

A Survey of Infant Mortality and Cost of Living Index of Some Developing Countries

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Abstract This work covered a survey of infant mortality rate and cost of living index of some developing countries. Data of infant mortality rate and corresponding cost of living index of these developing countries was collected for a five year period. The ordinary least squares method was used to fit five functional forms of regression model considered. The comparative suitability of the models for the data was investigated using model diagnostic procedures in order to identify the best model. Results showed that all the models have statistically significant t and F-ratios. The Log-Lin model was adjudged to have the best fit since in addition to its statistical significance, it also resulted in the lowest MSE and the highest coefficient of determination (R^2) which all highlighted an overall goodness of fit.

Keywords Infant Mortality Rate, Cost of living index, Functional forms, Ordinary Least Squares, Goodness of fit

1. Introduction

Infant mortality is the death of children under the age of one year. Infant mortality rate refers to one of the important indices of economic development and social health status of any country. It is considered as the most sensitive measures of mortality. Infant mortality rate can be calculated by the number of deaths of children in a particular region within one year divided by the number of live birth for that region during the same year multiplied by 1000. It is generally classified by neo-natal death (0-28 days) and post natal death (1month - 12 months). Again, the early neo-natal death is known as pre-natal death (0 -1 week). Neonatal deaths are further subdivided into early (first week) and late (second, third and fourth weeks). In prosperous countries, neonatal deaths account for about two-third of infant mortalities. Many studies have showed that death are higher during the first year of live irrespective of whether the overall level of mortality are high or low. [7] found that 57.7 percent of deaths under one year old occur during the first month of their lives. The most important causes of death in neonates were prematurity, low birth weights (44.4%) and later gastroenteritis (30.3%). In addition, narcotic toxics (9.6%) had been identified as another cause of infant mortality.

Cost of living is the price of goods and services required for maintaining an average level standard of living. Cost of living varies from time to time. A cost of living index is a

theoretical price index that measures relative cost of living overtime or regions. It is an index that measures differences in the price of goods and services, and allows for substitutions with other items as prices vary. Cost of living calculations are also used to compare the cost of maintaining a certain standard of living in different geographic areas. Difference in cost of living between locations can also be measured in terms of purchasing power rate. A developing country is also known as an LMIC, or a low and middle income country. An increase in infant and child mortality rates especially in Africa and other developing nations had been of great interest to many in recent times. Increasing rate of infant mortality in most developing countries had been attributed to mainly poverty resulting from corruption and bad leadership. Some had been attributed to high level of female illiteracy rates. Poor health resulting from pollution, a consequence of oil spillage and industrialization, outbreak of epidemics, limited access to portable water, poor sanitation and waste disposal strategies to mention a few. The study of infant mortality using multiple linear regression and reciprocal regression had been reported in [1] and [2] with some notable results. These studies considered parents' income and female literacy rates as predictors to child mortality rate. These studies are also limited to only one country. It is against this background that this work seeks to investigate the influence of living cost index on infant mortality in some selected developing nations of the world. The choice of an appropriate regression model is mandatory for accurate prediction of infant mortality and efficient policy formulation which is why the consideration of different functional forms of regression is required in this work.

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2. Materials and Methods

There exist different functional forms of regression model which are linear in the parameters but not necessarily linear in the variables. Most of these models are usually subjected to appropriate transformation so that they can satisfy the linearity condition in order to allow for the application of ordinary least squares technique. In this work, the reciprocal model, the lin-log model, log-log model, log-lin model and the log-reciprocal regression model were fitted to the data of infant mortality and cost of living index of some selected developing countries using the ordinary least squares technique. The countries considered are Venezuela, Bahamas, Estonia, Malta, Uruguay, Lebanon, Cyprus, Latvia, Costa Rica, Tunisia, Algeria, Ghana, Nigeria, Zimbabwe, Bahrain, Iran, Cambodia, Oman, Panama, Serbia, Kenya, Namibia, Mauritius, Egypt, Ethiopia, Tanzania, Uganda, Libya, South Africa and Morocco. The performance of each of the models was determined via comparison using some model diagnostic procedures and overall goodness of fit measures. This comparison will provide information on the best model for the data. The model with the highest coefficient of determination and overall goodness of fit will be adjudged the best. Data of infant mortality was sourced from UNICEF Global Database while the cost of living index was sourced from www.numbeo.com. The data is a five year data of infant mortality rate and cost of living index collected from 30 developing countries between 2013 and 2018. All the analysis was carried out using SPSS (version 20.0). Each of the estimated models will be assessed for any problem of econometrics and an appropriate model diagnostic procedure will be used to identify the functional form with best fit.

3. Functional Forms

The different forms of two-variable regression models which are linear in parameters; not necessarily linear or non-linear in variables considered are the reciprocal, log-linear, lin-log and logarithmic-reciprocal models. They have the particular feature that they can be made linear in parameters by transformation such that the classical linear regression assumption on linearity is satisfied and the ordinary least square method can be used for their estimation. The reciprocal regression model is of the form

$$Y_i = \beta_0 + \beta_1 \left(\frac{1}{X_i}\right) + \mu_i \quad (1)$$

Although (1) is nonlinear in variable X_i because it enters inversely or reciprocally, the model is linear in β_0 and β_1 , it is a linear regression and has a feature that as X increases indefinitely, $\beta_1 \left(\frac{1}{X_i}\right)$ approaches zero, Y_i approaches the asymptotic value of β_0 .

Also, of great importance is the logarithmic reciprocal model which has the form

$$\ln Y_i = \beta_0 - \beta_1 \left(\frac{1}{X_i}\right) + \mu_i \quad (2)$$

(2) is also called the log hyperbola model. It is best used in describing situations in which Y_i initially increases at an increasing rate and then increases at a decreasing rate. Such behavior or feature is of particular interest in microeconomics.

The log-linear model is another interesting model which has the form

$$\ln Y_i = \beta_0 + \beta_1 \ln X_i + \mu_i \quad (3)$$

It is also called the exponential regression model. It is linear in parameters β_0 and β_1 and also linear in the logarithm of variables Y_i and X_i . This feature allows for estimation by means of the OLS. (3) is also called the log-log or double log model. It is very popular in applied econometrics.

Other functional forms include semi-log model which are of two types; Log-Lin and Lin-Log models. The Log-Lin model is represented by

$$\ln Y_i = \beta_0 + \beta_1 X_i + \mu_i \quad (4)$$

while the Lin-Log is of the form

$$Y_i = \beta_0 + \beta_1 \ln X_i + \mu_i \quad (5)$$

Semi-log models are relevant for modeling growth rate of economic variables such as population, productivity, income to mention a few. Generally, Y_i depicts the dependent variable, X_i the independent variable, μ_i the stochastic disturbance term which is NID i.e. $\mu_i \sim N(0, \sigma_i^2)$.

Upon transformation of any of the five forms, one may replace $\ln X_i$ or $\left(\frac{1}{X_i}\right)$ by X_i^* , likewise $\ln Y_i$ by Y_i^* for simplicity so that we have a typical two-variable regression of the form

$$Y_i^* = \beta_0 + \beta_1 X_i^* + \mu_i \quad (6)$$

Eq. (6) which is the typical two-variable linear regression model will be fitted to the data by the OLS procedure so that

$\beta_0 = \bar{Y}^* - \beta_1 \frac{\sum X_i^*}{n}$ and $\beta_1 = \frac{n \sum Y_i^* X_i^* - \sum Y_i^* \sum X_i^*}{n \sum (X_i^*)^2 - (\sum X_i^*)^2}$ are the parameter estimates.

4. Analysis and Discussion of Results

Data of infant mortality was sourced from UNICEF Global Database while the cost of living index of some developing countries was sourced from www.numbeo.com. The data is a five year data of infant mortality rate and cost of living index of 30 developing countries collected from 2013 to 2017. The models used are five different functional forms of regression model. Their comparative suitability was investigated using some model fit criteria in order to identify the model with the best fit. The five functional forms considered in this work are reciprocal, Log-Lin, Lin-Log, Log-Log and Log-reciprocal models. The ordinary least square method was used to fit the five models to the data where infant mortality rate was the outcome variable (Y) and cost of living index was the predictor (X). The statistical analysis of the data was carried out using SPSS (version 20.0). The analysis will reveal the parameter estimates,

standard error estimates (for each parameter), and coefficient of determination, t-ratio and F-ratio as well as MSE of each of the estimated models. The t-ratio, F-ratio, the coefficients of determination, and MSE will provide information on the statistical significance of the parameters (or variables) and (overall) goodness of fit. The model with statistically significant t and F-ratios, highest coefficient of determination and lowest MSE will be adjudged to be the best model.

Table 1 is a table of comparison of results of different fitted functional forms of regression models. The comparison of the performance of each of the models was done using the coefficient of determination, mean square error, p-values of the t-ratio (for test of significance of parameters) and F-ratio (test of overall regression).

Results showed that all the five functional forms gave parameter estimates with reasonable S.E. estimates. It is also observed that all the five forms give statistically significant t-ratio and F-ratios at 5percent level. Besides, the coefficient of determination R^2 are relatively reasonable in all the five functional forms but the Log-Lin model yielded the highest coefficient of determination value and the lowest MSE value.

5. Discussion and Conclusions

The negative sign in the (partial) slope parameter of the estimated Lin-Log, Log-Lin and Log-log models implies that for every unit increase in the cost living index, there will be a decrease in the infant mortality rate. Similarly, the positive signs (and the inverse proportionality between the outcome variable and predictor) in the estimated reciprocal and log-reciprocal models also show that for every increase in the living index, there will be a decrease in the mortality rate. These results, in addition to their statistically significant

t-ratio and F-ratio, highlighted overall goodness of fit in all the functional forms considered and made us conclude that each of the models is capable of fitting the data. This is in consonance with the result of [1]. The coefficient of determination for each of the models also highlighted a goodness of fit in each of the models. In fact, the model with the least R^2 value of 0.036 indicated that approximately 3.6 percent variation of the cost of living index (of the countries) is explained by variation in infant mortality rates in the model. The Log-Lin model yielded the highest R^2 value of 0.492 which clearly means that approximately 50 percent variation in cost of living index is explained by variation in infant mortality rate by the model. In addition to this result, the Log-Lin model yielded the lowest MSE. These lead to the conclusion that the log-Lin model is the best model for the data since it has the lowest mean square error value and the highest R^2 value in addition to its statistically significant t and F ratios. A very good model fit usually have R^2 value very close to 1 and R^2 value may improve with the inclusion of more independent variables. However, a relatively low R^2 value does not necessarily imply a bad fit in [4] but the inclusion of other variable (s) in the model, apart from cost of living index, is suggested in order to improve the R^2 value. This suggestion may be necessary as literacy rate and poor health resulting from limited access to safe water, outbreak of epidemics, high percentage of people living with infectious diseases, poor sanitation and other hygiene problems as well as pollution may influence infant mortality rate apart from 'widespread' poverty in developing countries. How well the latter can be well measured or quantified remains a daunting question because of inadequate information, personnel and adequate technology for monitoring or keeping tab on such statistics in most developing countries.

Table 1. Table of Comparison

S/N	Model	Parameter & Standard Error Estimates $\beta_0 \beta_1$ S.E (β_0) S.E (β_1)	t-ratio t P-value	Coefficient of Determination R^2	MSE	F-ratio F p-value	P-Value
1	Reciprocal	11.426 624.262 (5.587) (265.477)	2.045 2.351 .043 0.02	0.036	349.069	5.529	0.02
2	Log-Lin	3.808 -0.02 (0.238) (0.04)	15.978 -4.66 0.00 0.00	0.482	0.958	21.718	0
3	Lin-log	80.068 -14.249 (20.193) (5.104)	3.965 -2.792 0.000 0.006	0.05	347.84	7.795	0.006
4	Log-log linear	6.892 -1.05 (0.95) (0.24)	7.254 -4.375 0.000 0.000	0.114	14.735	19.137	0
5	Log-reciprocal	1.083 47.442 (0.254) (12.078)	7.11 3.928 0.000 0.000	0.094	11.501	15.428	0

*p-value shows significance at 5% level figures in parentheses represents standard error estimates

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