A Study on Vital Events of South Indian States

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Abstract: The National Information Resource for understanding public health and policy making that scrutinizes the key indicators like Fertility, Mortality and Causes of Death. The registration of birth and death can be helpful to change the health policy of a nation. Hence, a study is required to find out whether there is an increase or a decrease in the birth and death. Further, it is to identify that the effects in measuring the rate of increase or decrease in births and deaths are sensitive areas to frame a health policy. Here, an attempt is made to assess the vital statistics such as Birth rate, Death rate, Natural Growth rate (NGR) and Infant Mortality rate (IMR) are also considered in the study for various states like Tamil Nadu, Andhra Pradesh, Kerala and Karnataka. Later, basic statistical analyses were also carried out with respect to various levels of births and deaths and to predict the growth rate for the upcoming years from 2014 to 2017.

Index Terms **- Vital Statistics, Correlation, Trend analysis, Census, SRS.**

I. INTRODUCTION

Vital Statistics holds an irrefutable place in any nation's data resources. The most general way of collecting the information about births and deaths is through Civil Registration, which is an administrative system used by governments to record vital events of the populations. Civil Registration collects this information on a continuous basis and is the only source that provides the individuals with a legal document. Birth and death rates are mainly required for the Department of Health (DH) of a Nation. The data are used to make policy decisions and monitor the mortality rates. The Public Health Outcomes Framework includes indicators related to births and deaths that set out the desired outcomes for public health. Users also include other public sector organizations such as the police and the home office who are interested in the causes of death. Private sector organizations such as banks, insurance and investment companies are particularly interested in deaths by single year of age and region that provide the risk estimation, while births data are also of interest to retailers to inform future demand.

II. CENSUS AND SAMPLE REGISTRATION SYSTEM (SRS)

Census is an absolute enumeration of each and every unit of the universe and a sample is a part of the universe that is studied and conclusions about the entire universe are drawn on the basis. The census method is very high in cost and it consumes more time as compared to the sample method. The investigator must decide which technique to choose depending on the factors such as, availability of resources, time factor, degree of accuracy desired and nature and scope of the problem. The quantified performance with respect to levels of births and deaths was collected secondarily. The secondarily collected data consisting of the levels of births and deaths and other issues related to mortality were obtained from the SRS. The SRS is a large-scale demographic survey for providing reliable annual estimates of birth rate, death rate and other fertility & mortality indicators at the national and sub-national levels. The SRS sample is replaced every ten years based on the latest census frame.

III. LIMITATION OF THE STUDY

There are few limitations considered in the study such as the area of the study which is carried out only in four states in India, the data considered for the study is secondary data, the limitations of the tools which are applied are applicable only for this study, the data pertained to considered Sample Registration Survey (SRS) records alone, among the SRS registration, the data are considered from 2004-2013 and the study is carried out only for Birth rate, Death rate, Natural Growth rate and Infant Mortality rate.

IV. DATA ANALYSIS

Data Analysis for this study is been carried out based on Statistical softwares such as Excel, SPSS, Minitab and STATISTICA. The Statistical Data Analyses carried out in this study are

- Descriptive Statistics
- Correlation Analysis
- Time series Analysis

Case 1: Descriptive Statistics

Descriptive statistics provides simple summaries about the sample and about the observations that have been made. Such summaries may be either quantitative or visual. These summaries may either form the basis of the initial description of the data as part of a more extensive statistical analysis, or they may be sufficient in and of themselves for a particular investigation. It is very helpful to examine the data to obtain a suitable set of relevant descriptive statistics. This alternative format is useful for further processing or graphical display. Here in this study, the basic percentage analysis method is used to observe and to compare the performance of the various states at different levels namely rural and urban. The results obtained using the descriptive statistics are represented in different graphs. Graphs are very useful for clarifying findings and illustrate the results.

Case 2: Correlation Analysis

The degree of relationship between the variables under consideration is measured through the correlation analysis. The measure of correlation called the correlation coefficient or correlation index summarizes in one figure the direction and degree of correlation. The correlation analysis refers to the techniques used in measuring the closeness of the relationship between the variables.

Types of Correlation

Correlation is described or classified in several different ways, they are

- Positive or negative
- Simple, partial and multiple
- Linear and non-linear

Karl Pearson's correlation coefficient formula

Linear relationships between variables can be quantified using the Pearson Product-Moment Correlation Coefficient,

$$r = \frac{\sum(X-\bar{X})(Y-\bar{Y})}{n\sigma_x\sigma_y}$$

where, r: The (product moment) Correlation coefficient

σ_x: Standard deviation of series X

σ_y: Standard deviation of series Y

n: Number of pairs of Observations

Multiple Correlations

When three or more variables are studied, it is a problem of either multiple or partial correlation. In multiple correlations three or more variables are studied simultaneously. If there are three variables X_1, X_2 and X_3 express the multiple correlation coefficient of a variable with the other two. Following usual notations, the formulae for multiple correlation coefficients $R_{1.23}$, $R_{2.13}$, and $R_{3.12}$ in terms of r_{12}, r_{13} and r_{23} are

$$R_{1.23} = \sqrt{\frac{r_{12}^2+r_{13}^2-2r_{12}r_{13}r_{23}}{1-r_{23}^2}}$$

$$R_{2.13} = \sqrt{\frac{r_{12}^2+r_{23}^2-2r_{12}r_{13}r_{23}}{1-r_{13}^2}}$$

$$R_{3.12} = \sqrt{\frac{r_{13}^2+r_{23}^2-2r_{12}r_{13}r_{23}}{1-r_{12}^2}}$$

where, $R_{1.23}$: Coefficient of multiple correlation between X_1 and the pair, X_2 and X_3

$R_{2.13}$: Coefficient of multiple correlation between X_2 and the pair, X_1 and X_3

$R_{3.12}$: Coefficient of multiple correlation between X_3 and the pair, X_1 and X_2

r_{12}: Coefficient of correlation between X_1 and X_2

r_{13}: Coefficient of correlation between X_1 and X_3

r_{23}: Coefficient of correlation between X_2 and X_3

Interpreting coefficient of correlation

When r = +1, it means there is perfect positive relationship between the variables. When r = -1, it means there is perfect negative relationship between the variables. And when r =0, it means that there is no relationship between the variables, i.e., the variables are uncorrelated.

Case 3: Trend Analysis and Forecasting

Trend Analysis is a statistical technique to aid interpretation of data. Using trend analysis it is possible to construct a model which is independent of anything known about the nature of the process of an incompletely understood system. This model can then be used to describe the behavior of the observed data. In the trend analysis procedure, the data can be fitted using a linear, quadratic, exponential, or S-curve model. The trend analysis is used when, the data is with constant trend, with no seasonal pattern and when the long range forecasting is required.

Forecasting

Forecasting is the process of making statements about events whose actual outcomes have not yet been observed. Prediction is a similar, but more general term. In any case, the data must be up to date in order for the forecast to be as accurate as possible. In the context of Statistics, Econometrics, Quantitative Finance, Seismology, Meteorology, and Geophysics the primary goal of time series analysis is forecasting. In the context of signal processing, control engineering and communication engineering it is used for signal detection and estimation, while in the context of data mining, pattern recognition and machine learning time series analysis can be used for clustering, classification, query by content, anomaly detection as well as forecasting. Forecasting on time series is usually done using automated Statistical Software packages and programming languages, such as R, SAS, SPSS, Minitab, Python etc.

V. RESULTS AND DISCUSSION

5.1 Case 1: Descriptive Statistics

In this case, different tables are formed for rural and urban area of Southern States of India. This analysis helps any common man to understand about the performance of the Southern States of India. Also the percentage analysis helps to understand the concepts clearly. The results are represented with suitable diagrams and interpretations. The factors considered for the analysis are Birth rate, Death rate, Natural growth rate, Infant mortality rate and Population.

Birth Rate

The following table shows the Percentage analysis of the Birth rate for the four South Indian states for the Rural and Urban Area.

Table 1: Percentage table for Birth Rate of South Indian states

Area	Andhra Pradesh	Karnataka	Kerala	Tamil Nadu	Total
Rural	27%	29%	21%	23%	100
Urban	26%	27%	23%	24%	100

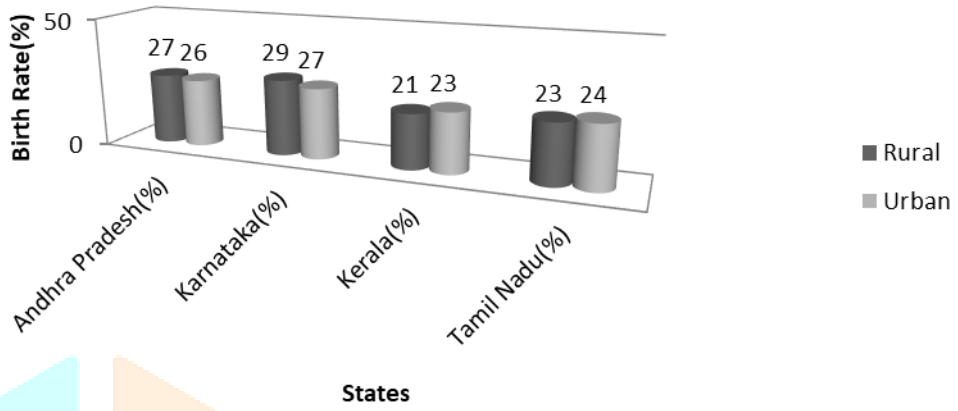

Figure 1: Comparison of Birth Rate of South Indian states

From the above computed result, it can be observed that the South Indian state, Karnataka has the highest Birth rate in rural as 29% and in urban as 27% and Kerala has the lowest Birth rate in rural as 21% and in urban as 23%. The diagram shows the variations in percentage (%) of the Birth rate for the rural and urban areas of the four South Indian states.

Death Rate

The following table shows the Percentage analysis of the Death rate for the four South Indian states for the Rural and Urban Area.

Table 2: Percentage table for Death Rate of South Indian states

Area	Andhra Pradesh	Karnataka	Kerala	Tamil Nadu	Total
Rural	26%	26%	22%	26%	100
Urban	23%	23%	27%	27%	100

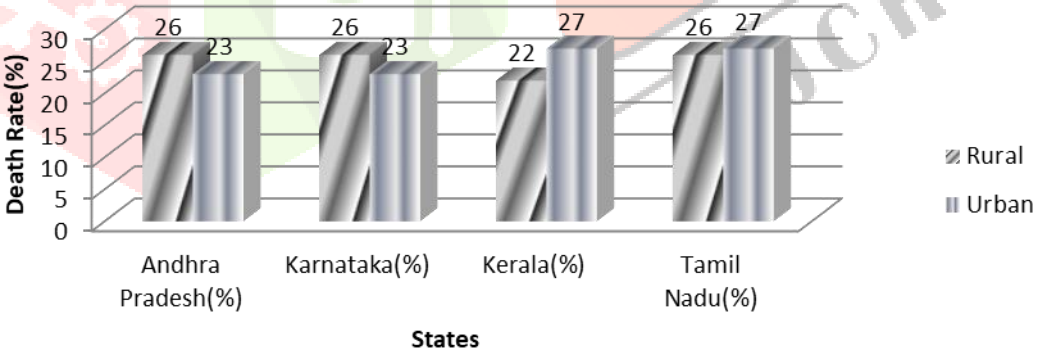

Figure 2: Comparison of Death Rate of South Indian states

From the above computed result, it can be observed that the South Indian state, Tamil Nadu has the highest Death rate in rural as 26% and in urban as 27% and Kerala has the lowest Death rate in rural as 22% and in urban as 27%. The diagram shows the variations in percentage (%) of the Death rate for the rural and urban areas of the four South Indian states.

Natural Growth Rate

The following table shows the Percentage analysis of the Natural Growth rate for the four South Indian states for the Rural and Urban Area.

Table 3: Percentage table for Natural Growth Rate of South Indian states

Area	Andhra Pradesh	Karnataka	Kerala	Tamil Nadu	Total
Rural	26%	32%	21%	21%	100
Urban	27%	30%	20%	23%	100

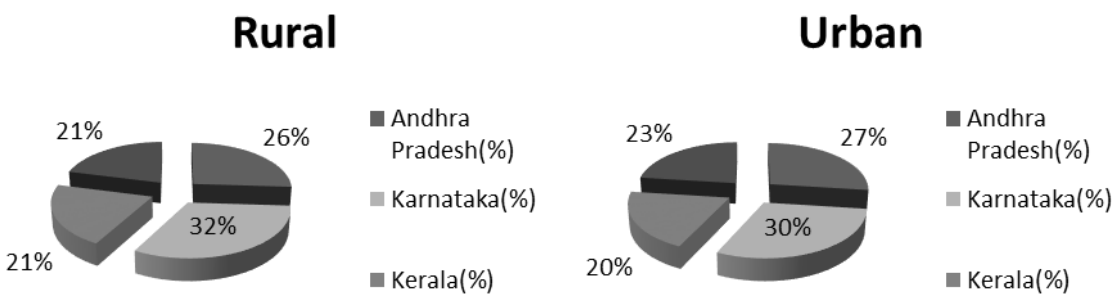

Figure 3: Comparison of Natural Growth Rate of South Indian states

From the above computed result, it can be observed that the South Indian state, Karnataka has the highest Natural Growth rate in rural as 32% and in urban as 30% and Kerala has the lowest Natural Growth rate in rural as 21% and in urban as 20%. The diagram shows the variations in percentage (%) of the Natural Growth rate for the rural and urban areas of the four South Indian states.

Infant Mortality Rate

The following table shows the Percentage analysis of the Infant Mortality rate for the four South Indian states for the Rural and Urban Area.

Table 4: Percentage table for Infant Mortality Rate of South Indian states

Area	Andhra Pradesh	Karnataka	Kerala	Tamil Nadu	Total
Rural	37%	31%	10%	22%	100
Urban	34%	31%	9%	26%	100

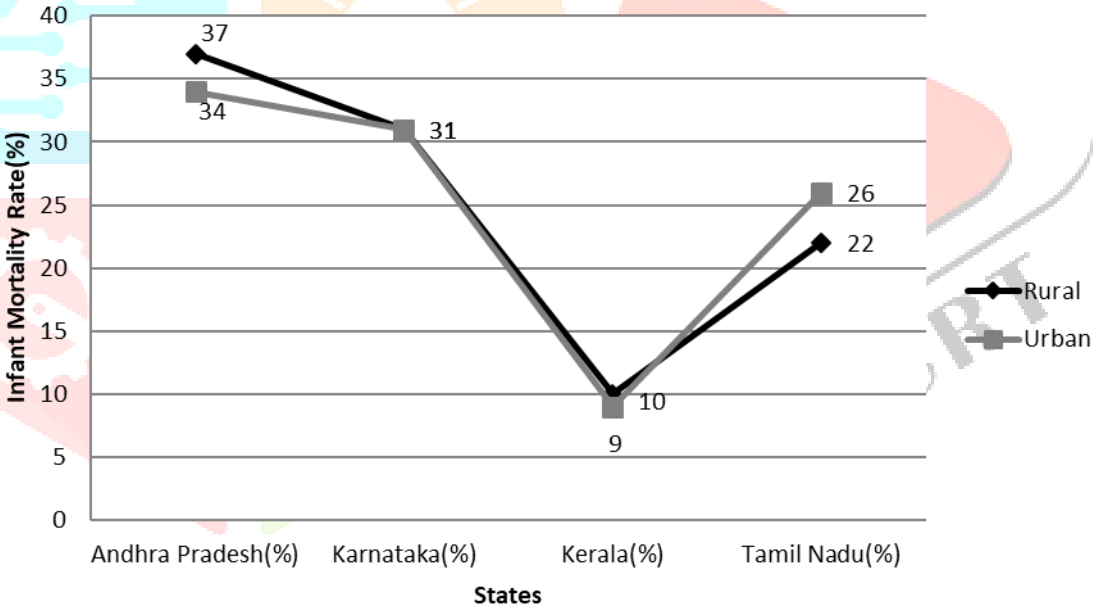

Figure 4: Comparison of Infant Mortality Rate of South Indian states

From the above computed result, it can be observed that the South Indian state, Andhra Pradesh has the highest Infant Mortality rate in rural as 37% and in urban as 34% and Kerala has the lowest Infant Mortality rate in rural as 10% and in urban as 9%. The diagram shows the variations in percentage (%) of the Infant Mortality rate for the rural and urban areas of the four South Indian states.

Population

The following table shows the Percentage analysis of the Population for the four South Indian states for the Rural and Urban Area.

Table 5: Percentage table for Population of South Indian states

Area	Andhra Pradesh	Karnataka	Kerala	Tamil Nadu	Total
Rural	25%	27%	22%	26%	100
Urban	24%	22%	17%	37%	100

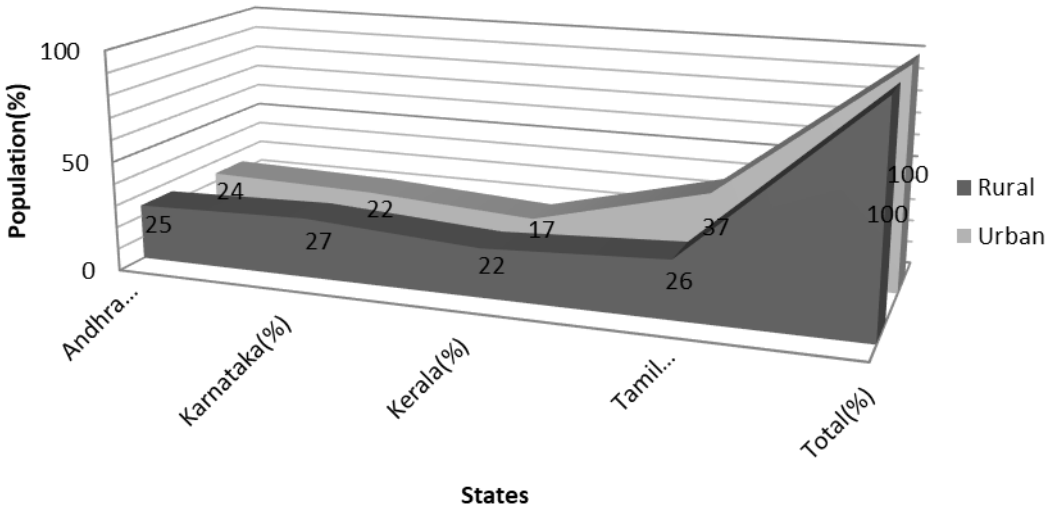

Figure 5: Comparison of Population of South Indian states

From the above computed result, it can be observed that the South Indian state, Karnataka has the highest population in rural as 27% and Tamil Nadu has the highest population in urban as 37% and Kerala has the lowest population in rural as 22% and in urban as 17%. The diagram shows the variations in percentage (%) of the population for the rural and urban areas of the four South Indian states.

5.2 Case 2: Correlation Analysis

In order to study the relationship between the vital events for different South Indian states, the statistical technique namely, Multiple Correlation analysis is carried out. To compute the multiple correlation, first it is needed to compute the simple correlations coefficients as,

r_{12}: Coefficient of simple correlation between Birth rate (X_1) and Death rate (X_2)

r_{13}: Coefficient of simple correlation between Birth rate (X_1) and Natural Growth rate (X_3)

r_{23}: Coefficient of simple correlation between Death rate (X_2) and Natural Growth rate (X_3)

Then the Multiple correlation coefficient,

$R_{1.23}$: Coefficient of multiple correlation between Birth rate (X_1) and the pair, Death rate (X_2) and Natural Growth rate (X_3).

$R_{2.13}$: Coefficient of multiple correlation between Death rate (X_2) and the pair, Birth rate (X_1) and Natural Growth rate (X_3).

$R_{3.12}$: Coefficient of multiple correlation between Natural Growth rate (X_3) and the pair, Birth rate (X_1) and Death rate (X_2).

For the Southern states Andhra Pradesh, Karnataka, Kerala and Tamil Nadu, multiple correlation technique is carried out for the Birth rate, Death rate and Natural Growth rate of the states. Taking Birth rate as X_1, Death rate as X_2 and Natural Growth rate as X_3.

Table 6: Multiple Correlation Coefficient for Andhra Pradesh

Variables	Correlation Coefficient			
	Andhra Pradesh	Karnataka	Kerala	Tamil Nadu
$R_{1.23}$	0.998	0.999	0.989	0.990
$R_{2.13}$	0.976	0.988	0.994	0.887
$R_{3.12}$	0.999	0.998	0.997	0.988

From the above table, the Multiple Correlation Coefficient for the Southern states Andhra Pradesh, Karnataka, Kerala and Tamil Nadu shows that there exists strong positive correlation between the vital events namely, Birth rate, Death rate and Natural Growth rate. Hence, it is concluded that, if Birth rate increases, the Death rate and the Natural Growth rate will also increase and vice versa, over the years.

5.3 Case 3: Trend Analysis and Forecasting

For the states Andhra Pradesh, Karnataka, Kerala and Tamil Nadu, the Birth rate, Death rate, Infant Mortality rate and Population, the trend analysis is carried out for assessing the trend pattern to check whether there is an increase or a decrease in the rates and for making predictions on the Birth rate, Death rate, Infant Mortality rate and Population for the next 7 upcoming years, from 2014 to 2020. In order to fit an appropriate model for the time series data under consideration, the observed data are first plotted against the time variables which results in the trend analysis plot. The Exponential Growth Curve is the suitable trend for fitting the collected data. The exponential growth curve model is fitted for all the states respectively for the data.

Andhra Pradesh

The Exponential Growth Curve models are fitted as,

$$B_t = 19.4697 \times (0.988398\text{^}t)$$

$$D_t = 7.2173 \times (1.00426^{\wedge}t)$$
$$N_t = 12.2896 \times (0.97719^{\wedge}t)$$
$$I_t = 63.9184 \times (0.95329^{\wedge}t)$$
$$P_t = 388.030 \times (1.00790^{\wedge}t)$$

where, B is the Birth rate,
D is the Death rate,
N is the Natural Growth rate,
I is the Infant Mortality rate,
P is the Population, which depends on the variable t (year).

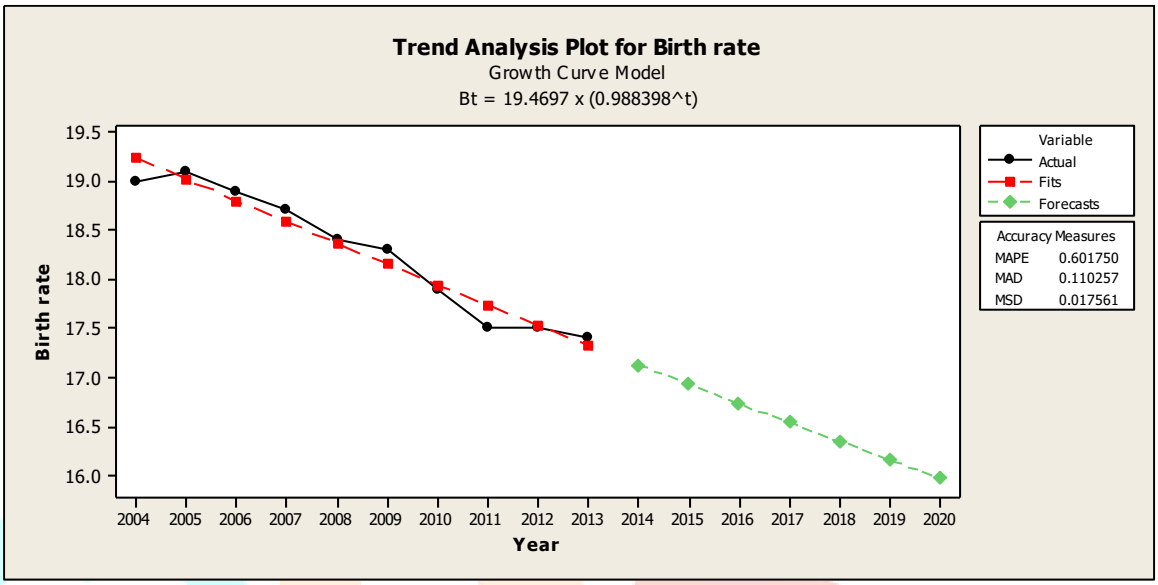

Figure 6: Trend Line for Birth rate in Andhra Pradesh

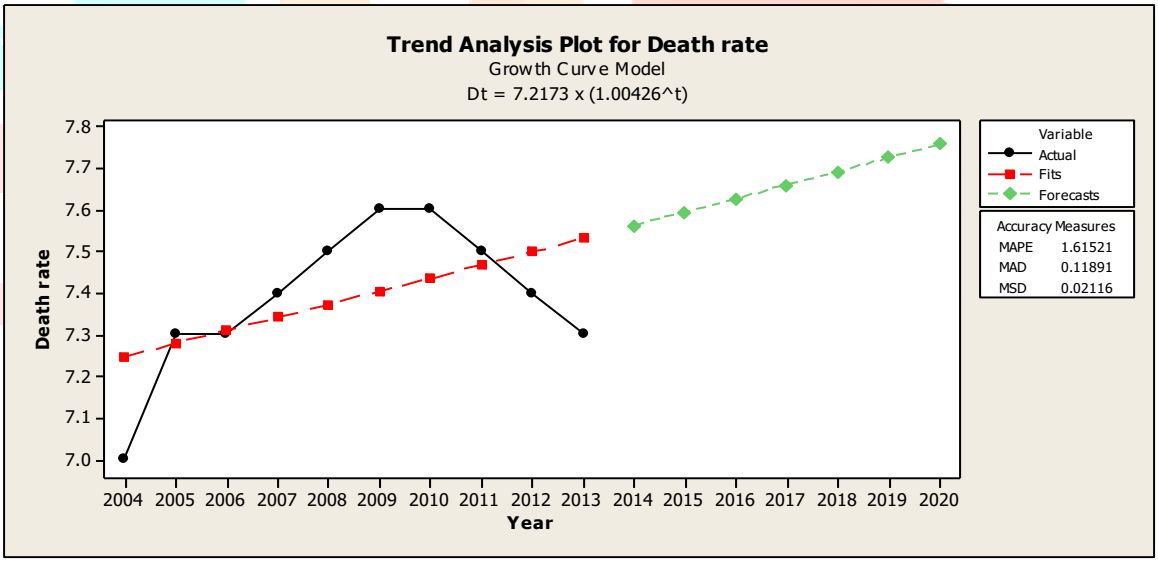

Figure 7: Trend Line for Death rate in Andhra Pradesh

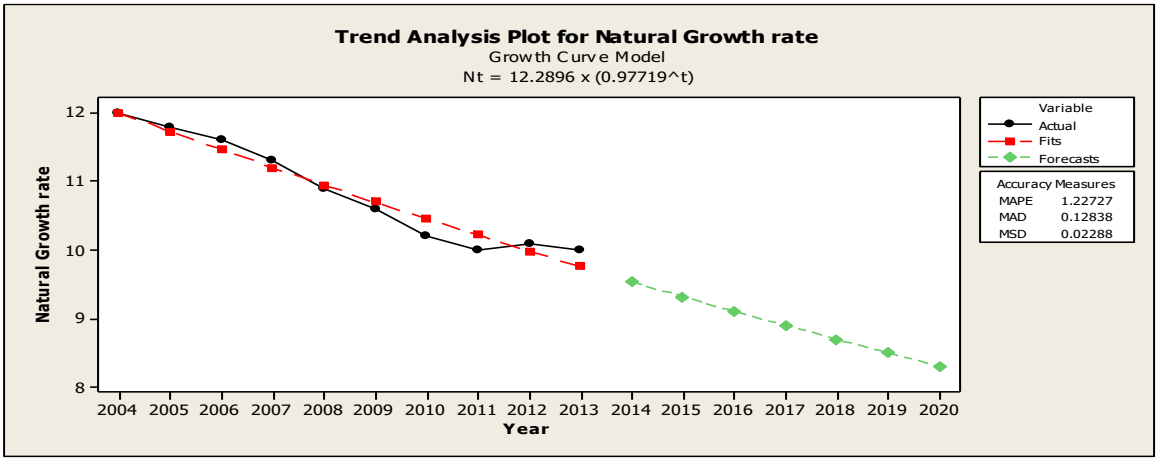

Figure 8: Trend Line for Natural Growth rate in Andhra Pradesh

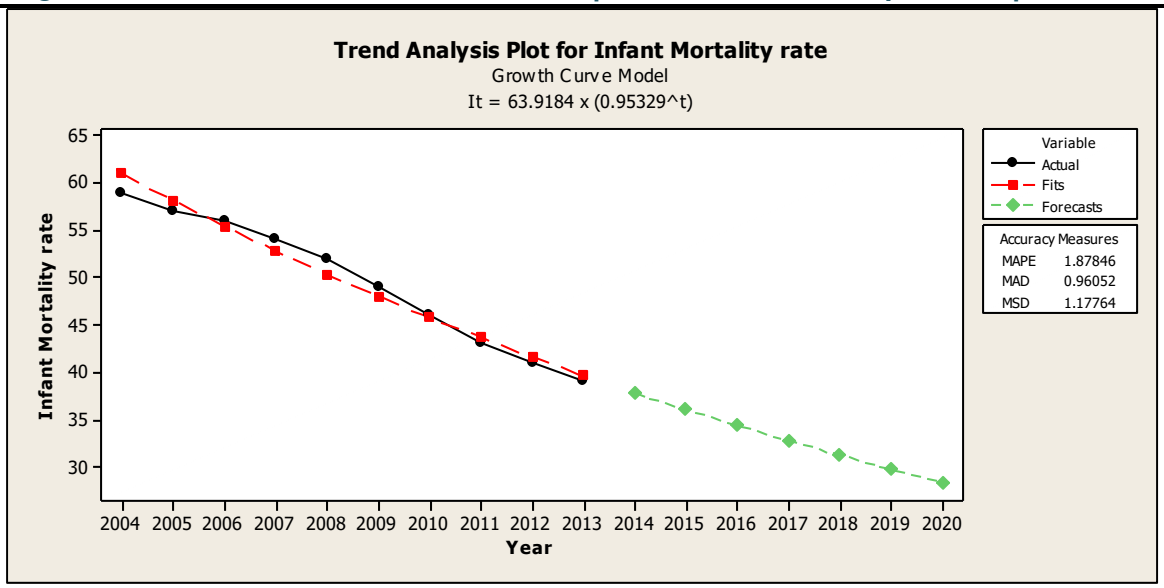

Figure 9: Trend Line for Infant Mortality rate in Andhra Pradesh

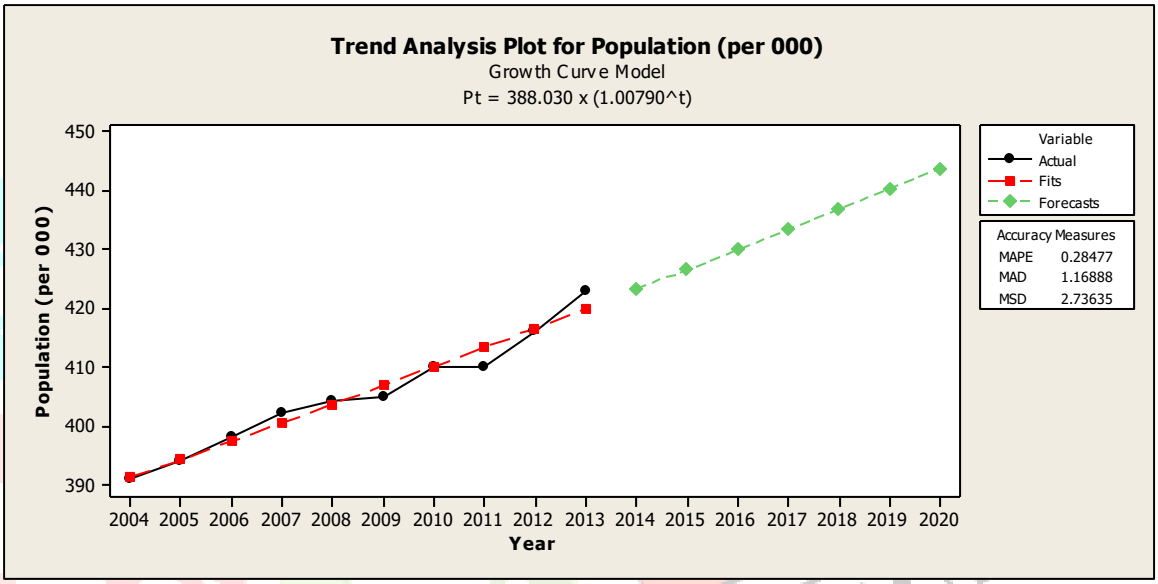

Figure 10: Trend Line for Population in Andhra Pradesh

Table 7: Forecast table for Andhra Pradesh

Period	2014	2015	2016	2017	2018	2019	2020
Birth rate	17.12	16.93	16.73	16.54	16.34	16.15	15.97
Death rate	7.56	7.59	7.63	7.66	7.69	7.73	7.76
Natural Growth rate	9.53	9.32	9.10	8.90	8.69	8.50	8.30
Infant Mortality rate	37.77	36.00	34.32	32.72	31.19	29.73	28.34
Population (per '000)	423	426	430	433	437	440	444

Based on the fitted models, forecast for the Birth rate, Death rate, Natural Growth rate, Infant Mortality rate and Population in Andhra Pradesh are obtained for the year 2014 to 2020. From these models, it can be observed that the Birth rate, Natural Growth rate and Infant Mortality rate are expected to be slightly decreasing year by year and the Death rate and Population are expected to be slightly increasing year by year in Andhra Pradesh.

Karnataka

The Exponential Growth Curve models are fitted as,

$$B_t = 21.1741 \text{ x } (0.985528\text{^}t)$$
$$D_t = 7.1243 \text{ x } (1.00011\text{^}t)$$
$$N_t = 14.0623 \text{ x } (0.97742\text{^}t)$$
$$I_t = 56.3901 \text{ x } (0.94374\text{^}t)$$
$$P_t = 427.629 \text{ x } (1.00352\text{^}t)$$

where, B is the Birth rate,
D is the Death rate,
N is the Natural Growth rate
I is the Infant Mortality rate
P is the Population, which depends on the variable t (year).

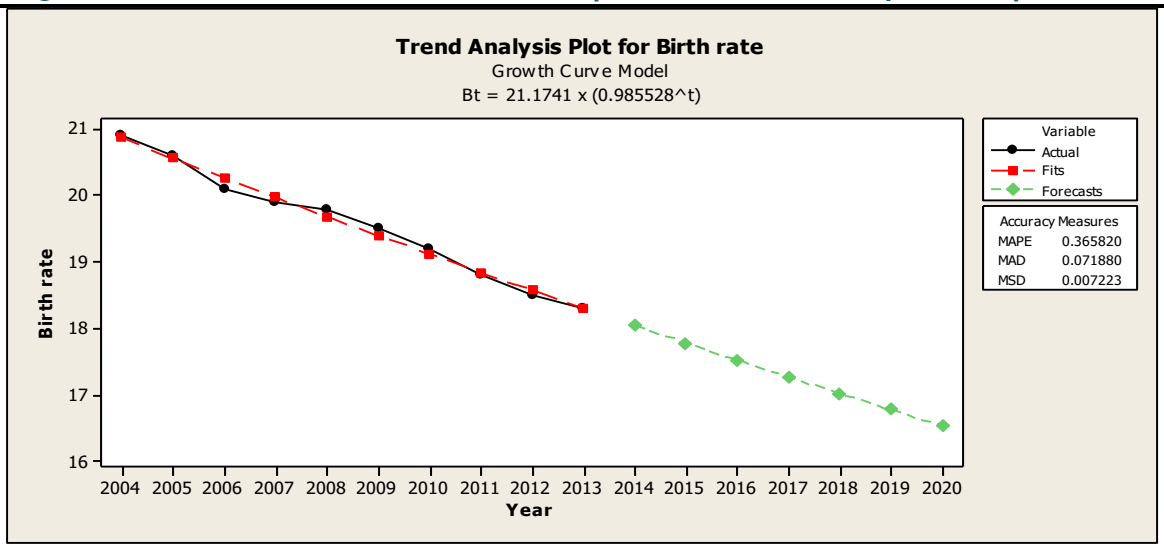

Figure 11: Trend Line for Birth rate in Karnataka

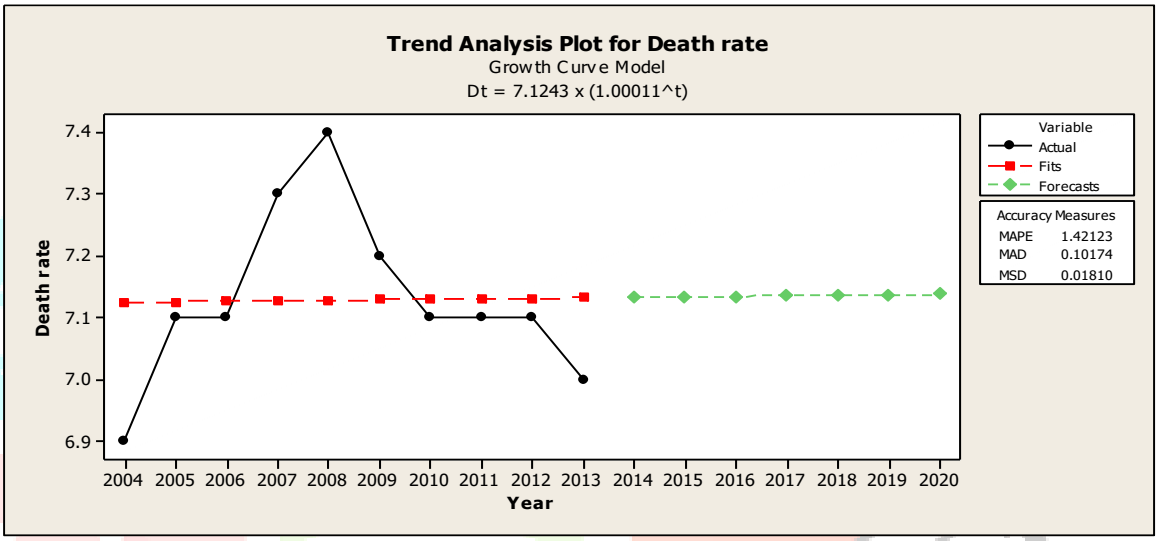

Figure 12: Trend Line for Death rate in Karnataka

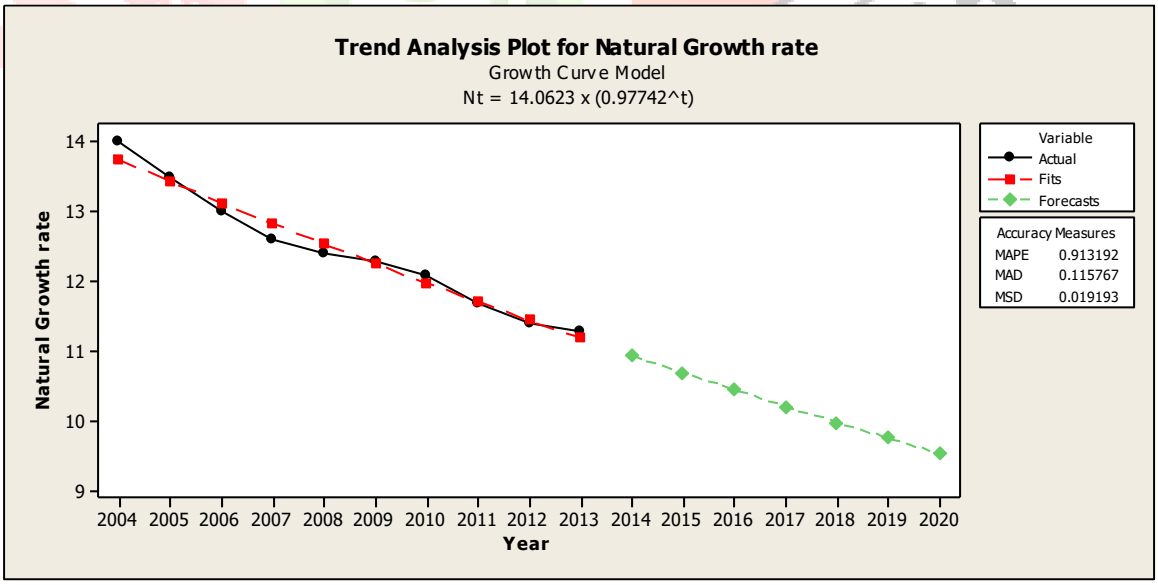

Figure 13: Trend Line for Natural Growth rate in Karnataka

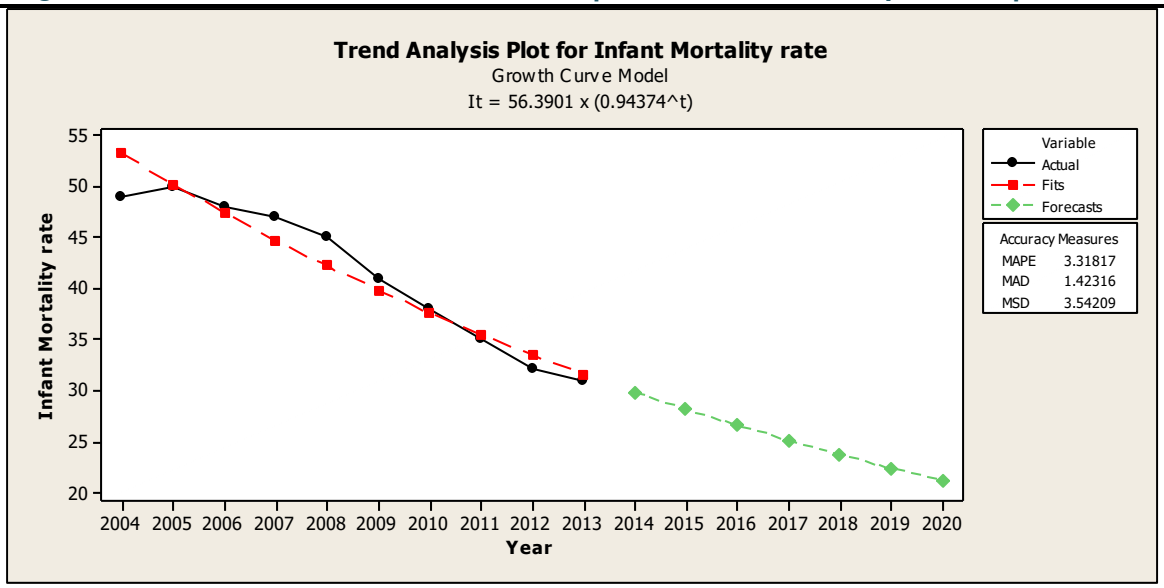

Figure 14: Trend Line for Infant Mortality rate in Karnataka

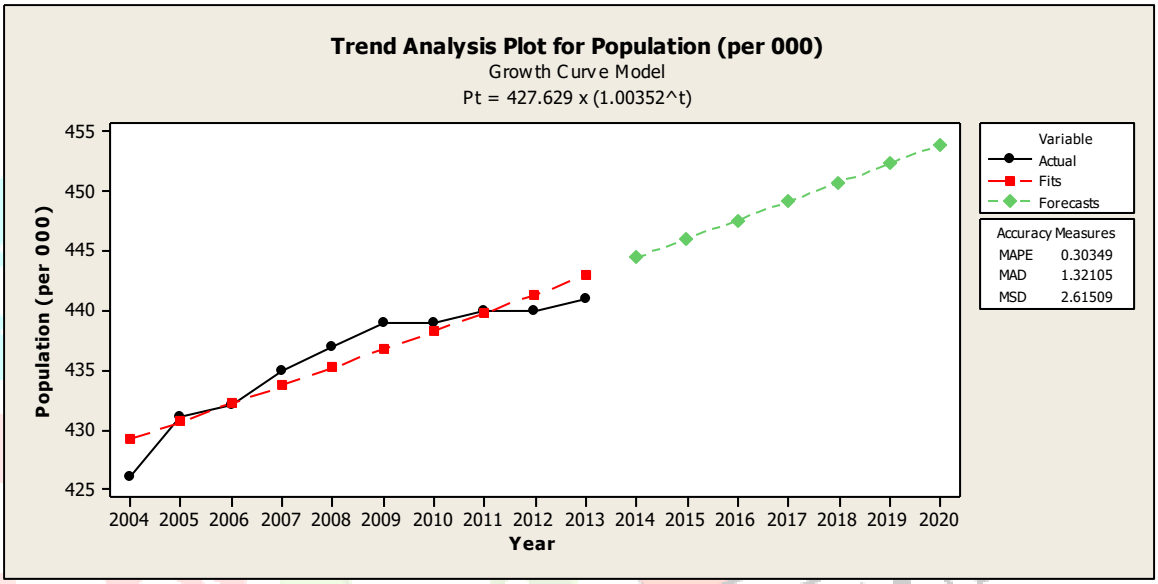

Figure 15: Trend Line for Population in Karnataka

Table 8: Forecast table for Karnataka

Period	2014	2015	2016	2017	2018	2019	2020
Birth rate	18.04	17.78	17.52	17.27	17.02	16.77	16.53
Death rate	7.13	7.13	7.13	7.14	7.14	7.14	7.14
Natural Growth rate	10.94	10.69	10.45	10.21	9.98	9.76	9.54
Infant Mortality rate	29.82	28.15	26.56	25.07	23.66	22.33	21.07
Population (per '000)	444	446	448	449	451	452	454

Based on the fitted models, forecast for the Birth rate, Death rate, Natural Growth rate, Infant Mortality rate and Population in Karnataka are obtained for the year 2014 to 2020. From these models, it can be observed that the Birth rate, Natural Growth rate and Infant Mortality rate are expected to be slightly decreasing year by year and the Death rate and Population are expected to be slightly increasing year by year in Karnataka.

Kerala

The Exponential Growth Curve models are fitted as,

$$B_t = 14.9786 \text{ x } (0.99866\text{^}t)$$
$$D_t = 6.2873 \text{ x } (1.01202\text{^}t)$$
$$N_t = 8.7197 \text{ x } (0.98780\text{^t})$$
$$I_t = 13.6236 \text{ x } (0.98679\text{^}t)$$
$$P_t = 327.371 \text{ x } (1.00941\text{^}t)$$

where, B is the Birth rate,

D is the Death rate,

N is the Natural Growth rate

I is the Infant Mortality rate

P is the Population, which depends on the variable t (year).

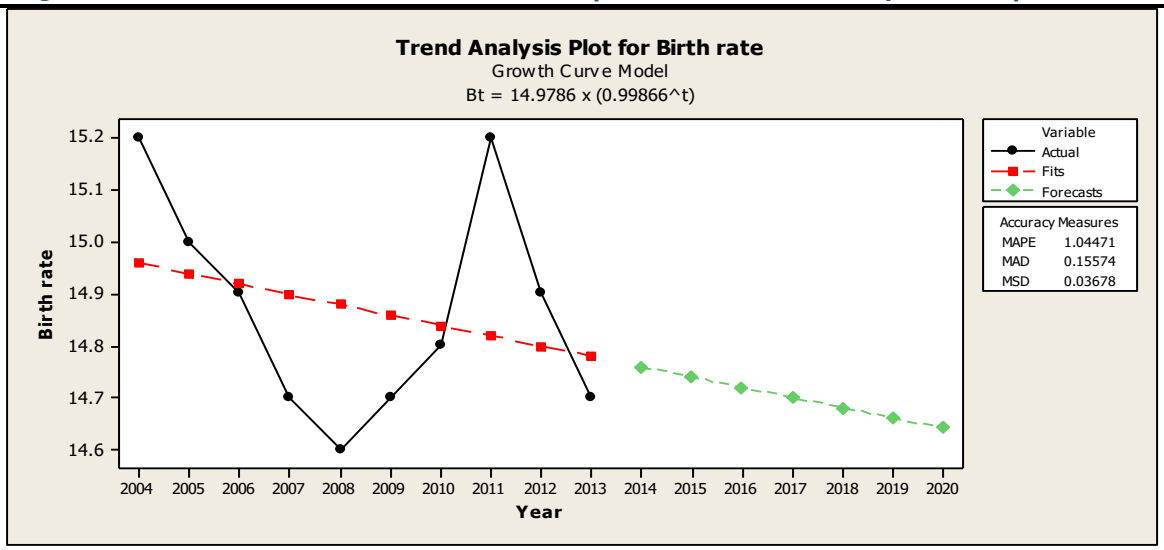

Figure 16: Trend Line for Birth rate in Kerala

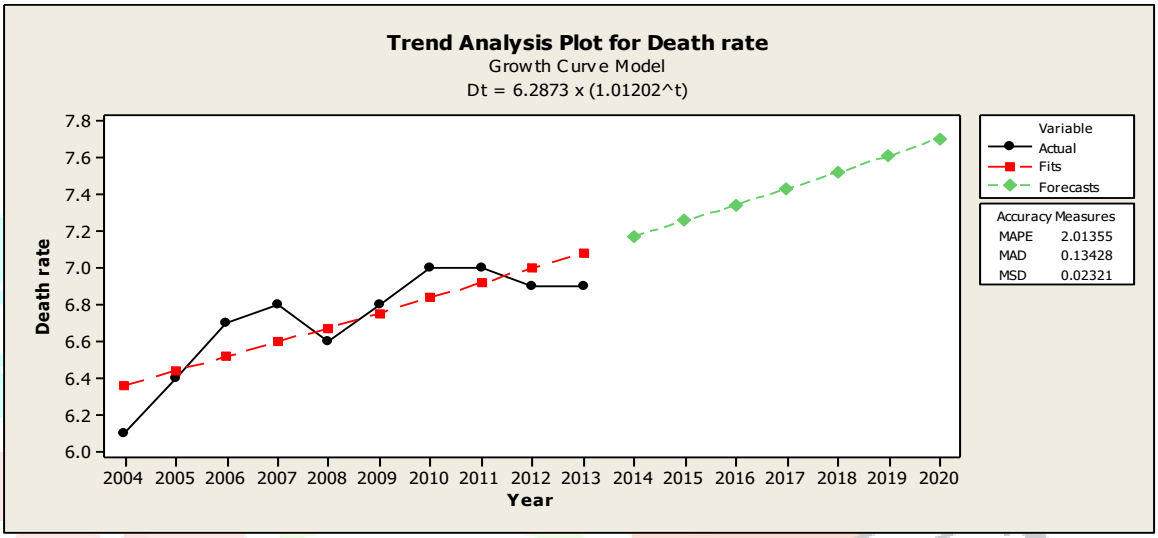

Figure 17: Trend Line for Death rate in Kerala

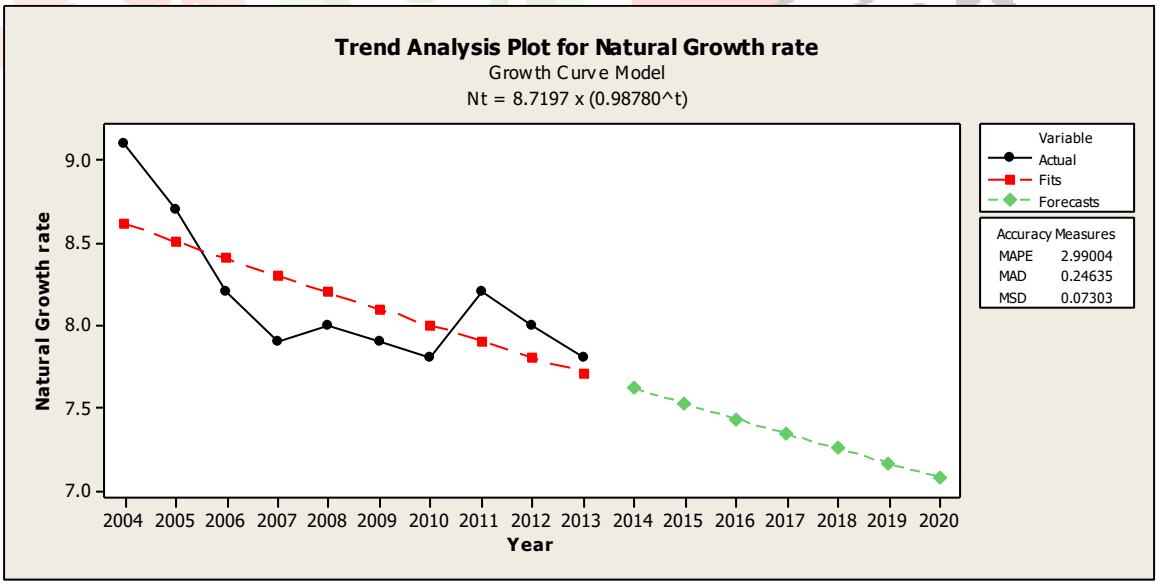

Figure 18: Trend Line for Natural Growth rate in Kerala

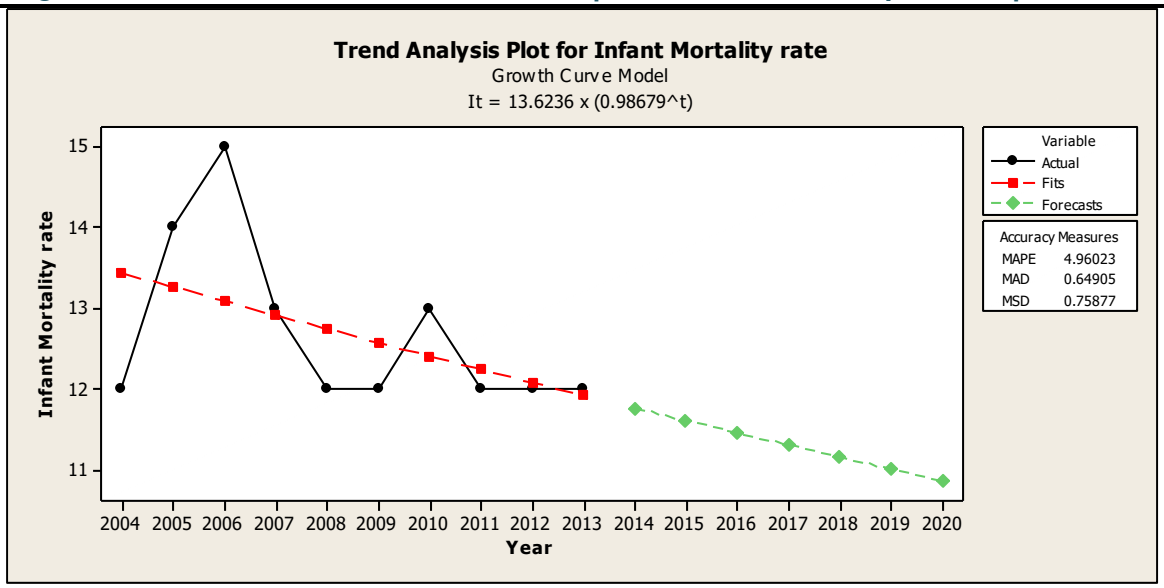

Figure 19: Trend Line for Infant Mortality rate in Kerala

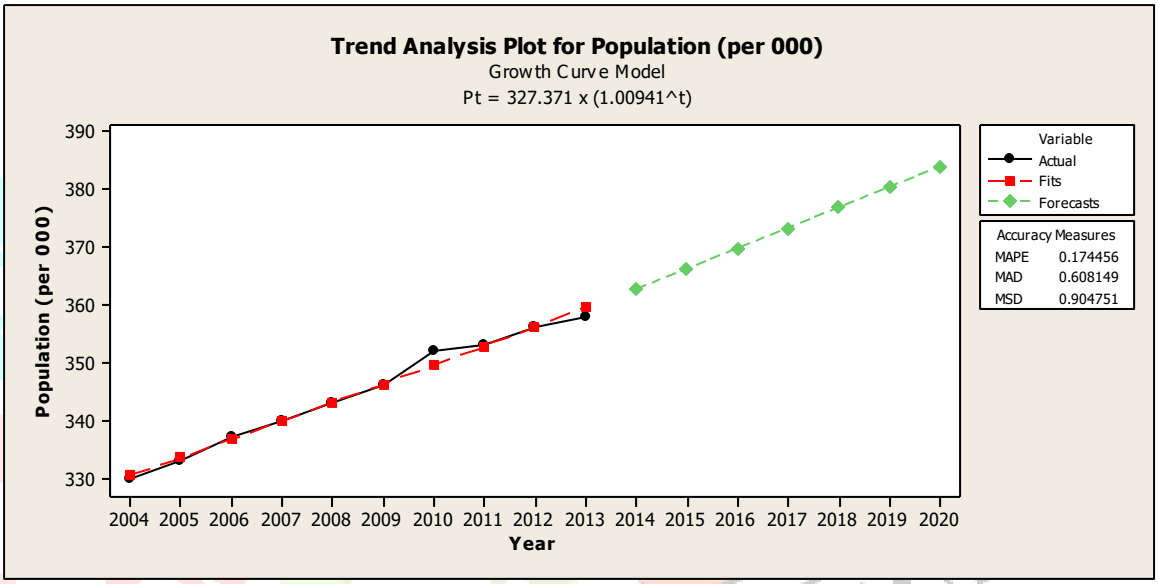

Figure 20: Trend Line for Population in Kerala

Table 9: Forecast table for Kerala

Period	2014	2015	2016	2017	2018	2019	2020
Birth rate	14.76	14.74	14.72	14.70	14.68	14.66	14.64
Death rate	7.17	7.26	7.34	7.43	7.52	7.61	7.70
Natural Growth rate	7.62	7.53	7.43	7.34	7.25	7.16	7.08
Infant Mortality rate	11.77	11.61	11.46	11.31	11.16	11.01	10.87
Population (per '000)	363	366	370	373	377	380	384

Based on the fitted models, forecast for the Birth rate, Death rate, Natural Growth rate, Infant Mortality rate and Population in Kerala are obtained for the year 2014 to 2020. From these models, it can be observed that the Birth rate, Natural Growth rate and Infant Mortality rate are expected to be slightly decreasing year by year and the Death rate and Population are expected to be slightly increasing year by year in Kerala.

Tamil Nadu

The Exponential Growth Curve models are fitted as,

$$B_t = 16.7682 \text{ x } (0.99257\text{^}t)$$
$$D_t = 7.4592 \text{ x } (0.99926\text{^}t)$$
$$N_t = 9.3432 \text{ x } (0.98631\text{^}t)$$
$$I_t = 45.7024 \text{ x } (0.91966\text{^}t)$$
$$P_t = 441.657 \text{ x } (1.00946\text{^}t)$$

where, B is the Birth rate,
D is the Death rate,
N is the Natural Growth rate
I is the Infant Mortality rate
P is the Population, which depends on the variable t (year).

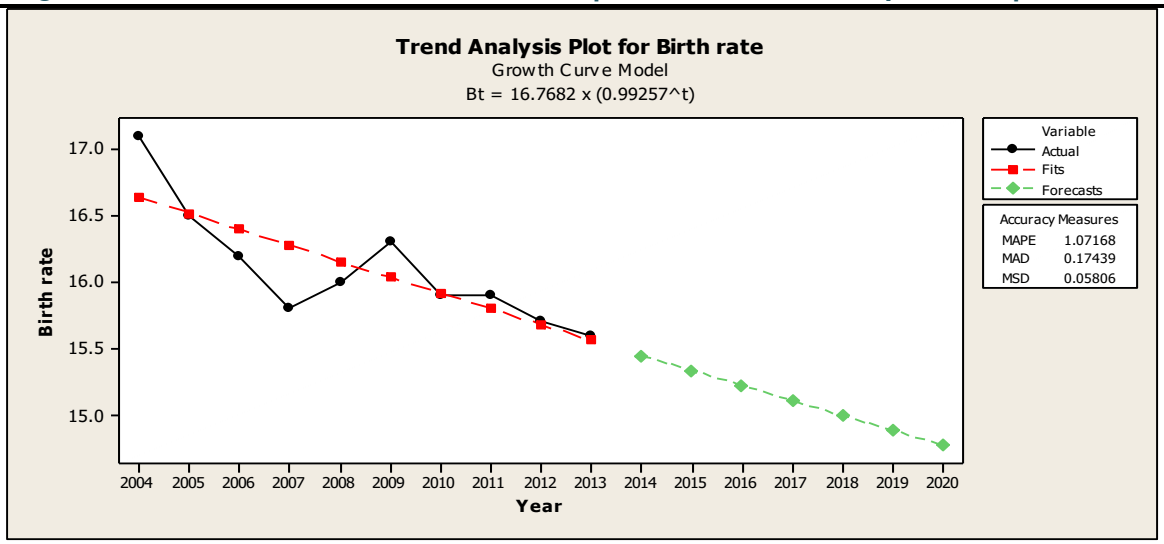

Figure 21: Trend Line for Birth rate in Tamil Nadu

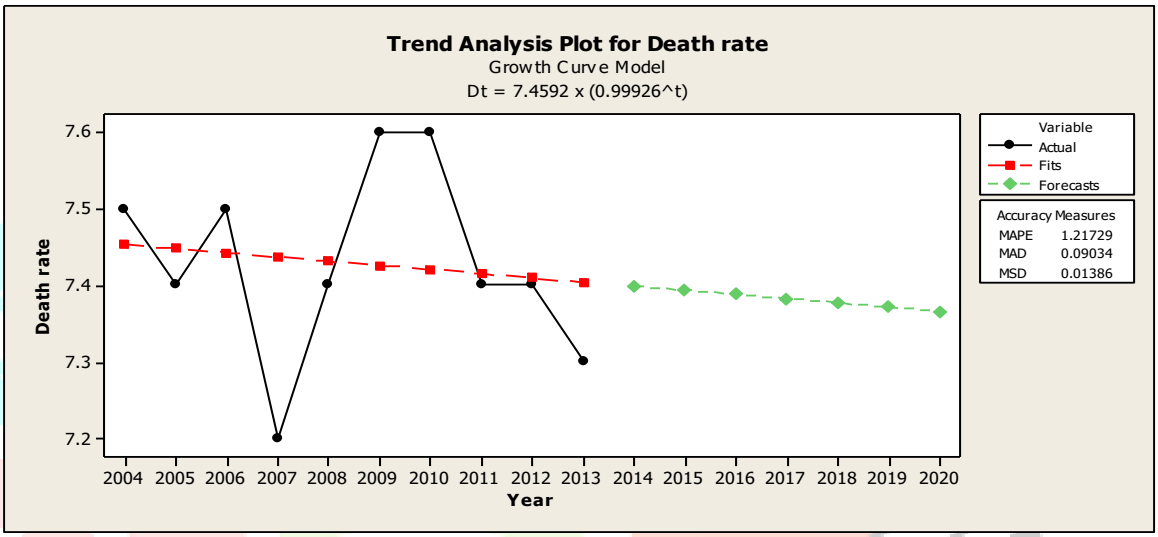

Figure 22: Trend Line for Death rate in Tamil Nadu

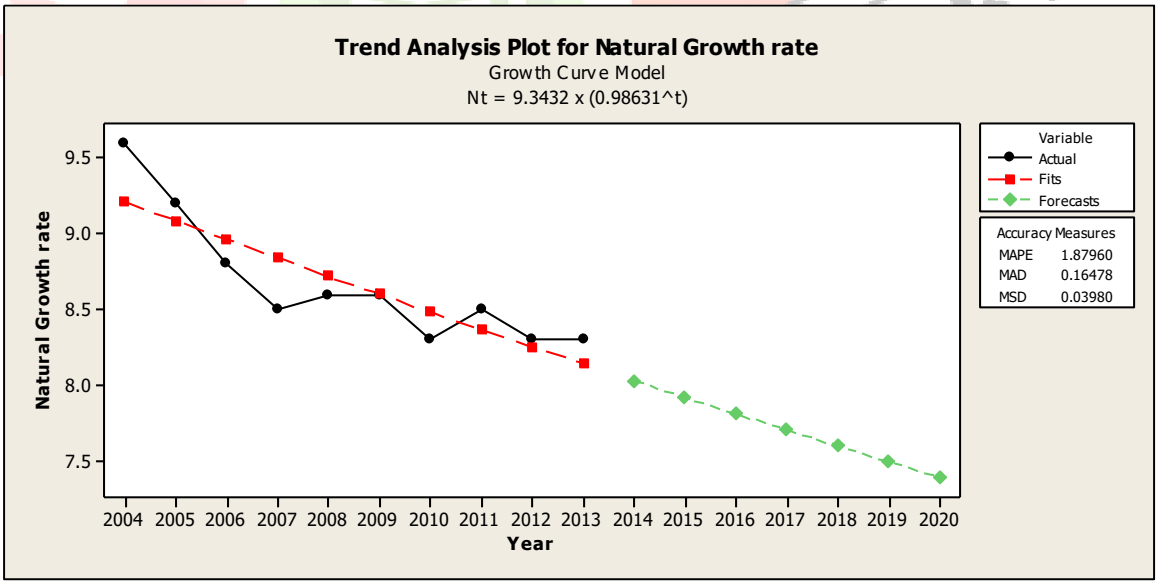

Figure 23: Trend Line for Natural Growth rate in Tamil Nadu

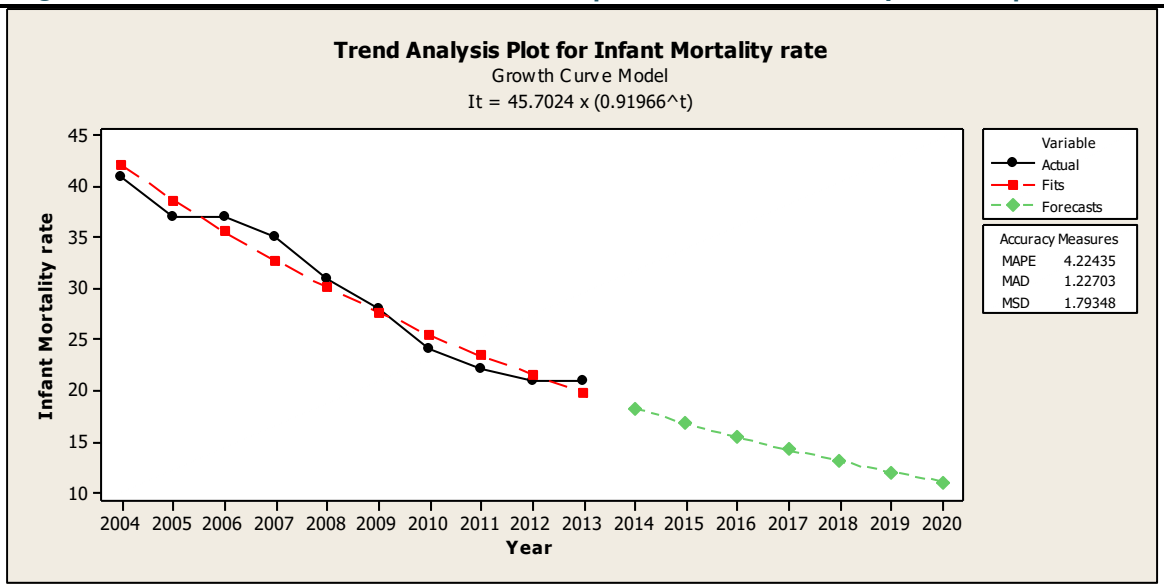

Figure 24: Trend Line for Infant Mortality rate in Tamil Nadu

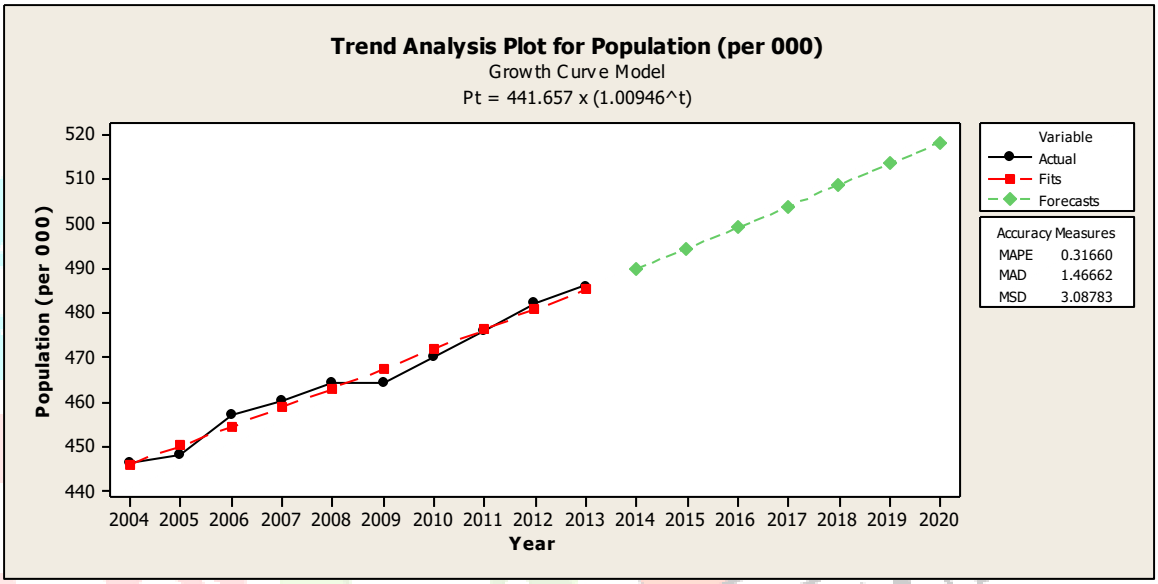

Figure 25: Trend Line for Population in Tamil Nadu

Table 10: Forecast table for Tamil Nadu

Period	2014	2015	2016	2017	2018	2019	2020
Birth rate	15.45	15.33	15.22	15.11	14.99	14.88	14.77
Death rate	7.40	7.39	7.39	7.38	7.38	7.37	7.37
Natural Growth rate	8.03	7.92	7.81	7.70	7.60	7.49	7.40
Infant Mortality rate	18.19	16.73	15.38	14.15	13.01	11.70	11.01
Population (per '000)	490	494	499	504	509	513	518

Based on the fitted models, forecast for the Birth rate, Death rate, Natural Growth rate, Infant Mortality rate and Population in Tamil Nadu are obtained for the year 2014 to 2020. From these models, it can be observed that the Birth rate, Natural Growth rate and Infant Mortality rate are expected to be slightly decreasing year by year and the Death rate and Population are expected to be slightly increasing year by year in Tamil Nadu.

VI. CONCLUSION

From this study, it is concluded that, the Birth rate, Death rate and Infant Mortality rate for the years from 2004 to 2013 shows that, there is a slight decline in all the South Indian states. But when compared to the Birth rate and Death rate, the overall population shows an increase over the years due to various reasons. In most of the Southern states of India, the population is varying with respect to the rural and urban areas. Also compared to the urban area, the population is high and increasing in the rural areas of the South Indian states namely, Andhra Pradesh, Karnataka, Kerala and Tamil Nadu. Hence, the government should take necessary steps to control the population growth in terms of Birth, Death and Infant Mortality. It is suggested that, the government should take a serious of steps to maintain the Birth rate in rural and urban areas. Further, this study helps the government to take suitable steps to make necessary health policies towards the development of the South Indian states, in terms of Birth, Death and Infant Mortality. Thus, this study may be helpful to frame suitable health policies for the betterment of the South Indian states. More number of awareness programs should be conducted among the public to be aware of the influence of

the Birth rate, Death rate, the Natural Growth rate and the Infant Mortality rate in their dwellings. Efforts to improve the quality of Vital Statistics will therefore be closely related to the development of Civil Registration Systems in countries.

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