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# MODELLING SECTORAL GDPS FOR FORECASTING INDIAN GDP USING ARMA MODELS

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**Abstract**

*Gross Domestic Product (GDP) is most widely used to measure and compare economic growth of countries. GDP of a country is value of all goods and services produced in the country in a given time, usually a year, and counted with duplication. Nature of modern economies being intricate, GDP is measured sector wise and then sector GDPs are added to form overall GDP. Sectors normally represent similar activities and therefore measurement issues are also similar. Study of growth of country primarily hinges on study of GDP and study of sector specific GDPs assumes critical importance in making a holistic assessment. With this objective, GDP of different sectors and also the over all GDP have been modelled using ARMA models and based on the optimal model future values have also been forecasted. The models and the future values throw important clues on the future course of development of these sectors.*

***Key words:*** GDP, Growth indicator, ARMA model

***JEL Classification:*** *O 41*

## 1. INTRODUCTION

Gross Domestic Product (GDP) is most widely used to measure and compare economic growth of countries. GDP of a country is value of all goods and services produced in the country in a given time, usually a year, and counted with duplication. Gross Domestic Product is a measure of production. The level of production is important because it largely determines how much a country can afford to consume and it also affects the level of employment. The consumption of goods and services, both individually and collectively, is one of the most important factors influencing the welfare of the community. [CSO, National Account Statistics, Sources and Methods, 2007]. Nature of modern economies being intricate, the measurement of GDP is a complex process. Sectors normally represent similar activities and therefore measure issues are also similar. GDP is, therefore, measured sector wise and then sector GDPs are added to form overall GDP.

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GDP and economic growth of India as also of other countries have received attention of researchers continuously and researches have thrown useful light for policy evaluation and formulation. Arvind Pangariya (2004) traced the higher growth experience of India with economic reforms initiated in 1990s and observed that liberalization was already under way during the 1980s and played a crucial role in stimulating growth during that decade. The more systemic reforms of the 1990sgave rise to more sustainable growth. Basworth and Collins (2007) compared economic performances of China and India using a simple growth accounting framework that produces estimates of the contribution of labour, capital, education, and total factor productivity for the three sectors of agriculture, industry, and services as well as for the aggregate economy. Ranjan, Jain and Dhal (2007) provided estimates of the potential growth rate for India by adopting alternative approaches of statistical trend filtering techniques and a production function. Empirical results of their showed that policy actions have significant association with output gap and inflation gap. Basu and Maertens (2007) studied broad macro parameters of the growth of the Indian economy since the nation's independence and a cross-country evaluation of where India stands. Ghosh (2009) studied nexus between electricity supply, employment and real GDP for India within a multivariate framework using autoregressive distributed lag (ARDL) bounds testing approach of cointegration and observed growth in real GDP and electricity supply are responsible for the high level of employment in India. Hofer, Schmidt and Weyerstrass (2010) gave an overview of used methods for medium-term macroeconomic projections, analyzed the performance of medium-term forecasts for Austria to illustrate the strengths and weaknesses of the typical approach and described some approaches to improve medium-run projections.

Recently Mohanti, Chakraborty, Das and John (2011) examined relationship between inflation rate and real GDP growth in India and observed that there existed statistically significant structural break in the relation between output growth and inflation in between 4.0 and 5.5 per cent of inflation above which inflation retards growth rate of GDP and below the threshold level, there is a statistically significant positive relationship between inflation rate and growth. Zeng (2011) developed a new forecasting framework for GDP growth in Korea to complement and further enhance existing forecasting approaches. Hawksworth and Tiwari (2011) revised their 2006 projections for potential growth in GDP in 17 leading economies over the period to 2050. They observed that India could overtake the US by 2050 on Purchasing Power Parity (PPP) basis and when looked at k at GDP at market exchange rates (MER), the overtaking process is slower but equally inexorable. India would be clearly the third largest economy in the world by 2050, well ahead of Japan and not too far behind the US on this MER basis. Wang (2011) tested the effect of openness to international trade at Chinese provincial level, by applying Comparable Green GDP data from 31 provinces and regions to a variant of Solow growth model and found that there seemed existence of a non-linear relationship between green GDP and openness,

measured both by volume of trade and foreign directly investment (FDI), at provincial level.

GDP at factor cost is sum total of GDP of different sectors of the economy. Different sectors have their specific growth patterns and impact overall GDP in different proportions. Study of growth of country primarily hinges on study of GDP and study of sector specific GDPs assumes critical importance in making a holistic assessment. It is, therefore, important to study the growth pattern of not only the GDP but also the pattern of different sectors of economy which add up to make GDP. With this objective in mind, in the present paper, the data from National Accounts Statistics (1951-2006-07) published by CSO [Back series 2007 & NAS 2008] has been used to get data for nine broad sectors that add up to overall GDP (at factor cost). Sector specific optimum models have been selected and estimated. Based on optimum model sector wise forecast for future years has been obtained. Overall GDP for future years has also been estimated based on sector forecasts.

## 2. METHODOLOGY FOR MODELLING OF DIFFERENT SECTORS

Models have been selected and fitted using ESYREG software developed by Dr. Herman J. Bierens, Pennsylvania State University. For model selection, EASYREG has estimated the maximal model and its sub models using the simplex method of Nelder and Mead. For each model the Akaike Information Criteria (AIC) has been calculated and compared. The model having least AIC value has been taken as optimal model for modelling the series and forecasting. The optimal model, thus obtained, has also been confirmed by computing Hannan-Quinn and Schwarz Information Criteria.

The maximum model assumed are with intercept

$$S_{gdp(t)} = \text{Intercept} + AR(p,q);\ p \ \&\ q = 1,2,\ldots.5,$$

and with time trend

$$S_{gdp(t)} = \text{Intercept} + \text{Slope}*t + AR(p,q);$$

Where AR(p,q) is a Autoregressive time series model

$$a(1,1)*u(t)+a(1,2)*u(t-1)+ \ldots\ldots a(1,p)*u(t-p)$$

$$= a(2,1)*e(t)+a(2,2)*e(t-1)+\ldots\ldots+a(2,q)*e(t-p)$$

a(1,1), a(1,2), ...., a(1,p) are autoregressive parameters and a(2,1), a(2,2), ...., a(2,q) are moving average parameters.

While attempting model selection, ARMA(5,5) was taken as maximal model. The maximal model and all sub models have been evaluated on Akaike Information Criteria (AIC). The optimal model based on least values of AIC has been selected in case of all the indicators. For each indicator model have been selected in the situations of intercept and intercept with linear time trend.

## 3. MODELLING OF SECTORS OF GDP

Each sector of economy is unique and has its individual dynamics, yet all sectors exhibit common set of peculiarities of the economy of the country. Typically, they all are cause and effect of one another and also of the whole. Agriculture sector, though contributes progressively low portion to overall GDP, affects most of the sectors by way of production fluctuations, supply of excess manpower to other sectors, exports and imports of food grains, movement and disposal of products etc. Similar is the feature of other sectors as well. In following subsections optimum models have been selected based on Akaike Information Criterion (AIC), though values of Hannan-Quin and Schwarz Criteria have also been observed, in respect of the nine sectors that constitute GDP (at factor cost) according to the classification adopted by CSO. The values of selection criterion are given in table A-1 and estimated value of parameters of models are given in table A-2 in Appendix.

### 3.1. Agriculture, Forestry & Fishing(AFF)

Agriculture sector continues to be key driver of India' development in spite of its declining share in country's overall GDP over the years. Contribution of agriculture sector in national economy is measured by share of agriculture GDP in total GDP and the dependence it affords to the largest portion of country's population. The share of agriculture and allied sectors has been declining all through. From around 45% in early seventies the share of Agri-GDP in total GDP stood at18.5% in 2005-06 (at 1999-2000 prices) [CSO, National Account Statistics (2007)]. But approximately 65% of population depend upon agriculture for their livelihood [NSSO, Situation Assessment Survey (2003)]. Other sectors of economy too depend upon agriculture sector because of large population it supports, though the extent of dependence varies from sector to sector.

Agriculture and allied sectors comprise of agriculture proper, livestock and livestock products and operation of irrigation system. The economic activities of forestry sector include forestry, logging and farmyard wood collection. Activities covered in the fishing sector are commercial fishing in ocean and inland waters, subsistence fishing in inland waters and artificial ponds, gathering of sea other sea products and fish curing.

For modelling the Agriculture, Forestry & Fishing sector's GPD, the optimal model without time trend is:

$$AFF_{gdp(t)} = \text{Intercept} + AR(1) \quad (1)$$

As the time is also an important variable for the study the growth of time series, we extended the above model considering the time trend and the resultant optimum model is

$$AFF_{gdp(t)} = \text{Intercept} + \text{Slope}^{*}t + ARMA(2,1) \quad (2)$$

Based on the selected optimal models (1) and (2), the future Agriculture, Forestry & Fishing sector's GDP is predicted as reported in the table given below:

**Table 1**
**Forecasting of AFF**

| *Year* | *Intercept* | *Time trend* |
|---|---|---|
| 2007-08 | 535737.0 | 529602.0 |
| 2008-09 | 541355.0 | 537583.0 |
| 2009-10 | 547092.0 | 541890.0 |
| 2010-11 | 552949.0 | 547826.0 |
| 2011-12 | 558931.0 | 553102.0 |
| 2012-13 | 565039.0 | 558704.0 |
| 2013-14 | 571275.0 | 564206.0 |
| 2014-15 | 577644.0 | 569791.0 |
| 2015-16 | 584147.0 | 575379.0 |

As can be seen from the forecast above, the GDP forecast comes more from the model with only time trend than what comes from the model where time also in an independent variable. However model with lesser value of Information Criterion (Akiake, Hannan-Quin & Schwarz) is expected to be better of the two. As such we consider the model with time trend as a better of the two to forecast the future values of GDP.

### 2.2. Mining and Quarrying (MQ)

Mineral resources are critical to any country and more so for a country of India's size. They provide basic raw material and fuel to core industries and their availability and extraction is of immense economic importance to growth of manufacturing sector.

The economic activities included in the sector are extraction of minerals from underground and surface mines, quarries and oil wells, with all supplementary operations for dressing and beneficiating ores and other crude minerals such as crushing, screening, washing, grading, milling, etc and other operations for rendering the minerals marketable. All these activities are covered to the extent they are carried at the mine site.

The estimates of Gross Value Added(GVA) in this sector are prepared following production approach. The value of output of each mineral is calculated at state level and value of corresponding inputs is deducted to obtain GVA. State level estimates are aggregated to get the National level estimates.

The optimal model without time trend is –

$$MQ_{gdp(t)} = \text{Intercept} + AR(1) \quad (3)$$

When time is also taken as independent variable in the model, we got the following optimal model:

$$MQ_{gdp(t)} = \text{Intercept} + \text{Slope}*t + ARMA(4,2) \quad (4)$$

The future values of GDP of Mining and Quarrying Sector estimated from models (3) and (4) are reported in table given below:

**Table 2**
**Forecasting of MG**

| *Year* | *Intercept* | *Time Trend* |
|---|---|---|
| 2007-08 | 60097.3 | 60587.4 |
| 2008-09 | 61983.6 | 62859.7 |
| 2009-10 | 63956.8 | 65144.4 |
| 2010-11 | 66020.8 | 67385.3 |
| 2011-12 | 68179.9 | 69610.9 |
| 2012-13 | 70438.4 | 71792.4 |
| 2013-14 | 72801.0 | 73939.4 |
| 2014-15 | 75272.3 | 76036.2 |
| 2015-16 | 77857.5 | 78084.4 |

Here also the model with time trend came out to better as values of Information Criteria is lower in time trend case vis-à-vis mode with only intercept.

### 2.3. Manufacturing (Mfg)

Strong manufacturing industry is prerequisite for achieving sustaining growth in long run. This is all the more true for a country of a billion plus population like India. Manufacturing sector is very important in more ways than one. Apart from creating wealth for the nation, it provides employment to large number of people of different skills, from unskilled labour to semi skilled, skilled and highly skilled manpower. This assumed significance for our country where there is large number of people with no education or with just some education.

The manufacturing sector is classifies it two broad sectors, the registered sector and unregistered sector. The sector covers manufacturing, processing and repair and maintenance services units irrespective of their employment size, investment and location. The registered sector covers all units registered under section 2m(i) and 2m(ii) of Indian Factories Act 1948 which respectively refers to factories employing 10 or more workers and using power or 20 or more workers without using power on any day in the preceding 12 months. The sector also covers Bidi and Cigar establishments registered under Bidi and Cigar Workers (Conditions of Employment) Act 1966. The unregistered sector covers the remaining units which are not covered in registered sector.

In the registered sector, GVA is estimated following production approach. In the un-registered sector GVA is estimated by workforce multiplied by corresponding GVA per worker. These estimates are first worked out for the bench mark year and then carried forward to subsequent years on the basis of indicators representing physical volume of activity.

The optimal model without time trend for this sector is-

$$Mfg_{gdp} = \text{Intercept} + \text{ARMA}(2,1) \quad (5)$$

When we considered the time trend also the optimal model came out to be:

$$Mfg_{gdp} = \text{Intercept} + \text{Slope}^*t + \text{ARMA}(5,3) \quad (6)$$

The forecast for future period of manufacturing sector GDP from the models (5) and (6) are presented in the Table 3 below.

**Table 3**
**Forecasting of Mfg**

| *Year* | *Intercept* | *Time Trend* |
|---|---|---|
| 2007-08 | 472953.0 | 465596.0 |
| 2008-09 | 507895.0 | 487015.0 |
| 2009-10 | 545851.0 | 506332.0 |
| 2010-11 | 587100.0 | 525587.0 |
| 2011-12 | 631947.0 | 542334.0 |
| 2012-13 | 680722.0 | 556742.0 |
| 2013-14 | 733787.0 | 568645.0 |
| 2014-15 | 791536.0 | 577542.0 |
| 2015-16 | 854396.0 | 583145.0 |

The model with only Intercept forecasts on significantly higher side vis-à-vis model with Intercept and time Trend. Going by the value of Information Criteria, the model with time trend is preferable here as well.

### 2.4. Electricity, Gas & Water supply (EGW)

The very name of sector amply conveys its importance, particularly for a country like India where development of these services for vast uncovered regions continues to be a challenge. Activities covered under Electricity sub-sector are generation, transmission and distribution of electricity. Gas sub-sector covers manufacture of gas, including gobar gas, and distribution through mains to households, industrial, commercials and other users. Water sub-sector covers collection, purification and distribution of water excluding the operation of irrigation systems.

Gross factor income in case of electricity and water sub-sectors and gross output net of inputs in case of gas sub-sector make GVA of this sector.

The optimal model without time trend for this sector is:

$$EGW_{gdp} = \text{Intercept} + \text{ARMA}(3,2) \quad (7)$$

and optimal model with time trend is :

$$EGW_{gdp} = \text{Intercept} + \text{Slope}^*t + \text{ARMA}(5,3) \quad (8)$$

The forecast of GDP of this sector for future years in accordance with model (7) and (8) are in table below –

**Table 4**
**Forecasting of EGW**

| *Year* | *Intercept* | *Time Trend* |
|---|---|---|
| 2007-08 | 63396.2 | 62157.5 |
| 2008-09 | 66062.0 | 63476.4 |
| 2009-10 | 68822.6 | 64565.1 |
| 2010-11 | 71627.5 | 65497.7 |
| 2011-12 | 74506.9 | 66169.7 |
| 2012-13 | 77444.1 | 66619.8 |
| 2013-14 | 80449.7 | 66855.6 |
| 2014-15 | 83518.3 | 66865.1 |
| 2015-16 | 86653.7 | 66660.7 |

Here also model with time trend has lower values of Information Criteria and thus can be take to better in its predictive capabilities than the model with only intercept.

### 2.5. Construction (Const)

This sector is crucial for infrastructure development which is crucial for overall development of economy. It also reflects wellbeing of people. Construction work covers whole of construction activity, both contractual and own account.

The selection criteria gave the following model for the only intercept case:

$$\text{Const}_{gdp} = \text{Intercept} + \text{AR}(2,1) \tag{9}$$

The optimal model when time is also taken as a variable is:

$$\text{Const}_{gdp} = \text{Intercept} + \text{Slope}^{*}t + \text{AR}(2,1) \tag{10}$$

The forecast for future years based on model (9) and (10) are given in the table below-

**Table 5**
**Forecasting of Const**

| *Year* | *Intercept* | *Time Trend* |
|---|---|---|
| 2007-08 | 228505.0 | 229490.0 |
| 2008-09 | 253301.0 | 254887.0 |
| 2009-10 | 281053.0 | 282576.0 |
| 2010-11 | 312124.0 | 312574.0 |
| 2011-12 | 346923.0 | 344864.0 |
| 2012-13 | 385912.0 | 379381.0 |
| 2013-14 | 429604.0 | 416013.0 |
| 2014-15 | 478580.0 | 454587.0 |
| 2015-16 | 533490.0 | 494865.0 |

Based on values of Information Criteria, the model with time trend is found to be better of the two models.

### 2.6. Trade, Hotel & Restaurant (THR)

The Trade sub-sector covers wholesale and retail trade in all commodities whether produced within country, imported or exported. It also includes activities of purchase and selling agents, brokers and auctioneers. Hotel and Restaurant sector covers services provided by hotels and other lodging places, restaurants, cafes and other eating and drinking places

GVA in this sector is estimated using different methods for different group of units due to difference in data availability for them.

The optimal model for this sector in without time trend case is:

$$THR_{gdp} = \text{Intercept} + AR(2,1) \tag{11}$$

For the model with time trend the optimal model is:

$$THR_{gdp} = \text{Intercept} + \text{Slope}^{*}t + AR(2,1) \tag{12}$$

Forecast based on models (11) and (12) are in the table-6 below-

**Table 6**
**Forecasting of THR**

| *Year* | *Intercept* | *Time Trend* |
|---|---|---|
| 2007-08 | 472308.0 | 465114.0 |
| 2008-09 | 506102.0 | 488426.0 |
| 2009-10 | 542217.0 | 510239.0 |
| 2010-11 | 580819.0 | 530171.0 |
| 2011-12 | 622088.0 | 547830.0 |
| 2012-13 | 666218.0 | 562823.0 |
| 2013-14 | 713414.0 | 574762.0 |
| 2014-15 | 763899.0 | 583269.0 |
| 2015-16 | 817909.0 | 587984.0 |

### 2.7. Transport, Storage and Communication (TSC)

This sector covers transport by railways and by other means, including services incidental to transport, storage and communication services. GVA is estimated by analysing budget documents of government and public sector units and by sample survey data in case of others.

Optimal model for without time trend case is:

$$TSC_{gdp} = \text{Intercept} + AR(4,1) \tag{13}$$

and for the Time Trend case, the optimal model is:

$$TSC_{gdp} = \text{Intercept} + \text{Slope}^{*}t + AR(2,1) \tag{14}$$

Forecast for future years is in the table below

**Table 7**
**Forecasting of TSC**

| *Year* | *Intercept* | *Time Trend* |
|---|---|---|
| 2007-08 | 373241.0 | 370241.0 |
| 2008-09 | 425840.0 | 417827.0 |
| 2009-10 | 485810.0 | 470180.0 |
| 2010-11 | 554433.0 | 527484.0 |
| 2011-12 | 632955.0 | 589884.0 |
| 2012-13 | 722805.0 | 657474.0 |
| 2013-14 | 825610.0 | 730290.0 |
| 2014-15 | 943232.0 | 808293.0 |
| 2015-16 | 1077800.0 | 891359.0 |

Like in sectors discussed above, model with time trend comes out to be better model in terms of Information Criteria.

### 2.8. Financing, Insurance, Real Estate and Business Services (FIRB)

Activities included here are (a) banking, insurance (b) ownership of dwellings, real estate services (c) renting of machinery and equipment without operator and renting of personal and household goods (d) computer and related activities (e) accounting, book keeping and related activities (f) research and development, market research and opinion polling, business and management consultancy, architectural, engineering and other technical activities (g) advertising and other business activities not elsewhere classified and (h) legal services.

Optimal model without time trend is:

$$FIRB_{gdp} = \text{Intercept} + \text{ARMA}(2,1) \tag{15}$$

and for time trend case, it is:

$$FIRB_{gdp} = \text{Intercept} + \text{Slope}^{*}t + \text{ARMA}(2,2) \tag{16}$$

**Table 8**
**Forecasting of FIRB**

| *Year* | *Intercept* | *Time Trend* |
|---|---|---|
| 2007-08 | 444904.0 | 436004.0 |
| 2008-09 | 482776.0 | 460358.0 |
| 2009-10 | 523917.0 | 483617.0 |
| 2010-11 | 568625.0 | 505421.0 |
| 2011-12 | 617222.0 | 525392.0 |
| 2012-13 | 670061.0 | 543143.0 |
| 2013-14 | 727524.0 | 558281.0 |
| 2014-15 | 790031.0 | 570410.0 |
| 2015-16 | 858035.0 | 579139.0 |

Here both the models are approximately equally good in terms of Information Criteria.

### 2.9. Community, Social and Personal services (CSP)

This sector covers GDP accruing out of Central and State Government Administration, work of Local Bodies, Education, Research & Scientific Services, Medical & Health Services of both public & private sectors, Sanitary Services, Legal Services and rest of the other services.

The optimal Model without time trend is:

$$CSP_{gdp} = \text{Intercept} + \text{ARMA}(1,2) \tag{17}$$

And for time trend case, it is:

$$CSP_{gdp} = \text{Intercept} + \text{Slope}^{*}t + \text{ARMA}(1,2) \tag{18}$$

Estimates of future values based on models (17) & (18) are in the table below –

**Table 9**
**Forecasting of CSP**

| *Year* | *Intercept* | *Time Trend* |
|---|---|---|
| 2007-08 | 412708.0 | 404395.0 |
| 2008-09 | 436840.0 | 417444.0 |
| 2009-10 | 462519.0 | 428973.0 |
| 2010-11 | 489856.0 | 438802.0 |
| 2011-12 | 518970.0 | 446763.0 |
| 2012-13 | 549985.0 | 452704.0 |
| 2013-14 | 583037.0 | 456493.0 |
| 2014-15 | 618270.0 | 458023.0 |
| 2015-16 | 655838.0 | 457210.0 |

### 2.10. Gross Domestic Product at factor cost(GDPF):

It is essentially a measure of income and not output. It represents the amount remaining for distribution out of gross value added after payment of all taxes on production and receipt of all subsidies on production. It is sum total GDP of the nine sector noted above.

Optimal model without time trend for this variable is:

$$GDPFC_{gdp} = \text{Intercept} + \text{ARMA}(3,2) \tag{19}$$

and ooptimal model with Time Trend is:

$$GDPFC_{gdp} = \text{Intercept} + \text{Slope}^{*}t + \text{ARMA}(2,1) \tag{20}$$

Forecast based on models (19) and (20) is given in table below –

**Table 10**
**Forecasting of GDPFC**

| *Year* | *Intercept* | *Time Trend* |
|---|---|---|
| 2007-08 | 3062970.0 | 3014440.0 |
| 2008-09 | 3275510.0 | 3160020.0 |
| 2009-10 | 3506100.0 | 3299030.0 |
| 2010-11 | 3754810.0 | 3429320.0 |
| 2011-12 | 4023970.0 | 3548680.0 |
| 2012-13 | 4314950.0 | 3654830.0 |
| 2013-14 | 4629830.0 | 3745460.0 |
| 2014-15 | 4970560.0 | 3818260.0 |
| 2015-16 | 5339420.0 | 3870960.0 |

## 4. COMPARISON BETWEEN GDP FORECAST AND SUM TOTAL OF FORECASTS OF CONSTITUENT SECTORS:

It is quite a subject of natural curiosity to examine the consonance of GDP forecasts with sum total of forecasts of its constituent sectors. The picture is in the table 11 and Table 12 below separately for without and with time trend cases.

**Table 11**
**(Model without Time Trend)**

| *Year* | *SGDP* | *% growth* | *FGDP* | *% growth* |
|---|---|---|---|---|
| 2007-08 | 3063850 | | 3062970 | |
| 2008-09 | 3282155 | 7.1 | 3275510 | 6.9 |
| 2009-10 | 3521238 | 7.3 | 3506100 | 7.0 |
| 2010-11 | 3783554 | 7.5 | 3754810 | 7.1 |
| 2011-12 | 4071723 | 7.6 | 4023970 | 7.2 |
| 2012-13 | 4388625 | 7.8 | 4314950 | 7.2 |
| 2013-14 | 4737502 | 7.9 | 4629830 | 7.2 |
| 2014-15 | 5121983 | 8.1 | 4970560 | 7.4 |
| 2015-16 | 5546126 | 8.3 | 5339420 | 7.4 |

**Table 12**
**(Model with Time Trend)**

| *Year* | *SGDP* | *% growth* | *FGDP* | *% growth* |
|---|---|---|---|---|
| 2007-08 | 3023187 | | 3014440 | |
| 2008-09 | 3189876 | 5.5 | 3160020 | 4.8 |
| 2009-10 | 3353517 | 5.1 | 3299030 | 4.4 |
| 2010-11 | 3520748 | 5.0 | 3429320 | 3.9 |
| 2011-12 | 3685950 | 4.7 | 3548680 | 3.5 |
| 2012-13 | 3849383 | 4.4 | 3654830 | 3.0 |
| 2013-14 | 4009485 | 4.2 | 3745460 | 2.5 |
| 2014-15 | 4164816 | 3.9 | 3818260 | 1.9 |
| 2015-16 | 4313826 | 3.6 | 3870960 | 1.4 |

SGDP: sum of sector forecasts, FGDP: Independent forecast of GDP based on GDP data

The sum total of the sector forecasts is a little on higher side uniformly over years than the independent forecast for GDP variable. It soothes the logic also as different sectors have different weights on GDP and even this weight is dynamic depending upon growth in different sectors in different years. Thus for forecasting GDP it seems better to forecast sector GDPs first and add them up to get forecast for overall GDP. But the fact that both are close by in most of the years indicates robustness of the models.

## 4. CONCLUSION

The study, though, does not establish suitability of a particular model to be used in forecast of GDP, yet it provides optimal models to make such forecasts. It also concludes that model with Time as an independent variable is preferable as value of Information Criteria has been found to be lower vis-à-vis model with time element.

**Appendix-I**

**Table A(1)**

| | *Trend* | *Best Model* | *RSS* | *S.E.* | *R^2* | *Akaike* | *Hannan-Quinn* | *Schwarz* |
|---|---|---|---|---|---|---|---|---|
| AFF | T-I | AR(1) | 3.80E+10 | 2.63E+4 | 0.95 | 2.04E+1 | 2.04E+1 | 2.05E+1 |
| | T-II | ARMA(2,1) | 1.29E+10 | 1.56E+4 | 0.98 | 1.94E+1 | 1.94E+1 | 1.95E+1 |
| MQ | T-I | AR(1) | 3.49E+08 | 2.52E+3 | 0.97 | 1.57E+1 | 1.57E+1 | 1.58E+1 |
| | T-II | ARMA(4,2) | 1.10E+08 | 1.50E+3 | 0.99 | 1.47E+1 | 1.49E+1 | 1.50E+1 |
| Mfg | T-I | ARMA(2,1) | 1.30E+10 | 1.57E+4 | 0.98 | 1.94E+1 | 1.94E+1 | 1.95E+1 |
| | T-II | ARMA(5,3) | 6.38E+09 | 1.16E+4 | 0.99 | 1.89E+1 | 1.90E+1 | 1.92E+1 |
| **EGW** | T-I | ARMA(3,2) | 2.82E+08 | 2.35E+3 | 0.98 | 1.56E+1 | 1.57E+1 | 1.58E+1 |
| | T-II | ARMA(5,3) | 1.43E+08 | 1.75E+3 | 0.99 | 1.51E+1 | 1.52E+1 | 1.54E+1 |
| Const | T-I | ARMA(2,1) | 2.23E+09 | 6.48E+3 | 0.98 | 1.76E+1 | 1.77E+1 | 1.78E+1 |
| | T-II | ARMA(2,1) | 1.13E+09 | 4.66E+3 | 0.99 | 1.70E+1 | 1.70E+1 | 1.72E+1 |
| THR | T-I | ARMA(2,1) | 9.52E+09 | 1.34E+4 | 0.98 | 1.91E+1 | 1.91E+1 | 1.92E+1 |
| | T-II | ARMA(2,1) | 5.57E+09 | 1.03E+4 | 0.99 | 1.86E+1 | 1.86E+1 | 1.88E+1 |
| TSC | T-I | AR(4,1) | 3.28E+09 | 8.01E+3 | 0.98 | 1.81E+1 | 1.82E+1 | 1.83E+1 |
| | T-II | ARMA(2,1) | 3.09E+09 | 7.71E+3 | 0.99 | 1.80E+1 | 1.81E+1 | 1.82E+1 |
| FIRB | T-I | ARMA(2,1) | 6.95E+09 | 1.15E+4 | 0.98 | 1.88E+1 | 1.88E+1 | 1.89E+1 |
| | T-II | AR(2,2) | 6.46E+09 | 1.13E+4 | 0.99 | 1.88E+1 | 1.88E+1 | 1.90E+1 |
| CSP | T-I | ARMA(1,2) | 9.40E+09 | 1.33E+4 | 0.98 | 1.91E+1 | 1.91E+1 | 1.92E+1 |
| | T-II | ARMA(1,2) | 4.41E+09 | 9.20E+3 | 0.99 | 1.83E+1 | 1.84E+1 | 1.85E+1 |
| GDPFC | T-I | AR(3,2) | 4.53E+11 | 9.42E+4 | 0.98 | 2.30E+1 | 2.31E+1 | 2.32E+1 |
| | T-II | AR(2,1) | 2.11E+11 | 6.37E+4 | 0.99 | 2.22E+1 | 2.23E+1 | 2.24E+1 |

T-I: Intercept term; T-II-Time Trend

**Table A-2**

| *GDP* | *Trend* | *Intercept* | *Slope* | *a(1,1)* | *a(1,2)* | *a(1,3)* | *a(1,4)* | *a(1,5)* | *a(2,1)* | *a(2,2)* | *a(2,3)* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| AFF | T-I | 2.70E+5 | | 1.02 | | | | | | | |
| | T-II | 6.80E+3 | 7.27E+4 | 0.55 | 0.42 | | | | | | |
| MQ | T-I | 1.91E+4 | | 1.05 | | | | | | | |
| | T-II | 1.11E+3 | -6.75E+3 | 1.29 | 0.38 | -0.66 | -0.03 | | 0.40 | 0.73 | |
| Mfg | T-I | 1.25E+5 | | 2.05 | -1.04 | 1.09 | | | | | |
| | T-II | 5.88E+3 | -4.50E+4 | 1.55 | 1.55 | -0.11 | -0.21 | -0.03 | 0.34 | 0.32 | 0.30 |
| EGW | T-I | 1.71E+4 | | 1.45 | 0.15 | -0.60 | | | 0.44 | 0.64 | |
| | T-II | 9.81E+2 | -1.14E+4 | 1.35 | -0.06 | 0.04 | -0.30 | -0.05 | 0.35 | 0.29 | 0.34 |
| Const | T-I | 5.29E+4 | | 2.10 | -1.09 | | | | 1.12 | | |
| | T-II | 2.31E+3 | -1.41E+4 | 2.18 | -1.20 | | | | 0.92 | | |
| THR | T-I | 1.12E+5 | | 2.06 | -1.06 | | | | 1.08 | | |
| | T-II | 5.68E+3 | -5.23E+4 | 2.08 | -1.09 | | | | 0.97 | | |
| TSC | T-I | 6.23E+4 | | 2.19 | -1.20 | -0.02 | 0.04 | | 1.14 | | |
| | T-II | 3.54E+03 | -4.03E+4 | 2.18 | -1.19 | | | | 0.88 | | |
| FIRB | T-I | 9.54E+4 | | 2.07 | -1.07 | | | | 1.09 | | |
| | T-II | 5.16E+3 | -5.44E+4 | 2.08 | -1.10 | | | | 0.93 | 0.03 | |
| CSP | T-I | 1.17E+05 | | 2.04 | -1.04 | | | | 1.07 | | |
| | T-II | 5.42E+3 | -4.01E+4 | 2.05 | -1.06 | | | | 0.98 | | |
| GDPFC | T-I | 8.72E+5 | | 1.54 | 0.00 | -0.53 | | | 0.54 | 0.60 | |
| | T-II | 3.66E+4 | -1.90E+5 | 2.08 | -1.10 | | | | 0.97 | | |

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