared	1.00	Mean dependent var		3.38
Adjusted R-squared	1.00	S.D. dependent var		0.98
F-statistic	1954.35	Durbin-Watson stat		1.70

PWMAN	Wholesale price index for manufactured articles
ER	Exchange rate
PWFUEL	Wholesale price index for fuel and energy

Wholesale prices: All Commodity Index

The WPI all commodity index is derived as a weighted sum of WPI primary articles, WPI fuel and energy and WPI manufactured articles.

PWAC= (20.11815 * PWPA + 14.91021 * PWFUEL + 64.97164 * PWMAN) / 100

Consumer Price Index: Industrial Workers

F7. LPCPIIW = f [LM3, LRSN, LPCPIIW(-1), {C, TT, D_i, S_i,}]

Table 5.F7: Consumer Price Index: Industrial Workers

Dependent Variable: LPCPIIW
Method: Two-Stage Least Squares
Sample (adjusted): 1972 2010
Included observations: 39 after adjustments

Instrument specification: C TT DRAIN10 LCBNTR LCBPRE CRRATIO LBPR LCPR(-1) LIPR(-1) LYAR(-1) LYIR(-1) LYSR(-1) KAR(-) KIR(-1) D68 S68 D96 S96 D76 S76 LIMPR(-1) LPCRUDE LEXPR(-1) DD75 DD99 DD74 DD108 DD77 LPCPIIW(-1)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.810	0.125	-6.487	0.000
LM3	0.134	0.022	6.234	0.000
LRSN	0.098	0.015	6.633	0.000
LPCPIIW(-1)	0.728	0.043	16.765	0.000
DD75	0.184	0.020	9.059	0.000
DD99	0.059	0.020	2.928	0.007
DD74	0.121	0.021	5.810	0.000
DD108	-0.047	0.021	-2.255	0.032
DD77	-0.079	0.021	-3.837	0.001

R-squared	1.000	Mean dependent var	3.71
Adjusted R-squared	1.000	S.D. dependent var	0.89
F-statistic	10168.760	Durbin-Watson stat	2.02

PCPIIW	Consumer price index for industrial workers
M3	Broad money
RSN	Short term interest rate (1 to 3 years deposit rate)

Fiscal Sector

In the fiscal sector, for tax revenues two alternative approaches are applied. The first one, like other sectors, uses a long term relationship between tax revenues and tax base, and a short term error correction mechanism. In the second one, we use a buoyancy based approach making a distinction between long term buoyancy and short term departures from it. This is because in the case of tax revenues there are large number of discretionary changes that tend to be exogenous and may have permanent or temporary effects. The deviation of actual buoyancy from long term buoyancy is taken to be exogenous.

Income Tax Revenue

G1. LITR = f [LPDYR, LPYN, {C, TT , D_i, S_i,}]

Table 5.G1: Income Tax Revenues: Levels

Dependent Variable: LITR
Method: Two-Stage Least Squares
Sample (adjusted): 1961 2010
Included observations: 50 after adjustments

Instrument specification: C TT DRAIN10 LCBNTR LCBPRE CRRATIO LBPR LCPR(-1) LIPR(-1) LYAR(-1) LYIR(-1) LYSR(-1) KAR(-) KIR(-1) D68 S68 D96 S96 D76 S76 LIMPR(-1) LPCRUDE LEXPR(-1) LITR(-1) DD76 DD64 DD78

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-4.399	2.621	-1.678	0.101
LPDYR	0.486	0.241	2.020	0.050
LPYN	0.163	0.070	2.325	0.025
LITR(-1)	0.754	0.098	7.652	0.000
DD76	0.267	0.084	3.173	0.003
DD64	0.204	0.085	2.411	0.020
DD78	-0.226	0.085	-2.645	0.011
R-squared	1.00	Mean dependent var		8.10
Adjusted R-squared	1.00	S.D. dependent var		1.98
F-statistic	4959.44	Durbin-Watson stat		1.77
PDYR	Personal disposable income at 2004-05 prices			
PYN	Implicit price deflator for GDP at market prices			
ITR	Income tax revenues			

Income tax revenue (LITR) depends on income and prices. We have used personal disposable income (PDYR) and deflator of GDP at current market prices (PYN) to indicate these two variables. The short term elasticity of income tax revenues with respect to real income is about 0.49 and that with respect to prices is estimated to be 0.17. The persistence coefficient is about 0.75. This equation also includes individual year dummies for 1963-64, 1975-76, and 1977-78.

Corporation Tax Revenue

In the case of corporate tax revenues we apply the buoyancy based approach. The buoyancy for corporate tax revenue is defined as follows:

BCPTR= [{CPTR-CPTR(-1)}/{YN-YN(-1)}*{YN(-1)/CPTR(-1)}]

The actual buoyancy is the sum of long term buoyancy (BCPTRL) and short term departure from it (DBCPTR).

BCPTR=BCPTRL+DBCPTR

The corporate tax revenues are given by:

G2. CPTR= CPTR(-1)+BCPTR*[CPTR(-1)/YN(-1)]/(YN-YN(-1)]

The long term buoyancy is estimated from the following equation.

Table 5.G2: Corporate Tax Buoyancy

Dependent Variable: BITR
Method: Least Squares
Sample (adjusted): 1961 2010
Included observations: 50 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-2.288	1.940	-1.179	0.245
BITR(-1)	-0.197	0.080	-2.450	0.019
LPVDYR	0.265	0.140	1.891	0.066
DD76	4.235	0.651	6.507	0.000
DD78	-2.529	0.658	-3.843	0.000
DD98	-1.902	0.651	-2.920	0.006
DD101	1.932	0.659	2.932	0.006
DD69	1.614	0.657	2.455	0.019
DD64	1.630	0.661	2.466	0.018
DD82	-1.298	0.649	-2.000	0.052
R-squared	0.70	Mean dependent var		1.23
Adjusted R-squared	0.63	S.D. dependent var		1.06
F-statistic	10.45	Durbin-Watson stat		1.92

Union Excise Duties

In the case of Union excise duties also a buoyancy based approach is followed. The relevant details are as follows:

BUDR= [{UDR-UDR(-1)}/{YN-YN(-1)}*{YN(-1)/UDR(-1)}]

The actual buoyancy is the sum of long term buoyancy (BUDRL) and short term departure from it.(DBUDR).

BUDR=BUDRL+DBUDR

The Union excise duty revenues are given by are given by:

G3. UDR= UDR(-1)+BUDR*[UDR(-1)/YN(-1)]/(YN-YN(-1)]

The estimated buoyancy equation is given by the following. It responds negatively to inflation and exchange rate depreciation. A number of single year breaks are noted reflecting discretionary changes.

Table 5.G3: Buoyancy of Union Excise Duties

Dependent Variable: BUDR
Method: Least Squares
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.326	0.369	9.007	0.000
BUDR(-3)	0.113	0.040	2.854	0.006
DLPYR	-15.274	2.448	-6.240	0.000
LER	-0.452	0.096	-4.722	0.000
DD80	-1.954	0.612	-3.193	0.002
DD90	3.464	0.584	5.927	0.000
DD101	4.271	0.595	7.179	0.000
DD103	5.350	0.595	8.988	0.000
DD109	-1.536	0.591	-2.601	0.012
DD91	-1.905	0.589	-3.235	0.002
R-squared	0.86	Mean dependent var		1.26
Adjusted R-squared	0.84	S.D. dependent var		1.43
F-statistic	34.65	Durbin-Watson stat		1.81

Import Duties

G4. LIDR = f [LIMPR, LIDR(-1) {C, TT , D_i,S_i,}]

Import duty revenues (LIDR) depend on volume of imports and unit price of imports both with higher than unit elasticities. Structural breaks at 1965-66 and 1986-87 are provided.

Table 5.G4: Import Duty Revenues: Levels

Dependent Variable: LIDR
Method: Two-Stage Least Squares
Included observations: 50 after adjustments

Instrument specification: C TT DRAIN10 LCBNTR LCBPRE CRRATIO LBPR LCPR(-1) LIPR(-1) LYAR(-1) LYIR(-1) LYSR(-1) KAR(-) KIR(-1) D68 S68 D96 S96 D76 S76 LIMPR(-1) LPCRUDE LEXPR(-1) DD101 D69 S69 LIDR(-1) D77 S77 D87 S87 DD66 DD73

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-2.721	1.553	-1.752	0.087
LIMPR	1.168	0.133	8.786	0.000
LPIMP	1.162	0.071	16.457	0.000
D87	5.456	0.503	10.850	0.000
S87	-0.133	0.014	-9.814	0.000
DD66	0.469	0.158	2.972	0.005
DD73	0.551	0.157	3.515	0.001
R-squared	0.99	Mean dependent var		8.68
Adjusted R-squared	0.99	S.D. dependent var		1.99
F-statistic	1407.90	Durbin-Watson stat		1.35

IDR: Import duty revenues; PIMP: Unit Value of imports
IMPR: Imports at constant prices in rupee terms

States Sales Taxes

G5. DLSSR = f [DLPCRUDE, DLPYN{C, TT, D_i, S_i,}]

Both real income (LYR) and implicit price deflator of GDP at factor cost (LPYR) significantly and positively determine the states sales tax revenues (LSSR). Structural breaks for the years 1963-64, 1975-76, and 1980-81 significantly determine the change in sales tax revenues.

Table 5.G5: States Sales Taxes: First Differences

Dependent Variable: DLSSR				
Method: Two-Stage Least Squares				
Sample (adjusted): 1961 2011				
Included observations: 51 after adjustments				
Instrument specification: DLPCRUDE DRAIN10 DLCBEIR(-1) DLCPR(-1) DLIDR(-1) DLRSN(-1) DLYSR1(-1) DLYSR2(-1) DLCPR(-1) DLIAR(-1) DLPYR(-1) DLUDR(-1) DLYIR(-1) DD76 DD82 DD64 DD80				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.088	0.019	4.549	0.000
DLPCRUDE	0.071	0.026	2.780	0.008
DLPYN	0.678	0.267	2.535	0.015
DD76	0.159	0.049	3.274	0.002
DD82	0.077	0.044	1.751	0.087
DD64	0.121	0.043	2.802	0.008
DD80	-0.097	0.049	-1.987	0.053
R-squared	0.46	Mean dependent var		0.15
Adjusted R-squared	0.39	S.D. dependent var		0.05
F-statistic	6.24	Durbin-Watson stat		2.39
SSR	State sales tax revenues			
PCRUDE	International price for crude petroleum			
PYN	Implicit price deflator for GDP at market prices			

State Excise Duties

G6. DLSEDR = f [DLPYR, LPYR{C, TT, D_i, S_i,}]

Table 5.G6: State Excise Duties: First Differences

Dependent Variable: DLSEDR
Method: Two-Stage Least Squares
Sample (adjusted): 1961 2011
Included observations: 51 after adjustments

Instrument specification: DLPCRUDE DRAIN10 DLCBEIR(-1) DLCPR(-1) DLIDR(-1) DLRSN(-1) DLYSR1(-1) DLYSR2(-1) DLCPR(-1) DLIAR(-1) DLPYR(-1) DLUDR(-1) DLYIR(-1) DD95 DD98 DD69 DD90 DD82 DD97

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.101	0.021	4.850	0.000
DLPYR	0.430	0.283	1.520	0.136
DD98	0.123	0.041	2.978	0.005
DD69	0.083	0.043	1.921	0.061
DD90	0.090	0.041	2.174	0.035
DD82	0.152	0.042	3.586	0.001
DD97	-0.106	0.041	-2.562	0.014
R-squared	0.542	Mean dependent var		0.14
Adjusted R-squared	0.480	S.D. dependent var		0.06
F-statistic	6.730	Durbin-Watson stat		1.82
SEDR	State excise duty revenues			
PYR	Implicit price deflator for agriculture and allied sectors			

Indirect taxes net of subsidies

This term is needed in linking GDP at factor cost to GDP at market prices. This is explained with linking equation that translates combined indirect taxes from public finance accounts to indirect taxes net of subsidies in the national income account.

G7. IDLS= F [CBITR, {C, TT, D_i, S_i,}]

Table 5.G7: Indirect Taxes net of Subsidies: Levels

Dependent Variable: LIDLS
Method: Least Squares
Sample (adjusted): 1961 2010
Included observations: 50 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.404	0.037	10.835	0.000
LCBITR	0.932	0.004	224.090	0.000
D110-D109	0.312	0.031	10.101	0.000
D90	-0.597	0.133	-4.481	0.000
S90	0.015	0.003	5.041	0.000
D100	0.796	0.203	3.917	0.000
S100	-0.016	0.004	-3.925	0.000
R-squared	1.00	Mean dependent var		10.042
Adjusted R-squared	1.00	S.D. dependent var		1.878
F-statistic	39414.48	Durbin-Watson stat		1.902
IDLS	Indirect taxes net of subsidies at current prices			
ITR	Income tax revenues			

Combined effective interest rate

G8a. FCBEIR = [(LRLN), CBEIR(-1) {C, T, D_i, S_i,}]

Table 5.G8a: Combined Effective Interest Rate: Levels

Dependent Variable: LCBEIR
Method: Two-Stage Least Squares
Sample (adjusted): 1981 2010
Included observations: 30 after adjustments

Instrument specification: C TT DRAIN10 LCBNTR LCBPRE CRRATIO LBPR LCPR(-1) LIPR(-1) LYAR(-1) LYIR(-1) LYSR(-1) KAR(-) KIR(-1) D68 S68 D96 S96 D76 S76 LIMPR(-1) LPCRUDE LEXPR(-1) LCBEIR(-1 TO -2) D89 S89

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.646	0.183	-3.523	0.002
LRLN	0.130	0.040	3.261	0.003
LCBEIR(-1)	0.487	0.168	2.894	0.008
LCBEIR(-2)	0.378	0.161	2.354	0.027
D89	0.194	0.075	2.584	0.016
S89	-0.003	0.002	-2.172	0.040

R-squared	0.98	Mean dependent var	-2.57
Adjusted R-squared	0.97	S.D. dependent var	0.19
F-statistic	216.59	Durbin-Watson stat	1.73

CBEIR	Effective interest rate on combined debt
RLN	Long-term interest rate defined as interest rates on deposits above 3-5 years maturity

The combined effective interest rate (CBEIR) is affected by positively by long term interest rate (RLN) and its own lagged term. A structural break is observed in 1988-89.

An error correction process is found to be significant in this case.

G8b. DLCBEIR = F[DRLN(-1), ZLCBEIR(-1), DLCBEIR, {C, T, D_i, S_i,}]

Table 5.G8b: Combined Effective Interest Rate: First Difference with Error Correction

Dependent Variable: DLCBEIR
Method: Two-Stage Least Squares
Sample (adjusted): 1961 2010
Included observations: 50 after adjustments

Instrument specification: DLPCRUDE DRAIN10 DLCBEIR(-1) DLCPR(-1) DLIDR(-1) DLRSN(-1) DLYSR1(-1) DLYSR2(-1) DLCPR(-1) DLIAR(-1) DLPYR(-1) DLUDR(-1) DLYIR(-1) ZLCBEIR(-1) DLCBEIR(-1) DD65 D63 S63 D76 S76 D89 S89 D75 DD77 DD80 DD100

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.133	0.026	5.058	0.000
DLRLN	0.085	0.070	1.225	0.229
ZLCBEIR(-1)	-1.111	0.033	-33.987	0.000
DLCBEIR(-1)	0.090	0.022	4.100	0.000
DD65	-1.426	0.042	-33.962	0.000
D63	0.619	0.058	10.724	0.000
S63	-0.042	0.003	-15.815	0.000
D76	-1.660	0.111	-15.014	0.000
S76	0.062	0.004	16.829	0.000
D89	0.970	0.096	10.059	0.000
S89	-0.024	0.003	-9.092	0.000
D75	0.163	0.039	4.183	0.000
DD77	0.259	0.035	7.436	0.000
DD80	0.085	0.033	2.604	0.013
DD100	0.054	0.031	1.735	0.092

R-squared	0.99	Mean dependent var	0.030
Adjusted R-squared	0.99	S.D. dependent var	0.319
F-statistic	387.28	Durbin-Watson stat	1.589

CBEIR	Effective interest rate on combined debt
RLN	Long-term interest rate defined as interest rates on deposits above 3-5 years maturity

Combined indirect taxes

G9. CBITR= UDR+IDR+SSR+SEDR+WCBITR \

Combined direct taxes

G10. CBDTR= ITR+CPTR+WCBDTR

Combined Tax Revenue

G11. CBTR = CBDTR+CBITR

Combined Revenue Receipts

G12. CBRR = CBTR + CBNTR

Combined Interest Payments

G13. CBIP = (CBEIR). CBDEBT(-1)

Combined Revenue Expenditure

G14. CBRE = CBIP + CBPRE

Combined Revenue Deficit

G15. CBRD = CBRE – CBRR

Combined Capital Expenditure

G16. CBKE = CBKR - CBRD

Combined Capital Receipts

G17. CBKR = CBFDO + CBNDKR

Combined Debt

G18. CBDEBT = CBDEBT(-1) + CBFDD

Fiscal deficit is derived as increment in the budgeted government liabilities.

A summary of equations for the different sectors considered in this Chapter is given in Table 5.H1.

Table 5.H1 Summary of Sectoral Equations

	Sector	Stochastic equations	Identities
A	Consumption demand	2	
B	Investment	5	8
C	Output	4	6
D	External sector	4	2
E	Monetary Sector	7	3
F	Prices	7	1
G	Fiscal sector	8	10
	Total	37	30

Model Closures and Exogenous Variables

Output Sector (the real sector) is closed with an income-expenditure identity. The fiscal sector is closed with a budget identity for the combined finances. The external sector is closed with a balance of payment identity. The model has 67 equations of which 37 equations are stochastic and remaining 30 equations are definitions/identities. A list of exogenous variables other than structural break dummies is given in Table 5.H2.

Table 5.H2: List of Exogenous Variables

Policy variables	Others	Accounting residuals	Expectatios
DBCPTR	ACRE	WCBDTR	XXDLPYR
DBUDR	CBNDKR	WCBITR	
CBFDD	CBNTR	WEXP	
DLCBPE	CFCRRATIO	WNIFCR	
RBICG	CWPN	WPDYR	
ISR2	ER	WPVDYR	
BPR	IPPDEBT	WYMR	
CRRATIO	NIB	WYRR	
	NWM0		
	PCRUDE		
	RBIFER		

The details of structural breaks variables used in the model are listed in Table 5H2. This list does not include individual year shifts.

Table 5 H3: Structural Break Dummies

Structural Break Years (With intercept or slope shifts)

Sixties	Seventies	Eighties	Nineties	Last decade
D, S 62	D, S 70	D, S 80	D, S 90	D, S 100
D, S 63	D, S 71	D81	D, S 91	D,S 101
D64	D, S 75	D82	D, S 93	D103
D, S 65	D, S 76	D, S 83	D, S 94	D106
D66	D, S 77	D86	D, S 95	D, S107
D, S67	D, S 79	D, S 88	D, S 96	
		D, S 89	D, S 97	
			D98	

Chapter 6

PREDICTION PERFORMANCE: EVALUATION

In this chapter we take up an evaluation of the model's capacity to estimate the endogenous variables within the sample in terms of both static and dynamic forecasts. In static forecasts, the actual values of lagged endogenous variable are used. In dynamic forecasts, the model generated values of lagged endogenous variables are used. Although various considerations arise in model evaluation, the most relevant of these is its forecasting performance, i.e., its ability to correctly estimate, first within the sample, the values of all endogenous variables, and then to guide in situations outside its sample. The more reliable a model turns out to be, the more useful it will be in decision- making situations.

Many available test procedures relate to single-variable forecasts which are compared against corresponding realizations and/or alternative forecasts. We first briefly review the methodology for forecast evaluation by defining the summary indicators and the diagnostic checks for identifying systematic errors in section 6.1.

Evaluating Model Performance: Methodology
a. Summary Measures and Diagnostic Checks

Once a forecast series P_t and a series of realizations A_t for t = 1, 2,…., n become available, there are various ways in which how closely the predictions emulate the realizations can be described. This can be done both with respect to levels and changes in levels of variables. It is useful to consider this distinction first.

Many of the descriptive measures of forecast accuracy have evolved with reference to changes in variables even if the model forecasts levels. Although the measures can easily be adapted to refer to levels, sometimes their interpretation would change.

When a model predicts levels, one can calculate 'changes' in one of two ways: (i) by successive differences between predicted levels ($\triangle P_t = P_t - P_{t-l}$) and (ii) by taking the difference between predicted level of a period and the actual level of the previous period ($\triangle P_t = P_t - A_{t-1}$). In the latter case, a comparison between predicted and actual changes is equivalent to a similar comparison between levels, i.e.

$$\triangle P_t - \triangle A_t = (P_t - A_{t-1}) - (A_t - A_{t-I}) = P_t - A_t \quad (1)$$

It is not always necessary to cast the evaluation framework in terms of changes as long as the measures used are correctly interpreted. Some of the standard statistical measures of forecast accuracy available in the literature are defined as follows.

(i) Correlation Coefficient between Predictions and Realizations

The correlation coefficient between two series is designed to indicate how closely the two move together. This statistics is defined as:

$$\rho_{PA} = \frac{\sum(P-\bar{P})(A-\bar{A})}{n\sigma_P\sigma_A} \qquad (2)$$

where, n is the sample size and σ's are the standard deviations of P and A.

The properties of this measure, viz. it is independent of the origin and unit of measurement, render it somewhat inappropriate in the context of measuring forecast accuracy. These properties imply that if all the forecasts were multiplied by a constant or a constant was added to these, this measure would not be able to pick it up. Despite this, the implicit scale of the measure from a minimum of -1 to a maximum of 1 remains a useful property.

(ii) Average Absolute Error

Average absolute error is defined as: $\sum_{t=1}^{n}\left|P_t - A_t\right| = \sum_{t=1}^{n}\left|u_t\right|$. This has a minimum value of zero when all $P_t = A_t$. It has no maximum value and it is not able to distinguish between turning point errors and ordinary errors.

(iii) Mean Square and Root Mean Square Errors

These measures are respectively defined as:

$$Mp = [1/n \Sigma (P_t - A_t)^2] \text{ and } RMSQ = \sqrt{Mp} \qquad (3)$$

These also have a minimum value of zero in the case of perfect forecasts. There is no upper limit. Their inadequacy lies in not having a proper unit of measurement. They give the same weight to a deviation whether a variable is measured in rupees or billion rupees or percentages. They however, have interesting mathematical and statistical properties and lend themselves to useful decompositions.

(iv) Inequality Coefficients

The inequality coefficients given in Theil (1961, 1966) are based on the mean square error. In addition, they provide a suitable unit of measurement. They may be defined both with respect to levels and changes as given below:

(a) Levels: With respect to levels, Theil's inequality coefficient may be defined as:

$$U_{L1} = [\Sigma (P_t - A_t)^2 / \Sigma A_t^2]^{1/2} \quad (4)$$

(b) Changes in Variables: With respect to changes, it may be defined as follows:

$$U_{C1} = \frac{[\Sigma (\Delta P_t - \Delta A_t)^2]^{1/2}}{(\Sigma \Delta A_t^2)^{1/2}} \quad (5)$$

Most of the statistics defined above have an implicit quadratic cost of error function and lead to a least squares ranking criterion, which has attractive properties.

The intuitive basis of all the measures defined above is the belief that the more closely predictions follow realizations, the better these are. This must however be qualified by the consideration that for all stochastic processes forecasts will be made with errors even if all the information in the universe is used (Granger, 1972). In such a case, optimal predictors are not necessarily those where the variances of predictions are equal to the variance of realizations. The point has been illustrated by decomposing the expected squared forecast error in the following manner:

$$S = E (P - A)^2 = (\mu_P - \mu_A)^2 + \sigma^2_P + \sigma^2_A - 2 \rho \sigma_P \sigma_A \quad (6)$$

Here μ_P, and μ_A are population means of predictions and realizations; σ_p^2 and σ_A^2 are respectively the population variances of predictions and realizations and ρ is the correlation coefficient. Assuming S to be a function of μ_P, σ_p and ρ, the necessary conditions for minimizing S can be obtained. S is minimized by taking ρ as large as possible with $\mu_P = \mu_A$ and $\sigma_p = \rho \sigma_A$. While the mean of the two series should coincide, the variances need not be equal.

Apart from ranking forecasts, a comparison of predictions and realizations may also be used for diagnostic checks on the forecasting procedures with a view to modify them. Some insight into the nature of prediction errors is obtained by regressing realizations.

$$A_t = \alpha + \beta P_t + u_t \quad (7)$$

This type of line is drawn in Chart 1. A value of α that is equal to zero means that the regression line passes through the origin and a unit value of β means that it coincides with the line of perfect forecasts (LPF). RL refers to the estimated line. In the case of unit correlation between P_t and A_t ($U_t = 0$, $V_t = 0$) we will get $\beta = 1$. Thus, the non-zero value of α, and non-unity value of β have been interpreted as 'systematic' errors in the forecast.

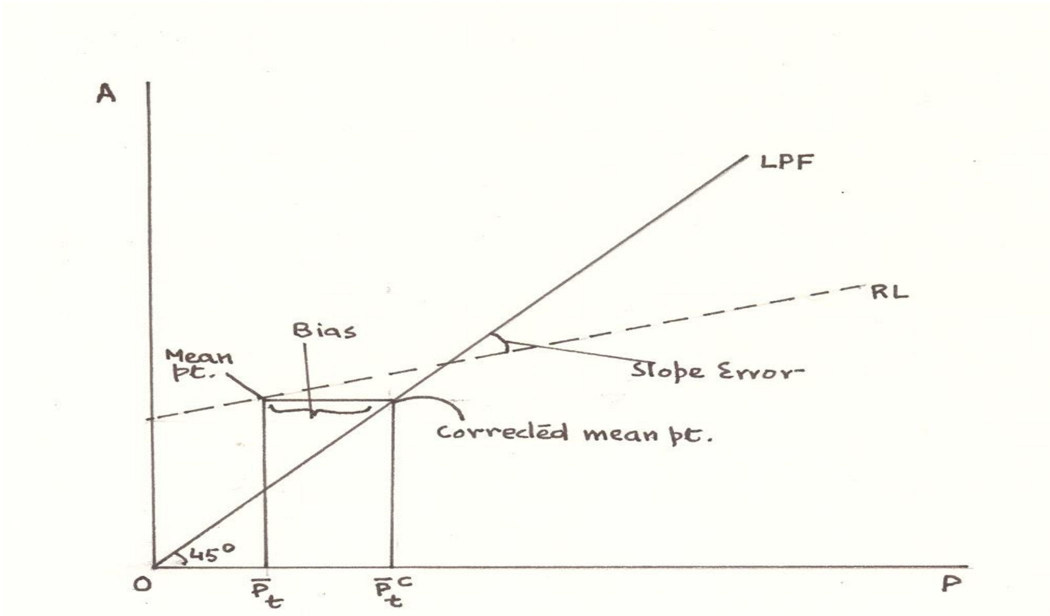

Chart 1: Errors of Bias and Slope

We observe from Chart 1 that the mean point (P_t, A_t) does not lie on the line of perfect forecast (LPF). This is a source of systematic bias and can be removed by shifting the regression line until the mean point lies on the LPF. As it is desirable for the mean point to be on the LPF, so also it is intuitively desirable that the whole regression line coincides with the LPF. If this is so, the forecast is called efficient (Mincer and Zarnotwitz, 1969). When it is not so, such efficiency can be obtained by rotating the shifted regression line such that it coincides with the LPF.

Theil (1958) has suggested that the mean square error M_P can be decomposed as follows:

$$M_P = (\mu_P - \mu_A)^2 + (S_p - r\,S_A)^2 + (1 - r^2)S_A^2 \qquad (8)$$

where μ_P and μ_A are the sample means of predictions and realization, S_P and S_A are their standard deviations and r is the correlation coefficient between them. The division of the terms on the right-hand side by the mean square error gives rise to the following quantities which are called 'inequality proportions':

$$U^M = (P - A) / M_P \qquad \text{mean proportion} \qquad (9)$$
$$U^R = (S_P - r\,S_A)^2 / M_P \qquad \text{slope proportion} \qquad (10)$$
$$U^D = (1-r^2)\,S_A / M_P \qquad \text{disturbance proportion} \qquad (11)$$

The terms thus provide information on the relative importance of one source of error vis-a-vis another. The mean proportion has a positive value if $\mu_P \neq \mu_A$. This is due therefore to 'bias'. The derivation of S_P for r S_A is due to slope error, and the third term is a disturbance component.

We have selected a subset of endogenous variables for the validation analysis.

Output Variables

From the output variables, we have looked at the following variables: YAR, YIR, YSR1, YSR2, and YR. The comparison is made between predicted and actual growth rates. The period covered is from 1983-84 to 2009-10. Table 6.1 gives the summary statistics regarding in-sample prediction performance for static as well as dynamic estimates. Theil statistics indicates fairly low value of the summary measure ranging from 0.2 to 0.5 with the latter relating to the agricultural sector. The decomposition of the mean square error indicates that the contribution of systematic errors like bias and slope errors are quite low. In all cases, the contribution of the disturbance proportion is the highest, indicating that systematic factors have been taken into account.

The next group of variables relate to consumption and investment demand. Table 6.2 gives the summary statistics regarding in-sample prediction performance for static as well as dynamic estimates. Theil statistics indicates fairly low value of the summary measure ranging from 0.3 to 0.8. In general static forecasts show better performance, which is to be expected.

Table 6.1: Prediction Performance: Output Variables (Comparison of Growth Rates)

Variable	Summary Measures		Decomposition of Mean Sq Error		
YAR	RMSQ	Theil Q	Bias	Slope	Disturbance
Static	2.646	0.474	0.005	0.202	0.792
Dynamic	2.732	0.489	0.005	0.231	0.764
YIR					
Static	3.12	0.43	0.001	0.266	0.734
Dynamic	2.75	0.38	0.040	0.002	0.958
YSR1					
Static	2.057	0.247	0.000	0.308	0.692
Dynamic	1.703	0.204	0.134	0.010	0.856
YSR2					
Static	2.00	0.28	0.000	0.180	0.820
Dynamic	2.05	0.29	0.008	0.072	0.919
YR					
Static	1.306	0.196	0.001	0.148	0.851
Dynamic	1.332	0.200	0.155	0.013	0.832

The decomposition of the mean square error indicates that the contribution of systematic errors like bias and slope errors are quite low. In all cases, the contribution of the disturbance proportion is the highest, indicating that systematic factors have been taken into account.

Table 6.2: Prediction Performance: Consumption and Investment (Comparison of Growth Rates)

Variable	Summary Measures		Decomposition of Mean Sq Error		
CPR	RMSQ	Theil Q	Bias	Slope	Disturbance
Static	1.918	0.333	0.000	0.305	0.695
Dynamic	1.791	0.311	0.085	0.146	0.769
CGR					
Static	3.37	0.44	0.000	0.067	0.932
Dynamic	2.71	0.36	0.000	0.025	0.975
IHR					
Static	19.043	0.843	0.002	0.090	0.908
Dynamic	16.266	0.720	0.001	0.000	0.999
IPCR					
Static	22.53	0.82	0.003	0.069	0.928
Dynamic	21.39	0.78	0.002	0.043	0.955
IGR					
Static	6.711	0.641	0.002	0.030	0.968
Dynamic	5.606	0.536	0.001	0.001	0.998

In Table 6.3, apart from indirect taxes net of subsidies, we look at exports and imports in dollar as well as rupee terms to see how the model performs. In almost all cases, the systematic errors of bias or low or very low and the disturbance error is the main source of error which is due to random factors.

Table 6.3: Prediction Performance: Export and Imports (Comparison of Growth Rates)

Variable	Summary Measures		Decomposition of Mean Sq Error		
EXPRDD	RMSQ	Theil Q	Bias	Slope	Disturbance
Static	7.275	0.520	0.000	0.052	0.948
Dynamic	7.275	0.520	0.000	0.052	0.948
IMPRDD					
Static	9.86	0.63	0.000	0.144	0.856
Dynamic	9.30	0.59	0.000	0.013	0.987
EXPR					
Static	7.614	0.527	0.003	0.049	0.948
Dynamic	7.614	0.527	0.003	0.049	0.948
IMPR					
Static	10.96	0.68	0.002	0.353	0.645
Dynamic	10.28	0.64	0.004	0.188	0.808

In Table 6.4, we look at the prediction performance in regard to the monetary sector variables. Theil statistics indicates fairly low value of the summary measure. In these cases also, the static forecasts show better performance, which is to be expected. The decomposition of the mean square error indicates that the contribution of systematic errors like bias and slope errors are quite low. In all cases, the contribution of the disturbance proportion is the highest, indicating that systematic factors have been taken into account. For M3 the slope error is somewhat higher than for other variables.

The next group of variables relates to various price indices. Table 6.5 shows the prediction performance in summary terms for four price variables and one monetary sector variable, namely time deposits. For the all-commodities wholesale price index, bias and slope errors are low for the static forecasts. In the of dynamic forecast, the slope error PYR, PYN, and WPIAC contributes about 40 percent of the overall error.

Table 6.4: Prediction Performance: Monetary Variables (Comparison of Growth Rates)

Variable	Summary Measures		Decomposition of Mean Sq Error		
DDN	RMSQ	Theil Q	Bias	Slope	Covariance
Static	5.556	0.329	0.002	0.239	0.759
Dynamic	5.100	0.302	0.185	0.001	0.814
M3					
Static	3.26	0.19	0.001	0.735	0.264
Dynamic	2.97	0.17	0.005	0.685	0.310
RSN					
Static	11.315	0.866	0.000	0.178	0.822
Dynamic	8.641	0.661	0.007	0.010	0.983
RLN					
Static	10.99	0.95	0.001	0.199	0.801
Dynamic	9.18	0.79	0.003	0.001	0.996
CBEIR					
Static	6.884	1.509	0.000	0.603	0.396
Dynamic	10.217	2.239	0.002	0.807	0.192

Theil statistics indicates fairly low value of the summary measure ranging from 0.1 to 0.5. In general static forecasts show better performance, in this case also. The decomposition of the mean square error indicates that the contribution of systematic errors like bias and slope errors are quite low. In all cases, the contribution of the disturbance proportion is the highest, indicating that systematic factors have been taken into account.

Table 6.5: Prediction Performance: Prices/Monetary Variables : Comparison of Inflation Rates

Variable	Summary Measures		Decomposition of Mean Sq Error		
PWAC	RMSQ	Theil Q	Bias	Slope	Disturbance
Static	3.455	0.477	0.001	0.508	0.491
Dynamic	2.689	0.372	0.024	0.135	0.841
PYN					
Static	2.51	0.33	0.002	0.405	0.593
Dynamic	2.08	0.27	0.002	0.011	0.987
PYR					
Static	2.514	0.326	0.002	0.400	0.598
Dynamic	2.134	0.277	0.009	0.015	0.975

For fiscal variables, summary statistics relating to the prediction performance, are given in Table 6.6. In this case also, the errors are limited. For ITR, the Theil statistic is higher than 1. Most of the mean square error is due to the disturbance term.

Table 6.6: Prediction Performance: Fiscal Variables (Comparison of Growth Rates)

Variable	Summary Measures		Decomposition of Mean Sq Error		
ITR	RMSQ	Theil Q	Bias	Slope	Disturbance
Static	12.176	0.582	0.003	0.340	0.657
Dynamic	25.700	1.228	0.632	0.204	0.164
CPTR					
Static	14.10	0.61	0.000	0.306	0.694
Dynamic	12.22	0.53	0.089	0.034	0.877
IDR					
Static	14.626	0.671	0.000	0.099	0.901
Dynamic	12.017	0.551	0.000	0.002	0.998
SSR					
Static	8.58	0.54	0.000	0.590	0.410
Dynamic	5.14	0.33	0.000	0.009	0.991
SEDR					
Static	5.978	0.381	0.000	0.173	0.827
Dynamic	4.497	0.287	0.001	0.006	0.993

Summary

In this chapter, we have looked at quality of prediction performance of the model through an evaluation of the prediction performance with respect the corresponding actuals for a selected group of key variables in the model. The errors are generally quite low and in most cases, the limited error that is left is not to due failure to account systematic elements. These are due to the contribution of the disturbance term that accounts for random influences.

Chapter 7

PROSPECTS OF THE INDIAN ECONOMY: OVERVIEW AND FORECASTS

This Chapter provides an overview of the recent macro-economic trends and projections. The presentation covers the following parts: output and aggregate demand, prices, fiscal sector, monetary sector and the external sector. The projections for 2011-12 to 2014-15 are based on a macro-econometric model of the Indian economy described in the previous chapters. The macroeconomic background is characterized by a slide in global growth forecasts; and domestically, slippage in the management of fiscal imbalances, continuing high inflation rates except for food and related items, weak investment sentiments, and low industrial growth.

Output and Aggregate Demand

a. Output: GDP at factor cost

After the dip in growth of GDP at factor cost in 2008-09 at 6.8 percent, there was incremental improvement in 2009-10 and 2010-11. In 2011-12, the first two quarters have shown particularly weak growth in mining and quarrying, manufacturing (second quarter), and construction. Comparing the quarterly growth rates (y-o-y) with the average annual growth rates for the period from 2005-06 to 2010-11 (Table 7.1), these three sectors show a deficient growth in both quarters. In the second quarter, all the service sectors components also showed deficient growth. However, the average growth patterns of earlier years show that growth picks up in the third and fourth quarters.

Table 7.1: GDP at Factor Cost: Sectoral Growth

(percent per annum)

Year / Quarter	Agriculture and allied sectors	Mining and quarry-ing	Manufact-uring	Electri-city, gas, and water supply	Construc-tion	Trade, hotels, transport, storage and communi-cations	Finan-cial, real estate and business services	Community, social and personal services	GDP at factor cost
2007-08	5.8	3.7	10.3	8.3	10.7	11	11.9	6.9	9.3
2008-09	-0.1	1.3	4.2	4.9	5.4	7.5	12.5	12.7	6.8
2009-10	0.4	6.9	8.8	6.4	7	9.7	9.2	11.8	8
2010-11	6.6	5.8	8.3	5.7	8.1	10.3	9.9	7	8.5
Growth Rates (Quarter over corresponding quarter of previous year)									
2010-11Q1	2.4	7.4	10.6	5.5	7.7	12.1	9.8	8.2	8.8

2010-11Q2	5.4	8.2	10.0	2.8	6.7	10.9	10.0	7.9	8.9
2010-11Q3	9.9	6.9	6.0	6.4	9.7	8.6	10.8	5.1	8.3
2010-11Q4	7.5	1.7	5.5	7.8	8.2	9.3	9.0	7.0	7.8
2011-12Q1	3.9	1.8	7.2	7.9	1.2	12.8	9.1	5.6	7.7
2011-12Q2	3.2	-2.9	2.7	9.8	4.3	9.9	10.5	6.6	6.9
Average growth (2005-11)									
Q1	2.9	4.5	9.9	7.1	9.4	10.3	11.7	7.9	8.6
Q2	3.2	4.2	9.4	6.5	8.8	10.5	11.9	9.1	8.9
Q3	4.4	4.6	8.8	6.7	8.9	9.8	11.7	8.5	8.4
Q4	3.9	4.6	9.5	7.4	9.3	10.6	11.5	7.0	8.6
Excess of 2011-12 over mean									
2011-12Q1	1.1	-2.7	-2.7	0.8	-8.2	2.4	-2.6	-2.3	-0.8
2011-12Q2	0.0	-7.1	-6.7	3.3	-4.5	-0.6	-1.4	-2.5	-2.0

Source: National Income Accounts, CSO

As indicated in Table 7.2, our forecast for the 2011-12 indicates a growth rate of less than 7 percent. There are clear signs of a second dip in growth after 2008-09. It picks up in 2012-13 but not by a substantial margin. In annual terms, the growth of GDP at factor cost in 2011-12 is likely to be lower by nearly 2.4 percentage points compared to peak growth rates achieved in the period 2005-06 to 2007-08 before the onset of the global economic crisis. In 2007-08, the growth rate was 9.3 percent.

Table 7.2: GDP at Factor Cost and its Components: Growth Rate Projections

(percent per annum)

Year	Agricultural and allied sectors	Industry	Service sector 1	Service sector 2	GDP at factor cost
2011-12	4.0	4.3	8.5	6.6	6.8
2012-13	2.4	7.1	8.1	7.5	7.0
2013-14	2.3	7.8	9.8	7.4	8.1
2014-15	2.3	8.3	10.4	7.6	8.6

Source: Based on RBI-MSE Macro-econometric Model

Service sector 1 includes construction, trade, hotels, restaurants, storage and communications, financial, real estate and business services

Service sector 2 consists of community, social and personal services

b. Aggregate Demand

The main components of aggregate demand are private and governments consumption expenditures, gross domestic capital formation, and exports net of imports. Table 7.3 gives the annual and quarterly growth in recent years and quarters on YoY basis. The private consumption demand in the first quarter has been relatively weaker. Private consumption demand has been falling quarter after quarter since 2010-11Q1. Government consumption demand has also been low. Given the need for containing fiscal deficit as also revenue deficit, chances of any strong fiscal stimulus emerging from the fiscal side are not high. Exports have shown a high growth averaging about 25 percent in the first two quarters of 2011-12 following a nearly 18 percent increase in 2010-11. Export demand is also expected to slowdown given the lowering of global growth prospects (Table 7.4).

Table 7.3: GDP at Market Prices: Components of Aggregate Demand

(percent per annum)

Year / Quarter	Privare consumption	Government consumption	Gross doemstic capital formation	Exports	Imports	GDP at market prices
2010-11Q1	9.5	6.7	12.1	9.8	15.2	12.1
2010-11Q2	9.0	6.4	10.6	10.5	11.4	10.6
2010-11Q3	8.6	1.9	8.2	24.8	0.4	8.2
2010-11Q4	8.0	4.9	2.2	25.0	10.3	2.2
2011-12Q1	6.3	2.1	9.6	24.3	23.6	9.6
2011-12Q2	5.9	4.0	1.2	27.4	10.9	1.2

Source (Basic Data): National Income Accounts, CSO.

Table 7.4: GDP at Market Prices: Components of Aggregate Demand: Projections

(percent per annum)

Year	Private consumption expenditure	Government consumption expenditure	Gross domestic capital formation	Exports	Imports	GDP at market prices
2011-12	7.1	6.9	1.9	21.6	13.3	6.7
2012-13	7.6	5.7	4.7	13.6	10.7	7.0
2013-14	8.3	5.6	10.6	13.5	15.0	7.9
2014-15	9.1	5.9	12.0	13.5	16.2	8.5

Source: As in Table 7.2.

Our projections indicate progressive improvement in private consumption demand but weakening of export demand as global growth slides but it will still be higher than the other components of growth. Government consumption demand can increase provided the government is able to stimulate the economy with the next year being the first year of the 12th five year plan. However, given the existing levels of fiscal deficit relative to GDP and the need also to contain revenue deficit, the extent to which government consumption expenditure can be stimulated is limited.

Prices

Table 7.5 gives the month-wise, year-on-year, inflation rates for major groups covered under the wholesale price index. Inflation as per the all commodities wholesale price index was 9.74 percent in April 2011. After falling for a few months, it again reached a level of 9.73 percent in October 2011. It is only after that it has shown a fall driven by a fall in inflation for primary articles particularly food articles. By November 2011, inflation in the WPI of the manufactured articles has not shown a downward trend. It is only in December 2011 that a slight fall is observed. The WPI based inflation for the fuel and energy group was nearly 15 percent in December 2011, showing a marginal fall from the corresponding figure in November 2011.

Table 7.5: Inflation based on Wholesale Price Index: 2011

(Percentage change over corresponding moth in the previous year)

Items	January	February	March	April	May	June
All Commodities	9.47	9.54	9.68	9.74	9.56	9.51
Primary Articles of which	18.44	15.89	13.44	15.09	12.92	11.31
Food Articles *of which*	16.68	10.95	9.41	10.66	8.25	7.64
Food grains (Cereals and Pulses)	-1.45	1.65	1.97	2.15	2.61	2.08
Fuel and Power	11.41	12.37	12.49	13.04	12.32	12.85
Manufactured products	5.32	6.26	7.45	6.80	7.43	7.90
Items	**July**	**August**	**September**	**October**	**November**	**December**
All Commodities	9.36	9.78	10.00	9.73	9.11	7.47
Primary Articles *of which*	11.47	12.46	12.22	11.40	8.53	3.07
Food Articles *of which*	8.19	9.62	9.62	11.06	8.54	0.74
Food grains (Cereals and Pulses)	2.53	3.33	3.91	5.59	4.64	4.11
Fuel and Power	12.04	12.91	14.02	14.79	15.48	14.91
Manufactured products	7.73	7.87	8.00	7.66	7.70	7.41

Source (basic data): Office of Economic Advisor, Government of India.

As indicated in Table 7.6, while overall inflation during 2011-12 considered for the year as a whole is projected to be around 9 percent in 2011-12. In 2012-13, it is projected to fall marginally. This is so because WPI inflation of the fuel and energy group will show only a slow decline and WPI inflation for manufactured articles appears to be entrenched.

Table 7.6: Inflation Rates based on Wholesale Price Index: Projections

(percent per annum)

Year	Wholesale price index (primary articles)	Wholesale price index (fuel and energy)	Wholesale price index (manufactured articles)	Wholesale price index (all commodities)
2011-12	8.6	14.1	7.5	8.8
2012-13	7.6	12.2	7.0	8.0
2013-14	8.3	11.4	6.7	7.9
2014-15	0.9	9.5	6.1	5.5

Source: As in Table 2

Monetary Sector

As shown in Table 7.7, growth in M1 responded far sharply to the periodic raising of the repo rate increases than M3 growth. Up to December 2010, the M3 growth had continued to increase reaching a level of nearly 19 percent. After that, the M3 growth started to fall with some spikes reaching a growth rates in the range of around 15 percent by November 2011.

Table 7.7: Money Supply and Liquidity

(percent per annum)

Year /Month	M0	M1	M3	L1	L2
2010April	17.40	15.92	15.25	14.82	14.82
2010May	21.05	16.51	15.17	14.55	14.55
2010June	23.36	19.15	15.17	14.94	14.94
2010July	25.72	19.45	15.72	15.53	15.53
2010August	25.60	17.56	15.57	15.01	15.00
2010Sept	21.67	15.90	15.21	15.00	14.99
2010Oct	20.92	19.96	17.32	16.93	16.92
2010Nov	22.81	21.13	16.44	16.05	16.04
2010Dec	22.09	19.60	18.68	17.97	17.96
2011Jan	21.61	14.04	16.52	16.22	16.21
2011Feb	17.77	13.71	16.66	16.37	16.36
2011March	19.14	9.82	16.01	15.83	15.82
2011April	19.41	10.85	17.70	17.21	17.20
2011May	17.48	8.97	16.93	16.57	16.56
2011June	16.00	7.21	17.19	16.86	16.86
2011July	15.94	4.67	16.48	16.20	16.19
2011Aug	16.43	5.25	16.81	16.73	16.72
2011Sep	15.42	4.08	16.27	16.49	16.49
2011Oct	18.36	1.58	14.44	14.74	14.73
2011Nov	13.75	1.95	15.16	15.41	15.41

Source (Basic Data): Database, Reserve Bank of India.

For the year as a whole in 2011-12, M0 and M3 is projected to be around 16-17 percent (Table 7.8). In 2012-13, with policy rates likely go down to encourage growth, we expect M3 to increase somewhat higher growth rate.

Table 7.8: Monetary Aggregates and Interest Rates: Growth Rates

(percent per annum)

Year	Reserve Money	Broad Money	Short term interest rate	Long term interest rate
2011-12	16.3	16.0	9.0	8.8
2012-13	15.0	17.8	8.9	8.8
2013-14	16.2	18.3	8.8	8.6
2014-15	16.2	19.4	8.0	7.8

Source: As in Table 2.

Fiscal Sector

Available information for nearly three quarters into the financial year 2011-12, summarized in Table 7.9, shows sluggish revenue growth for the central government and high dependence on fiscal deficit for financing government expenditures. There are clear signs that the budgeted deficit target of the central government will be exceeded by more than one percentage point of GDP. Although government expenditure growth has also been sluggish, it is likely to pick up during the last three months of the fiscal year. By November 2011, more than 90 percent of the budgeted revenue deficit had already been incurred compared to a corresponding figure of 51 percent in the previous year.

As indicated in Table 7.10, given the levels of real growth and price levels, most tax revenues will show a growth in the 14-15 percent range with direct taxes performing marginally better than indirect taxes.

The combined fiscal deficit relative GDP is likely to be in excess of 8 percent of GDP in 2011-12. Incremental correction will take it down to about 7 percent by 2014-15 (Table 7.11).

Table 7.9: Fiscal Indicators: Central Government

(percentage of actuals to budget estimates for full year)

Fiscal Indicators	Budget Estimates for 2011-12 (Rs.crore)	Actuals up to November 2011 (Rs. Crore)	Actuals up to Nov 2011 (percentage)	Corresponding percentage last year(%)
Revenue Receipts	789892	392813	49.7	69.9
Tax revenue (net)	664457	320470	48.2	55.5
Non-tax revenue	125435	72343	57.7	121.6
Non-plan revenue expenditure	733558	485446	66.2	68.1
of which Interest payments	267986	165910	61.9	54.1
Plan revenue expenditure	363604	187824	51.7	56.8
Capital expenditure	160567	87424	54.4	65.2
Non-plan capital expenditure	82624	53970	65.3	45.4
Plan capital expenditure	77943	33454	42.9	55.3
Total expenditure	1257729	760694	60.5	62.3
Revenue deficit	307270	280457	91.3	50.7
Fiscal deficit	412817	353369	85.6	48.9
Primary deficit	144831	187459	129.4	39.2

Source: Comptroller General of Accounts, Government of India.

Table 7.10: Main Tax Revenues: Projections

(Percent per annum)

Year	Income tax revenue	Corporate tax revenue	Union excise duties	Import duty revenues	Sales tax revenue
2011-12	15.9	14.1	13.4	15.4	14.0
2012-13	16.5	15.0	14.3	15.6	14.4
2013-14	17.5	16.1	15.3	15.7	14.4
2014-15	18.6	16.7	15.9	15.7	14.4

Source: As in Table 2

Table 7.11: Overall Fiscal Position: Combined Account of Central and State Governments

Year	Combined direct taxes	Combined indirect taxes	Combined revenue receipts	Combined revenue expenditure	Combined revenue deficit relative to GDP	Combined fiscal deficit relative to GDP
2011-12	14.7	14.1	13.2	14.1	4.5	8.2
2012-13	15.5	14.5	13.7	11.3	4.0	8.0
2013-14	16.5	14.7	14.2	11.8	3.5	7.5
2014-15	17.3	14.8	14.7	12.1	3.0	7.0

Source: As in Table 7.2

External Sector

The external sector is being driven by two key factors: first, the slowdown of the global economy and secondly the movement of the oil prices. In spite of the global slowdown, exports from India still showed a healthy growth of about 24 percent in the first half of 2011-12. This is partly due to the fact that there has been a change over time in the direction of India's exports, shifting away from the traditional destinations consisting mainly of a group of developed countries more towards the emerging markets that show healthier growth prospects. Partly, this is due to depreciation of the Indian rupee. At the same time, with oil prices keeping firm, imports in dollar terms, when converted back in rupee terms, show a sharp upsurge because of the depreciating rupee. This has led to a massive deficit in the trade account.

With the Euro-zone crisis and a general atmosphere of uncertainty in the western world, there is also a 'backwash' effect leading to withdrawal of dollars from the Indian economy leading to a drying up of foreign investment inflows. These factors taken together lead to expectations regarding growing shortage of dollars, thereby resulting in a further depreciation of the Indian rupee.

Most forecasts regarding the global growth prospects including the World Bank, the IMF and the UN, growth projections for 2012 onwards are being revised downwards. In the latest UN Report on growth prospects, the growth rates have been reduced compared to the estimates provided last year. In the Pre-Release to Global Economic Situation and Prospects, 2012, it is noted that global economic growth started to decelerate on a broad front in mid-2011 and this slow growth is expected to continue in 2012 and 2013. The United Nations baseline forecast projects growth of 2.6 per cent for 2012 and 3.2 per cent for 2013, which remains below the pre-crisis pace of global growth. In the pre-release document for World Economic Situation and Prospects for 2012, for all major economies and groups of economies, compared to the 2011 forecasts, down ward adjustments have been made. A summary is given in Table 7.12.

Their baseline assumption for crude oil price per barrel for 2012 and 2013 is $100, lowered from $107 for 2011. After October 2011, a fall in the growth rate of exports in dollar terms as well as in rupee terms is visible (Table 7.13). Imports also show a fall. We expect the share of exports and imports to rise relative to GDP. The trade imbalance will rise and the current account deficit will be a little below 4 percent in 2011-12.

Table 7.12: Global Growth Projections

Details	Forecasts (Percent per annum)						Extent of revision from previous forecast (% points)	
	2005-2008a	2009	2010b	2011c	2012c	2013c	2011	2012
World	3.3	-2.4	4	2.8	2.6	3.2	-0.5	-1
Developed economies	1.9	-4	2.7	1.3	1.3	1.9	-0.7	-1.1
United States	1.8	-3.5	3	1.7	1.5	2	-0.9	-1.3
Japan	1.3	-6.3	4	-0.5	2	2	-1.2	-0.8
European Union	2.2	-4.3	2	1.6	0.7	1.7	-0.1	-1.2
EU-15	2	-4.3	2	1.6	0.7	1.7	-0.1	-1.2
New EU Member States	5.4	-3.7	2.3	2.9	2.6	3.1	-0.2	-1.4
Economies in Transition	7.1	-6.6	4.1	4.1	3.9	4.1	-0.3	-0.7
Developing economies	6.9	2.4	7.5	6	5.6	5.9	-0.2	-0.6
China	11.9	9.2	10.4	9.3	8.7	8.5	0.2	-0.2
India	9	7	9	7.6	7.7	7.9	-0.5	-0.5

Source: UN (2011), World Economic Situation and Prospects: Pre-Release

Notes: a: Average percentage change; b: actual or most recent estimate; c: Forecasts based in part on Project Link and base line projections of the UN/DESA World Economic Forecasting Model

Table 7.13: External Sector: Current Account Balance Relative to GDP at market prices

Year	Exports relative to GDPmp at constant prices	Imports relative to GDPmp at constant prices	Trade balance relative to GDPmp at current prices	Current account balance relative to GDPmp at current prices
2011-12	27.6	32.8	-6.0	-3.6
2012-13	29.3	33.9	-5.7	-3.4
2013-14	30.8	36.1	-6.5	-4.4
2014-15	32.2	38.7	-7.7	-5.6

Source: As in Table 2.

Overall Assessment of Outlook

The key parameters where the macro-economic weaknesses are most critical in 2011-12 become apparent by comparing these with 2007-08, the previous 9 plus growth year. A summary is given in Table 7.14. The 2011-12 growth prospects and the previous peak (and potential growth) show a difference of nearly 2.5 percentage points. We consider that nearly half of this deficiency is due to lower savings relative to GDP by a margin of about 5 percentage points of GDP. This is mainly due to public sector dis-saving, which in turn is largely due to higher revenue deficit of the central government. The balance of the deficiency of more than one percentage point is due to higher portion of investment going into inventories and valuables. With an investment in net fixed capital stock being only 28 percent of GDP, a growth of around 7 percent only seems possible. In the first half of 2007-08, the overall investment as percentage of GDP at current market prices was 35.3 percent. In 2011-12, based on figures for the first two quarters, the composition of investment indicates that only 28.2 percent is in gross fixed capital formation, 3.4 percent is the change in stocks and 3.7 percent accounts for investment in valuables. This indicates that only 28 percent of GDP is adding to the productive capacity and 7.1 percent is for inventories or valuables.

Table 7.14: Comparison between 2007-08 and 2011-12

(Percent)

Indicators	**2007-08**	**2011-12 (Estimates)**
Growth (GDP at factor cost)	9.3	6.8
Inflation (WPI All Commodities)	4.8	8.8
Savings ratio (% to GDPmp)	37	32
Investment ratio (% to GDP mp)	38.2	35*
Current Account deficit (% to GDPmp)	(-) 1.3	(-) 3.6
Exchange rate (Rs. Per USD)	40.2	51.4
Fiscal deficit (Centre and States) (% of GDPmp)	4.2	8.2
Revenue deficit (Centre and States) (% GDPmp)	0.85	4.5

Note: * Investment in net fixed capital stock only about 28%.

These deficiencies require structural corrections. For the savings rate to improve, government revenue deficit has to go down. Furthermore, households have to be encouraged to save more in the form of financial assets. If out of the households savings in financial form of about 11 percent or less, about 8.5 percent is preempted by government on account of fiscal deficit of the central and state governments, then interest rates are bound to remain firm.

Concluding Observations

Overall we expect growth during 2011-12 to be about 6.9 percent. There will some improvement in 2012-13 but the margin of improvement will be limited because of sluggish global growth prospects and limited scope for fiscal stimulus given the high levels of central fiscal deficit relative to GDP. From the monetary side, any substantial reduction in the policy rate in the immediate future may easily trigger inflation again as inflation in fuel and energy group and manufactured articles is entrenched. Any immediate reduction in the repo rate is however not suggested since January-March quarter is associated with relatively higher demand both from private consumption expenditure side and government expenditure. Subsequently however, a cut in policy rates may be considered.[22] Structural corrections on the fiscal side will make countercyclical interventions on the monetary side more effective.

[22] We have assumed a 100 basis points reduction during 2012-13. We have also assumed that government will target a reduction in fiscal and revenue deficit relative to GDP, attempting to bring it down in incremental steps.

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List of Variables

List of Variables			
Variable name	Description	Unit	Source of basic data
ACRE	Area under cultivation	Rs. crore	NAS
AIRG	Share of irrigated land to total area under cultivation	Rs. crore	NAS
BCPTR	Buoyancy of corporate tax revenues	Rs. crore	NAS
BCREDIT	scheduled commercial banks bank credit	Rs. crore	NAS
BFC	scheduled commercial bank food credit	Rs. crore	NAS
BIDR	buoyancy of import duty revenues	Rs. crore	NAS
BITR	buoyancy of income tax revenues	Rs. crore	NAS
BM/BMM	Net govt borrowing from the market	Rs. crore	NAS
BNFC	Non-food credit commercial bansk	Rs. crore	NAS
BPR	Bank policy rate (bank rate/repo rate)	Rs. crore	NAS
BRATE	Bank rate	Rs. crore	NAS
BSSR	buoyancy of state sales tax revenues	Rs. crore	NAS
BUDR	Buoyancy of Union excise duty revenues	Rs. crore	NAS
CAS	Current account surplus	Rs. crore	NAS
CBDEBT	Combined debt	Rs. crore	IPFS
CBDTR	Combined direct tax revenues	Rs. crore	IPFS
CBEIR	Effective interest rate on combined debt	Rs. crore	IPFS
CBFDD	Combined fiscal deficit derived (annual increase in outstanding liabilities from central and state governments)	Rs. crore	IPFS
CBFDO	Combined fiscal deficit offical (annual increase in outstanding liabilities from central and state governments)	Rs. crore	IPFS
CBIP	Combined interest payments	Rs. crore	IPFS
CBITR	combined indirect taxes	Rs. crore	IPFS
CBKE	combined capital expenditure	Rs. crore	IPFS
CBKR	Combined capital receipts	Rs. crore	IPFS
CBNDKR	Combined non-debt capital receipts	Rs. crore	NAS
CBNTR	Combined non-tax revenues	Rs. crore	NAS
CBOTR	Combined other tax revenues	Rs. crore	NAS
CBPE	Combined primary expenditure	Rs. crore	NAS
CBPRE	Combined primary revenue expenditure	Rs. crore	NAS
CBRD	Combined revenue deficit	Rs. crore	NAS
CBRE	Combined revenue expenditure	Rs. crore	NAS
CBRR	Combined revenue receipts	Rs. crore	NAS
CBTR	Combined tax revenues	Rs. crore	NAS
CFC	Consumption of fixed capital at current prices	Rs. crore	NAS
CFCR	Consumption of fixed capital at current prices	Rs. crore	NAS

List of Variables			
Variable name	Description	Unit	Source of basic data
CGN	Government consumption expenditure at current prices	Rs. crore	NAS
CGR	Government consumption expenditure at constant prices	Rs. crore	NAS
CPR	Private consumption expenditure	Rs. crore	NAS
CPRE	Central primary revenue expenditure	Rs. crore	NAS
CPTR	Corporate tax revenues	Rs. crore	NAS
CRRATIO	Cash-reserve ratio	Rs. crore	RBI
CWPN	Currency with public	Rs. crore	NAS
DBRATE	Change in bank rate	Rs. crore	NAS
DDN	Demand deposits	Rs. crore	NAS
EMPA	Work force in agriculture	Rs. crore	NAS
ER	Exchange rate	Rs. Per US $	RBI
EXPR	Exports at constant prices	Rs. crore	NAS
EXPRDD	Exports at constant prices divided by exchnage rate	USD	NAS
FDRATIO	Fiscal deficit to GDP ratio	Percent	IPFS
FERT	Fertilizer used in agriculture	Million tons	
FINV	Foreign investment	Rs crore	RBI
GDFCR	Gross domestic capital formation	Rs. crore	NAS
GGIR	Gross investment	Rs. crore	IPFS
IAR	Invetsment in agriculture	Rs. crore	NAS
ICSPR	Investment in community, social, and public services	Rs. crore	NAS
IDLSN	Indirect taxes net of subsidies at current prices	Rs. crore	NAS
IDLSR	Indirect taxes net of subsidies at constant prices	Rs. crore	NAS
IDR	Import duty revenues	Rs. crore	NAS
IGN	Government Investment at current prices	Rs. crore	NAS
IGR	Government Investment at constant prices	Rs. crore	NAS
IHN	Investment by household sector at current prices	Rs. crore	NAS
IHR	Investment by household sector at constant prices	Rs. crore	NAS
IIR	Investment in industries	Rs. crore	NAS
IMPNOILD	Non-oil imports in dollar terms	Rs. crore	NAS
IMPNOILN	Non-oil Imports at current prices in rupee terms	Rs. crore	NAS
IMPNOILR	Non-oil Imports at constant prices in rupee terms	Rs. crore	NAS

List of Variables			
Variable name	Description	Unit	Source of basic data
IMPOILDN	Oil imports in dollar terms	Rs. crore	NAS
IMPOILN	Imports at current prices in rupee terms	Rs. crore	NAS
IMPOILR	Imports at constant prices in rupee terms	Rs. crore	NAS
IMPR	Imports at constant prices in rupee terms	Rs. crore	NAS
IPCN	Investment by private corporate sector at current prices	Rs. crore	NAS
IMPRDD	Imports at constant prices in rupee terms divdied by exchange rate	USD	
IPCR	Investment by private corporate sector at constant prices	Rs. crore	NAS
IPN	Investment by private sector at current prices	Rs. crore	NAS
IPPDEBT	Interest payment on public debt	Rs. crore	NAS
IPR	Investment by private sector at constant prices	Rs. crore	NAS
IPR	Private investment expenditure at constant prices	Rs. crore	NAS
IPUB	Excess of government investment as given in National Income Account over combined capital expenditure of central and state governments	Rs. crore	NAS & IPFS
ISR	Investment in services at constant prices	Rs. crore	NAS
ISR1	Investment in construction, trade, transport, communications, and storage and financial services	Rs. crore	NAS
ISR2	Investment in community, social, and public services	Rs. crore	NAS
ITR	Income tax revenues	Rs. crore	NAS
KAR	Net fixed capital stock in agriculture	Rs. crore	NAS
KCRR	Net fixed capital stock in construction	Rs. crore	NAS
KCSPR	Net fixed capital stock community, social and personal services	Rs. crore	NAS
KEGWSR	Net fixed capital electricity, gas, and water supply	Rs. crore	NAS
KFIEBR	Net fixed capital stock in finance, real estate and business services	Rs. crore	NAS
KIR	Net fixed capital stock in industry	Rs. crore	NAS
KMANR	Net fixed capital stock in manufacturing	Rs. crore	NAS
KMQR	Net fixed capital stock in mining and quarrying	Rs. crore	NAS
KN	Capital stock	Rs. crore	NAS
KR	Capital stock	Rs. crore	NAS
KSR	Net fixed capital stock in services sector	Rs. crore	NAS

List of Variables			
Variable name	Description	Unit	Source of basic data
KSR1	Net fixed capital stock in construction, trade, transport, communications, and storage and financial services	Rs. crore	NAS
KSR2	Net fixed capital stock in community, social, and public services	Rs. crore	NAS
KTHTCR	Net fixed capital stock in trade, transport, communications, and storage	Rs. crore	NAS
M0	Reserve money	Rs. crore	RBI
M3	Broad money	Rs. crore	RBI
MM	Money multiplier (M3/M0)	Rs. crore	RBI
NBCB	Net RBI credit to banks	Rs. crore	RBI - HBMS
NBCG	Net RBI credit to central government	Rs. crore	
NIB	Net invisibles	Rs. crore	NAS
NIFCR	Net investment in fixed capital stock	Rs. crore	NAS
(N)RBICG	Net RBI credit to government (centre and states)	Rs. crore	RBI
(N)RBIFER	Net RBI foreign exchange assets	Rs. crore	RBI
NWM0	Excess of M0 over NRBICG and NRBIFER	Rs. crore	RBI
PCRUDE	International price for crude petroleum	US$ per barrel	IMF, Financial Statistics
PDYN	Personal disposable income at current prices	Rs. crore	RBI
PDYR	Personal disposable income at 1999-00 prices	Rs. crore	NAS
PEXP	Unit value of exports	Index (1999-00 = 100)	NAS
PI	Implicit price deflator of investment	Index (1999-00 = 100)	NAS
PIMP	Unit value of imports	Index (1999-00 = 100)	NAS
PVDYN	Private income at current prices	Rs. crore	NAS
PVDYR	Private income at 1999-00 prices	Rs. crore	NAS
PWAC	Wholesale price index for all commodities	Index	Office of Economic Advisor
PWFOOD	Wholesale price index foodgrains	Index	Office of Economic Advisor

List of Variables			
Variable name	Description	Unit	Source of basic data
PWFUEL	Wholesale price index for fuel and energy	Index	Office of Economic Advisor
PWMAN	Wholesale price index for manufactured articles	Index	Office of Economic Advisor
PWPA	Wholesale price index for primary articles	Index	Office of Economic Advisor
PYAR	Implicit price deflator for agriculture and allied sectors	Index	NAS
PYN	Implicit price deflator for GDP at market prices	Index	NAS
PYNAR	Implicit price deflator for non-agricultural sectors	Index	NAS
PYR	Implicit price deflator for agriculture and allied sectors	Index	NAS
RAIN	Rainfall	various sources	
RDRATIO	Ratio of revenue deficit to GDP at market prices	percent	IPFS
RER	Real exchange rate	estimated	
RLN	Long-term interest rate defined as interest rates on deposits above 3-5 years maturity	Rs. crore	RBI - HBMS
RLNR	Real long term interest rate	% per annum	RBI-NAS
RM0	Reserve money at constant prices (deflated by pyn)	Rs. crore	RBI
RM3	Broad money at constant prices (deflated by pyn)	Rs. crore	RBI
RSN	Long-term interest rate defined as interest rates on deposits of 3-5 years maturity	% per annum	RBI
SEDR	State excise duty revenues	Rs. crore	IPFS
SIAR	Share of investment in agriculture	Percent	NAS
SIIR	Share of investment in industry	Percent	NAS
SISR1	Share of investment in service sector 1agriculture	Percent	NAS
SISR2	Share of investment in service sector 2agriculture	Percent	NAS
SSR	State sales tax revenues	Rs. crore	IPFS
TBL	Trade-balance	Rs. crore	NAS
TOT	Terms of trade between agriculture and non-agriculture	Percent	NAS

List of Variables			
Variable name	Description	Unit	Source of basic data
TT	Time trend		
TTN	Time deposits	Rs. crore	RBI
UDR	Union excise duties	Rs. crore	IPFS
WCBDTR	Direct taxes other than income tax and corporation tax	Rs. crore	IPFS
WCBTR	Taxes other than itr,cptr,idr,udr, ssr,sedr,wsotr (mostly service tax revenue)	Rs. crore	IPFS
WCBITR	Indirect taxes other than idr, udr,ssr, and sedr	Rs. crore	IPFS
WEXP	Index of world exports	Index	UN
WFORCE	Aggregate work force	Estimated	
WGGIR	Residual in gross investment	Rs. crore	NAS
WNIFCR	Residual in net increase in fixed capital stock	Rs. crore	NAS
WPDYR	Residual in personable disposable income	Rs. crore	NAS
WPVDYR	Residual in personable disposable income	Rs. crore	NAS
WYMR	Residual in personable disposable income	Rs. crore	NAS
WYRR	Excess of GDPfc and sum of sectoral GDPfc in back series base 2004-05	Rs. crore	NAS
XPYR	Expected level GDPfc deflator	Estimated	
XYIR	Expected output of industrial sector	Estimated	
XYSR	Expected output of service sector	Estimated	
XXDLPYR	Expected rate of inflation (wrt GDPfc deflator)	estimated	
YAR	Output (GDP at factor cost) in agriculture and allied sectors	Rs. crore	NAS
YCRR	Output (GDP at factor cost) in construction	Rs. crore	NAS
YCSPR	Output (GDP at factor cost) in community, social and public services	Rs. crore	NAS
YEGWSR	Output (GDP at factor cost) in electricity, gas and water supply	Rs. crore	NAS
YFIEBR	Output (GDP at factor cost) in financial, real estate, and business services	Rs. crore	NAS
YIR	Output (GDP at factor cost) in industry	Rs. crore	NAS
YMANR	Output (GDP at factor cost) in manufacturing	Rs. crore	NAS
YMQR	Output (GDP at factor cost) in mining and quarrying	Rs. crore	NAS
YMR	GDP at market prices at constant prices	Rs. crore	NAS
YN	GDP at market prices at current prices	Rs. crore	NAS
YNAR	GDP in non-agricultural sector at constant prices	Rs. crore	NAS
YR	GDP at factor cost at constant prices (sum of sectoral GDPfc)	Rs. crore	NAS
YRR	GDP at factor cost at constant prices	Rs. crore	NAS

List of Variables

Variable name	Description	Unit	Source of basic data
YSR	Output (GDP at factor cost) in the services sector	Rs. crore	NAS
YSR1	Output (GDP at factor cost) in the construction, trade, hotels etc. and financial and real estate services	Rs. crore	NAS
YSR2	Output (GDP at factor cost) in the community, social and public services	Rs. crore	NAS
YTHTCR	Output (GDP at factor cost) in the construction, trade, hotels, transport, storage and communications services	Rs. crore	NAS

APPENDICES

Appendix Table A1: One Year Ahead Estimated Expectations based on VECM Models

(percent)

Years	Growth Rate of Broad Money	Growth Rate of Agricultural Output	Growth Rate of Industrial Output	Growth Rate of Services 1 output	Growth Rate of Services 2 Output	Growth Rate of GDP at factor Cost	Inflation Rate (GDP at factor cost)
	GM3_1	GYAR_1	GYIR_1	GYSER1_1	GYSER2_1	GYR_1	IRATE_1
1982	19.014	-2.603	3.925	0.571	3.879	0.423	14.887
1983	18.316	6.050	6.841	3.207	4.409	5.075	7.270
1984	16.642	3.300	5.342	4.733	5.208	4.373	0.435
1985	17.156	-2.057	4.354	3.366	4.934	1.768	11.471
1986	15.413	-4.272	5.350	3.675	4.359	1.195	10.878
1987	17.037	4.590	6.634	6.317	3.299	5.369	9.260
1988	17.461	4.140	2.627	3.722	4.879	3.811	12.369
1989	17.790	1.744	1.367	2.430	6.890	2.620	13.231
1990	17.426	-5.087	3.320	4.170	6.334	1.240	10.682
1991	17.077	4.472	8.064	8.981	7.286	7.129	3.434
1992	17.825	-2.027	7.243	5.397	5.963	3.519	10.625
1993	15.954	2.105	3.170	6.328	4.927	4.267	13.448
1994	16.553	8.555	6.873	7.289	5.524	7.327	7.449
1995	19.218	13.131	9.242	6.843	6.242	9.135	3.504
1996	18.879	1.002	5.386	4.048	6.379	3.729	12.130
1997	17.236	7.941	3.519	7.827	5.018	6.590	5.814
1998	16.216	-0.610	4.726	6.525	5.272	3.965	8.419
1999	17.715	6.863	3.805	8.214	4.910	6.489	8.274
2000	17.390	-3.114	7.845	8.006	5.868	4.748	9.351
2001	19.084	4.694	13.003	9.222	5.811	8.359	6.790
2002	19.282	-2.892	8.430	4.881	4.362	3.626	11.750
2003	19.521	5.231	9.964	6.896	3.552	6.636	5.256
2004	19.213	3.729	9.447	5.290	4.779	5.699	2.781
2005	15.963	5.814	10.122	9.357	2.973	7.812	2.833
2006	14.517	1.471	8.210	9.233	7.543	7.166	8.631
2007	15.348	5.964	9.303	12.956	7.937	10.205	1.404
2008	18.048	-1.525	5.782	8.039	8.381	5.847	4.781
2009	20.440	0.946	2.761	9.641	6.156	6.354	7.113
2010	19.816	4.175	1.288	7.638	8.396	5.957	7.338
2011	19.069	2.046	2.782	7.143	6.668	5.441	6.467
2012	17.346	1.705	3.814	5.744	5.654	4.741	6.371
2013	15.897	2.371	6.183	6.388	4.120	5.400	6.176
2014	15.931	3.168	8.106	7.376	3.423	6.307	6.799
2015	16.249	2.417	8.396	8.403	4.884	7.036	7.496

Appendix Table 2: Medium Term Expectations: (Five Yearly Averages): based on VECM Models (percent)

Years	Broad Money	Agricultural Output	Industrial Output	Services 1 Output	Services 2 Output	GDP at Factor Cost	Inflation Rate (GDP at Factor Cost)
	GM3_M	GYAR_M	GYIR_M	GYSER1_M	GYSER2_M	GYR_M	IRATE_M
1982	17.518	2.322	3.883	3.468	3.996	3.181	9.876
1983	16.950	2.497	4.974	4.218	4.248	3.725	8.096
1984	16.529	2.291	4.510	4.124	4.680	3.602	7.746
1985	15.305	1.706	4.566	4.387	4.473	3.481	9.515
1986	15.348	2.016	4.884	4.623	4.367	3.710	9.014
1987	16.539	2.996	5.103	4.931	4.335	4.223	8.537
1988	17.163	3.272	4.047	4.307	4.779	3.972	8.572
1989	17.479	1.998	1.602	2.851	5.418	2.712	13.365
1990	17.341	1.966	4.963	5.541	5.572	4.287	8.821
1991	18.423	2.306	6.778	7.498	7.041	5.729	8.708
1992	16.741	2.687	5.911	6.271	5.933	5.064	9.418
1993	16.886	4.473	5.659	6.474	5.016	5.524	8.147
1994	17.965	3.860	6.418	6.284	5.739	5.535	7.250
1995	18.656	2.903	5.600	5.571	5.492	4.769	8.911
1996	17.528	3.430	5.469	6.053	5.403	5.076	9.289
1997	17.884	3.073	5.836	6.595	5.140	5.255	8.751
1998	17.072	3.043	6.340	6.564	5.489	5.410	8.810
1999	18.065	4.238	7.139	7.695	5.885	6.471	9.693
2000	17.598	3.060	7.432	7.867	6.636	6.396	9.322
2001	18.041	3.370	7.130	8.177	7.463	6.714	9.613
2002	17.347	2.627	5.967	6.168	5.555	5.198	9.637
2003	18.063	1.795	4.944	5.194	5.179	4.374	8.986
2004	17.943	1.780	5.154	5.058	5.336	4.389	8.555
2005	17.490	2.471	6.934	7.316	5.154	5.937	6.472
2006	15.050	4.234	6.891	10.466	8.461	8.275	6.618
2007	16.547	1.920	5.863	10.393	7.851	7.723	2.052
2008	17.064	1.187	4.737	7.908	6.720	5.979	4.944
2009	18.968	1.519	3.469	7.454	4.043	5.309	8.175
2010	17.612	2.693	4.435	6.858	5.652	5.569	6.630
2011	17.612	2.693	4.435	6.858	5.652	5.569	6.630
2012	17.612	2.693	4.435	6.858	5.652	5.569	6.630
2013	17.612	2.693	4.435	6.858	5.652	5.569	6.630
2014	17.612	2.693	4.435	6.858	5.652	5.569	6.630
2015	17.612	2.693	4.435	6.858	5.652	5.569	6.630

Appendix Table A3. One-year Ahead forecasts based on VAR Models

	dlpyr	dlyrr	dlm3
1971	0.0505819	0.0279414	0.0621932
1972	-0.0163358	0.0682922	0.0999515
1973	0.0501772	0.0484816	0.0906919
1974	0.1167644	0.0520969	0.1432421
1975	0.1033617	0.037665	0.152168
1976	0.0906647	0.0154699	0.1214131
1977	-0.0264564	0.0339766	0.1430681
1978	0.1303196	0.0132201	0.178579
1979	0.0185123	0.0535656	0.1855766
1980	0.140698	-0.0534166	0.1839487
1981	0.140065	0.0389799	0.1865692
1982	0.11155	0.0162133	0.156702
1983	0.0681764	0.0061617	0.1631996
1984	0.0136949	0.0386821	0.1503528
1985	0.0673946	0.0391713	0.1634354
1986	0.0476966	0.0365908	0.1550045
1987	0.0834558	0.0394194	0.1643376
1988	0.1022133	0.0292284	0.1713108
1989	0.0771652	0.0406926	0.1577496
1990	0.0857753	0.03019	0.1615289
1991	0.0820605	0.055045	0.1628995
1992	0.0596298	0.0919876	0.1660841
1993	0.1366295	0.0608759	0.1525565
1994	0.0951716	0.0552582	0.1477484
1995	0.0933148	0.061986	0.180939
1996	0.141357	0.0095528	0.1524836
1997	0.0955217	0.0395954	0.1677959
1998	0.087233	0.0511024	0.1601431
1999	0.0665729	0.0496284	0.1638858
2000	0.0902642	0.0444947	0.1645447
2001	0.106727	0.0049194	0.1772551
2002	0.044445	0.0331796	0.1687589
2003	0.0367461	0.0762168	0.1829879
2004	0.0398745	0.0603879	0.1617572
2005	0.0451308	0.0687502	0.1503636
2006	0.0721145	0.0703926	0.1405584
2007	0.0221271	0.0854408	0.1527101
2008	0.0553774	0.0568504	0.1738733
2009	0.0590675	0.0466307	0.1646723
2010	0.0702007	0.042303	0.1554527
2011	0.0640775	0.0626113	0.1594402
2012	0.0642792	0.061024	0.1583272
2013	0.0640452	0.0600552	0.1569494
2014	0.0635055	0.0600031	0.1558798
2015	0.0629499	0.0607519	0.1555052

Appendix A4: Stationarity and Structural Breaks: Selected Macro Aggregates

(i) Testing for Stationarity with Structural Breaks: Output Variables

Variable: LYAR (Log GDP Agriculture and Allied Activities at Factor Cost at 2004-05 Prices)

1. ADF (Stationary) Test Results

Null Hypothesis: LYAR has a unit root
Exogenous: Constant
Lag Length: 6 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	1.736387	0.9996

Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-4.739461	0.0016

2. Test Statistics for Multiple Breaks

Specification: z_t ={1, Trend}, x =0, h = 11 and M=3, N=60 (1950-51 to 2009-10)
$SupF_T$ (2|1): 5.715 $SupF_T$ (3|2): 8.245 WDmax :46.126* UDmax: 46.126*
Number of Breaks selected by Sequential Procedure at 5% significance level: 1 **Breaks:** 38 (1987-88)

Note: * Significance at 1% level; ** significance at 5% level.

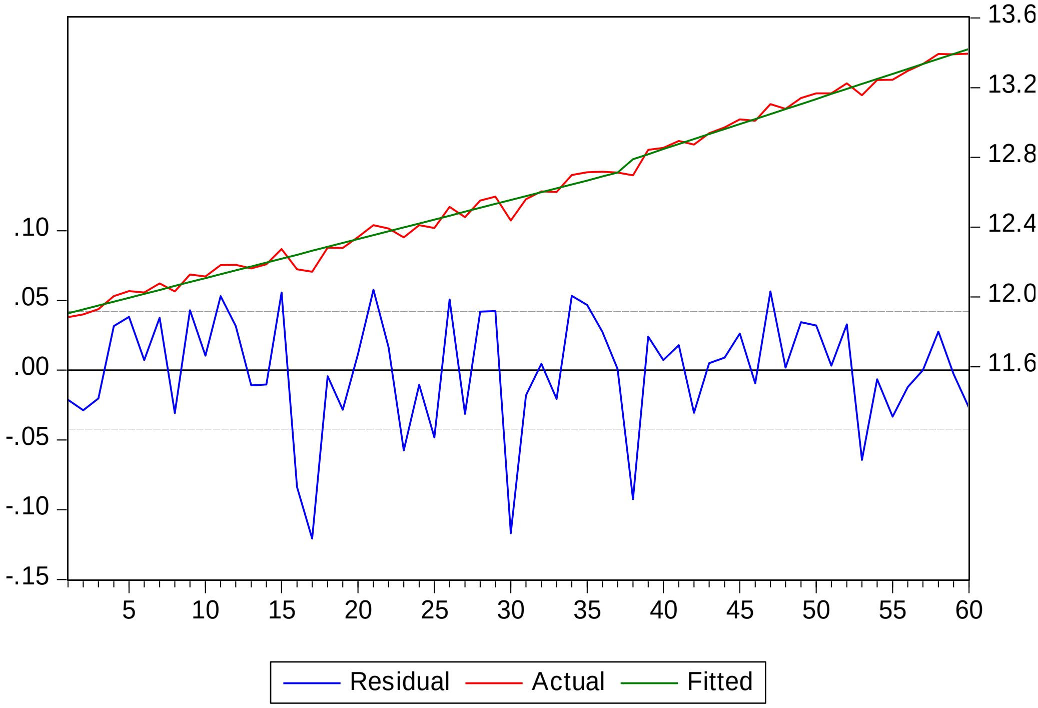
3. Estimates of the Model Selected by Sequential Method at 5 % Significance Level

Dependent Variable: LYAR
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
A1 (1950-51 to 1986-87)	11.88356	0.014145	840.1105	0.0000
A2 (1987-88 to 2009-10)	11.69766	0.065519	178.5391	0.0000
A1 x Trend	0.022411	0.000649	34.52965	0.0000
A2 x Trend	0.028746	0.001325	21.69444	0.0000

R-squared	0.991750	Mean dependent var	12.61482
Adjusted R-squared	0.991308	S.D. dependent var	0.452115
S.E. of regression	0.042152	Akaike info criterion	-3.430736
Sum squared resid	0.099500	Schwarz criterion	-3.291113
Log likelihood	106.9221	Hannan-Quinn criter.	-3.376122
Durbin-Watson stat	1.937195		

4. Residual Plot



5. ADF Test (Residual)

Null Hypothesis: LYAR_RES has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-7.348336	0.0000

Variable: LYIR (Log GDP Industry at Factor Cost at 2004-05Prices)

1. ADF (Stationary) Test Results

Null Hypothesis: LYIR has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	0.710348	0.9914

Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-1.807680	0.6883

Null Hypothesis: D(LYIR) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-5.759101	0.0000

2. Test Statistics for Multiple Breaks

Specification: z_t ={1, Trend}, x =0, h = 11 and M=5, N=60 (1950-51 to 2009-10)
$SupF_T$ (2|1): 65.589* $SupF_T$ (3|2): 52.749* $SupF_T$ (4|3): 4.609 $SupF_T$ (5|4): 3.023 WDmax :289.051* UDmax: 193.140*
Number of Breaks selected by Sequential Procedure at 5% significance level: 4 **Breaks:** 12 (1961-62), 22 (1971-72), 38 (1987-88) and 51 (2000-01)

Note: * Significance at 1% level; ** significance at 5% level.

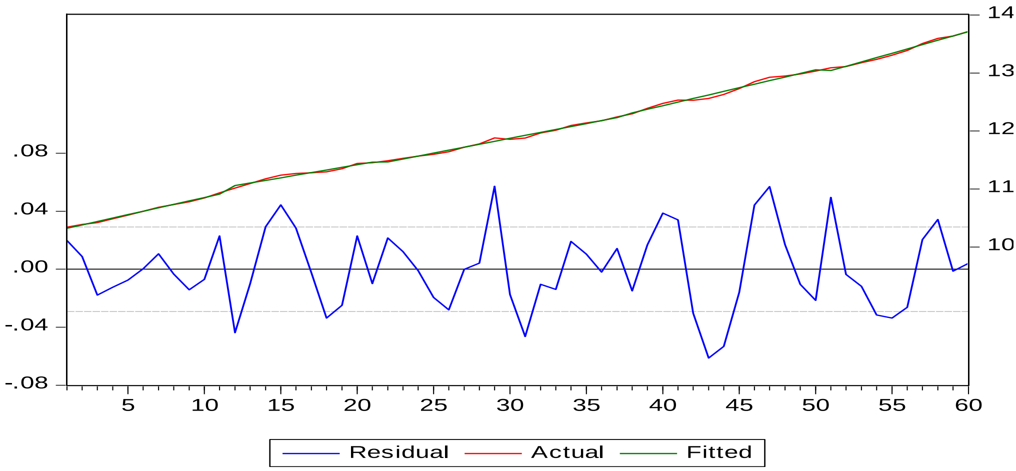
3. Estimates of the Model Selected by Sequential Method at 5% Significance Level

Dependent Variable: LYIR
Sample: 1 60
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
B1 (1950-51 to 1960-61)	10.26376	0.018836	544.9073	0.0000
B2 (1961-62 to 1970-71)	10.51962	0.053708	195.8663	0.0000
B3 (1971-72 to 1986-87)	10.34582	0.047165	219.3526	0.0000
B4 (1987-88 to 1999-00)	9.965295	0.095342	104.5219	0.0000
B5 (2000-01 to 2009-10	9.238546	0.178216	51.83889	0.0000
B1 x Trend	0.058958	0.002777	21.22947	0.0000
B2 x Trend	0.044941	0.003207	14.01419	0.0000
B3 x Trend	0.050930	0.001580	32.24136	0.0000
B4 x Trend	0.061783	0.002159	28.61548	0.0000
B5 x Trend	0.074571	0.003207	23.25381	0.0000

R-squared	0.999221	Mean dependent var	11.96062
Adjusted R-squared	0.999080	S.D. dependent var	0.960491
S.E. of regression	0.029127	Akaike info criterion	-4.083266
Sum squared resid	0.042420	Schwarz criterion	-3.734209
Log likelihood	132.4980	Hannan-Quinn criter.	-3.946731
Durbin-Watson stat	1.345118		

4. Residual Plot



5. ADF Test (Residual)

Null Hypothesis: LYIR_RES has a unit root
Exogenous: Constant
Lag Length: 9 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-4.526594	0.0006

Variable: LYSR1 (Log GDP Services 1 at Factor Cost at 2004-05 Prices)

1. ADF (Stationary) Test Results

Null Hypothesis: LYSR1 has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	6.092362	1.0000

Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	1.894316	1.0000

Null Hypothesis: D(LYSR1) has a unit root
Exogenous: Constant
Lag Length: 7 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	0.339781	0.9782

Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-5.664033	0.0001

2. Test Statistics for Multiple Breaks

Specification: z_t ={1, Trend}, x =0, h = 11 and M=5, N=60 (1950-51 to 2009-10)
$SupF_T$ (2|1): 199.833* $SupF_T$ (3|2): 38.814* $SupF_T$ (4|3): 10.749 $SupF_T$ (5|4): 10749 WDmax :1556.63* UDmax: 2765.938*
Number of Breaks selected by Sequential Procedure at 5% significance level: 4 **Breaks:** 13 (1962-63), 22 (1971-72), 38 (1987-88) and 51 (2000-01)

Note: * Significance at 1% level; ** significance at 5% level.

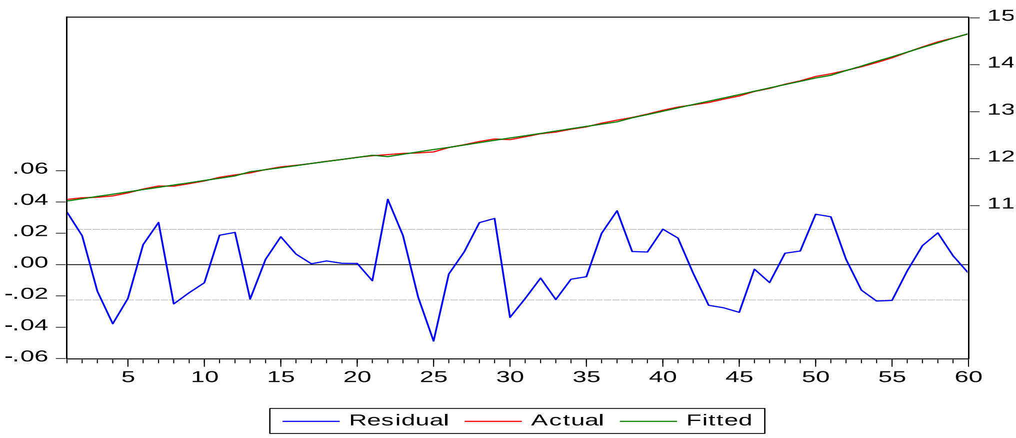
3. Estimates of the Model Selected by Sequential Method at 5 % Significance Level

Dependent Variable: LYSR1
Sample: 1 60
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C1(1950-51 to 1961-62)	11.05064	0.013877	796.3114	0.0000
C2 (1962-63 to 1970-71)	11.15071	0.050053	222.7771	0.0000
C3 (1971-72 to 1986-87)	10.95761	0.036511	300.1156	0.0000
C4 (1987-88 to 1999-00)	10.17744	0.073805	137.8957	0.0000
C5 (2000-01 to 2009-10)	8.751861	0.137960	63.43768	0.0000
C1 x Trend	0.048513	0.001886	25.72907	0.0000
C2 x Trend	0.043852	0.002911	15.06469	0.0000
C3 x Trend	0.049401	0.001223	40.39902	0.0000
C4 x Trend	0.070826	0.001671	42.37645	0.0000
C5 x Trend	0.098518	0.002482	39.68607	0.0000

R-squared	0.999567	Mean dependent var	12.61854
Adjusted R-squared	0.999490	S.D. dependent var	0.998049
S.E. of regression	0.022548	Akaike info criterion	-4.595337
Sum squared resid	0.025420	Schwarz criterion	-4.246280
Log likelihood	147.8601	Hannan-Quinn criter.	-4.458801
Durbin-Watson stat	1.165587		

4. Residual Plot



5. ADF Test (Residual)

Null Hypothesis: LYSR1_RES has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-6.641900	0.0000

Variable: LYSR2 (Log GDP Services 2 at Factor Cost in 2004-05 prices)

1. ADF (Stationary) Test Results

Null Hypothesis: LYSR2 has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	2.462600	1.0000

Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on AIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.499464	0.9809
Test critical values:	1% level	-4.124265	
	5% level	-3.489228	
	10% level	-3.173114	

Null Hypothesis: D(LYSR2) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-4.068983	0.0022

2. Test Statistics for Multiple Breaks

Specification: z_t ={1, Trend}, x =0, h = 11 and M=3, N=60 (1950-51 to 2009-10)			
$SupF_T$ (2|1): 34.362*	$SupF_T$ (3|2): 38.147*	WDmax :336.314*	UDmax: 262.534*
Number of Breaks selected by Sequential Procedure at 5% significance level: 3			
Breaks: 12 (1961-62), 34 (1983-84) and 48 (1997-98)			

Note: * Significance at 1% level; ** significance at 5% level.

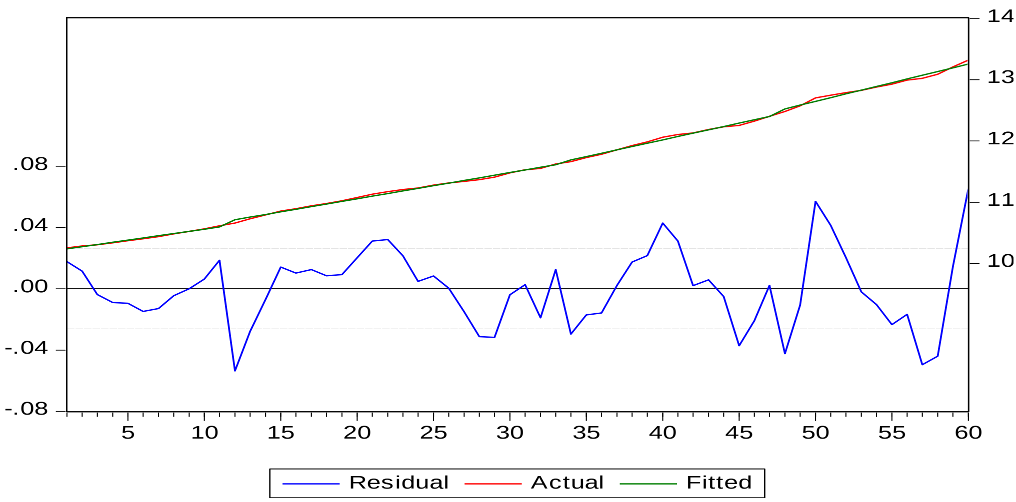
3. Estimates of the Model Selected by Sequential Method at 5 % Significance Level

Dependent Variable: LYSR2
Sample: 1 60
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D1 (1950-51 to 1960-61)	10.20323	0.016885	604.2918	0.0000
D2 (1961-62 to 1982-83)	10.20151	0.020512	497.3418	0.0000
D3 (1983-84 to 1996-97)	9.837520	0.070455	139.6278	0.0000
D4 (1997-98 to 2009-10)	9.599427	0.104763	91.63018	0.0000
D1 x Trend	0.035744	0.002490	14.35772	0.0000
D2 x Trend	0.042751	0.000877	48.72316	0.0000
D3 x Trend	0.054517	0.001731	31.49325	0.0000
D4 x Trend	0.060931	0.001935	31.48233	0.0000

R-squared	0.999248	Mean dependent var	11.60654
Adjusted R-squared	0.999146	S.D. dependent var	0.893624
S.E. of regression	0.026110	Akaike info criterion	-4.329423
Sum squared resid	0.035450	Schwarz criterion	-4.050177
Log likelihood	137.8827	Hannan-Quinn criter.	-4.220194
Durbin-Watson stat	0.929858		

4. Residual Plot



5. ADF Test (Residual)

Null Hypothesis: LYSR2_RES has a unit root Exogenous: Constant Lag Length: 1 (Automatic - based on AIC, maxlag=10)		
	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-4.433770	0.0007

(ii) Testing for Stationarity with Structural Breaks: Fiscal Variables

Variable: LCBDTR (Log Combined Direct Taxes)

1. ADF (Stationary) Test Results

Null Hypothesis: LCBDTR has a unit root Exogenous: Constant Lag Length: 10 (Automatic - based on AIC, maxlag=10)		
	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	4.397853	1.0000
Exogenous: Constant, Linear Trend Lag Length: 10 (Automatic - based on AIC, maxlag=10)		
	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	1.000938	0.9998
Null Hypothesis: D(LCBDTR) has a unit root Exogenous: Constant Lag Length: 0 (Automatic - based on AIC, maxlag=10)		
	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-5.406980	0.0000

2. Test Statistics for Multiple Breaks

Specification: z_t ={1, Trend}, x =0, h = 11 and M=3, N=60 (1950-51 to 2009-10)
$SupF_T$ (2|1): 32.368* $SupF_T$ (3|2): 0.000 WDmax :363.369* UDmax: 1217.978*
Number of Breaks selected by Sequential Procedure at 5% significance level: 2 **Breaks:** 23 (1972-73), and 35 (1984-85)

Note: * Significance at 1% level; ** significance at 5% level.

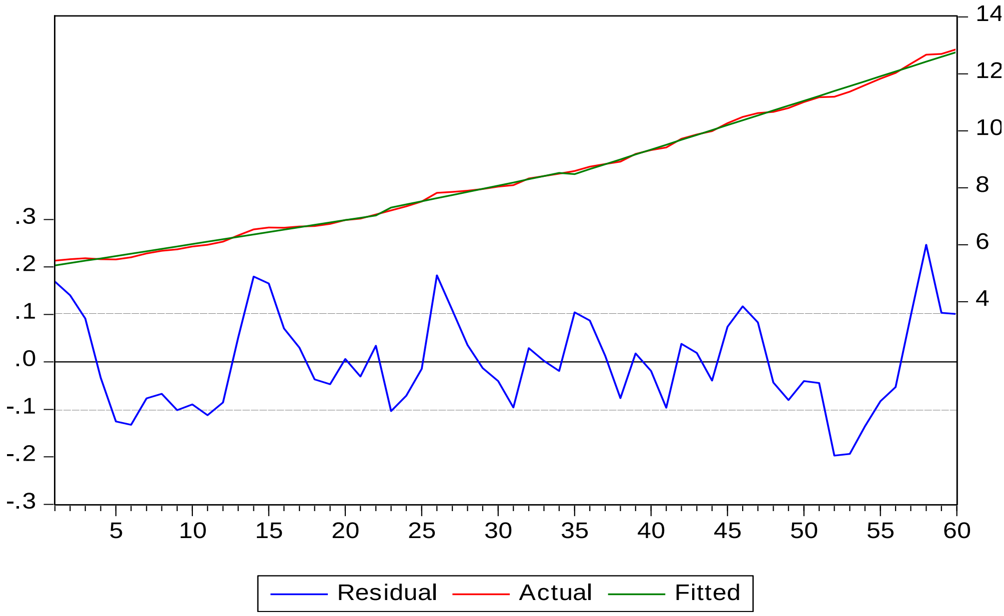
3. Estimates of the Model Selected by Sequential Method at 5 % Significance Level

Dependent Variable: LCBDTR
Sample: 1 60
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
E1 (1950-51 to 1971-72)	5.186670	0.044953	115.3810	0.0000
E2 (1972-73 to 1983-84)	4.780321	0.244508	19.55076	0.0000
E3 (1984-85 to 2009-10)	2.480810	0.128070	19.37076	0.0000
E1 x Trend	0.083856	0.003423	24.50044	0.0000
E2 x Trend	0.109927	0.008517	12.90681	0.0000
E3 x Trend	0.171463	0.002663	64.38215	0.0000

R-squared	0.998097	Mean dependent var	8.442327
Adjusted R-squared	0.997920	S.D. dependent var	2.233323
S.E. of regression	0.101848	Akaike info criterion	-1.636024
Sum squared resid	0.560147	Schwarz criterion	-1.426590
Log likelihood	55.08072	Hannan-Quinn criter.	-1.554103
Durbin-Watson stat	0.689325		

4. Residual Plot



5. ADF Test (Residual)

Null Hypothesis: LCBDTR_RES has a unit root Exogenous: Constant Lag Length: 4 (Automatic - based on AIC, maxlag=10)		
	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-4.189888	0.0016

Variable: LCBITR (Log Combined Indirect Taxes)

1. ADF (Stationary) Test Results

Null Hypothesis: LCBITR has a unit root Exogenous: Constant Lag Length: 1 (Automatic - based on AIC, maxlag=10)		
	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	0.219507	0.9716
Exogenous: Constant, Linear Trend Lag Length: 1 (Automatic - based on AIC, maxlag=10)		
	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-3.141071	0.1068
Null Hypothesis: D(LCBITR) has a unit root Lag Length: 0 (Automatic - based on AIC, maxlag=10)		
	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-6.355625	0.0000

2. Test Statistics for Multiple Breaks

Specification: z_t ={1, Trend}, x =0, h = 11 and M=5, N=60 (1950-51 to 2009-10)
$SupF_T$ (2|1): 42.432* $SupF_T$ (3|2): 26.209* $SupF_T$ (4|3): 9.327 $SupF_T$ (5|4): 9.327 WDmax :437.295* UDmax: 1199.158*
Number of Breaks selected by Sequential Procedure at 5% significance level: 4 **Breaks:** 9 (1958-59), 18 (1967-68), 35 (1984-85) and 48 (1997-98)

Note: * Significance at 1% level; ** significance at 5% level.

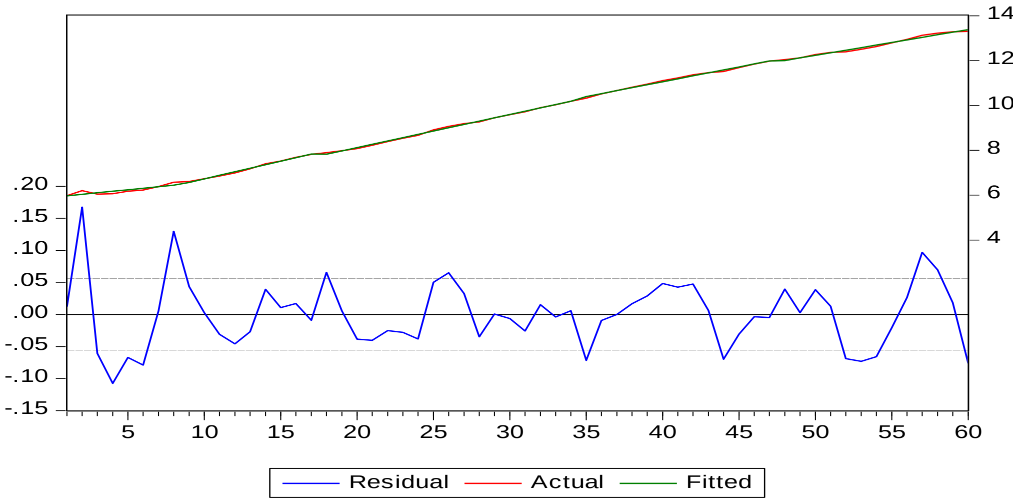
3. Estimates of the Model Selected by Sequential Method at 5 % Significance Level

Dependent Variable: LCBITR
Sample: 1 60
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
F1 (1950-51 to 1957-58)	5.901380	0.043639	135.2331	0.0000
F2 (1958-59 to 1966-67)	5.152845	0.095828	53.77159	0.0000
F3 (1967-68 to 1983-84)	5.174136	0.073357	70.53322	0.0000
F4 (1984-85 to 1996-97)	5.773824	0.170913	33.78230	0.0000
F5 (1997-98 to 2009-10)	6.503448	0.224710	28.94146	0.0000
F1 x Trend	0.068171	0.008642	7.888530	0.0000
F2 x Trend	0.157538	0.007230	21.78893	0.0000
F3 x Trend	0.147334	0.002773	53.13820	0.0000
F4 x Trend	0.132077	0.004151	31.81551	0.0000
F5 x Trend	0.114609	0.004151	27.60754	0.0000

R-squared	0.999515	Mean dependent var	9.633525
Adjusted R-squared	0.999427	S.D. dependent var	2.340484
S.E. of regression	0.056005	Akaike info criterion	-2.775747
Sum squared resid	0.156827	Schwarz criterion	-2.426690
Log likelihood	93.27242	Hannan-Quinn criter.	-2.639212
Durbin-Watson stat	1.290340		

4. Residual Plot



5. ADF Test (Residual)

Null Hypothesis: LCBITR_RES has a unit root
Exogenous: Constant
Lag Length: 4 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-6.412918	0.0000

Variable: LCBRE (Log Combined Revenue Expenditure)

1. ADF (Stationary) Test Results

Null Hypothesis: LCBRE has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	2.658297	1.0000

Exogenous: Constant, Linear Trend
Lag Length: 3 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.347479	0.4023

Null Hypothesis: D(LCBRE) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-5.170445	0.0001

2. Test Statistics for Multiple Breaks

Specification: z_t ={1, Trend}, x =0, h = 11 and M=5, N=60 (1950-51 to 2009-10)
$SupF_T$ (2|1): 66.210* $SupF_T$ (3|2): 44.990* $SupF_T$ (2|1): 19.8848* upF_T (3|2): 10.362 WDmax :691.004* UDmax: 354.884*
Number of Breaks selected by Sequential Procedure at 5% significance level: 5 **Breaks:** 9 (1958-59), 18 (1967-68), 32 (1984-85), 42 (1991-92) and 51 (2000-01)

Note: * Significance at 1% level; ** significance at 5% level.

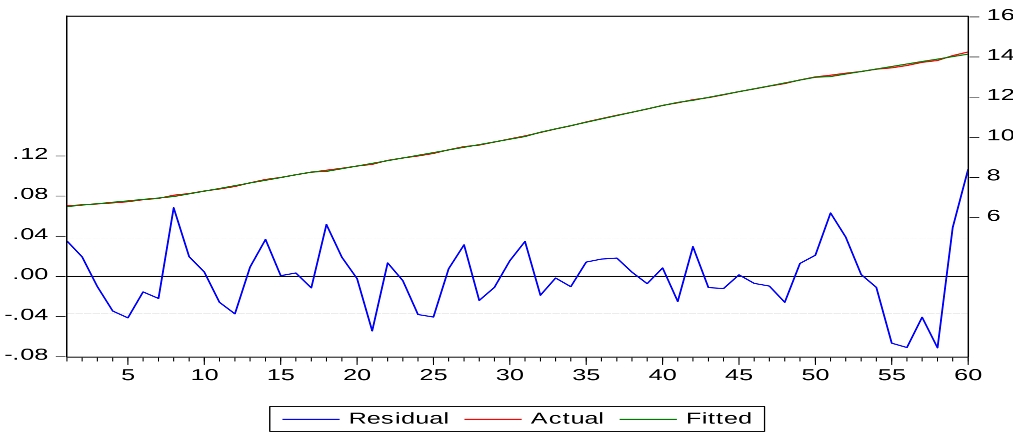
3. Estimates of the Model Selected by Sequential Method at 5 % Significance Level

Dependent Variable: LCBRE
Sample: 1 60
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
G1 (1950-51 to 1957-58)	6.480162	0.029062	222.9765	0.0000
G2 (1958-59 to 1966-67)	5.962703	0.063819	93.43142	0.0000
G3 (1967-68 to 1983-84)	5.905862	0.061398	96.18918	0.0000
G4 (1984-85 to 1990-91)	4.953890	0.150345	32.95025	0.0000
G5 (1991-92 to 1999-00)	5.819507	0.221843	26.23250	0.0000
G6 (2000-01)	6.702594	0.228207	29.37074	0.0000
G1 x Trend	0.071110	0.005755	12.35581	0.0000
G2 x Trend	0.135669	0.004815	28.17564	0.0000
G3 x Trend	0.133321	0.002473	53.91477	0.0000
G4 x Trend	0.165622	0.004106	40.33330	0.0000
G5 x Trend	0.143456	0.004815	29.79303	0.0000
G6 x Trend	0.124057	0.004106	30.21112	0.0000

R-squared	0.999802	Mean dependent var	10.16642
Adjusted R-squared	0.999757	S.D. dependent var	2.393160
S.E. of regression	0.037298	Akaike info criterion	-3.562918
Sum squared resid	0.066773	Schwarz criterion	-3.144049
Log likelihood	118.8875	Hannan-Quinn criter.	-3.399075
Durbin-Watson stat	1.184424		

4. Residual Plot



5. ADF Test (Residual)

Null Hypothesis: LCBRE_RES has a unit root
Exogenous: Constant
Lag Length: 5 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-5.898612	0.0000

Variable: LCBDEBT (Log Combined Debt)

1. ADF (Stationary) Test Results

Null Hypothesis: LCBDEBT has a unit root
Exogenous: Constant
Lag Length: 8 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	0.231404	0.9721

Exogenous: Constant, Linear Trend
Lag Length: 8 (Automatic - based on AIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.675443	0.2508
Test critical values:	1% level	-4.148465	
	5% level	-3.500495	
	10% level	-3.179617	

Null Hypothesis: D(LCBDEBT) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-4.397339	0.0008

2. Test Statistics for Multiple Breaks

Specification: z_t ={1, Trend}, x =0, h = 11 and M=3, N=60 (1950-51 to 2009-10)
$SupF_T$ (2|1): 148.055* $SupF_T$ (3|2): 2.207 WDmax :2115.882* UDmax: 1269.247*
Number of Breaks selected by Sequential Procedure at 5% significance level: 2 **Breaks:** 31 (1980-81), and 43(1992-93)

Note: * Significance at 1% level; ** significance at 5% level.

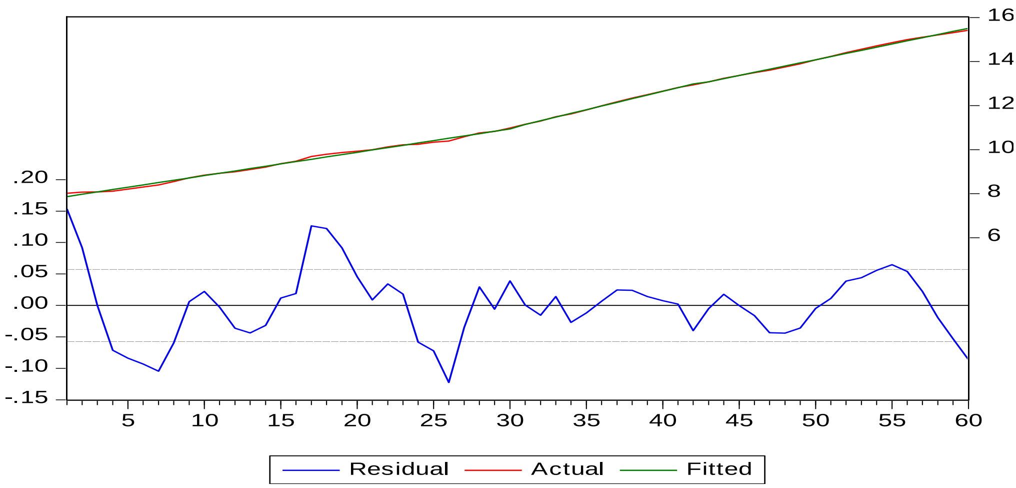
3. Estimates of the Model Selected by Sequential Method at 5 % Significance Level

Dependent Variable: LCBDEBT
Sample: 1 60
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
H1 (1950-51 to 1979-80)	7.762928	0.021483	361.3500	0.0000
H2 (1980-81 to 1991-92)	5.974467	0.175888	33.96749	0.0000
H3 (1992-93 to 2009-10)	6.935163	0.134906	51.40750	0.0000
H1 x Trend	0.105869	0.001210	87.48626	0.0000
H2 x Trend	0.166886	0.004797	34.78641	0.0000
H3 x Trend	0.142953	0.002606	54.84822	0.0000

R-squared	0.999436	Mean dependent var	11.40427
Adjusted R-squared	0.999384	S.D. dependent var	2.311339
S.E. of regression	0.057369	Akaike info criterion	-2.783986
Sum squared resid	0.177725	Schwarz criterion	-2.574552
Log likelihood	89.51958	Hannan-Quinn criter.	-2.702065
Durbin-Watson stat	0.485276		

4. Residual Plot



5. ADF Test (Residual)

Null Hypothesis: LCBDEBT_RES has a unit root
Exogenous: Constant
Lag Length: 5 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-3.987957	0.0029

Testing for Stationarity with Structural Breaks: Investment Variables
Variable: LIHR (Log Household Investment at 2004-05 prices)
1. ADF (Stationary) Test Results

Null Hypothesis: LIHR has a unit root
Exogenous: Constant
Lag Length: 8 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	1.654154	0.9995

Exogenous: Constant, Linear Trend
Lag Length: 8 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-0.363212	0.9864

Null Hypothesis: D(LIHR) has a unit root
Exogenous: Constant
Lag Length: 10 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.079610	0.2535

Exogenous: Constant, Linear Trend
Lag Length: 7 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-4.987542	0.0009

2. Test Statistics for Multiple Breaks

Specification: z_t ={1, Trend}, x =0, h = 11 and M=3, N=60 (1950-51 to 2009-10)
$SupF_T$ (2|1): 124.389* $SupF_T$ (3|2): 9.040 WDmax :159.939* UDmax: 121.134*
Number of Breaks selected by Sequential Procedure at 5% significance level: 2 **Breaks:** 15 (1964-65), and 31 (1980-81)

Note: * Significance at 1% level; ** significance at 5% level.

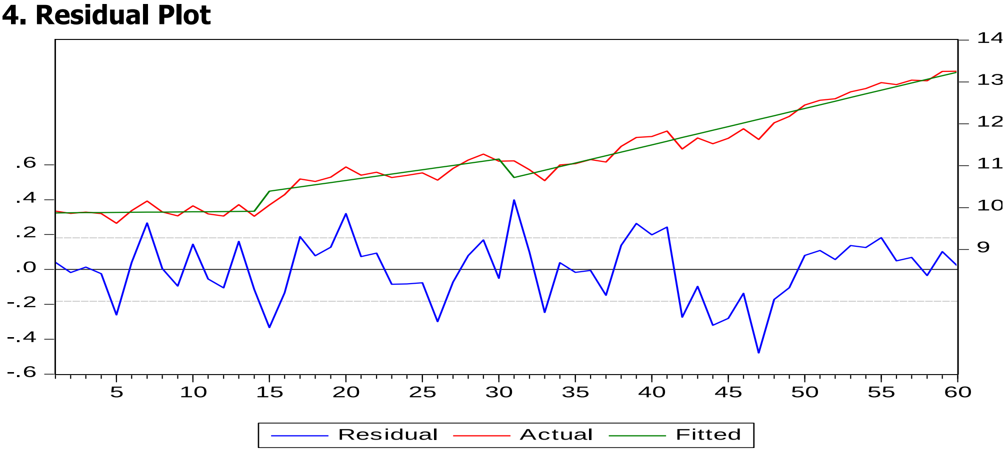
3. Estimates of the Model Selected by Sequential Method at 5 % Significance Level

Dependent Variable: LIHR
Sample: 1 60
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
I1 (1950-51 to 1963-64)	9.871146	0.102577	96.23183	0.0000
I2 (1964-65 to 1979-80)	9.627945	0.226330	42.53939	0.0000
I3 (1980-81 to 2009-10)	8.022953	0.177522	45.19424	0.0000
I1 x Trend	0.002807	0.012047	0.233018	0.8166
I2 x Trend	0.051021	0.009854	5.177493	0.0000
I3 x Trend	0.086892	0.003833	22.67042	0.0000

R-squared	0.972357	Mean dependent var	11.17003
Adjusted R-squared	0.969797	S.D. dependent var	1.045555
S.E. of regression	0.181707	Akaike info criterion	-0.478208
Sum squared resid	1.782932	Schwarz criterion	-0.268774
Log likelihood	20.34625	Hannan-Quinn criter.	-0.396287
Durbin-Watson stat	1.318072		

4. Residual Plot



5. ADF Test (Residual)

Null Hypothesis: LIHR_RES has a unit root
Exogenous: Constant
Lag Length: 8 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.287449	0.1070

Variable: LIPCR (Log Private Corporate Investment at 2004-05 prices)
1. ADF (Stationary) Test Results

Null Hypothesis: LIPCR has a unit root
Exogenous: Constant
Lag Length: 8 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	0.396847	0.9810

Exogenous: Constant, Linear Trend
Lag Length: 8 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-1.201394	0.8995

Null Hypothesis: D(LIPCR) has a unit root
Exogenous: Constant
Lag Length: 5 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-3.893403	0.0039

2. Test Statistics for Multiple Breaks

Specification: z_t ={1, Trend}, x =0, h = 11 and M=3, N=60 (1950-51 to 2009-10)
$SupF_T$ (2|1): 7.452 $SupF_T$ (3|2): 8.006 WDmax :52.871* UDmax: 33.064*
Number of Breaks selected by Sequential Procedure at 5% significance level: 1 **Breaks:** 25 (1974-75)

Note: * Significance at 1% level; ** significance at 5% level.

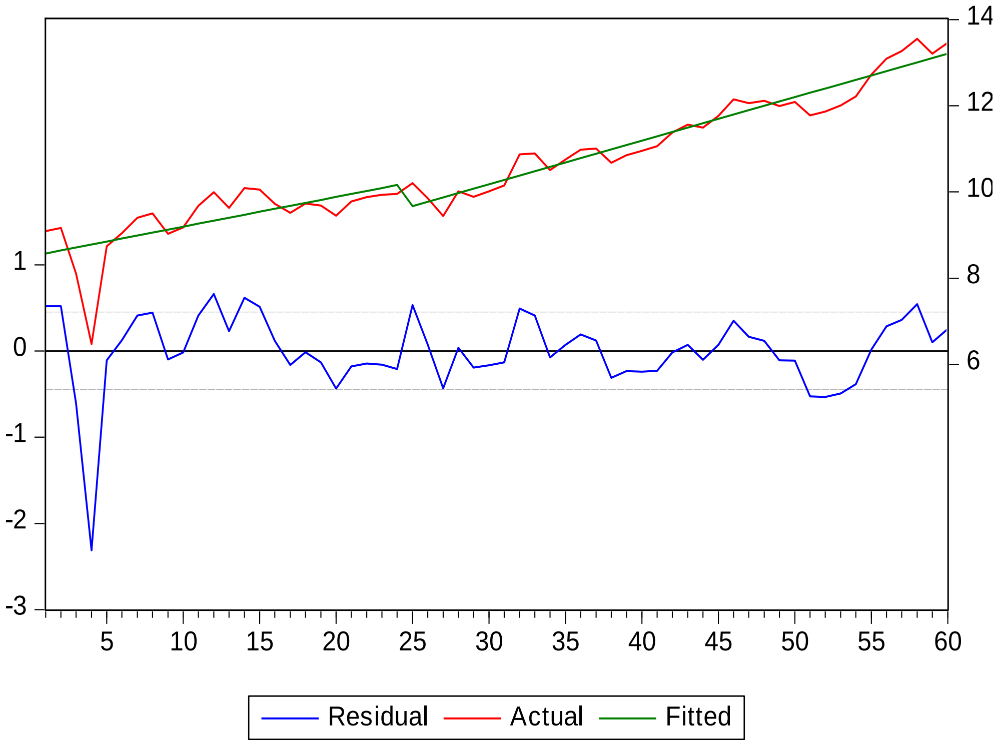
3. Estimates of the Model Selected by Sequential Method at 5 % Significance Level

Dependent Variable: LIPCR
Sample: 1 60
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
J1 (1950-51 to 1973-74)	8.504398	0.189850	44.79531	0.0000
J2 (1974-75 to 2009-10)	7.149726	0.316273	22.60620	0.0000
J1 x Trend	0.069045	0.013287	5.196511	0.0000
J2 x Trend	0.100995	0.007229	13.97101	0.0000

R-squared	0.904021	Mean dependent var	10.61219
Adjusted R-squared	0.898879	S.D. dependent var	1.416924
S.E. of regression	0.450575	Akaike info criterion	1.307758
Sum squared resid	11.36902	Schwarz criterion	1.447381
Log likelihood	-35.23274	Hannan-Quinn criter.	1.362372
Durbin-Watson stat	1.196537		

4. Residual Plot



5. ADF Test (Residual)

Null Hypothesis: LIPCR_RES has a unit root
Exogenous: Constant
Lag Length: 7 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-4.163876	0.0018

Variable: LIGR (Log Government Investment at 2004-05 Prices)
1. ADF (Stationary) Test Results

Null Hypothesis: LIGR has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-0.962370	0.7610

Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.315744	0.4190

Null Hypothesis: D(LIGR) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-6.986233	0.0000

2. Test Statistics for Multiple Breaks

Specification: z_t ={1, Trend}, x =0, h = 11 and M=3, N=60 (1950-51 to 2009-10)
$SupF_T$ (2|1): 19.870* $SupF_T$ (3|2): 4.646 WDmax :92.662* UDmax: 122.347*
Number of Breaks selected by Sequential Procedure at 5% significance level: 2 **Breaks:** 16 (1965-66), 34 (1984-85) and 46 (1995-96)

Note: * Significance at 1% level; ** significance at 5% level.

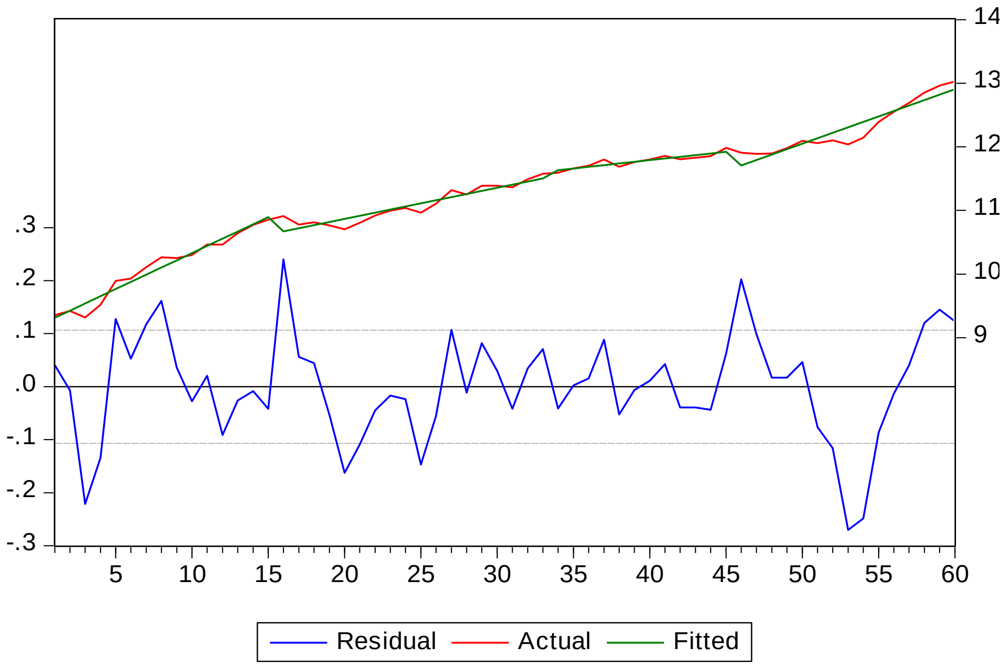
3. Estimates of the Model Selected by Sequential Method at 5 % Significance Level

Dependent Variable: LIGR
Sample: 1 60
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
K1 (1950-51 to 1964-65)	9.198556	0.057915	158.8287	0.0000
K2 (1965-66 to 1983-84)	9.887210	0.121269	81.53135	0.0000
K3 (1984-85 to 1994-95)	10.73654	0.353416	30.37936	0.0000
K4 (1995-96 to 2009-10)	7.766000	0.338719	22.92756	0.0000
K1 x Trend	0.113128	0.006370	17.76000	0.0000
K2 x Trend	0.049025	0.004842	10.12411	0.0000
K3 x Trend	0.026357	0.008913	2.957038	0.0047
K4 x Trend	0.085657	0.006370	13.44737	0.0000

R-squared	0.987607	Mean dependent var	11.28437
Adjusted R-squared	0.985939	S.D. dependent var	0.898855
S.E. of regression	0.106587	Akaike info criterion	-1.516143
Sum squared resid	0.590762	Schwarz criterion	-1.236897
Log likelihood	53.48430	Hannan-Quinn criter.	-1.406915
Durbin-Watson stat	0.995618		

4. Residual Plot



5. ADF Test (Residual)

Null Hypothesis: LIGR_RES has a unit root
Exogenous: Constant
Lag Length: 6 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-4.478900	0.0007

(iii) Testing for Stationarity with Structural Breaks: Export and Import Variables

Variable: LEXPR (Log Exports in 2004-05 Prices)

1. ADF (Stationary) Test Results

Null Hypothesis: LEXPR has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	2.877264	1.0000

Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-1.340340	0.8678

Null Hypothesis: D(LEXPR) has a unit root
Exogenous: Constant
Lag Length: 3 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.122132	0.2370

Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-8.192109	0.0000

2. Test Statistics for Multiple Breaks

Specification: z_t ={1, Trend}, x =0, h = 11 and M=3, N=60 (1950-51 to 2009-10)
$SupF_T$ (2|1): 62.267* $SupF_T$ (3|2): 0.000 WDmax :523.593* UDmax: 396.196*
Number of Breaks selected by Sequential Procedure at 5% significance level: 2 **Breaks:** 20 (1969-70), and 38 (1987-88)

Note: * Significance at 1% level; ** significance at 5% level.

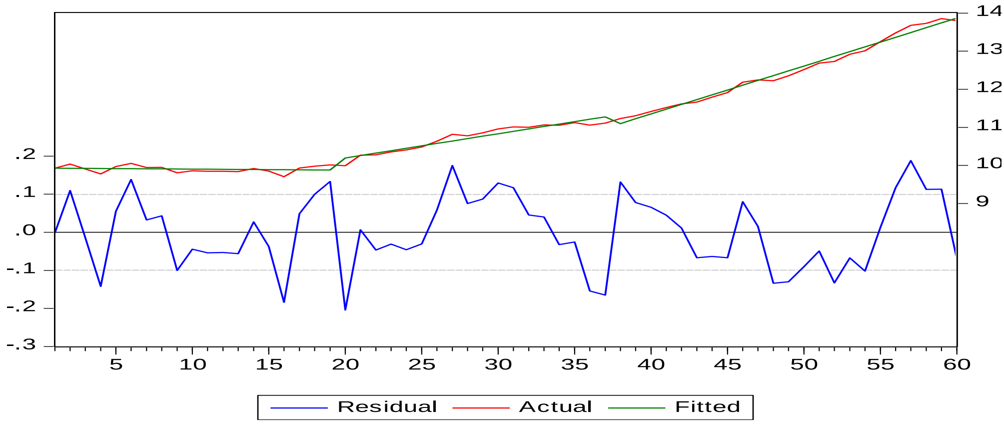
3. Estimates of the Model Selected by Sequential Method at 5 % Significance Level

Dependent Variable: LEXPR
Sample: 1 60
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
L1 (1950-51 to 1968-69)	9.929966	0.047478	209.1471	0.0000
L2 (1969-70 to 1986-87)	8.926811	0.130840	68.22717	0.0000
L3 (1987-88 to 2009-10)	6.316180	0.154529	40.87367	0.0000
L1 x Trend	-0.002693	0.004164	-0.646750	0.5205
L2 x Trend T	0.063497	0.004517	14.05852	0.0000
L3 x Trend	0.125869	0.003125	40.27609	0.0000

R-squared	0.994202	Mean dependent var	11.14235
Adjusted R-squared	0.993665	S.D. dependent var	1.249119
S.E. of regression	0.099417	Akaike info criterion	-1.684343
Sum squared resid	0.533725	Schwarz criterion	-1.474908
Log likelihood	56.53028	Hannan-Quinn criter.	-1.602421
Durbin-Watson stat	1.252858		

4. Residual Plot



5. ADF Test (Residual)

Null Hypothesis: LEXPR_RES has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-5.077828	0.0001

Variable: LIMPR (Log Imports at 2004-05 Prices)

1. ADF (Stationary) Test Results

Null Hypothesis: LIMPR has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	1.904752	0.9998

Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-0.739747	0.9650

Null Hypothesis: D(LIMPR) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-7.690597	0.0000

2. Test Statistics for Multiple Breaks

Specification: z_t ={1, Trend}, x =0, h = 11 and M=5, N=60 (1950-51 to 2009-10)
$SupF_T$ (2|1): 62.344* $SupF_T$ (3|2): 16.920 $SupF_T$ (2|1): 16.920* $SupF_T$ (3|2): 3.289 WDmax :492.353* UDmax: 277.089*
Number of Breaks selected by Sequential Procedure at 5% significance level: 3 **Breaks:** 28 (1977-78), 40 (1989-90) and 51 (2000-01)

Note: * Significance at 1% level; ** significance at 5% level.

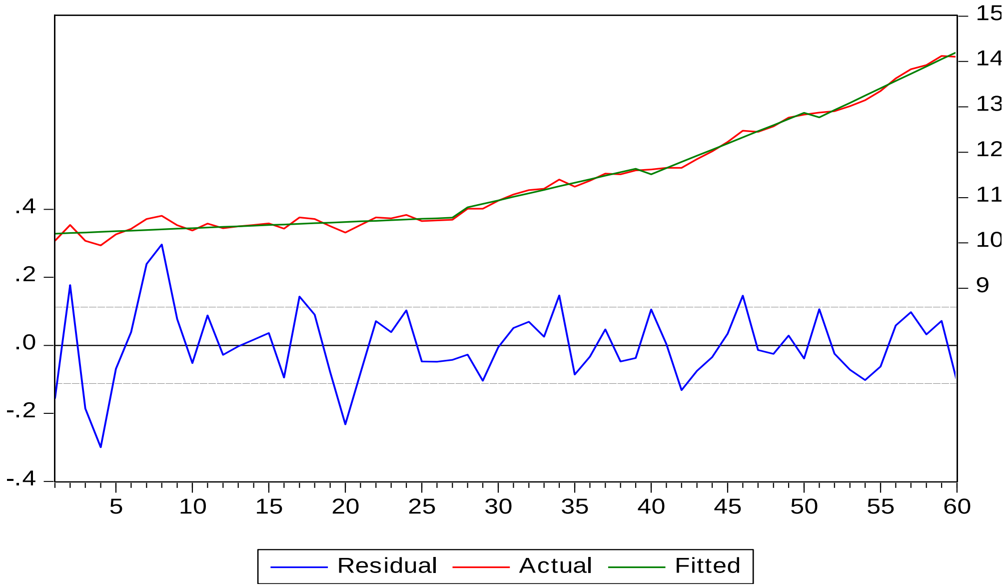
3. Estimates of the Model Selected by Sequential Method at 5 % Significance Level

Dependent Variable: LIMPR
Sample: 1 60
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
M1 (1950-51 to 1976-77)	10.19002	0.044501	228.9846	0.0000
M2 (1977-78 to 1988-89)	8.610503	0.316600	27.19676	0.0000
M3 (1989-90 to 1999-00)	6.099140	0.483534	12.61368	0.0000
M4 (2000-01 to 2009-10)	4.587377	0.687841	6.669245	0.0000
M1 x Trend	0.013590	0.002778	4.892696	0.0000
M2 x Trend	0.077600	0.009401	8.254490	0.0000
M3 x Trend	0.135383	0.010719	12.63043	0.0000
M4 x Trend	0.160396	0.012377	12.95924	0.0000

R-squared	0.992269	Mean dependent var	11.39646
Adjusted R-squared	0.991229	S.D. dependent var	1.200347
S.E. of regression	0.112419	Akaike info criterion	-1.409596
Sum squared resid	0.657181	Schwarz criterion	-1.130350
Log likelihood	50.28788	Hannan-Quinn criter.	-1.300368
Durbin-Watson stat	1.485186		

4. Residual Plot



5. ADF Test (Residual)

Null Hypothesis: LIMPR_RES has a unit root
Exogenous: Constant
Lag Length: 3 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-6.312198	0.0000

(iii) Testing for Stationarity with Structural Breaks: Monetary Variables

Variable: LM0 (Log Reserve Money)

1. ADF (Stationary) Test Results

Null Hypothesis: LM0 has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	1.588162	0.9994

Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.225513	0.4666

Null Hypothesis: D(LM0) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-4.583555	0.0004

2. Test Statistics for Multiple Breaks

Specification: z_t ={1, Trend}, x =0, h = 11 and M=5 N=59 (1951-52 to 2009-10)
$SupF_T$ (2|1): 27.741* $SupF_T$ (3|2): 33.459* $SupF_T$ (2|1): 16.898** $SupF_T$ (3|2): 16.898** WDmax :3507.166* UDmax: 2215.599*
Number of Breaks selected by Sequential Procedure at 5% significance level: 4 **Breaks:** 8 (1958-59), 19 (1969-70), 27 (1977-78), and 49 (1999-00)

Note: * Significance at 1% level; ** significance at 5% level.

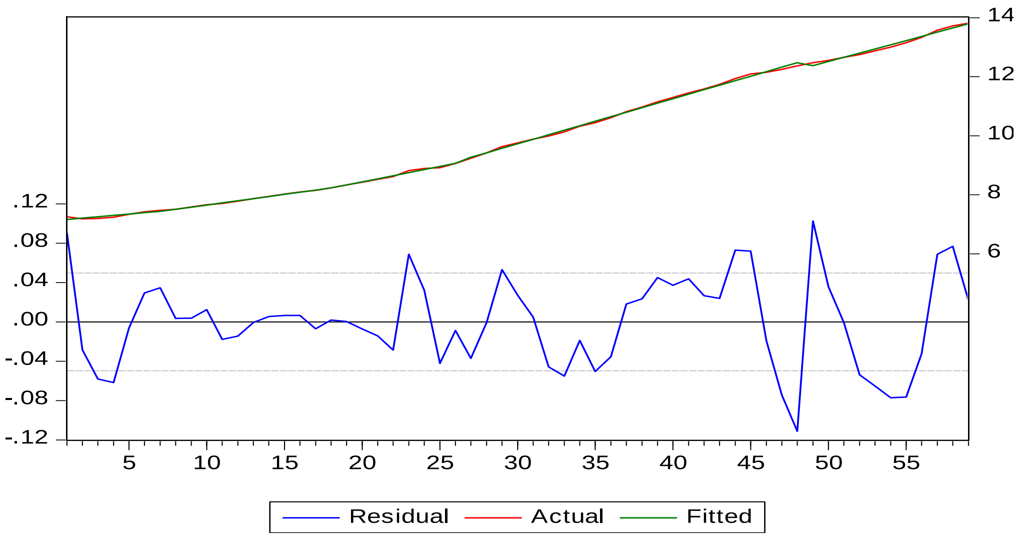
3. Estimates of the Model Selected by Sequential Method at 5 % Significance Level

Dependent Variable: LM0
Sample (adjusted): 1 59
Included observations: 59 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
N1 (1951-52 to 1957-58)	7.119849	0.042006	169.4943	0.0000
N2 (1958-59 to 1968-69)	6.927841	0.063403	109.2668	0.0000
N3 (1969-70 to 1976-77)	6.326337	0.173451	36.47325	0.0000
N4 (1977-78 to 1998-99)	5.148548	0.063525	81.04760	0.0000
N5 (1999-00 to 2009-10)	5.438711	0.256342	21.21659	0.0000
N1 x Trend	0.045437	0.009393	4.837335	0.0000
N2 x Trend	0.072457	0.004739	15.28972	0.0000
N3 x Trend	0.105499	0.007669	13.75608	0.0000
N4 x Trend	0.152675	0.001670	91.40787	0.0000
N5 x Trend	0.141553	0.004739	29.86999	0.0000

R-squared	0.999534	Mean dependent var	10.00700
Adjusted R-squared	0.999448	S.D. dependent var	2.116415
S.E. of regression	0.049703	Akaike info criterion	-3.012251
Sum squared resid	0.121047	Schwarz criterion	-2.660126
Log likelihood	98.86139	Hannan-Quinn criter.	-2.874795
Durbin-Watson stat	1.153042		

4. Residual Plot



5. ADF Test (Residual)

Null Hypothesis: LM0_RES has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-5.593044	0.0000

Variable: LM3 (Log Broad Money)

1. ADF (Stationary) Test Results

Null Hypothesis: LM3 has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	2.184257	0.9999

Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.518177	0.3186

Null Hypothesis: D(LM3) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-4.258809	0.0013

2. Test Statistics for Multiple Breaks

Specification: z_t ={1, Trend}, x =0, h = 11 and M=3, N=59 (1951-52 to 2009-10)
$SupF_T$ (2|1): 9.993** $SupF_T$ (3|2): 53.079 $SupF_T$ (2|1): 36.211* $SupF_T$ (3|2): 5.995 WDmax :9025.07* UDmax: 4532.109*
Number of Breaks selected by Sequential Procedure at 5% significance level: 1 **Breaks:** 17 (1967-68)

Note: * Significance at 1% level; ** significance at 5% level.

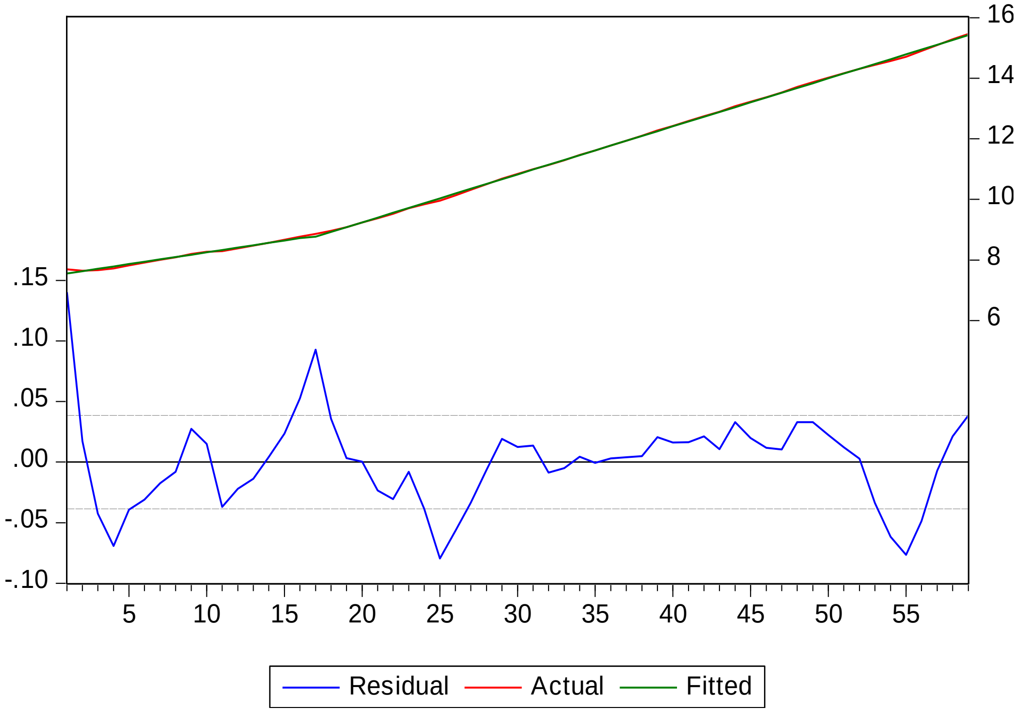
3. Estimates of the Model Selected by Sequential Method at 5 % Significance Level

Dependent Variable: LM3
Sample (adjusted): 1 59
Included observations: 59 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
O1 (1951-52 to 1966-67)	7.476272	0.020198	370.1409	0.0000
O2 (1967-68 to 2009-10)	6.073173	0.018921	320.9742	0.0000
O1 x Trend	0.077799	0.002089	37.24469	0.0000
O2 x Trend	0.158444	0.000473	334.7487	0.0000

R-squared	0.999767	Mean dependent var	11.02110
Adjusted R-squared	0.999755	S.D. dependent var	2.459746
S.E. of regression	0.038517	Akaike info criterion	-3.610049
Sum squared resid	0.081595	Schwarz criterion	-3.469199
Log likelihood	110.4964	Hannan-Quinn criter.	-3.555067
Durbin-Watson stat	0.580183		

4. Residual Plot



5. ADF Test (Residual)

Null Hypothesis: LM3_RES has a unit root
Exogenous: Constant
Lag Length: 3 (Automatic - based on AIC, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-3.760478	0.0056

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