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Research Paper

A comparison between continuous exponential, discrete logistics and continuous logistics growth models in forecasting birth rate of newborn in Malaysia

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Abstract

This research develops techniques which are helpful in forecasting birth rate of male and female newborn in Malaysia. The techniques used in this study are Continuous Exponential, Discrete Logistics and Continuous Logistics Growth models. For the purpose of this study, secondary data of Total Birth Rate in Malaysia obtained from National Population and Family Development Board (NPFDB) Malaysia covering the period 1995 up to 2009 was used. From the result, it was found that Continuous Logistics model is the best model to forecast the birth rate of newborn in Malaysia since it has the lowest SSE values which are 598.462 for male and 392.8738 for female.

Keywords: *Mathematical Modeling, Exponential Growth, Logistics Growth, Logistics Continuous Growth, Birth Rate, Malaysia.*

1. Introduction

The Crude Birth Rate of Malaysia population has been constantly decrease from 27.9 in 1990 to 17.2 in 2012 [19]. Decline in births have been higher in urban areas than rural locations, and more rapid for Chinese and Indians than for Malays. Differing use levels of contraceptives, which can be partly attributed to family planning programmes, have been assessed to be the main factor in the continuing reduction in fertility [1]. Population distribution by sex shows that male exceeds female for the period of 2010–2040. Nevertheless, the percentage of male population decreased from 51.5 per cent (2010) to 50.8 per cent (2040) whilst the percentage of female increased from 48.5 to 49.2 per cent for the same period [2]. The decreasing in the growth rate of Malaysia population may caused due to fertility rate, socio-economic differences, health reasons and level of education. In order to compare the birth rate between male and female newborn in Malaysia, Continuous Exponential, Discrete Logistics and Continuous Logistics Growth models were developed and compared in order to determine which technique is the most appropriate to forecast the growth rate of newborn in Malaysia.

2. Materials and methods

2.1. Continuous exponential growth model

Continuous Exponential growth model occurs when the growth rate of a mathematical function is proportional to the function's current value. Assumptions of Exponential Model are Continuous birth rate (e.g., no seasonality), babies are differed (e.g., gender) and sample space is limited. However, exponential model is robust; it gives reasonable precision even if these conditions do not meet [3]. Organisms may differ in their age, survival, and mortality. But the population consists of a large number of organisms, and thus their birth and death rates are averaged.

The mathematical model based on this description is given by:

$Y = ce^{kx}$

Where:

Y = P_{n+1} = Predicted Exponential Growth model

e^{k} = 1 + r = growth rate of male birth and female birth

X = t = years of birth rate

2.2. Discrete logistics growth

Discrete Logistics Growth model is used when direct effect of each individual as the size of the population changes. For example, if the size of the population increases, there is less food and water, fewer nesting sites and hiding places, etc. per individual. This will directly effect the individual's reproductive rate and risk of death. This type of competition among members of the same population is referred to as intraspecific competition. Since the size of the population directly effects the individual, this is a density-dependent model [4].

The mathematical model based on this description is given by:

$$P_{n+1} = P_n + rP_n\left(1 - \frac{P_n}{M}\right)$$

Where:

P_{n+1} =Predicted Logistic Growth model

P_n =The representing the initial amount of male birth and female birth in year 1995 to 2009.

r =Growth rate of male birth and female birth

M =The carrying capacity of male birth and female birth

2.3. Continuous logistic growth

Continuous Logistics Growth model in continuous time follows from the assumption that each individual reproduces at a rate that decreases as a linear function of the population size. Population sizes that are less than K, the population will increase in size: at population sizes that are greater than K the population size will decline; and at K itself the population neither increases nor decreases. The carrying capacity is therefore a stable equilibrium for the population, and the model exhibits the regulatory properties classically characteristic of intraspecific competition. For the continuous time model, birth and death are continuous. The net rate of such a population will be denoted by dN/dt. This represents the 'speed' at which a population increases in size, N, as time, t, progresses [5].

The equation for the continuous time model is shown below:

$$P_{n+1} = \frac{A}{B + Ce^{-kt}}$$

Where:

P_{n+1} = Predicted Logistic Growth model

A & B = Constant

3. Results and finding

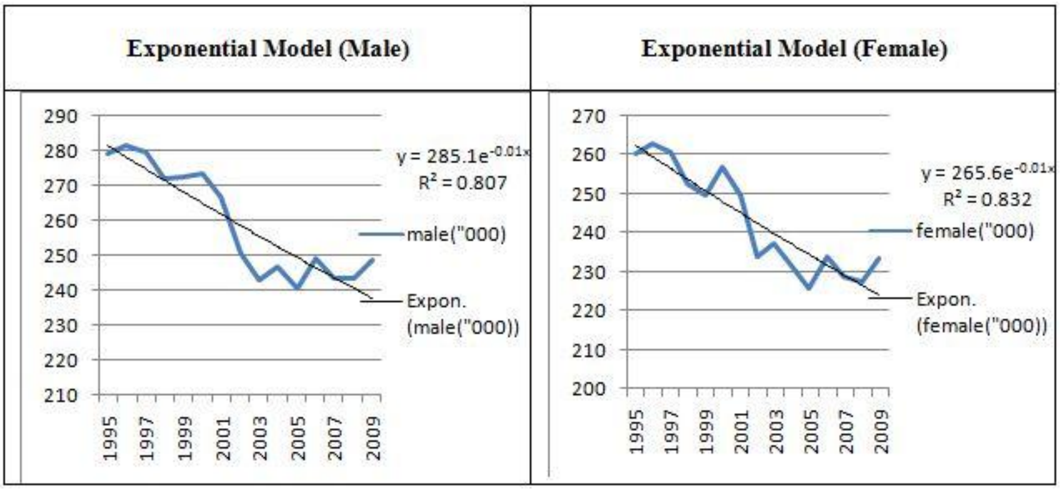

Fig. 1: Shows the Continuous Exponential Growth for Male and Female Birth In Malaysia. The Exponential Growth Rate for the Male and Female Are -0.012 and -0.011 Respectively. The Sum of Square Error (SSE) For Male and Female Are 777.895 and 585.251 Respectively.

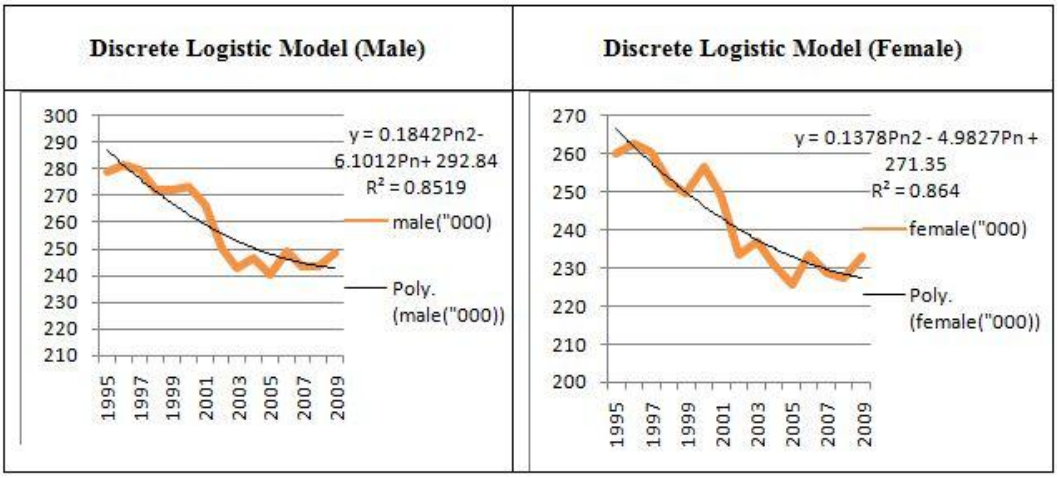

Fig. 2: Shows the Discrete Logistic Growth for Male and Female Birth In Malaysia. The Graph Shows That R, M And R/M Are -6.1012, 0.1842 And 38.55 For Male And 4.9827, 0.1378 And 43.42 For Female. The Sum of Square Error (SSE) For Male and Female Are 2314.504 and 1100.972 Respectively.

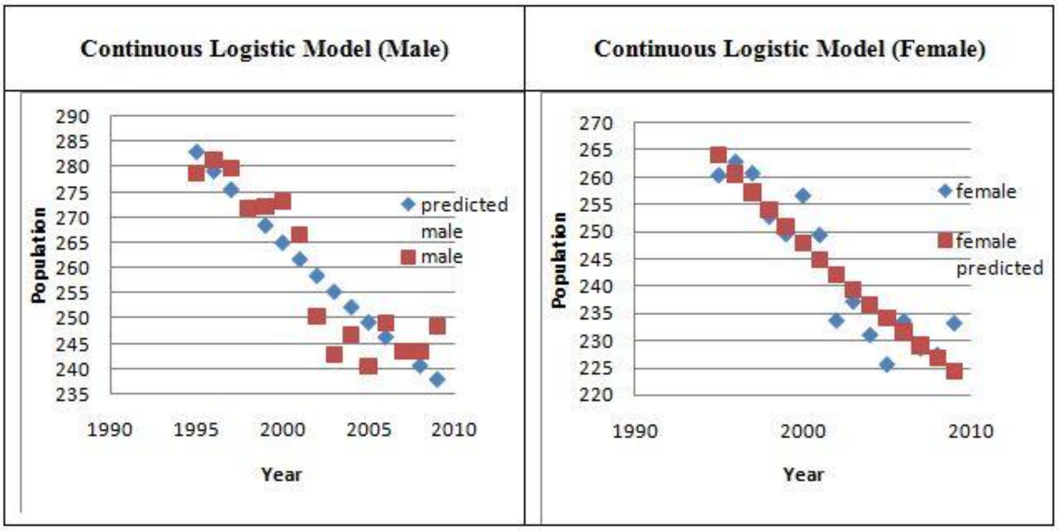

Fig. 3: Shows the Continuous Logistic Growth for Male and Female Birth In Malaysia. The Sum of Square Error (SSE) For the Male and Female Are 598.4624 and 392.8738 Respectively.

4. Conclusion

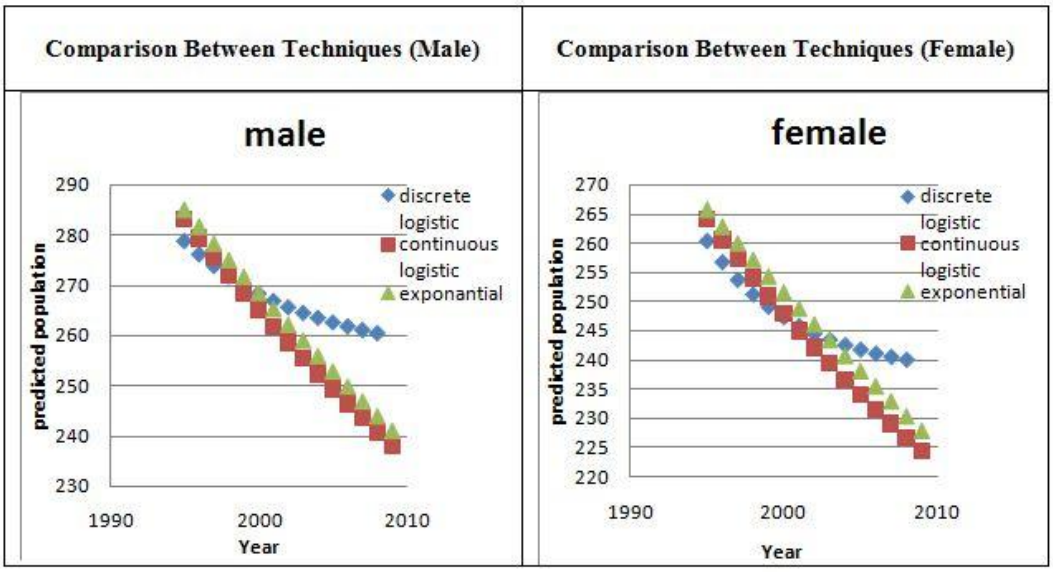

Fig. 4: Shows A Comparison Between Continuous Exponential, Discrete Logistics and Continuous Logistics Model In Forecasting Birth Rate of Newborn In Malaysia.

Table 1: A Comparison between Models of Male Newborn Birth Rate

MODEL (male)	EQUATION (FORMULA)	EQUATION	SSE
Discrete Logistic	$P_{n+1}=(1+r)P_n-(rP_n^2/M)$	$P_{n+1}=-0.004x^2=1.102x$	2314.504
Continuous Exponential	$P_{n+1}=P_oe^{-kt}$	$P_{n+1} = 285.1e^{-0.012x}$	777.8923
Continuous Logistic	$P_{n+1}=A/(B+Ce^{-kt})$	$P_{n+1}=2.901885/(0.240787-0.23053e^{-0.0006t})$	598.462

Table 2: A Comparison between Models of Female Newborn Birth Rate

MODEL (female)	EQUATION (FORMULA)	EQUATION	SSE
Discrete Logistic	$P_{n+1}=(1+r)Pn-(rP_n^2/M)$	$P_{n+1}=-0.0006x^2+1.1423x$	1100.972
Continuous Exponential	$P_{n+1}=P_oe^{-kt}$	$y = 265.64e^{-0.011x}$	585.2507
Continuous Logistic	$P_{n+1}=A/(B+Ce^{-kt})$	$P_{n+1}=2.56983/(0.025668-0.01593e^{-0.0812t})$	392.8738

By comparing Continuous Exponential, Discrete Logistics and Continuous Logistics models, it can be concluded that Continuous Logistics model is the best model to forecast the birth rate of newborn in Malaysia since it has the lowest SSE values which are 598.462 for male and 392.8738 for female while the Continuous Exponential and Discrete Logistics SSE value for male and female are 777.8923, 585.2507, 2314.504 and 1100.972 respectively.

References

[1] Hamid Arshat and Tey Nai Peng ,1988, *An Overview of the Population Dynamics in Malaysia , Malaysian Journal of Reproductive Health, Vol. 6, No. 1, pp. 23- 46. (SCOPUS-Cited Publication)*

[2] The Office of Chief Statistician Malaysia, 2014, *Population And Housing Census Of Malaysia*, Department of Statistics Malaysia.

[3] Alexei Sharov, 1997, *Exponential Model*. URL https://home.comcast.net/~sharov/PopEcol/lec5/exp.html

[4] Lewis D. Ludwig, n.d.,*Discrete VS Continuous Population Models.* Department of Mathematics and Computer Science, Denison University.

[5] Amrita Vishwa Vidyapeetham University, n.d., *Logistic Population Growth: Continuous and Discrete. URLhttp://amrita.vlab.co.in/?sub=3&brch=65&sim=1110&cnt=1*