# An Automatic Leading Indicator Based Growth Forecast For 2016-17 and The Outlook Beyond

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# An Automatic Leading Indicator Based Growth Forecast For 2016-17 and The Outlook Beyond[1]

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## Abstract

Building on the early work of Mitchell and Burns (1938,1946), the automatic leading indicator (ALI) approach has been developed over the last few decades by Geweke (1977), Sargent and Sims (1977), Stock and Watson (1988), Camba-Mendez et al. (1999) , Mongardini and Sedik (2003), Duo-Qin et al. (2006), Grenouilleau (2006) and others. It has come to be widely accepted as one of the most effective methods for macroeconomic forecasting. This paper uses the ALI approach to forecast aggregate and sectoral GDP growth for 2016-17. The approach uses a dynamic factor model (DFM) in the form of state space representation to extract factors from a pool of variables and then the factors are incorporated into a VAR model to generate the forecast series. Three alternate models have been tried: demand side, supply side and combined model. The model with the lowest RMSE is selected for the forecast. Real GDP growth is forecast at 6.7% for 2016-17 without factoring in the impact of demonetisation. Incorporating that impact reduces the forecast to 6.1%.

**Keywords:** Growth Rate, Forecasting, Automatic Leading Indicator, Dynamic Factor Model, Agriculture, Industry, Services, GDP, Demonetization

**JEL Classification codes:** C32, C5, O4

[1] In the preparation of this paper, we have benefitted from extensive discussions with N.R. Bhanumurthy in the early stages of our work. We have also benefited from very useful discussions with Rathin Roy. However, the authors are solely responsible for the views expressed in the paper or remaining errors if any.

## 1. INTRODUCTION

In most mature and emerging market economies analysts have access to a large number of macroeconomic series. However, building an appropriate econometric model using multiple data series to produce reasonably accurate forecasts and test economic theories has remained a challenge for econometricians. Not all time series models can incorporate large numbers of variables, e.g. a vector autoregression (VAR) model cannot function with more than a few variables. Models like macro econometric structural models, etc. are constrained to use same frequency data. Also, if the parameters to be estimated are large relative to the number of observations, the model runs into a problem of limited degrees of freedom. Similarly, if a model consists of a large number of variables relative to the number of observations, the model cannot be estimated using conventional techniques. This constrains us from using all the available information. Finally, as Mongardini and Sedik point out “The relevant statistics to judge the direction of economic activity are only available with a considerable lag, delaying the appropriate policy response” (Mongardini and Sedik, 2003). Timely availability of statistical data is critical if forecasts of macroeconomic activities are to be useful for policy making either by the government or by the corporate sector.

In this context, the coincident indicator index and leading economic indicator index developed in 1938 by Mitchell and Burns and their colleagues in NBER was a major advance in summarizing and forecasting the state of macroeconomic activity (Burns and Mitchell 1938, 1946). Coincident indicators are correlated with current economic activities and leading indicators are correlated with future economic activities (Mongardini and Sedik, 2003). Thus, the coincident indicator index is coincident with the reference cycle or business cycle. Earlier there were studies to measure individual facets of the overall state of economic activity but none measured the overall state of the economy, i.e., the reference cycle. Stock and Watson argued that the business cycle refers to co-movements in different economic activities and not just fluctuations in GNP, therefore the reference cycle is best measured by looking at the co-movements of several aggregate time series. It is based on the assumption that there is a single unobserved variable common to many macroeconomic series (Stock and Watson, 1988). They proposed a model to estimate this unobserved variable as representing the state of the economy. It is similar to that in Sargent and Sims (1977). This unobserved variable refers to the “current state of the economy and is a common element in the fluctuations of key aggregate time series variables” (Stock and Watson, 1988).

The dynamic factor model (DFM) is used to capture the co-movement of macroeconomic series which are driven by a set of unobserved dynamic factors. DFM was initially proposed by Geweke (1977) as a time series extension of factor models which are used to deal with a large number of explanatory variables. “The dynamic factors are intended to summarize the information content of a group of possible leading indicator variables too numerous to be used directly in a VAR model” (Mendez et al., 1999). DFM consists of a small number of unobserved dynamic factors that leads to the observed co-movements of macroeconomic series. The common dynamic factors are driven by common economic shocks. Identification of such shocks is essential for conducting policy analysis. These shocks, which may be embedded in a large number of variables, are efficiently handled by DFM.

There is a vast empirical literature on DFMs that capture the co-movements of macroeconomic time series with a small number of dynamic factors. DFMs have been used, among others, by Sargent and Sims (1977), Geweke and Singleton (1977), Engle and Watson (1981), Stock and Watson (1989) and Camba-Mendez et al., 1999. Sargent and Sims (1977) showed that a few factors can explain a large fraction of the variance of macroeconomic series. Geweke and Singleton (1981) used a two-factor dynamic model to explain the business cycle. Forecasting the sectoral wage rates in Los Angeles, Engle and Watson (1981) found that DFM gave better forecasts as compared to a regression model without latent variables. Stock and Watson (1989) followed this approach in using a system with a large number of variables to explain variations in macroeconomic aggregates.

Camba-Mendez et al. (1999) used a model to forecast GDP growth for European countries in which a dynamic factor model was used to summarize the information content of a group of possible leading indicators. The method is similar to the leading index used by Stock and Watson, 1989. As the information is selected automatically from a group of indicators, the model is described as ALI (Camba-Mendez et al. 1999). The performance of the ALI model was assessed by comparing errors in its out-of-sample forecasts relative to the in-sample data set with that using alternative technique. Cambs-Mendez et al. found that forecasts based on the ALI method gave significantly better results compared to VAR models.

Qin et al. (2006) compared the ALI method with macro-econometric structural models (MESMs) in forecasting GDP growth and inflation and also found that the ALI method produces better forecast than those based on MESMs. They suggested that the forecast of ALI could be improved by choosing the initial set of indicators based on theories. Banerjee et al., 2003 also found that the ALI method provided significantly better forecasts as compared to traditional VAR models. They also pointed out that the performance of ALI is quite sensitive to the choice of variables.

The purpose of this paper is to capture the turning points and forecast the growth of real GDP and real sectoral GDP growth for the year 2016-17 using the ALI method. The next section describes the ALI method, the list of variables used and the data sources. The forecast results are presented in the third section.

## 2. METHODOLOGY

In this paper we have adopted the ALI technique to forecast real GDP and real sectoral GDP growth. The Kalman filter algorithm has been used for estimating the model. Three alternative models were tried for the forecasts: demand side model, supply side model and combined model. The model with the minimum root mean square error (RMSE) among the three was chosen for the forecast.

Time series data from 1982-83 to 2015-16 has been used to generate the forecast for the year 2016-17. The initial set of demand side and supply side variables are listed in Table 2.1 below. The combined model combines the demand and supply side variables as the name indicates. The variables were chosen broadly on the basis of their correlation with GDP and sectoral growth.

**Table 2.1: List of Variables for forecasting Real GDP Growth**

| Demand side | Supply side |
|---|---|
| 1. Stock of food grains | 1. Imports of Principal Commodities - US Dollar |
| 2. Developmental Expenditure of the Central and State Governments as % GDP at MP | 2. Net capital stock |
| 3. Non-Developmental Expenditure of the Central and State Governments as % GDP | 3. Electricity Generated |
| 4. Real Food credit | 4. Employment in Public and Organized Private Sectors |
| 5. Real Non-food credit | 5. Rainfall in India during July |
| 6. Real Effective Exchange Rate | 6. Rainfall in India during Dec |
| 7. Real Interest Rate | 7. Rainfall in India during January, February, July, August, September and December |
| 8. Real Money (M3) | |
| 9. Foreign Exchange Reserves | |
| 10. Fiscal Deficit as % GDP at MP | |
| 11. Rate of gross capital formation | |
| 12. Ratio of Export to Import | |

The supply side indicators for the agriculture growth forecast include all the supply side variables mentioned in table 2.1 above. For the demand side agriculture forecast all the demand side variables were included except the real non-food credit variable. The rate of gross capital formation here refers to capital formation related to agriculture sector. Similarly for the forecast of growth in industry and services, the rate of capital formation refers to capital formation in the respective sectors. The rest of the variables in the demand side and supply side models for industry and services are the same as those used for the aggregate GDP growth forecast model.

The data series are at constant prices. The variables used in the model are tested for unit root using Augmented Dickey Fuller test. All the variables are required to be stationary in ALI model. The variables which were not stationary at levels were transformed to their respective growth rates to make them stationary.

In the demand side model fiscal deficit as percent of GDP and real interest rate were found to be stationary at levels and the rest of the series were converted to their change rates to make them stationary. In the supply side data set 'Imports of Principal Commodities' and all the rainfall indicators were stationary at levels. The rest of the series were converted to rates of change to make the series stationary. The growth rates of aggregate net capital stock (NCS), net capital stock in industries (NCSIND) and net capital stock in agriculture (NCSAGRI) were adjusted for structural breaks to transform these series from non-stationary to stationary by introducing dummy variables for the break years[2]. An estimated break date is observed in 2005 for NCS and NCSIND and for NCSAGRI an estimated break date is observed in 2000. The Bai-Perron structural break test was applied to identify the break dates.

Using the transformed series, the principal component method was applied to extract factors for the three different models. The number of factors extracted depends on the proportion of variance explained by the factors. There is no set rule for how many components should be used. Typically the first principal component accounts for the largest variance and the additional variation explained by each subsequent component diminishes with the increase in components. In this paper we have taken as many factors as were required to explain at least 50 per cent of variation of the variables under study. This was limited to three or four factors since the number of observations is limited. With a larger number of observations more factors could have been extracted to explain a higher proportion of variance in the observed data and get better forecasts.

The model used for estimation is specified below:

**<u>The ALI model</u>**

$$y_t = As_t + By_{t-1} + e_t \qquad (1)$$

$$s_t = C + \Phi s_{t-1} + u_t \qquad (2)$$

[2] In this study the following regression is used for the non-stationary series after estimating the trend and intercept break dates: $y_t = \Sigma D_i + \Sigma \beta_i t^* D_i + et$ where Di's are intercept dummies and $\beta_i t^* D_i$ is the interaction dummy with trend t. Using OLS the equation is estimated and the ADF test is performed on its residuals. If the residual becomes stationary then it can be concluded that the series is trend stationary with structural breaks.

where $y_t$ is (N×1), $s_t$ is (K×1), A is (N×K), B is (N×N) and Φ is (K×K).

A, B, C and Φ are the parameters to be estimated. $e_t$ and $u_t$ are modeled as Gaussian error terms $e_t$ ˜ iid N(0,R) , $u_t$ ˜ iid N(0,Q) and $E(e_t,u_t)=0$.

The representation of the ALI model is also known as a state-space model. The first equation, the measurement equation, describes the relation between the observed variable ($y_t$) and the unobserved state variable ($s_t$). Equation (2) is the transition equation which describes the dynamics of unobserved variables. All the variables in the model are required to be stationary as explained earlier.

Model estimation consisted of two steps:

Step 1: Extraction of factors by principal component method.

Step 2: Forecasting $y_t$ from (1) using the extracted factors.

The estimation aims at estimating the parameters A, B, C and Φ to recover the unobserved state variable $s_t$.

The Kalman filter is a recursive algorithm that provides an optimal estimate of $\mathbf{s_t}$ conditional on information up to time t-1 and knowledge of the state space parameters **A, B, C, Φ , R and Q.**

The Kalman filter involves the following steps:

i. **Initialization** - Starting values for the conditional mean and variance of the state at time t-1 ($S_{t|t-1}$ and $P_{t|t-1}$ respectively).

ii. **Prediction** - At time t, form an optimal prediction $y_{t|t-1}$ using an estimated value for $S_{t|t-1}$ .

iii. **Correction** - Use the observed value of y at time t to calculate the prediction error

$$\eta_{t|t-1}= y_t-y_{t|t-1}$$

This prediction error is used to refine our estimate of $s_{t|t}$ .

$S_{t|t}-S_{t|t-1}=K_t (y_t-y_{t|t-1}) + \delta_t$ where $\delta_t$ is a disturbance term.

The equation represents a least square regression where $S_{t|t}-s_{t|t-1}$ is the dependent variable and $(y_t-y_{t|t-1})$ is the explanatory variable.

Thus $K_t = E_t[(S_{t|t}-S_{t|t-1})(y_t-y_{t|t-1})]/[E_t[(y_t-y_{t|t-1})^2]$. $K_t$ can be simplified as $K_t = A_t P_{t|t-1}/V_{t|t-1}$ where, $P_{t|t-1}$ is the variance of $S_t$ given information at t-1 and $V_{t|t-1}$ is the variance of $Y_t$ given information at t-1. $K_t$ is known as Kalman gain.

# 3. GROWTH RATE FORECASTS

The reference period of the exercise starts from 1980s, the period when liberalization was initiated. The economy experienced a distinct increase in its growth rate from 1980-81. The economy has also undergone significant structural change in the composition of GDP during this period, with a large decline in the share of agriculture and a large increase in services. The change in the share of industry has been modest.

GDP growth has been led primarily by services, especially financing; insurance; real estate and business services; and trade, hotels and restaurants. Accordingly, the share of services increased sharply from 38 per cent in 1981-82 to 66 per cent in 2012-13. On the other hand, the share of agriculture declined from 35 per cent in 1981-82 to 16 per cent in 2012-13 and the share of industry increased from 26 per cent in 1981-82 to 30 per cent in 2012-13.

Figure 3.1 shows the share of agriculture, industry and services in overall GDP from 1981-82 to 2012-13 in 2004-05 prices and from 2011-12 to 2014-15 in 2011-12 prices. Comparing the sector shares in the overlapping years 2011-12 and 2012-13 in the two series we observe that shares of both agriculture and industry are higher and that of services lower in the new 2011-12 prices based series compared with the earlier 2004-05 prices based series. However both the old and new series shows a declining trend in the shares of agriculture and a rising trend in the share of services. The share of industry is relatively stable.

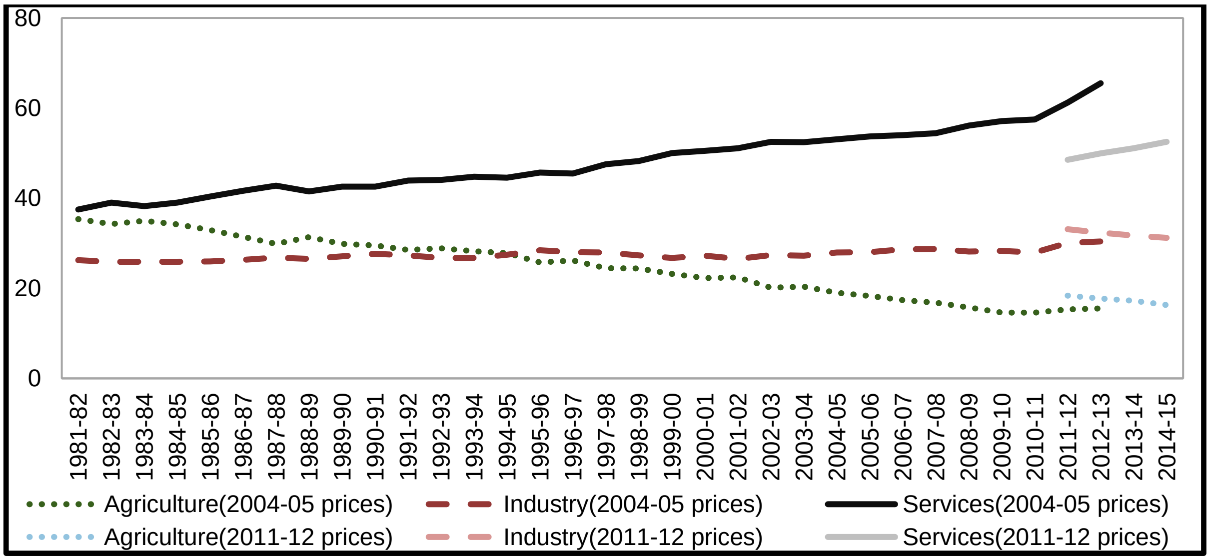
### 3.1.1. Growth Forecast for Agriculture

Although the green revolution and technological advancement has substantially increased the production of major crops, the lack of adequate irrigation and inadequate input use have constrained growth in this sector. Growth is also volatile because the sector is still highly dependent on rainfall, which is a major determinant of growth in the sector (Dev, 2013). Other important challenges faced by the sector include land scarcity relative to availability of labour; inadequate access to credit, consequent shortfall in input use and low productivity; soil erosion; inadequate storage facilities; lack of cold chains for some products, etc. (Dwivedy, 2011).

The sector accounted for 16 per cent of GDP in 2014-15. During the last fifteen years agricultural growth was positive in all the years except 2002-03 and 2014-15 ( figure 3.2). In 2002-03 agriculture suffered from a severe drought and the negative growth in 2014-15 is attributable to wake monsoons for two successive years.

The growth forecast for agriculture in 2016-17 is based on the list of indicators given in table 2.1. We derive factors from the indicators by the principal component method. The numbers of factors extracted are based on the proportion of variance explained by the factors as shown in table 3.2.

**Figure 3.1: Share of Agriculture, Industry and Services in GDP from 1981 to 2014 (at 2004-05 Prices and 2011-15 prices)**



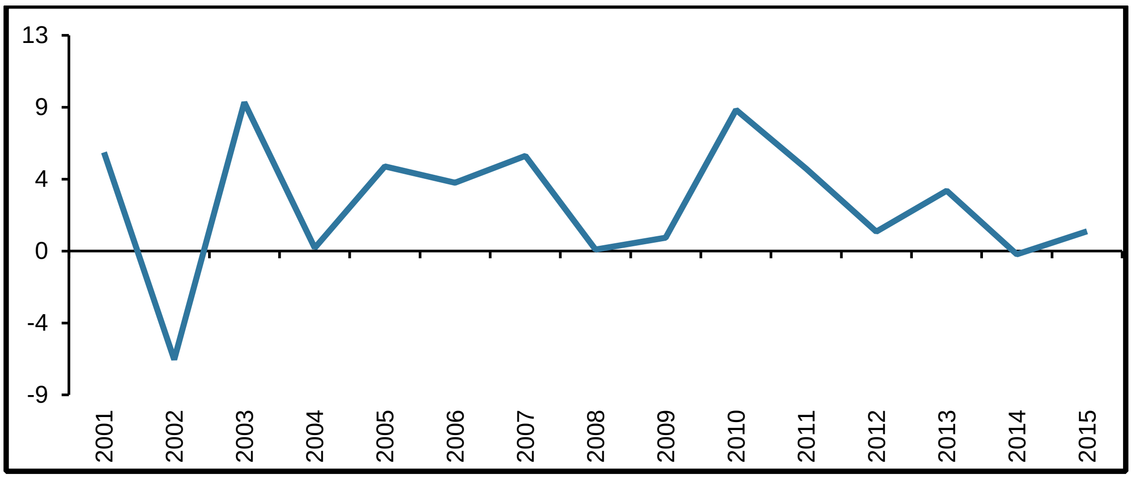

**Source**: National Accounts Statistics, CSO
**Note 1:** Data from 1981-82 to 2010-11 are at 2004-05 prices and from 2011-12, the data are at 2011-12 prices.
**Note 2:** (1) Agriculture = agriculture, forestry & fishing, (2) Industry = mining & quarrying+ manufacturing+ electricity, gas & water supply+ construction and (3) Services = trade, hotels & restaurants + transport, storage & communication+ financing, insurance, real estate & business services+ community, social & personal services]

**Table 3.1: Share of Agriculture, Industry and Services in GDP at 2004-05 and 2011-12 prices**

| Sectors | Share in GDP (%) | | | |
|---|---|---|---|---|
| | In 2004-05 prices | | In 2011-12 prices | |
| | 2011-12 | 2012-13 | 2011-12 | 2012-13 |
| **Agriculture** | 15.3 | 15.5 | 18.4 | 17.7 |
| **Industry** | 30.1 | 30.4 | 33.1 | 32.3 |
| **Services** | 61.3 | 65.5 | 48.5 | 50.0 |

**Source**: National Accounts Statistics, CSO and authors' calculation

**Figure 3.2 - Growth Rate of Agriculture: 2001 to 2015**




**Source**: National Accounts Statistics, CSO

**Table 3.2: Proportion of Agriculture Growth Variance Explained by Successive Components**

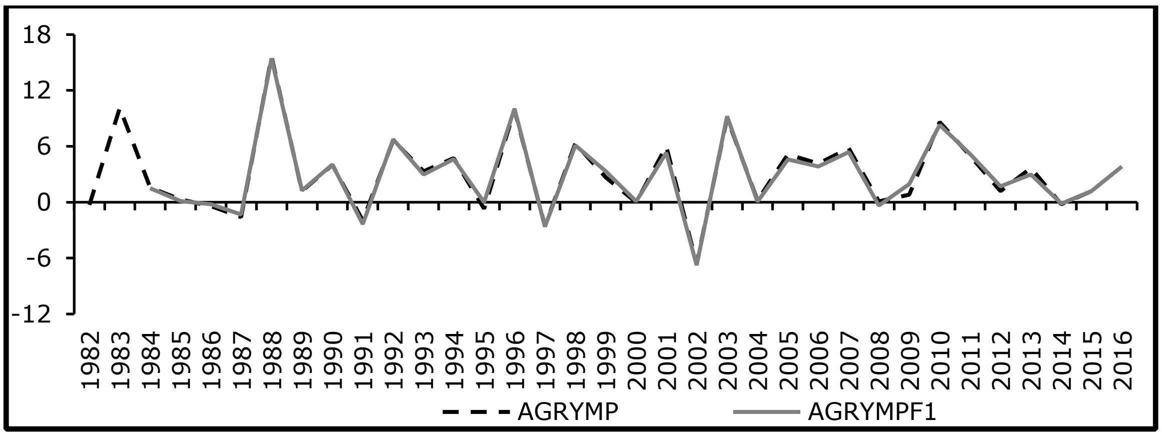
| Variance Proportion (%) | Component 1 (F1) | Component 2 (F2) | Component 3 (F3) | Component 4 (F4) | Cumulative Variance |
|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) |
| **Demand Model** | 21.4 | 17.0 | 15.0 | -- | 53.4 |
| **Supply Model** | 37.0 | 18.3 | 15.6 | -- | 70.9 |
| **Combined Model** | 17.9 | 13.3 | 11.9 | 10.5 | 53.6 |

**Source**: Authors' Calculation

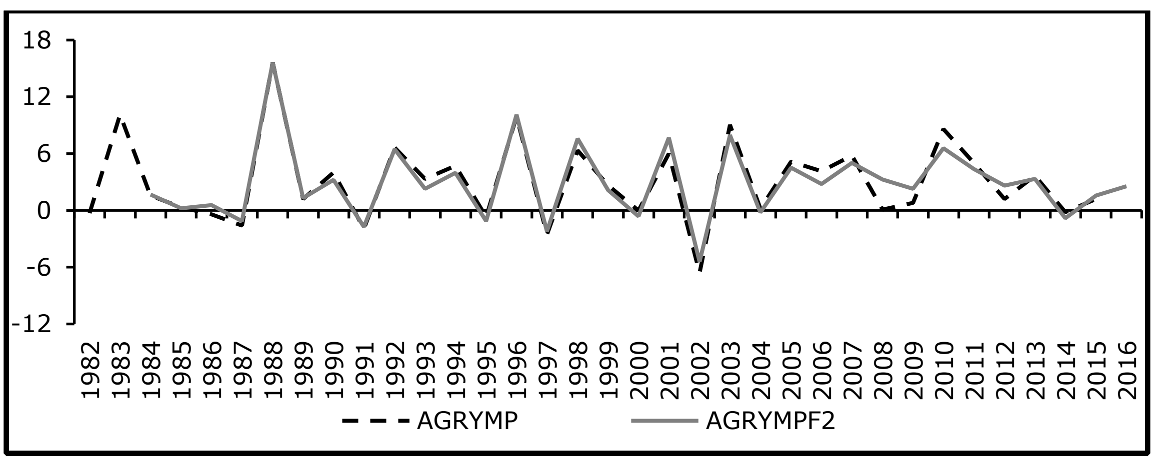
The three components of the demand model explain 53.4% of the total variation in agricultural growth. In the supply side model the first two components are adequate to explain more than 50% of total variation. But we have taken three components, explaining nearly 71% of the variation, as this is likely to give a better forecast. For the combined model we have selected four components as the first three components explain only 43.1% of the variation. Drawing on the fourth component is necessary to explain at least 50% of the total variation in growth of agriculture.

**Figure 3.3: Agricultural Growth Tracking and Forecast for 2016-17**

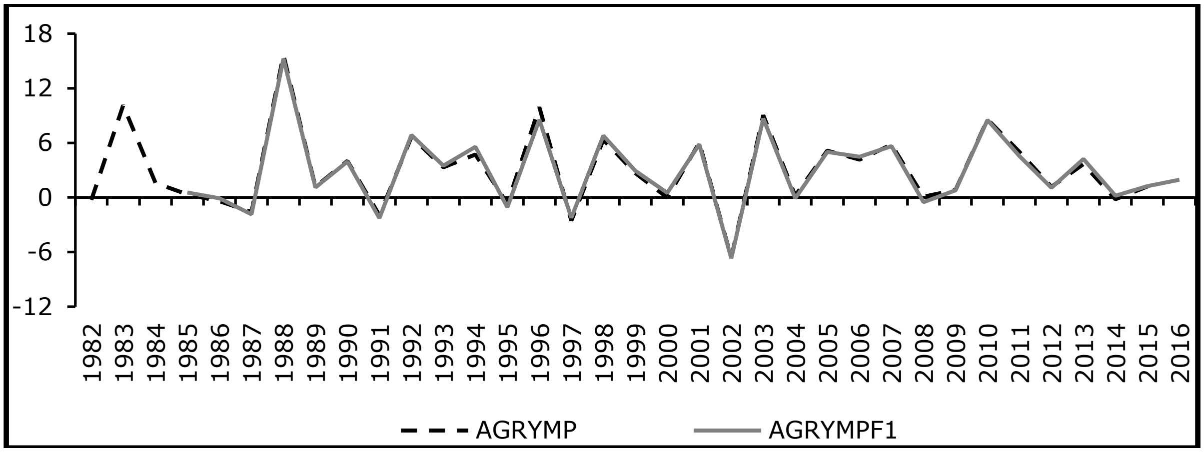
**i. Demand Model**




**ii. Supply Model:**



**iii. Combined Model:**




**Source**: Authors' Calculation
**Note**: The dashed line indicates the actual agriculture growth and solid line represents the agriculture growth forecast

The agriculture growth forecast based on the demand, supply and combined models, along with their RMSE, are presented below in table 3.3.1. Selecting the demand model forecast, which has the lowest RMSE, we get an agricultural growth forecast of 3.8 per cent for 2016-17.

**Table 3. 3.1: Root Mean Square Error of Estimated Models- Agriculture**

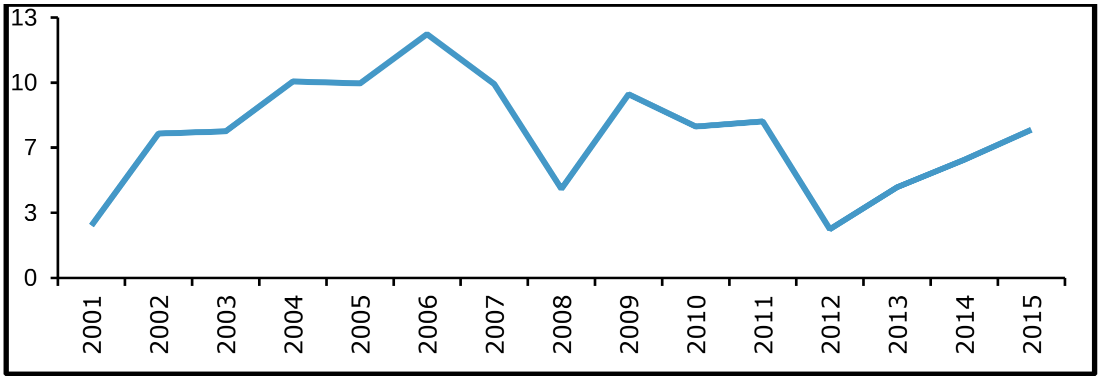
| Models | Demand | Supply | Combined |
|---|---|---|---|
| GDP Growth in Agriculture 2016-17 | **3.8** | 2.5 | 2.0 |
| RMSE | 0.39 | 1.03 | 0.42 |

**Source**: Authors' Calculation

### 3.1.2 Growth Forecast for Industry

Industry contributed 31 per cent of total GDP in 2014-15, with manufacturing constituting the largest component within the sector. The industry sector grew at positive rates in all the years from 2001 to 2015, with the highest growth of 12.2 per cent being recorded in 2006 as shown in Figure 3.4.

**Figure 3.4 - Industrial Growth 2001 to 2015**




**Source**: National Accounts Statistics, CSO

The proportion of variance explained by the principal component factors derived from the indicators listed above in Table 2.1 are given in Table 3.3. The cumulative variance explained by the selected factors, three for demand and supply models and four for the combined model, are 54.8%, 74.8% and 54.7% respectively.

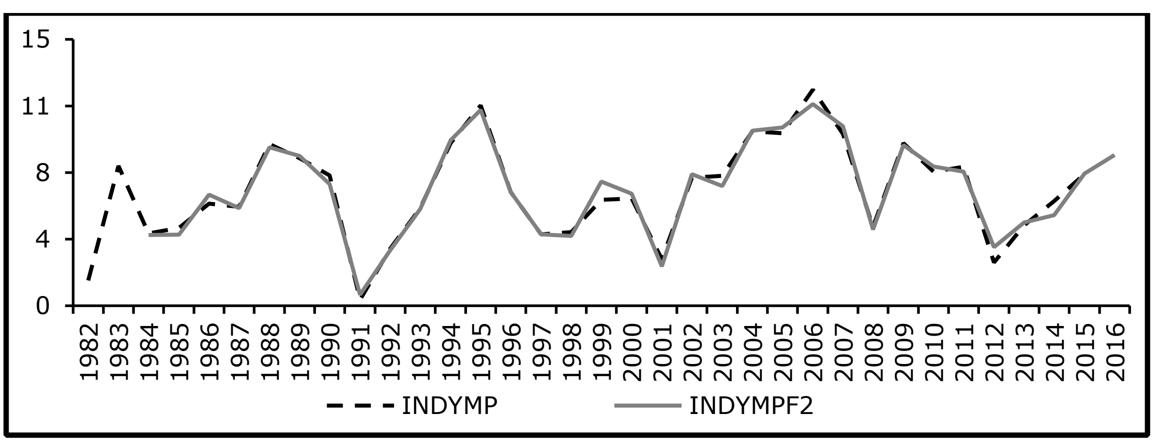
**Table 3.3: Proportion of Industrial growth Variance Explained by Successive Components**

| Variance Proportion (%) | Component 1 (F1) | Component 2 (F2) | Component 3 (F3) | Component 4 (F4) | Cumulative Variance |
|---|---|---|---|---|---|
| **(1)** | (2) | (3) | (4) | (5) | (6) |
| **Demand Model** | 23.7 | 17.2 | 13.9 | -- | 54.8 |
| **Supply Model** | 38.6 | 20.5 | 15.7 | -- | 74.8 |
| **Combined Model** | 17.0 | 16.2 | 11.1 | 10.4 | 54.7 |

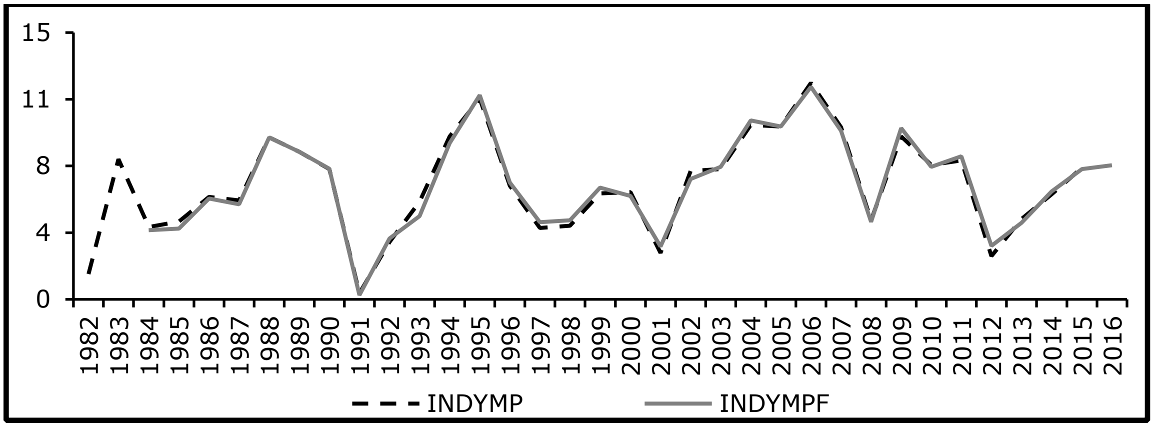
**Source**: Authors' Calculation

**Figure 3.5: Industrial Growth Tracking and Forecast for 2016-17**

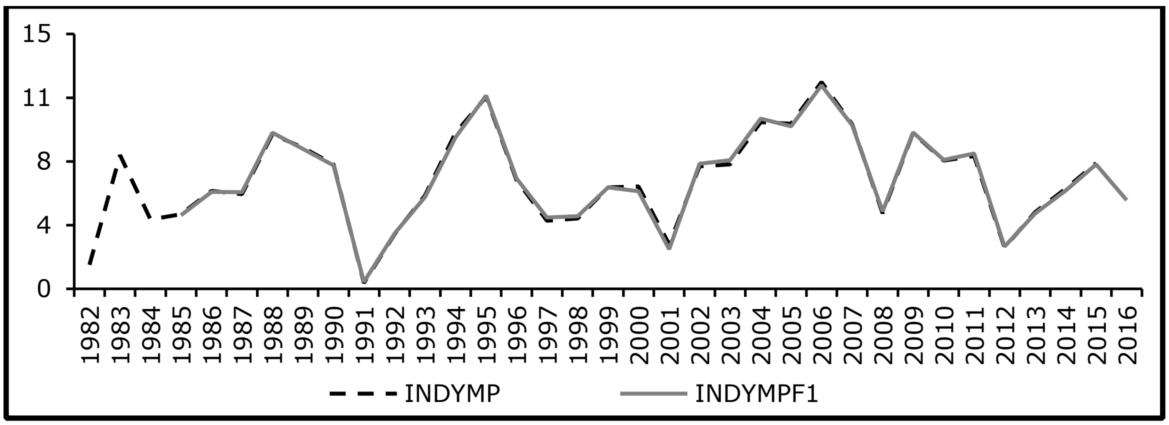
**i. Demand Model:**



**ii. Supply Model:**




**iii. Combined Model:**




**Source**: Authors' Calculation

**Note**: The dashed line indicates the actual industry growth and solid line represents the industry growth forecast

The industry growth forecasts based on the demand, supply and combined, models, along with their RMSE, are presented in table 3.3.2.

**Table 3.3.2: Root Mean Square Error of Estimated Models- Industry**

| Models | Demand | Supply | Combined |
|---|---|---|---|
| GDP Growth in Industry 2016-17 | 8.5 | 7.5 | **5.2** |
| RMSE | 0.40 | 0.29 | 0.14 |

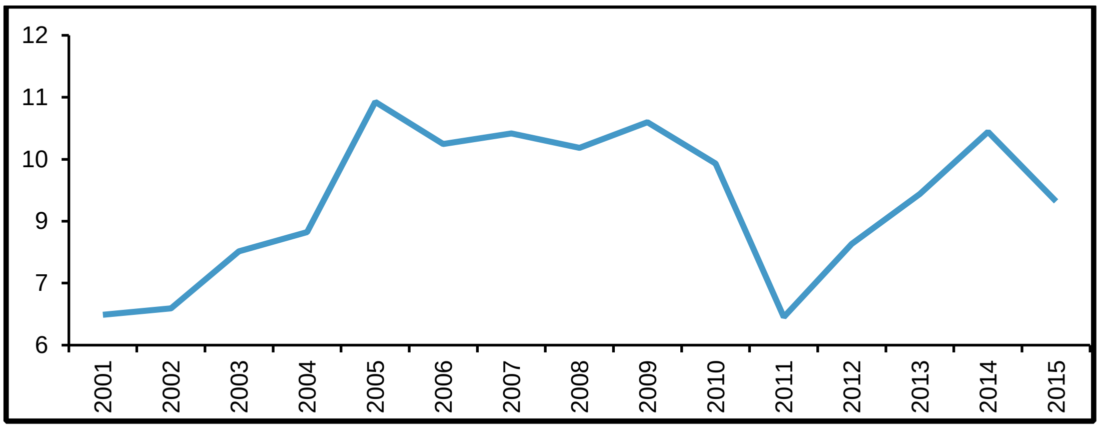
**Source**: Authors' Calculation

Selecting the combined model, which has the lowest RMSE, the industrial growth forecast works out to 5.2 per cent for 2016-17, down from 7.4 per cent in 2015-16.

#### 3.1.3 Services Sector Growth Forecast

Following the initiation of liberalization in 1980s, services sector growth accelerated in the 1990s, significantly increasing its share of GDP. It is now the largest sector in the economy, accounting for 53 per cent of total GDP in 2014-15, with 'trade, hotels, restaurants' and real estate, constituting the largest components. Growth of services sector for the last fifteen years is presented in Figure 3.6.

**Figure 3.6: Trend in Growth of Service 2001 to 2015**




**Source**: National Accounts Statistics, CSO

Table 3.4 presents the proportion of variance in growth of services sector explained by the principal component factors. Column (2) to (4) represents the variation explained by individual factors (or components). The last column (6) presents the cumulative variance explained by all the factors taken together.

**Table 3.4: Proportion of Service Sector Growth Variance Explained by Successive Components growth**

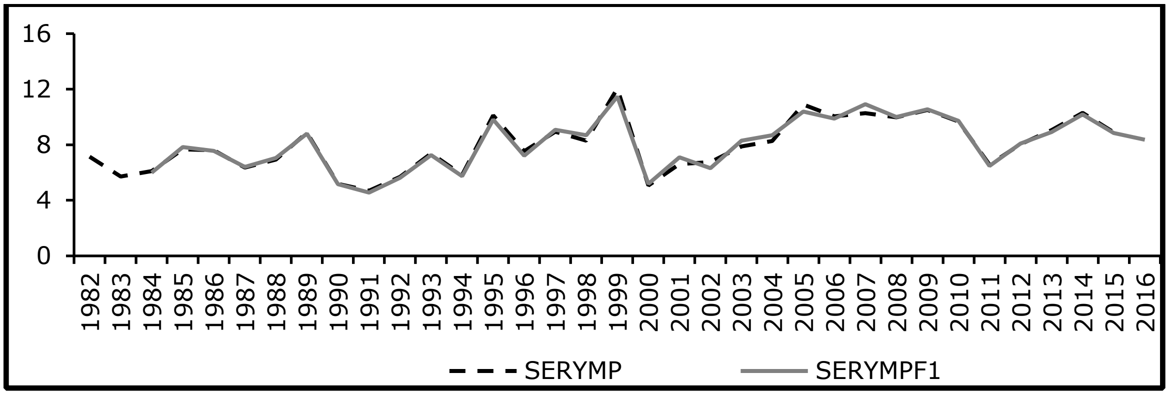
| Variance Proportion (%) | Component 1 (F1) | Component 2 (F2) | Component 3 (F3) | Component 4 (F4) | Cumulative Variance |
|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) |
| Demand Model | 20.8 | 19.0 | 14.1 | -- | 53.9 |
| Supply Model | 43.6 | 21.2 | 15.0 | -- | 79.8 |
| Combined Model | 20.1 | 14.2 | 12.0 | 9.7 | 56.0 |

**Source**: Authors' Calculation

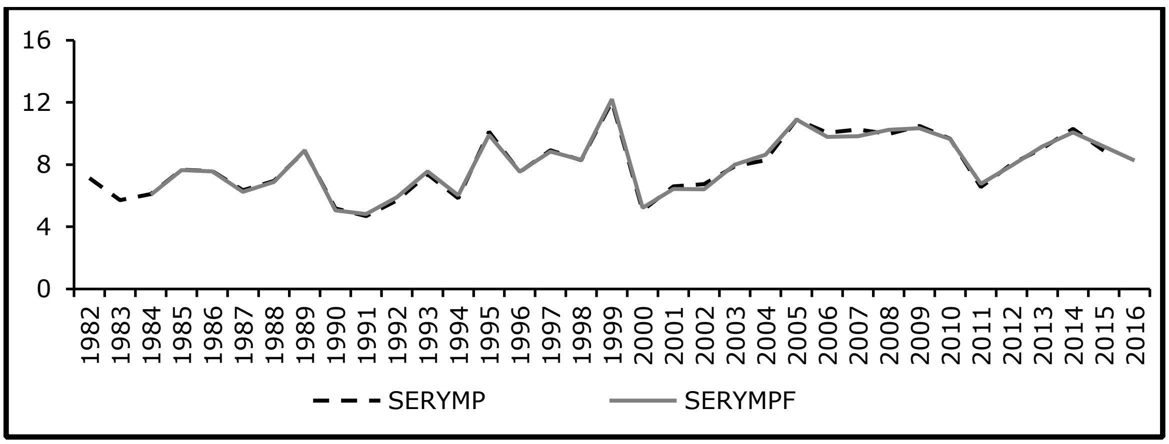
Figure 3.7 displays how the demand, supply and combined models track services sector growth and the forecast for 2016-17.

**Figure 3.5: GDP Growth Forecast in Service for 2016-17**

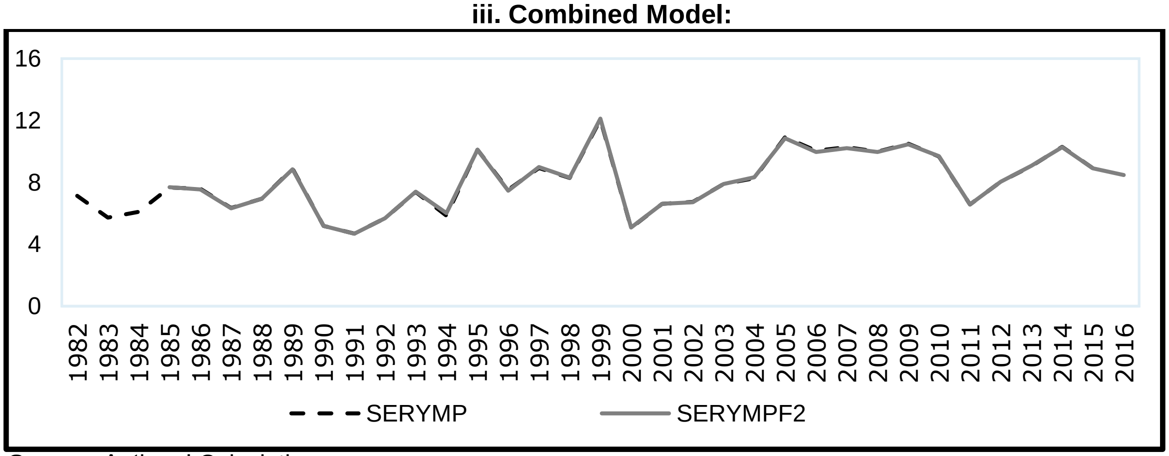
**i. Demand Model:**




**ii. Supply Model:**




**iii. Combined Model:**




**Source**: Authors' Calculation

**Note**: The dashed line indicates the actual service growth and solid line represents the service growth forecast

The service sectors growth forecast based on the demand, supply and combined models, along with their RMSE are presented in below table 3.3.3.

**Table 3.3.3: Root Mean Square Error of Estimated Models- Services**

| Models | Demand | Supply | Combined |
|---|---|---|---|
| GDP Growth in Services 2016-17 | 8.3 | 8.4 | **8.5** |
| RMSE | 0.27 | 0.18 | 0.05 |

**Source**: Authors' Calculation

The growth forecast using the demand, supply and combined models are 8.4%, 8.3% and 8.5% with RMSE of 0.27, 0.18 and 0.05 respectively. The combined model, having the lowest RMSE, is selected. It yields a services sector growth forecast of 8.5% for 2016-17, down from 8.9% in 2015-16.

### 3.1.4. GDP Growth Forecast

Finally, we come to the real GDP growth forecast. For each of the three models, demand side, supply side and combined, table 3.5 columns (2) to (4) present the proportion of variation explained by individual components. The last column (6) presents the cumulative variance explained by all the factors taken together.

**Table 3.5: Proportion of GDP Growth Variance Explained by Successive Components**

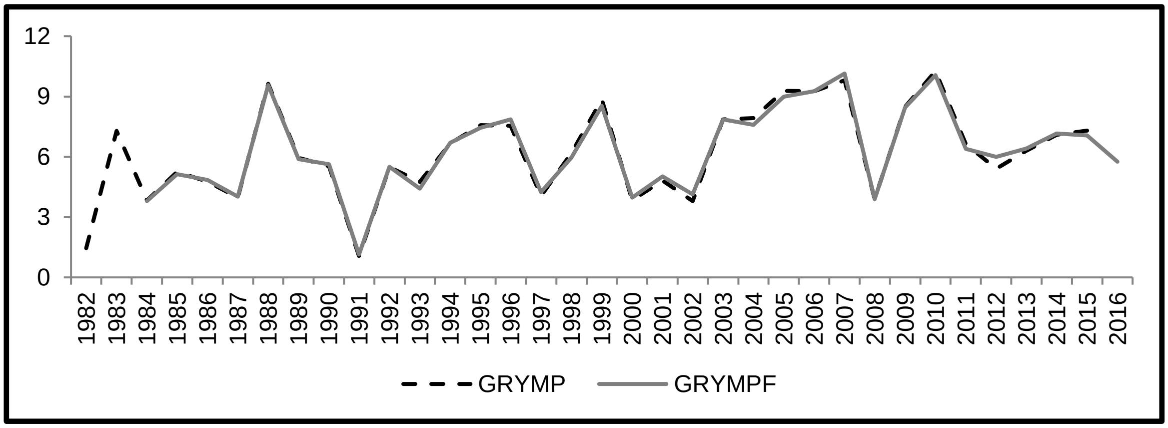
| Variance Proportion (%) | Component 1 (F1) | Component 2 (F2) | Component 3 (F3) | Component 4 (F4) | Cumulative Variance |
|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) |
| Demand Model | 22.9 | 17.9 | 14.1 | -- | 54.9 |
| Supply Model | 43.0 | 16.0 | 15.5 | -- | 74.5 |
| Combined Model | 19.1 | 15.2 | 11.7 | 10.0 | 56.0 |

**Source**: Authors' Calculation

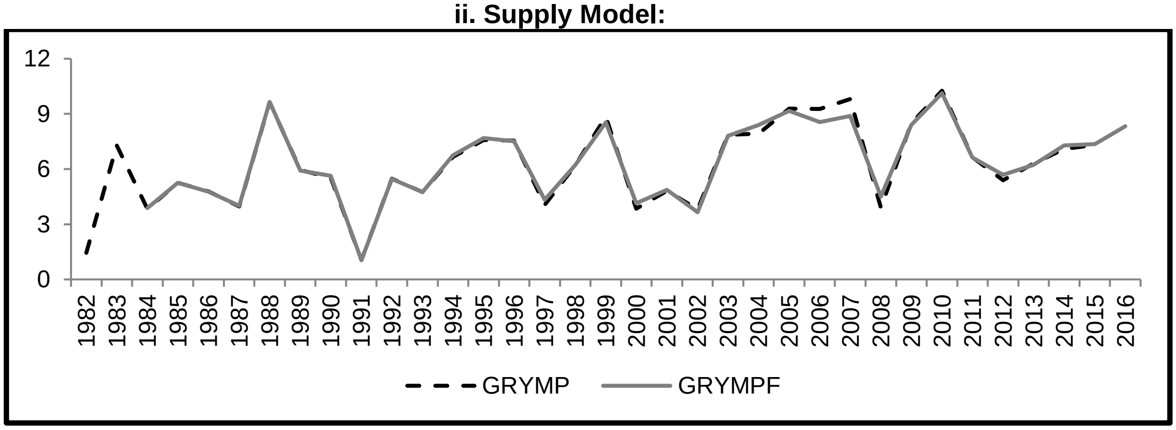
How the three models track actual growth and the forecast for 2016-17 are displayed in Figure 3.6

**Figure 3.6: GDP Growth Tracking and Forecast for 2016-17**

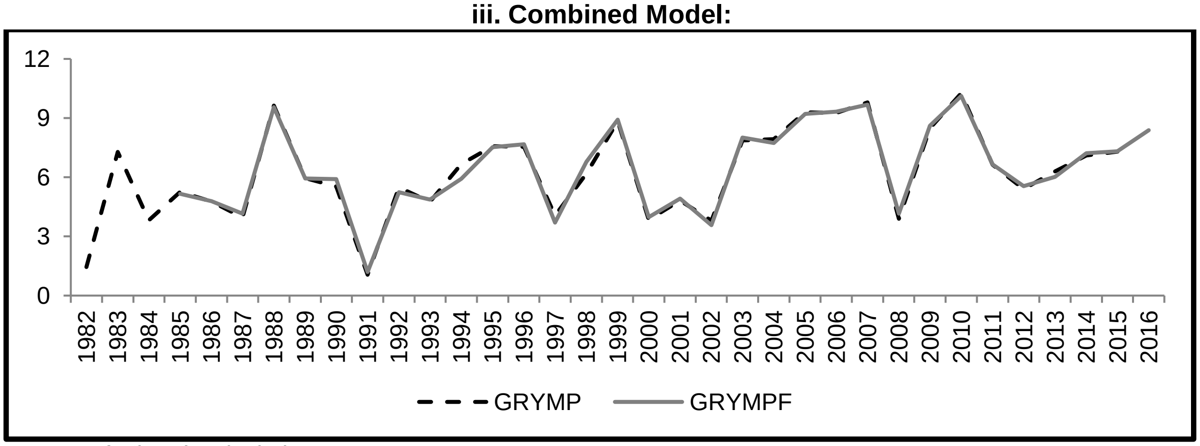
**i. Demand Model:**




**ii. Supply Model:**




**iii. Combined Model:**




**Source**: Authors' Calculation

**Note**: The dashed line indicates the actual GDP growth and solid line represents the GDP growth forecast

The GDP growth forecast based on the three models, demand, supply and combined, along with their RMSE are presented in below table 3.3.4.

**Table 3.3.4: Root Mean Square Error of Estimated Models - GDP**

| Models | Demand | Supply | Combined |
|---|---|---|---|
| **GDP Growth 2016-17** | **5.7** | 8.3 | 8.4 |
| **RMSE** | 0.21 | 0.28 | 0.24 |

**Source**: Authors' Calculation

The real GDP growth forecast of the demand, supply and combined models are 5.7%, 8.3% and 8.4%, with root mean square errors (RMSE) of 0.21, 0.28 and 0.24 respectively. Selecting the demand model, which has the lowest RMSE, we get a real GDP growth forecast of 5.7% for 2016-17, declining from 7.3% in 2015-16[3]. However, this is no more than a preliminary estimate which requires two adjustments.

First, the forecast is based on time series data which is old series data (2004-05 base) till 2010-11 and the new series data (base 2011-12) since 2011-12. It was mentioned earlier that comparing the two series of GDP growth rates there is a distinct step up in the growth rate with the new series during the overlapping years 2011-12 and 2012-13. Hence, an adjustment factor had to be applied, raising the growth forecast to 6.7 per cent. The second adjustment is to capture the impact of demonetization. This could not be done directly in the ALI model forecast. As discussed earlier, ALI models have to have data of uniform frequency and the data used for forecasting are all of annual frequency. Such annual data cannot capture the impact of an episode like the demonetization shock which was delivered only during the eighth month of the year.

To make this second adjustment, we have exploited the strong correlation between non-food credit and GDP which is statistically significant at 1% level. Non-food credit increased by INR 1,85,067 crore from 30th October 2015 to 25th December 2015 and it declined by INR 69,859 crore from 28th October 2016 to 23rd December 2016. Thus there was a substantial negative change in the last two months of 2016 compared to the same period in 2015.This change is reflected in the annual growth of outstanding non-food credit showing a major decline from 10.7 per cent in December 2015 to only 5.4 per cent in December 2016. Applying the elasticity of GDP growth with respect to non-food credit growth to this change in non-food credit growth, we get a downward adjustment of the 2016-17 GDP growth forecast from 6.7 % to 6.1%.

[3] This forecast is not comparable with an aggregate weighted average of the three sectoral growth forecasts because the factors selected for the three sector forecasts can be different from one another and from the factors selected for the overall GDP forecast. Further, the model selected on the basis of RMSE minimization can be different for the different sectors and different from that selected for forecasting overall GDP. Finally, while the sector forecast are of GDP at factor cost the aggregate GDP forecast refers to GDP at market prices.

# 4. THE 2016-17 GROWTH FORECAST & THE OUTLOOK BEYOND

The final real GDP growth forecast for 2016-17, after adjusting for the demonetisation shock is 6.1 per cent. How does this compare with official projections?

Starting with the second advance estimate of 2016-17 GDP recently released by the central Statistical Organisation (CSO), it needs to be pointed out that the 7.1% growth projection that has attracted much attention refers to GDP at market prices. The CSO's projection of gross value added (GVA) at basic prices is 6.7%, down from 7.8% in 2015-16 (Table 4.1).

**Table 4.1: The CSO Second Advance estimate for 2016-17**

| Sector | Share in GVA (%) | Growth Rates (%) | |
|---|---|---|---|
| | 2016-17 | 2015-16 | 2016-17 |
| 1. Agriculture & Allied Activities | 15.1 | 0.8 | 4.4 |
| 2. Utilities | 2.1 | 5.1 | 6.6 |
| 3. Public Services (including Security & Defence) | 12.8 | 6.9 | 11.2 |
| 4. Industry & Other Services | 70.0 | 6.7 | 4.5 |
| 5. GVA at Basic Price | 100.0 | 7.8 | 6.7 |
| 6. GDP at Market Prices | -- | 7.9 | 7.1 |

**Source:** MOSPI, CSO

Further, disaggregating gross value added (GVA) and setting aside the sectors not much affected by the demonetisation shock, i.e., agriculture[4], utilities and public services (including defence & security), leaves the other industries and services. These sectors, which account for about 70% of GVA, do reveal a very significant dip in growth from 6.7% in 2015-16 to only 4.5% in 2016-17 in the CSO projections.

This is despite the fact that the advance estimates are not designed to capture the impact of mid-year episodes like the demonetisation shock. Also, such supplementary indicators that are used for the advanced estimates , e.g., sales and sales tax data, were distorted by the gaming

[4] Agriculture being a point input point output sector, the cash rationing following demonetisation would have affected not the initial sowing operations but the application of labour and inputs only during the plant growth period through November and December. To that extent the impact on agricultural output would have been moderate.

that went on to circumvent the impact of demonetisation, such as sales channel stuffing by producers. In other words, the CSO advance estimates should not be treated as rigorous forecasts, especially when there are episodes like the demonetisation shock during the reference period.

Apart from the CSO advance estimates, an alternative set of Government projections are provided in the Economic Survey, which estimates growth for 2016-17 at 6.5%. Furthermore, the Budget for FY2017-18 assumes a nominal growth rate of 11% for 2016-17. Deducting from that the CSO implicit deflator of 4.8% yields a growth rate of 6.2%. This is only marginally higher than our forecast of 6.1%.

For the year 2017-18 a rigorous ALI forecast, which is best suited for a one period ahead forecast, will have to await the revised CSO estimates of GDP for 2016-17. It is quite likely that the positive base effect of the dip in growth in 2016-17 will lead to a forecast of more than 7% in 2017-18. How much more will depend on the extent of the actual growth dip in 2016-17. That recovery will depend, however, on two key domestic developments.

One is the roll out of the Goods and Services Tax (GST), which is now expected to happen before July, 2017. The other is progress on dealing with what the Economic Survey has called the ‘twin balance sheet problem’, i.e., the high level of stressed assets in the banking sector, especially the public sector banks. This reflects the excessive debt overhang of the corporate sector, which has led to negative growth of private investment in 2016-17. This could spill over into 2017-18 in a ‘business as usual’ scenario.

Growth in a medium to long term perspective would depend on how both external and internal conditions evolve. Recent data on improving expectations of purchase managers and others notwithstanding, the global outlook remains uncertain. Recent IMF forecasts suggest a relatively benign global environment (Table 4.2).

However, how the US economy will perform under a new Trump policy regime -- both domestic and external -- remains uncertain. The European Union finally seems to be on a recovery path, but it is modest and many constituent economies remain fragile. Recovery in Japan is also very weak while China continues to decelerate. Growth in emerging market and developing economies is much more robust, especially in Asia. However, for sustaining high growth in the 7%-8% range or more, India will largely have to depend on internal drivers at home.

The key domestic driver for high growth in the medium to long term has to be major structural reform along a wide front in addition to the GST and cleaning of bank balance sheets already discussed earlier.

**Table 4.2: IMF Medium Term Forecast**

| Countries | Growth rates | | |
|---|---|---|---|
| | **2016** | **2017*** | **2018*** |
| World | 3.1 | 3.4 | 3.6 |
| Advanced Economies | 1.6 | 1.9 | 2.0 |
| USA | 1.6 | 2.3 | 2.5 |
| European Union | 1.7 | 1.6 | 1.6 |
| Japan | 0.9 | 0.8 | 0.5 |
| Emerging Market & Developing Economies (EMDE) | 4.1 | 4.5 | 4.8 |
| Asia EMDE | 6.3 | 6.4 | 6.3 |
| China | 6.7 | 6.5 | 6.0 |
| India | 6.6 | 7.2 | 7.7 |

**Source:** World Economic Outlook, IMF.
*Forecast

A high priority in the required menu is a reversal of the elitist bias in India's education policy to significantly step up the coverage and quality of basic education. This alone can lay the foundation for an effective skill development drive, which in turn is a necessary condition for sustained high growth of productive employment and output (Mundle 2017). A second priority is the reform of the regulatory environment. There is an entrenched bias against large scale production in labour laws and other regulatory laws enforced by an army of predatory inspectors. Finally, it is imperative that India's infrastructure deficit in power, roads, railroads, ports, airports, telecommunications and irrigation be urgently eliminated.

## 5. CONCLUSION

This paper has presented forecasts of overall GDP growth and growth of agriculture, industry and services for 2016-17 based on an ALI model. Although this model provides robust forecasts and is very effective in tracking the turning points, the forecast is limited to only a one step ahead forecast. Also, the forecasts are quite sensitive to the choice of initial indicators, and that choice has to be exercised with great care.

The sectoral forecasts for agriculture, industry and services are 3.8 per cent, 5.2 per cent and 8.5 per cent respectively. As explained earlier, these sectoral forecasts cannot be aggregated to generate the overall GDP growth forecast. GDP growth itself is forecast at 6.7% without taking account of the impact of demonetization. After factoring in that impact, the final real GDP growth forecast for 2016-17 comes down to 6.1%. Some official projections are also in the same ballpark, suggesting that there will be a significant growth dip in 2016-17. While this will provide a positive base effect that could push growth above 7% in 2017-18, much will depend on successful roll out of the GST and progress in cleaning up bank and corporate balance sheets that are holding back the revival of the private investment cycle. Sustaining high growth over the medium to long term will require structural reforms across a much wider front, including reform of basic education policy and labour and other regulatory policies that have an entrenched bias against large scale production or employment. It will also require elimination of India's severe infrastructure deficit.

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**Appendix**

**Demand Side variables and Data sources:**

| Indicators | Source | Unit |
|---|---|---|
| **Growth Rate of GDP at Market Price (2004-05 prices)** | Computed from CSO, Press Releases & Statements, Summary of macroeconomic aggregates at current prices, 1950-51 to 2013-14 and Summary of macroeconomic aggregates at constant (2004-05) prices, 1950-51 to 2013-14. | INR crore |
| **Growth Rate of GDP at Market Price (2011-12 prices)** | Computed from CSO, Press Releases & Statements, Annual and Quarterly Estimates of GDP at current and Constant prices, 2011-12 series and Growth rates from 2012-13 to 2015-16-Economic survey 2015-16,vol-2. | INR crore |
| **Growth Rate of Agricultural Sector's GDP (2011-12 prices)** | Computed from CSO, National Accounts Statistics Back Series 2011, Statement 5: Gross Domestic Product by economic activity at 2004-05 prices and National Accounts Statistics 2015, Statement 1.6: Gross Value Added by economic activity at constant (2011-12) prices (from 2011-12 to 2013-14) and Press Releases & Statements, Annual and Quarterly Estimates of GDP at current and Constant prices, 2011-12 series (for 2014-15 1st RE) | Per cent |
| **Growth Rate of Industrial Sector's GDP (2011-12 prices)** | Computed from CSO, National Accounts Statistics Back Series 2011, Statement 5: Gross Domestic Product by economic activity at 2004-05 prices and National Accounts Statistics 2015, Statement 1.6: Gross Value Added by economic activity at constant (2011-12) prices (from 2011-12 to 2013-14) and Press Releases & Statements, Annual and Quarterly Estimates of GDP at current and Constant prices, 2011-12 series (for 2014-15 1st RE) | Per cent |
| **Growth Rate of Service Sector's GDP (2011-12 prices)** | Computed from CSO, National Accounts Statistics Back Series 2011, Statement 5: Gross Domestic Product by economic activity at 2004-05 prices and National Accounts Statistics 2015, Statement 1.6: Gross Value Added by economic activity at constant (2011-12) prices (from 2011-12 to 2013-14) and Press Releases & Statements, Annual and Quarterly Estimates of GDP at current and Constant prices, 2011-12 series (for 2014-15 1st RE) | Per cent |
| **Rate of Gross Capital Formation** | National Accounts Statistics 2014, Statement 1: Macro Economic Aggregates (from 1982-83 to 2011-12 at 2004-05 prices) and Economic Survey 2015-16, Table 0.1: Key Indicators) from 2012-13 to 2014-15 at 2011-12 prices. | Per cent |
| **Rate of Gross Capital Formation in Agriculture** | Computed from CSO, National Accounts Statistics Back Series 2011, Statement 14: Capital Formation By Industry Of Use (at constant prices 2004-05) and National Accounts Statistics, 2015, Statement 1.10: Gross Capital Formation by industry of use (At constant prices 2011-12) | Per cent |
| **Rate of Gross Capital Formation in Industry** | Computed from CSO, National Accounts Statistics Back Series 2011, Statement 14: Capital Formation By Industry Of Use (at constant prices 2004-05) and National Accounts Statistics, 2015, Statement 1.10: Gross Capital Formation by industry of use (At constant prices 2011-12) | Per cent |
| **Rate of Gross Capital Formation in Services** | Computed from CSO, National Accounts Statistics Back Series 2011, Statement 14: Capital Formation By Industry Of Use (at constant prices 2004-05) and National Accounts Statistics, 2015, Statement 1.10: Gross Capital Formation by industry of use (At constant prices 2011-12) | Per cent |
| **Ratio of Export to Import (calculated)** | RBI, Handbook of Statistics on Indian Economy, Table 127 : India's Foreign Trade - Rupees | Ratio |

| | | |
|---|---|---|
| **Developmental Expenditure of the Central and State Governments** | RBI, Handbook of Statistics on Indian Economy, Table 116 : Developmental and Non-Developmental Expenditure of the Central and State Governments and for 2013-14 to 2015-16 -HBS (Table 103 : Major Heads of Developmental and Non-Developmental Expenditure of the Central Government) and State finances :A study of Budgets, RBI (Table III.5: Expenditure Pattern of State Governments) | INR Crore |
| **Non-Developmental Expenditure of the Central and State Governments** | RBI, Handbook of Statistics on Indian Economy, Table 116 : Developmental and Non-Developmental Expenditure of the Central and State Governments and for 2013-14 to 2015-16 -HBS (Table 103 : Major Heads of Developmental and Non-Developmental Expenditure of the Central Government) and State finances :A study of Budgets ,RBI (Table III.5: Expenditure Pattern of State Governments) | INR Crore |
| **Food Credit** | RBI, Annual Report, Sectoral Deployment of Gross Bank Credit | INR Crore |
| **Non Food Credit** | RBI, Handbook of Statistics on Indian Economy, Table 49 : Sectoral Deployment of Non-Food Gross Bank Credit (Outstanding) | INR Crore |
| **Fiscal Deficit** | RBI, Handbook of Statistics on Indian Economy, Table 113 : Combined Deficits of Central and State Governments | INR Crore |
| **Foreign Exchange Reserves** | RBI, Handbook of Statistics on Indian Economy Table 157 : Foreign Exchange Reserves | US $ Million |
| **Broad Money** | RBI, Handbook of Statistics on Indian Economy, Table 46 : Average Monetary Aggregates | INR Crore |
| **Real Effective Exchange Rate (REER)** | RBI, Handbook of Statistics on Indian Economy, Table 149 : Indices of Real Effective Exchange Rate (REER) and Nominal Effective Exchange Rate (NEER) of the Indian Rupee (36- Currency Bilateral Weights) (Financial Year - Annual Average) | Per Cent |
| **Stock of Food grains** | RBI, Annual Report, Macroeconomic and Financial Indicators and for 2015-16-Economic Survey 2015-16,vol-2 (Table 5.15: Public Distribution System - Procurement, Offtake and Stocks) | Million Tonnes |
| **Real Interest Rate(computed by deducting inflation from nominal Interest Rate(Weighted average lending rate )** | RBI, Database On Indian Economy, Weighted average lending rate of SCBs for all loans and for major sectors - as on 31st March | Per cent |

**Supply Side variables and Data sources:**

| Indicators | Source | Unit |
|---|---|---|
| **Net Capital Stock (At constant (2004-05)prices)(as on 31st March)** | MOSPI, CSO, Statement 15: Net Capital Stock by type of institutions , National Accounts Statistics Back Series 2011 and Statement 21: Net capital stock by type of institution, National Accounts Statistics 2014 | INR Crore |
| **Net Capital Stock in Agriculture (At constant (2004-05)prices)(as on 31st March)** | MOSPI, CSO, National Accounts Statistics Back Series 2011,Statement 17: Net Fixed Capital Stock by industry of use at 2004-05 prices and Statement 22: Net Capital stock by industry of use, National Accounts Statistics 2014 | INR Crore |
| **Net Capital Stock in Industry (At constant (2004-05)prices)(as on 31st March)** | MOSPI, CSO, National Accounts Statistics Back Series 2011,Statement 17: Net Fixed Capital Stock by industry of use at 2004-05 prices and Statement 22: Net Capital stock by industry of use, National Accounts Statistics 2015 | INR Crore |
| **Net Capital Stock in Services (At constant (2004-05)prices)(as on 31st March)** | MOSPI, CSO, National Accounts Statistics Back Series 2011,Statement 17: Net Fixed Capital Stock by industry of use at 2004-05 prices and Statement 22: Net Capital stock by industry of use, National Accounts Statistics 2016 | INR Crore |
| **Electricity generated** | Economic Survey 2015-16,A43, Table 1.25 : Progress of Electricity Supply (Utilities & Non-Utilities) | (Billion KWH) |
| **Imports of Principal Commodities - US Dollar** | RBI, Handbook of Statistics, Table 130 : Imports of Principal Commodities - US Dollar | US $ Million |
| **Employment in Public and Organised Private Sectors*** | RBI, Handbook of Statistics, Table 15 : Employment in Public and Organised Private Sectors | Million |
| **Employment is computed by adding data on Public and Organised Private Sectors (Due to data non-availability from 2012 to 2013, the data for 2011 is assumed for these years).** | The public sector comprises all Governmental agencies: Central, State, Quasi-Government (both Central and State) and local bodies. The private sector comprises all establishments (under the organised sector) employing 10 or more persons. | |
| **Rainfall in India during July** | https://data.gov.in/catalog/all-india-area-weighted-monthly-seasonal-and-annual-rainfall-mm | Millimeter |
| **Rainfall in India during Dec** | https://data.gov.in/catalog/all-india-area-weighted-monthly-seasonal-and-annual-rainfall-mm | Millimeter |
| **Rainfall in India during January, February, July, August, September and December** | https://data.gov.in/catalog/all-india-area-weighted-monthly-seasonal-and-annual-rainfall-mm | Millimeter |

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