Modelling of Economic Growth Rate of Agriculture Sector of India using Solow Growth Model with Growth Differential Equation

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Abstract

Our prime objective is to study the effect of agriculture sector on Indian economy by using Solow growth model. Another objective is to study the effect of Agriculture sector on GDP of Indian economy during the period 1990 to 2010. Indian economy is primly depends upon Agriculture sector. This sector affects on GDP of our country. To predict the economical growth or to observe behaviour of Indian economy. It is necessary to work on agriculture sector using Solow production model and the modelling in differential equation. In the beginning we estimate the parameters for the period 1990 to 2010. The computations where capital labour force total factor productivity and total productions and also the real GDP growth figures and their variations. This model provide the best approximation to predict effect of agriculture sector in Indian economy withrespect to real aggregate GDP growth.The ratio of the main economical variables like production per worker, capital output ratio and capital per worker.The result shows a close relationship between actual and calculated growth rate in the period 1990 to 2010. We conclude a correlation between actual growth rates and calculated growth rates are near about similar.

Keywords: *Solow growth model, Indian GDP growth, economic growth of India by the affectof agriculture sector, economic variables, actual and calculated growth rate.*

1. Introduction:

Economic growth all over the world has not been same for a longtime. Some economics grow fastlycompare to other economy. Economist says thatparticularly small economies generally grow fastlyas compare to larger economies. We are interested for long term changes in the GDP due to agriculture sector particularly. There are different rates by which the different sectors affect our economy[1]. This issue is started from 1940's there are so many sectors who has broad range of outcomes. Their progress for any direction directly affects on our economy i.e. in our GDP.

The economy of India is developing and mixed economy. It is the world's sixth largest economy by nominal GDP. And the third largest economy by purchasing power party. In 2017 the labour force of India was about 520.4 million[12].

In 2017 GDP of India is 6.7%. Contribution of remaining sector as, Agriculture 47%, Industry 22, Service 31%. India has rank of 141 in per capita GDP.After 1991 economic liberalisation, India achieve 6 to 7% average GDP growth[2]. Annually in financial year 2015 and 2017, India economybecomethe world's fastest Growing economy. The long-term growth prospective of time Indian economy is positive due to its young population. Corresponding load dependency ratio healthy savings and investment rate. Increasing integration into the global economy India has one of the fastest growing service sectors in the world. The annual growth rate above 9%. Since 2001 which contributes 57% of GDP in 2012-2013[11] [15].

The Agriculture sector is the largest employer in Indians economy but contributes to declining share of its GDP 17% India ranks second worldwide in farm output.The industry sector has held a steady share of its economic contribution 26% of GDP.

Agriculture and allied sectors like forestry, logging and fishing accounted for 17% of GDP and employed 49% of its total work force in 2014. As the Indians economy has diversified and grown agricultures contribution to GDP has steady declined from 1951 to 2011. [7] [8] [26]

Yet it is still the country's largest employment source and significant piece of overall socio-economic development. Crop-yield per-unit area of all crop has growing since 1950.Due to the special emphasis placed on agriculture in the five year plan. The steady improvement in irrigations, technology, applications of modern agricultural practices and provision of agricultural credit and subsides, since the green revolution of India. However international comparisons reveal the average yield in the India is generally 30% to 50% of the highest average yield in the world. Indiareceives an average annual rainfall of 1208 mm. Total annual precipitation of 4000 billion cubic meter. The total utilisable water resources,including surface and ground water amounting 1123 billion cubic meters. About 39% of total cultivated area is irrigated. India in land water resources. Marine resources provide employment to the nearly 6 million people in the fisheries sector.

Over the six and half decades since independence the country has brought about a landmark agricultural revolution that has transform the nation from chronic dependence n grain imports into a global agricultural power house that is now a net exporter of food. [13] [14] [15] [24] [25]

The main objective of the study is to use the SolowGrowth Model as a basis to economic model of agriculture sector during the period 1990 to 2010. To estimate the economic growth of our country for the past transition period relative to real condition of the India economy.

2. Justification of the study are,

(1) Now the thing is well known that Solow model provides good. Approximation with respect to aggregate GDP and to the ratios of main economical variables like production per labour, capital output ratio or capital per labour

(2) Economic growth always takes the centre stage in most of economic policies and is necessarily associated with economic development as there can be no development without growth.

(3) Economic growth directly affects on standard of living and also on national development.

(4) The study will equipped policy makers with the relevant data for the design of appropriate policies that will result in higher and sustainable growth rates for the whole economy.

The Solow model production function is the foundations of models economies and also new theory of economic growth; growth rate models are obtained using different equation techniques in 1990 to 2010. [2] [17]

3. Review of the method:

This paper focus on effect of agriculture sector on Indian economy using Solow growth model with differential equation. We start introducing assumptions for the model type. Which is augmented form of cobb-Douglas production function. Definition of parameters then we can work to develop labour supply model followed by the total factor productivity model for the more, we went to develop the capital accumulation model, production model using the Solow production function model.The development of growth model using Solow production function. [1] [2] [3]

1) Assumptions : The following assumptions are made saving and investment decision are developing from external factors (climate, import, export policies and local issues)
2) Storage Factor and technological growth are excluded in the model.
3) It is assume that each factor of production get reduced the returns rate. That is increscent of one factor are added to fix amount of the other factors of production output increases, but increment is negligible.
4) It is assume that labour supply grow by itself .
5) The economy is closed to external forces and government intervention.
6) Reduction in Capital is ignored

3.1. The Production Function :

Solow growth model starts with production function 'P' is a function F quantity of capital 'C' and labour 'L'

$$P = F(C, L) \quad .....(1)$$

Solow assume that inputs are increased by certain multiple then output will also increased by the same multiple that is in equation 1) for any positive constant 'a' the following must hold that is production function is the homogeneous function. [20] [21]

$$a\, f(C,L) = f(aC, aL)$$

in equation (1) multiply by any positive constant 'a' then the following must hold.

$$a\, P = f(aC, aL) \quad .....(2)$$

using equation (2) let $a = \frac{1}{L}$ we get

$$\frac{P}{L} = f\left(\frac{C}{L}, 1\right)$$

.....(3)

For convenience by equation (3) can be written as,

$$P = f(C) \quad .....(4)$$

Where

$$\frac{P}{L} = p \text{ and } \frac{C}{L} = c \text{ and function}$$

f (c) instead of f (c, 1)

The equation (3) describes output per worker as a function of capital per worker. This representation of production function in per worker terms is quiet appropriate for the study of growth as the change per capita output if well fare in society increase there is increment in output per person that's why economic growth require increase is instead of P. in addition to assuming function is homogeneous Solow further assume positive but decreasing in profit return. For single in put that is slope of output continuously decrease because additional increment in creative to L. gives smaller and smaller output.This is natural characteristics of Solow model. [5] [6] [10]

The general production function with physical capital C, labour L and improvement in irrigation technology and application of modern agricultural practises 'A' is given by.

$$P(t) = f(C, L, A) \quad .....(5)$$

Time t is discrete t = 1,2,3…………… N. the Solow model is interpreted by (5) equations i.e. (1) micro productions function (2) GDP equation, (3) saving function, (4) change in capital, (5) change in labour force. [29]

In equation, (1) according to neoclassical production function 'f' is the functional relationship between input and outputs but we have limitations we may reach to quantitative conclusions but unable to quantitative solutions due to this Solow applied cobb-douglas production in his model the Solow model indentified total factor productivity in the long term growth but did not give explanation of what it determines in Solow model long run growth determined by some factors apart from capital and labour i.e. developing from external factor to the model. The Solow measures total factor productivity but generally it attached to the labour variable in the macroeconomic since return on investment does not show large change in time or between developing nations developed nations human productivity does not seem to change. [20] [21] [22]

The intensive production function is assumed to have following properties.

$$\left.\begin{array}{l} f(0) = 0 \\ f'(c) > 0 \\ f'(c) < 0 \end{array}\right\}$$

.....(6)

And Inada conditions

$$\left.\begin{array}{l} \lim_{c\to 0} f'(c) = \infty \\ \lim_{c\to\infty} f'(c) = 0 \end{array}\right\} \quad .....(7)$$

In macro economics the Inada conditions named after Japanese economist KenIchi Inada are assumed about the shape of production function that Guarantee the stability of economic growth path in a neoclassical growth model there are six conditions given a continuously differentiable function.[9] [10]

$$f : X \to Y$$

Where S is the set of $\{x | x \epsilon R^n_+\}$

$$y\, \{Y | Y \epsilon R_+\}$$

The conditions are the value of function f (x, x= 0)
1) $f\ (x)_{at\ x=0} = 0$is f (0) =0
2) the function is concave on x
3) that is the function is strictly increase in t
4) the derivate of function is decreasing
5) the limit of the first derivative is positive infinity at 0
6) the limit of first derivative is zero at positive infinity.

According to cob and Douglas (1928) it can shown that the Inada Conditions implies than the production function must be asymptotically production function is similar to general production function in (5) where,[3] [23]

P (t) = F(C, L, A).

Solow coupled labour supply L and productivity A. Due to development in agriculture sector is one of the factors that is

$$P\ (t) = F\ (C, A, L) \qquad .....(8)$$

In Cobb-Douglas production function productivity was constant with value one. In Solow-model productivity was made to grow proportional to it. We beings with the production function of Solow (1956) is, [16]

$$P(t) = C^{\alpha}(AL)^{\beta} \qquad .....(9)$$

If we put Z (t) = A (t) L (t) then equation (9) becomes

$$P\ (t) = C^{\propto}\ (Z)^{\beta} \qquad .....\ (10)$$

Where
P (t) total output (GDP)
A (t) total factor productivity (in developing in irrigation and new techniques of farm cultivation.

C (t) capital accumulation, L (t) labour supply,α and $\beta$are output elasticity's of capita and labour. [23] [25]

3.2. Definition of Parameters :

The models contain certain parameter that are important to motion then here in order to put the results into perspective.

$(\varrho - \gamma)$: This parameter represents the rate of labour supply. This constant of proportionality may not-exist in the real world. Labour may not grow exogenously. The growth of labour may vary according to certain natural or economic conditions.

'ϱ' shows that labour will grow upwards forever

'γ' shows that labour will grow downward forever, until a point of equilibrium is achieved that is the point at which "$\varrho - \gamma$", 'γ' is the parameter for exit rate of labour in the economy.

β : Show assumed that the marginal productivity of labour is proportional to the amount of production per unit of labour. The constant of proportionality represented as β. The constant of proportionality may vary from time to time. The value of βmay not remain the same over a period of time.

θ : This is the constant of proportionality depicting the rate of growth of total factor productivity. Solow assumed total factor productivity to be exogenous. That is the growth rate is not affected by the national income or amount of capital.

TFP and labour supply are assumed to be exogenously determined we derived expressions (models) for the determinants labour supply, total factor production, capital accumulation and production function.[5] [6] [30] [32]

3.3. The Labour Supply Model:

From the assumption for labour supply can be written mathematically as

$$\frac{dL}{dt} = \varrho L - \gamma L = (\varrho - \gamma)\ L$$

$$\frac{dL}{dt} = (\varrho - \gamma)\, L \qquad .....(11)$$

Where $'\varrho'$ is rate of labour supply

$'\gamma'$is rate at which people leave the labour sector

Equation (11) is first order homogeneous linear differential equation it can be solve by separating variable in L_0. [8] [32]

$$\frac{dL}{L} = (\varrho - \gamma)\, L$$

Now, integrating both side we get.

$$\int \frac{dL}{L} = \int (\varrho - \gamma)\, dt$$

$$ln\,(L) = (\varrho - \gamma)\, t + c$$

Taking exponent in both side we get

$$L = e^{(\varrho-\gamma)\, t + c}$$

$$L = e^{c} e^{(\varrho-\gamma)\, t}$$

Put $L_0 = e^c$(initial capital)

Therefore,

$$L\,(t) = L_0\, e^{(\varrho-\gamma)\, t}$$

.....(12)

This gives labour supply factor (model)

3.4. Total Factor Productivity Model :

Diewert (1992) define productivity ratio as the ratio of output factor to an input factor. The model is assume that total factor productivity have an internal cause that is grows proportional to itself. [30] [31]

$$\therefore \frac{dA}{dt} = \theta\, A\,(t) \qquad ..... (13)$$

Equation (13) is first order homogeneous linear differential equation in A which can be solve by separating variables.

$$\therefore \frac{dA}{A} = \theta\, dt$$

Integrating both side we get

$$\int \frac{dA}{A} = \int \theta\, dt$$

$$\ln (A) = \theta\ t + c$$

Taking exponent we get $A = e^{\theta\, t + c}$

$$\therefore A = e^{c} e^{\theta t}$$

Put $A_0 = e^{c}$ (Initial Productivity)

$$A\,(t) = A_0 e^{\theta t}$$

$$A\ (t) = A_0 e^{\theta t} \qquad \text{..... (14)}$$

Where θ is parameter of growth in productivity.

3.5. Capital Accumulation Model:

Capital accumulation the dynamic that motivates to follow the profit, involving the investment of money with the goal of increasing the initial monetary value of said asset as a financial return whether in the form of profit, interest or capital gains the process of capital accumulation from the basis of capitalism and is one of the defining characteristics of a capitalist economic system. [10] [32]

Let $\frac{dc}{dt}$ denote the change in capital with time. In a closed economy total output P equals to total income in closed economy that is fraction of income saved is the investment which construct change in capital. This change in capital is denoted by 'v' and

Therefore the amount will be equals to

VP (t).

where P (t) = F (C, A, L)

In this sector (agriculture) without government involvement investment is equal to savings we get.

$$\frac{dc}{dt} = Vf\ (C, A, L) \qquad \text{.....(15)}$$

From equation (8)

P (t) = F (C, A, L.)

This gives $\frac{dc}{dt} = VP\ (t)$ ..... (16)

This equation can be action as from equation (9)

$$\frac{dc}{dt} = VC^{\propto}(AL)^{\beta} \qquad \text{..... (17)}$$

But $L\ (T) = L_0 e^{(\varrho - \gamma)t}$

And $A\ (T) = A_0 e^{\theta t}$

Using this in equation (17) we get

$$\frac{dc}{dt} = VC^{\propto}\left(A_0 e^{\theta t} L_0 e^{(\varrho-\gamma)t}\right)^{\beta}$$

Dividing both side by $C^{\propto}$

$$\frac{dc}{C^{\propto}} = V(A_0 e^{\theta t} L_0 e^{(\varrho-\gamma)t})^{\beta} dt$$

On Integrating both side we get

$$\int \frac{dc}{C^{\propto}} = \int V\ (A_0 e^{\theta t} L_0 e^{(\varrho-\gamma)t})^{\beta} dt$$

$$\therefore \frac{C^{1-\propto}}{1-\propto} = V(A_0 L_0)^{\beta} \int e^{\theta t}\ e^{(\varrho-\gamma)t})^{\beta} dt$$

$$\therefore \frac{C^{1-\propto}}{1-\propto} = V(A_0 L_0)^{\beta} \int e^{(\theta+\varrho-\gamma)\beta t}\ dt$$

$$\therefore \frac{C^{1-\propto}}{1-\propto} = \frac{V(A_0 L_0)^{\beta} . e^{(\theta+\varrho-\gamma)\beta t}}{(\theta+\varrho-\gamma)\beta} + C^1$$

But $1-\propto = \beta$ (due to constant return scale that is homogeneous property of P holds if $\propto + \beta = 1$ then above equation becomes

$$\therefore \frac{C^{\beta}}{\beta} = \frac{V(A_0 L_0)^{\beta} .\ e^{(\theta+\varrho-\gamma)\beta t}}{(\theta+\varrho-\gamma)\beta} + C'$$

$$\therefore C^{\beta} = \frac{\beta V(A_0 L_0)^{\beta} .\ e^{(\theta+\varrho-\gamma)\beta t}}{(\theta+\varrho-\gamma)\beta} + C'$$

If t = 0, $\therefore\ C^{\beta} = \frac{V(A_0L_0)^{\beta}.\ e^{(\theta+\varrho-\gamma)\beta t}}{(\theta+\varrho-\gamma)} + C'$ .....(18)

(Co) = C_0 (Initial Capital), then

$$\therefore\ C_0^{\beta} = \frac{V(A_0L_0)^{\beta}.\ e^{(\theta+\varrho-\gamma)\beta(0)}}{(\theta+\varrho-\gamma)\beta} + C'$$

$$\therefore\ C_0^{\beta} = \frac{V(A_0L_0)^{\beta}.\ e^{0}}{(\theta+\varrho-\gamma)} + C'$$

$$\therefore\ C_0^{\beta} = \frac{V(A_0L_0)^{\beta}}{\theta+\varrho-\gamma} + C'$$

$$C' = C_0^{\beta} - \frac{V(A_0L_0)^{\beta}}{\theta+\varrho-\gamma}$$

.....(19)

From (18) and (19) we get

$$C^{\beta} = \frac{V(A_0L_0)^{\beta} e^{(\theta+\varrho-\gamma)\beta t}}{\theta+\varrho-\gamma} + C_0^{\beta} - \frac{V(A_0L_0)^{\beta}}{\theta+\varrho-\gamma}$$

$$C^{\beta} = \frac{V(A_0L_0)^{\beta}}{\theta+\varrho-\gamma}\left(e^{(\theta+\varrho-\gamma)\beta t} - 1\right) + C_0^{\beta}$$

$$C^{\beta} = \frac{V(A_0L_0)^{\beta}}{\theta+\varrho-\gamma}\left(e^{(\theta+\varrho-\gamma)\beta t} - 1\right) + \frac{(\theta+\varrho-\gamma)C_0^{\beta}}{\theta+\varrho-\gamma}$$

$$C^{\beta} = \frac{V(A_0L_0)^{\beta}\left(e^{(\theta+\varrho-\gamma)\beta t} - 1\right) + (\theta+\varrho-\gamma)C_0^{\beta}}{\theta+\varrho-\gamma}$$

Then model of Capital Accumulation is given by

$$C\ (t) = \left[\frac{V(A_0L_0)^{\beta}\left(e^{(\theta+\varrho-\gamma)\beta t} - 1\right) + (\theta+\varrho-\gamma)C_0^{\beta}}{\theta+\varrho-\gamma}\right]^{\frac{1}{\beta}}$$

Put $\mu = A_0L_0$

$$\omega = \theta+\varrho-\gamma$$

We get

$$C(t) = \left[\frac{V\mu^{\beta}\left(e^{\omega\beta t} - 1\right) + \omega\ C_0^{\beta}}{\omega}\right]^{\frac{1}{\beta}}$$

......(20)

This gives capital accumulation factor

3.6. The Production Model:

Using the Robert Solow production function.[17][18][19]

$$P\ (t) = C^{\propto}\ (AL)^{\beta}$$

Using equations (12), (14) and (20) Production Function becomes

$$P\ (t) = \left\{\left[\frac{V(A_0L_0)^{\beta}\left(e^{(\theta+\varrho-\gamma)\beta t} - 1\right) + (\theta+\varrho-\gamma)C_0^{\beta}}{\theta+\varrho-\gamma}\right]^{\frac{1}{\beta}}\right\}^{\propto} \left[A_0e^{\theta t}L_0e^{(\varrho-\gamma)t}\right]^{\beta}$$

$$P\ (t) = \left\{\left[\frac{V(A_0L_0)^{\beta}\left(e^{(\theta+\varrho-\gamma)\beta t}-1\right)+\ (\theta+\varrho-\gamma)C_0^{\beta}}{\theta+\varrho-\gamma}\right]^{\frac{1}{\beta}}\right\}^{1-\beta}\ \left[(A_0L_0)\ e^{(\theta+\varrho-\gamma)t}\right]^{\beta}$$

$$P\ (t) = \left\{\left[\frac{V(A_0L_0)^{\beta}\left(e^{(\theta+\varrho-\gamma)\beta t}-1\right)+\ (\theta+\varrho-\gamma)C_0^{\beta}}{\theta+\varrho-\gamma}\right]^{\frac{1-\beta}{\beta}}\right\}\left[(A_0L_0)^{\beta}e^{(\theta+\varrho-\gamma)t}\right]\beta$$

Put $\mu = A_0L_0, \quad \omega = \theta+\varrho-\gamma$

And $\tau = \frac{1-\beta}{\beta}$

Then above equation becomes [23][23]

$$\text{P (t)=} \left[\frac{V\mu^{\beta}\left(e^{\omega\beta t}-1\right)+\omega\ C_0^{\beta}}{\omega}\right]^{\tau}\ \left[\mu\ e^{\omega\tau}\right]^{\beta}$$

$$\text{P (t)=} \left[\mu^{\beta}e^{\omega\beta t}\right]\left[\frac{V\mu^{\beta}\left(e^{\omega\beta t}-1\right)+\omega\ C_0^{\beta}}{\omega}\right]^{\tau} \qquad .....(21)$$

Equation (21) gives the production model of the economy.

The growth Model

The growth model is given by

ΔP = P (t) – P (t-1) .....(22)

Δt = 1 .....(23)

From equation 21 and 22

$$\nabla P = \left[\mu^{\beta}e^{\omega\beta t}\right]\left[\frac{V\mu^{\beta}\left(e^{\omega\beta t}-1\right)+\ \omega\ C_0^{\beta}}{\omega}\right]^{\tau} - \left[\mu^{\beta}e^{\omega\beta\ (t-1)}\right]\left[\frac{V\mu^{\beta}\left(e^{\omega\beta t}-1\right)+\ \omega\ C_0^{\beta}}{\omega}\right]^{\tau} \qquad .....(24)$$

Therefore the percentage change (R) of the total output over the time, thus the rate of growth becomes.

$$R_t = \left[\frac{Change\ in\ production\ function\ over\ the\ time}{Initial\ production\ function\ for\ that\ time}\right] x\ 100\%$$

$$R_t = \left[\frac{P\ (t)-P\ (t-1)}{P\ (t-1)}\right] x\ 100\%\text{------------------(25)}$$

This is equation of the economic growth rate in agriculture sector on Indian economy.[24][25][27]

4. Result and Discussion :

In this section we apply the real data of agriculture sector of Indian economy from 1990 to 2010. It calculates the result using capital model, labour model, total factor productivity models and production model. Finally we calculatethe growth rate using Solow growth model. These models are applied to 1990 years data as a base year and the models are simulated for the period 1990 to 2010. For applying these models we consider the data for the year 1990 as base year. Then simultaneously we apply model from 1990 to 2010.

5. Computations for the period 1990 to 2010 :

Tables and show the results of the computations for the periods 1990 to 2010. There computations were obtained by writing mat lab number equations (12), (14), (20), (21) and (25) as follows -

Labour : $L\ (t) = L_0e^{(\varrho-\gamma)}, L_0 = 208849, \varrho-\gamma = 0.0128$

And t= 1,2,3.......20

Where A_0 = 100, θ = 0.0128, t= 1,2,3,.....20

Growth Rate :

$$Q\ (t) = \frac{(p\ (t)\ ) - P\ (t-1))}{P\ (t-1)}\ x\ 100$$

t = 1,2,.......20.

6. Conclusion :

The purpose of the research paper was to establish an appropriate economic growth model and to find economic growth in agriculture sector of our country. The principal determinants of economicgrowth are the labour supply, active working population, population with capital etc.

To observe changes in GDP we have to see how data regarding labour, capital and productive function varies time to time. Thus the element used in production increases. We expect the GDP also increases. The result on total factor productivity shows that there is a positive relation between real GDP growth & TFP. There is positive relation of GDP growth on capital.

The economic growth is defined as the increase in the amount of goods and services by an economy over times to measure progress in GDP. The key prerequisites for improve decision making, the principle determinants of economic growth as used in the study where, capital, labour and total factor productivity (TFP).

According to Slavin (2005) "growth is the qualitative increase in physical scale while development is qualitative, improvement or the unfolding of potentiality. An economy can grow without development or development without growing, or do both or neither.

The determinants have some effects on economic growth; α & β are the output elasticity's of labour & capital respectively are constant determinants by availability of technology output change in level of labour or capital used in the production. Cobb-Douglas model assumed that $\alpha = 0.7$ & $\beta = 0.3$ which was one of assumptions used in the models, α & β can be shown to be labour capital share of output. Solow simplify that an economy-wide production function.

$$P\ (t) = C^{\alpha}\ (AL)^{\beta}$$

As indicated in (9) Solow assumed that TFP is proportional to itself unlike cabb-douglas TFP is equals to 1 in those function a little work needs to be done on the parameters $\alpha,\ \beta$ from time to time in the production function. The appropriate model that answers all the questions of the system being described by the model. For example our production model of economy's growth at (24) could be said to be describe the system of economic growth if it computes the intended output of the economy appropriately.

6.1. We can draw six graph regarding the data computed.

Graph 1 : It shows total labour force actual and calculated of the agriculture sector of India from the year 1990 to 2010.

Graph 2 : It shows actual and calculated total factor of productivity factor of India. Blue (lower) line shows actual TFP and Red (Upper) line shows calculated TFP.

Graph 3 : It shows actual and calculated capital of agriculture sector of India from 1990 to 2010 in which blue (lower) line shows actual total capital of agriculture sector of India. Red (upper) line shows calculated total capital of agriculture sector of India.

Graph 4 : It shows actual production of agriculture sector of India from 1990 to 2010.

Graph 5 : It shows the calculated production of agriculture sector of India from 1990 to 2010.

Graph 6 : It shows calculated GDP of agriculture sector of India from 1990 to 2010.

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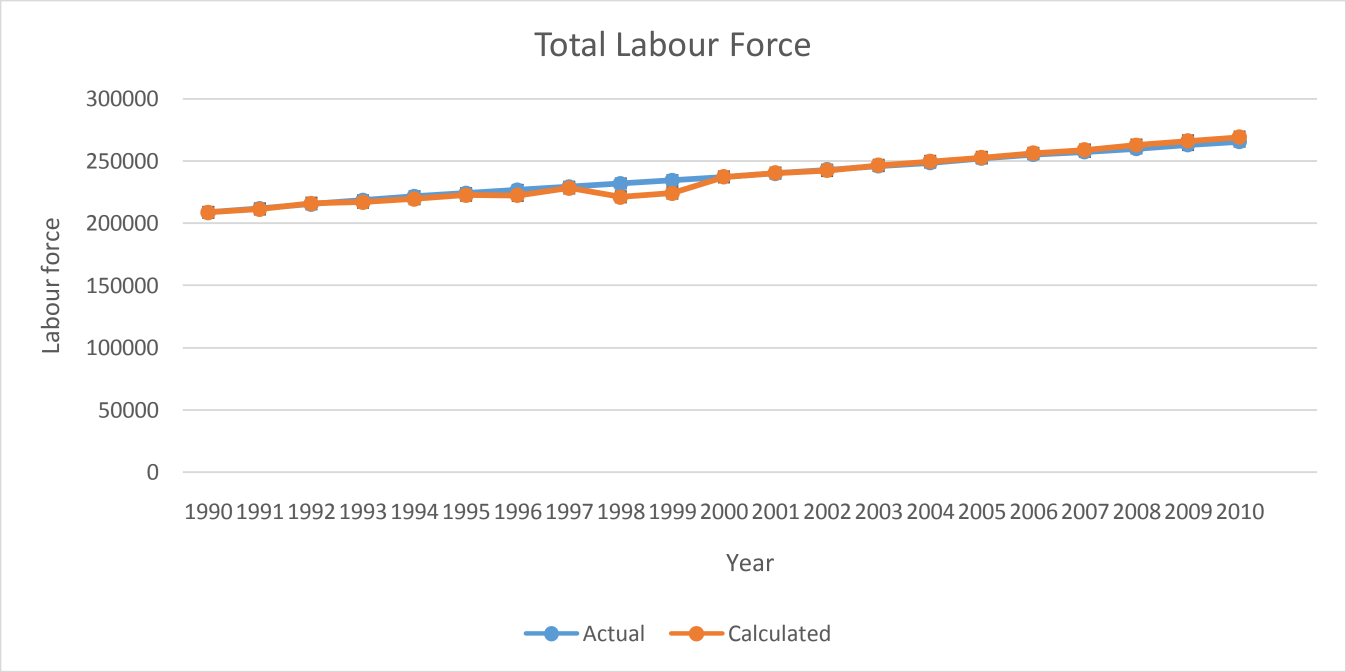
Table No. 1 : Actual and Calculated Estimations for Labour, Total Factor Productivity and Capital

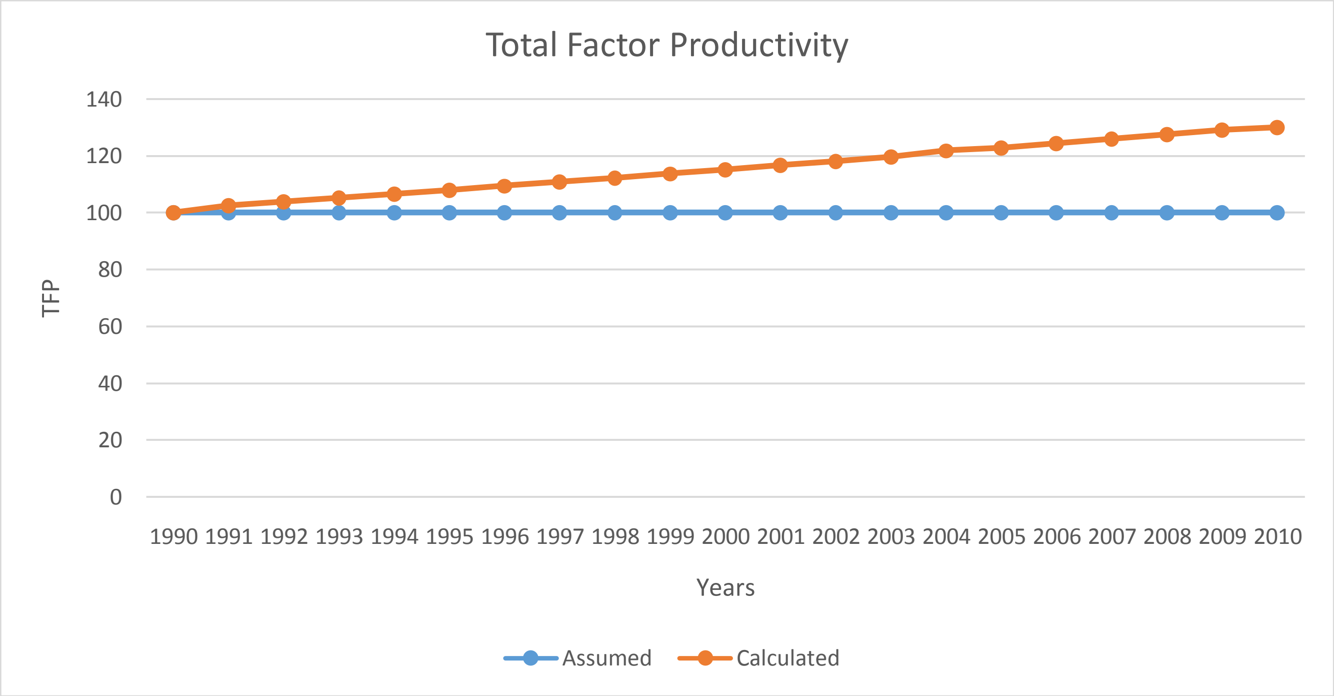
Year	Total Labour		Total Factor Productivity		Total Capital	
	Actual	Calculated	Assumed	Calculated	Actual	Calculated
1990	208849	208849	100	100	6,011,079,351,000	6,011,079,351,000
1991	212100	211539	100	102.59	5,018,296,271,000	6,702,565,367,956
1992	215324	216265	100	103.91	5,666,884,198,400	7,449,532,629,394
1993	218548	217025	100	105.25	5,797,406,233,200	8,248,499,018,238
1994	221809	219820	100	106.61	6,926,561,273,500	9,108,059,137,988
1995	224340	222652	100	107.98	7,465,480,111,800	10,028,059,137,988
1996	226908	222521	100	109.37	7,533,347,419,300	11,013,738,147,071
1997	229501	228426	100	110.78	8,654,324,660,200	12,065,453,339,827
1998	232105	221368	100	112.21	8,981,397,502,200	13,186,960,247,204
1999	234700	224349	100	113.65	10,565,244,718,200	14,381,276,778,032
2000	237268	237368	100	115.12	9,981,439,249,300	15,651,513,765,649
2001	240235	240426	100	116.60	10,437,229,714,200	17,000,877,889,667
2002	243170	242523	100	118.10	11,226,326,070,000	18,432,674,632,477
2003	246049	246660	100	119.63	12,989,361,890,700	19,950,311,308,724
2004	248844	249838	100	121.77	16,856,682,871,700	21,557,300,165,902
2005	252191	253056	100	122.73	19,595,576,035,600	23,257,261,559,139
2006	255606	256316	100	124.31	22,216,518,150,200	25,053,927,203,188
2007	257507	259008	100	125.9	26,248,710,626,500	26,951,143,504,607
2008	260257	262962	100	127.53	24,877,441,197,900	28,952,874,977,080
2009	262986	266350	100	129.16	29,169,534,364,700	31,063,207,742,843
2010	265699	269381	100	--	33,276,366,740,700	33,286,353,123,140

Table 2 : Actual and Calculated Estimations of GDP and GDP Growth Rate

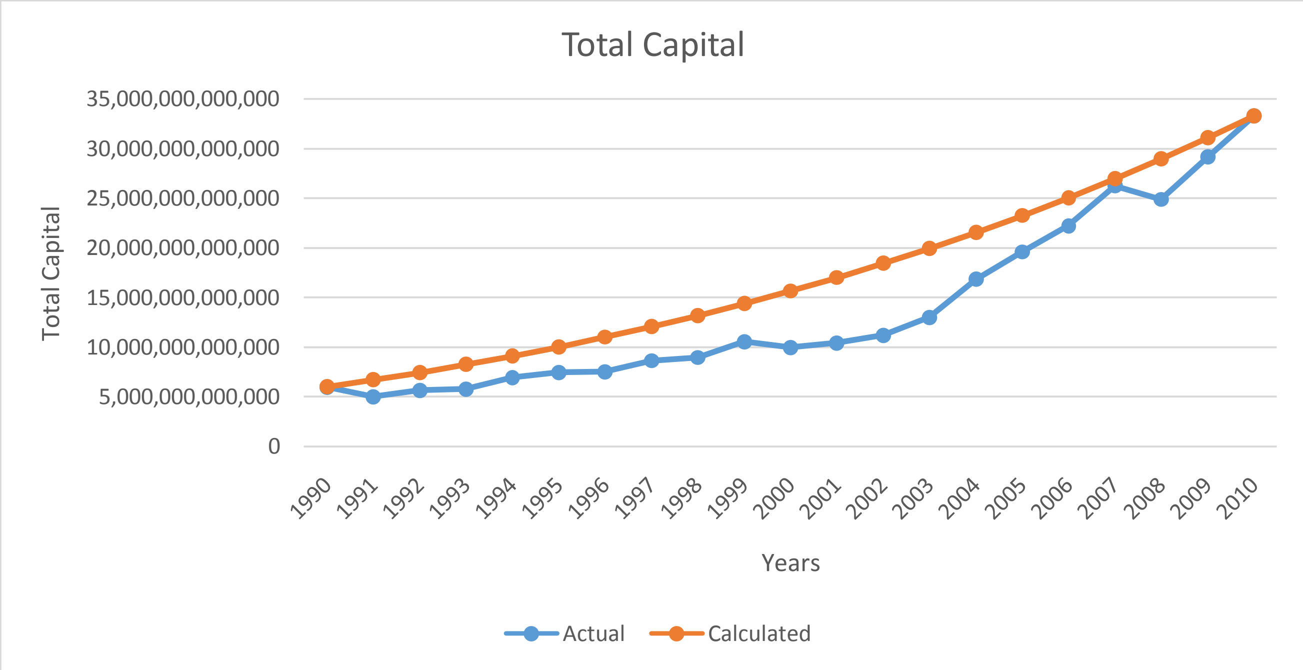
Year	Production		Periods
	GDP (Constant/2000 US $)	Calculated	t
1990	483,512,300,751.00	483,907,383,857.07	0
1991	494,331,517.790.00	495,031,684,049.72	1
1992	505,503,635,000.00	506,423,784,163.89	2
1993	517,930,501,314.00	518,090,314,002.97	3
1994	532,175,717,420.00	530,038,082,582.57	4
1995	542,038,550,605.00	542,274,052,392.55	5
1996	553,998,768,513.00	554,805,373,768.52	6
1997	567,635,514,717.00	567,639,374,375.53	7
1998	580,603,715,175.00	580,783,566,806.78	8
1999	593,944,655,300.00	594,245,653,300.44	9
2000	608,032,565,700.00	608,033,530,577.58	10
2001	612,513,302,717.00	622,155,294,804.25	11
2002	636,617,924,327.00	636,619,246,681.03	12
2003	651,423,514,721.00	651,433,896,663.29	13
2004	666,509,314,321.00	666,607,970,315.51	14
2005	682,150,444,230.00	680,150,413,803.06	15
2006	698,070,215,325.00	698,070,399,525.23	16
2007	714,359,959,175.00	714,377,331,892.77	17
2008	731,075,577,981.00	731,080,853,254.01	18
2009	743,188,514,212.00	748,190,849,973.22	19
2010	766,005,302,000.00	765,717,458,665.14	20



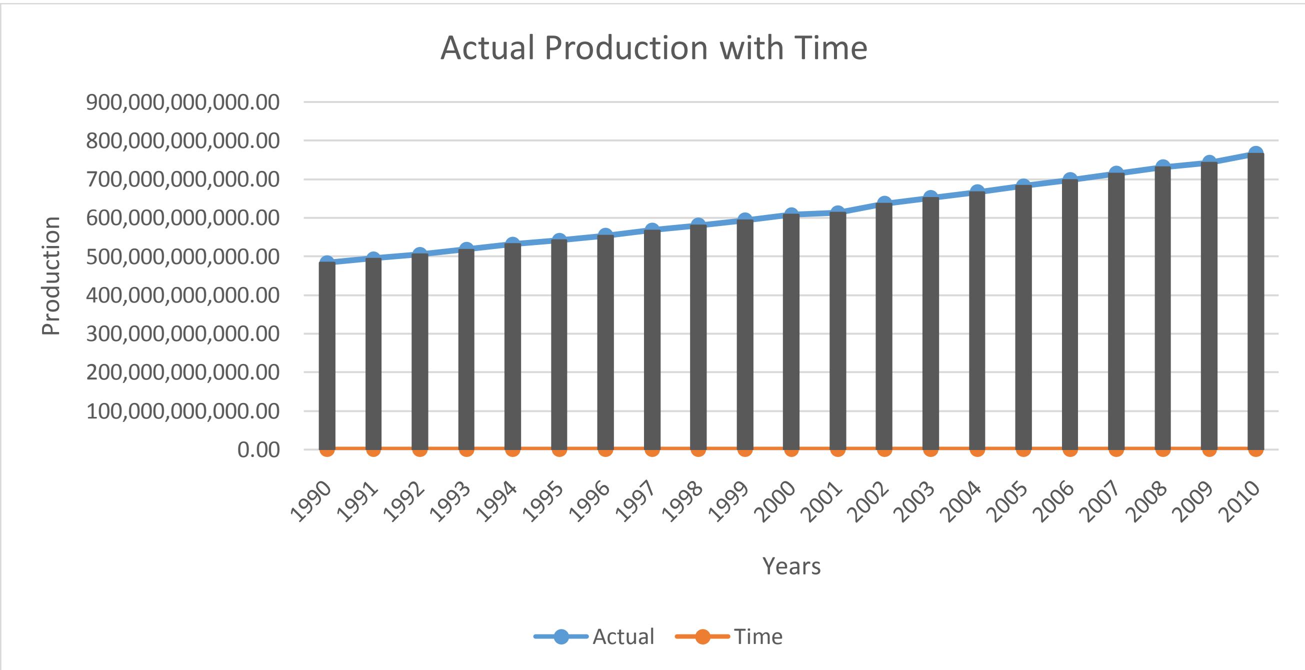
Graph - 1



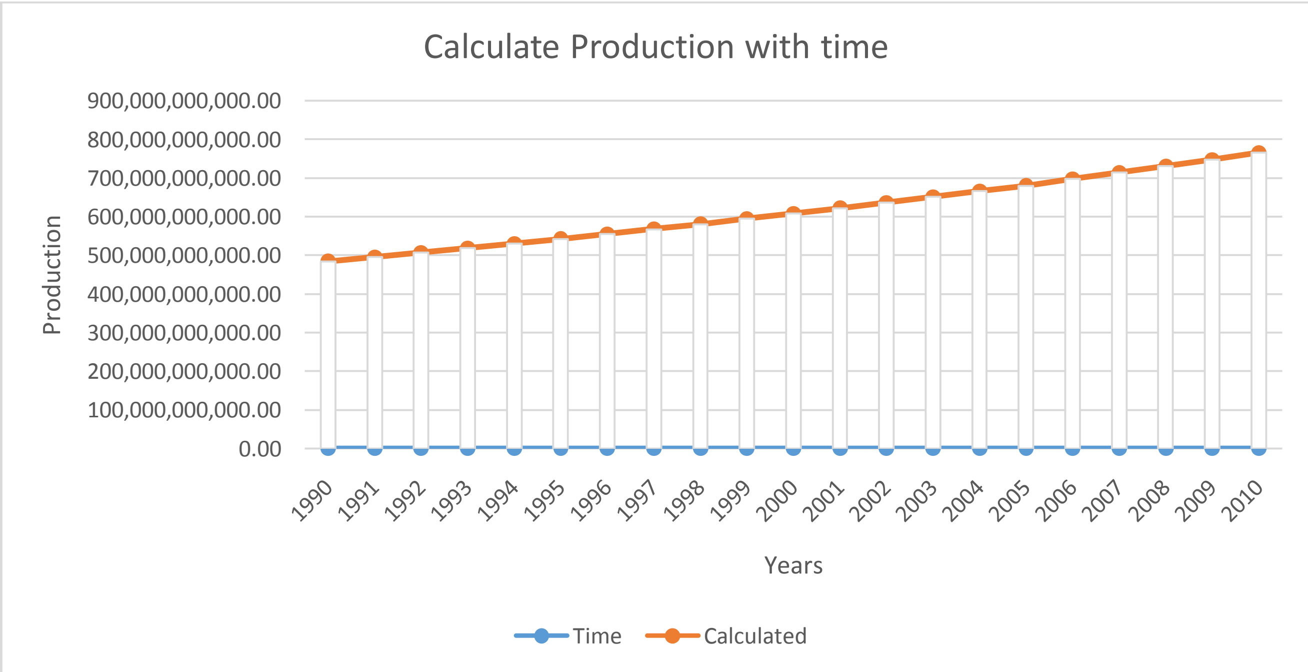
Graph - 2



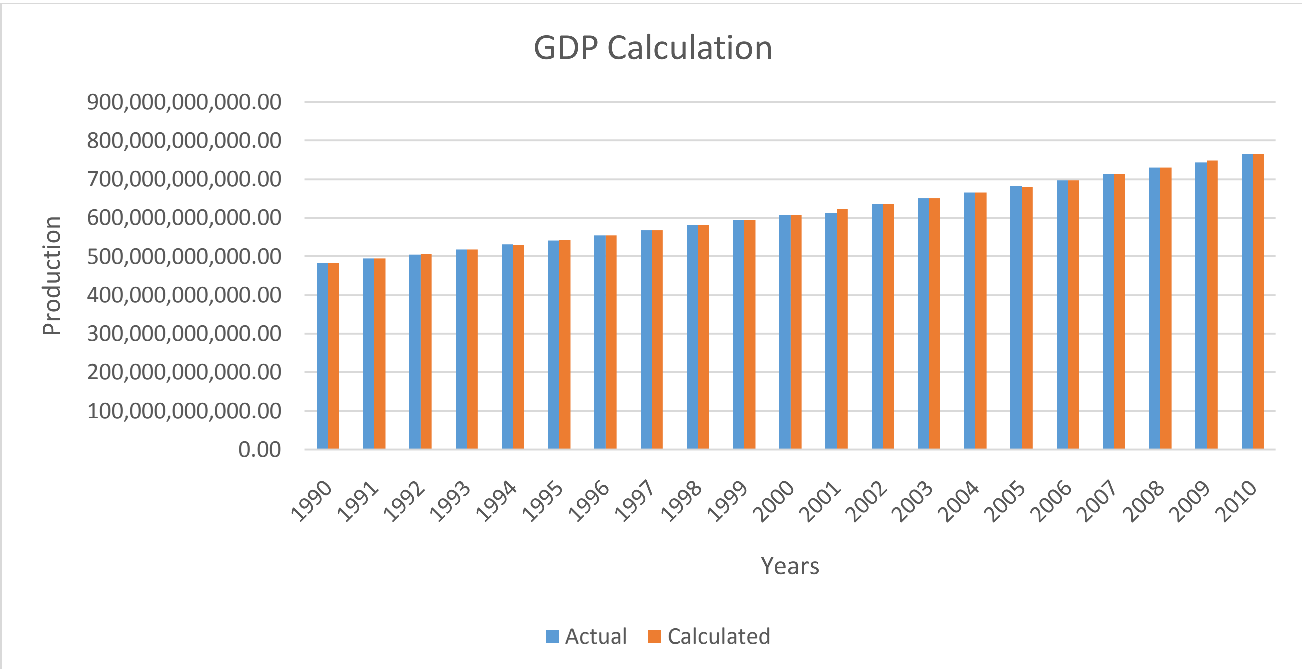
Graph - 3



Graph - 4



Graph - 5



Graph - 6