

Forecasting Total Fertility Rate (TFR) In South Africa

¹Dr. Smartson. P. NYONI, ²Tatenda. A. CHIHOHO, ³Thabani NYONI

¹ZICHIRE Project, University of Zimbabwe, Harare, Zimbabwe

²Independent Health Economist, Zimbabwe

³SAGIT Innovation Center, Harare, Zimbabwe

Abstract - In this research article, the ANN approach was applied to analyze TFR. The employed annual data covers the period 1960-2018 and the out-of-sample period ranges over the period 2019-2030. The residuals and forecast evaluation criteria (Error, MSE and MAE) of the applied model indicate that the model is stable in forecasting TFR in South Africa. The results of the study indicate that annual total fertility rates in South Africa are likely to remain around 2.4 births per woman over the out-of-sample period. Therefore, we recommend that the authorities in South Africa should create more demand for family planning, HIV testing and antiretroviral therapy (ART) services, address challenges being faced by adolescents and young adults when seeking health services and continuously fund women empowerment program activities.

Keywords: ANN, Forecasting, Total fertility rate (TFR).

I. INTRODUCTION

South Africa's HIV prevalence among 15-19 year olds women was around 12.7% in 2011 and among pregnant 15-24 year olds was about 20.5% (Lince-Deroche, 2013). Young women and adolescent girls are at high risk of unintended pregnancies and HIV by age 17, and 50% of the teenagers are sexually active (Jewkes et al, 2009). Several studies done in South Africa have revealed that a variety of barriers to contraceptive use among women include lack of access, fear of adults, and providers' negative attitudes about young women's sexuality and concern for confidentiality when seeking healthcare services (Pandey et al, 2009; Jewkes et al, 2001). Kwazulu Natal has the highest HIV burden with an HIV prevalence of 44 % reported in the 2015 antenatal survey (MOH, 2015). Sexually transmitted infections are endemic in this part of the country and many adolescent girls and young women come late for treatment leading to pelvic inflammatory disease and an increase in ectopic pregnancy and infertility (Harrison et al, 2005).

Total fertility rate has been declining over the past decades in South Africa from 6.1 births per woman in 1955 to 2.4 births per woman in 2020 (Worldometer, 2020). The country reported an infant mortality rate of 23.6 deaths per 1000 live births and under five mortality rate of 30.7 deaths per 1000 live births in 2020 (Worldometer, 2020). There is a positive relationship between TFR and infant mortality. There are few studies that have been done at country and regional level which have examined or forecasted fertility rates. Moreira et al (2019) described the reasons for nonuse of contraception among women with demand for contraception not satisfied in low and middle-income countries (considering both overall countries and various subgroups of women). A descriptive analysis of the reasons for nonuse of contraceptive methods was performed among sexually active women with demand for contraception not satisfied. The prevalence of each reported reason was also evaluated according to marital status, woman's age and schooling, area of residence, wealth index, and parity. The study results indicated that on average, 40.9% of women in need of contraception were not using any contraceptive methods to avoid pregnancy. The most prevalent reasons for nonuse of contraceptives were "health concerns" and "infrequent sex," but the prevalence of each reason varied substantially across countries. A secondary analysis of data from a study conducted to monitor the implementation of a UNFPA package of interventions directed to improve SRH in young people of Sierra Leone was done by Labat et al (2018). The study was a household quantitative survey with open ended questions used to illustrate and complete the analysis. The study indicated that there is a need to reach out to the 40% of young people who are sexually active and neither pregnant nor with pregnancy desire, and are not using condom or contraception. Hoffman et al (2017) examined prevalence of factors potentially associated with HIV risk, focusing on partnership characteristics and consistent condom use. Data were drawn from a representative interviewer-administered survey of 2nd-4th year students conducted during registration at a university campus in KwaZulu-Natal. The study concluded that Sexual partnership characteristics potentially place sexually active university students at high HIV risk.

In this paper we aim to project TFR in South Africa using an artificial intelligence technique. The results of the study are expected to reveal likely future trends in TFR in the country. This will help in planning and allocation of resources towards health sector, education and job creation.

II. METHODOLOGY

The Artificial Neural Network (ANN) approach, which is flexible and capable of nonlinear modeling; will be applied in this study. The ANN is a data processing system consisting of a large number of highly interconnected processing elements in

architecture inspired by the way biological nervous systems of the brain appear like. Since no explicit guidelines exist for the determination of the ANN structure, the study applies the popular ANN (12, 12, 1) model based on the hyperbolic tangent activation function. This paper applies the Artificial Neural Network (ANN) approach in predicting annual total fertility rates in South Africa.

Data Issues

This study is based on annual total fertility rate (births per woman) in South Africa for the period 1960 – 2018. The out-of-sample forecast covers the period 2019 – 2030. All the data employed in this research paper was gathered from the World Bank online database.

III. FINDINGS OF THE STUDY

ANN Model Summary

Table 1: ANN model summary

Variable	S
Observations	47 (After Adjusting Endpoints)
Neural Network Architecture:	
Input Layer Neurons	12
Hidden Layer Neurons	12
Output Layer Neurons	1
Activation Function	Hyperbolic Tangent Function
Back Propagation Learning:	
Learning Rate	0.005
Momentum	0.05
Criteria:	
Error	0.063532
MSE	0.016532
MAE	0.107228

Residual Analysis for the Applied Model

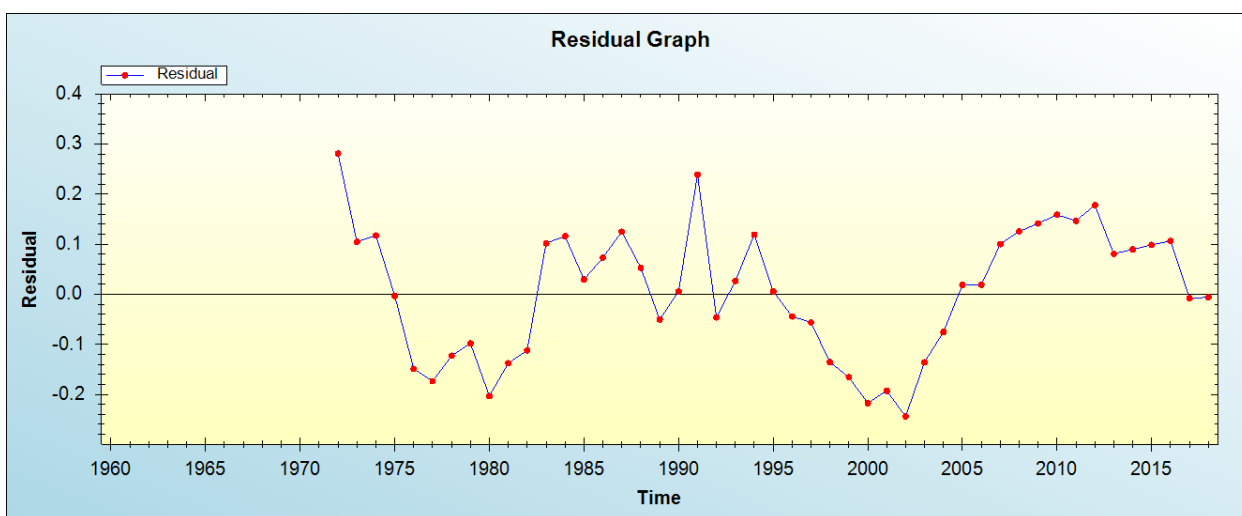


Figure 1: Residual analysis

In-sample Forecast for S

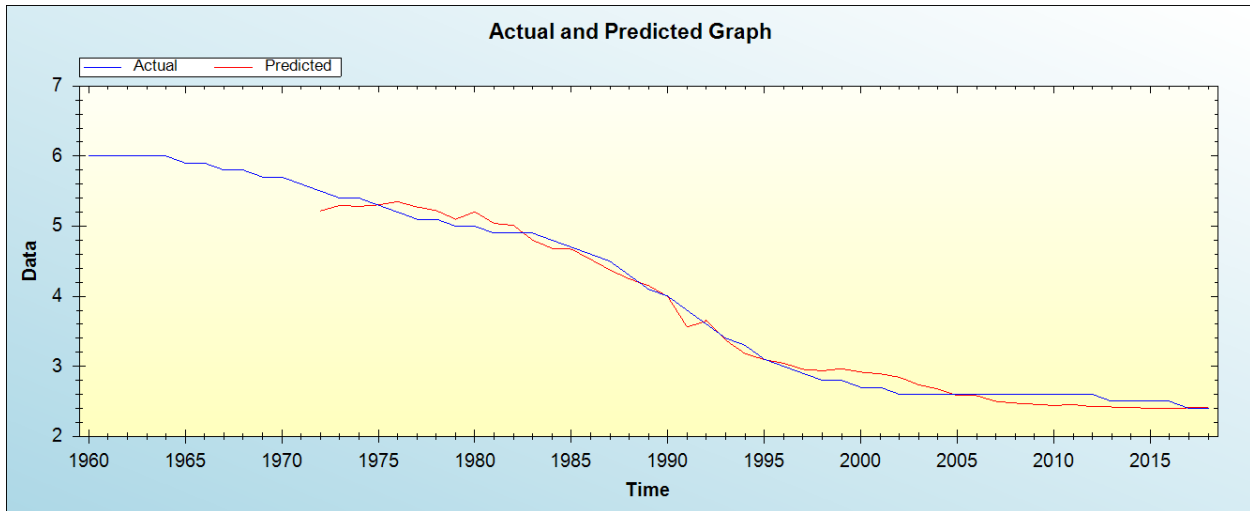


Figure 2: In-sample forecast for the S series

Out-of-Sample Forecast for S: Actual and Forecasted Graph

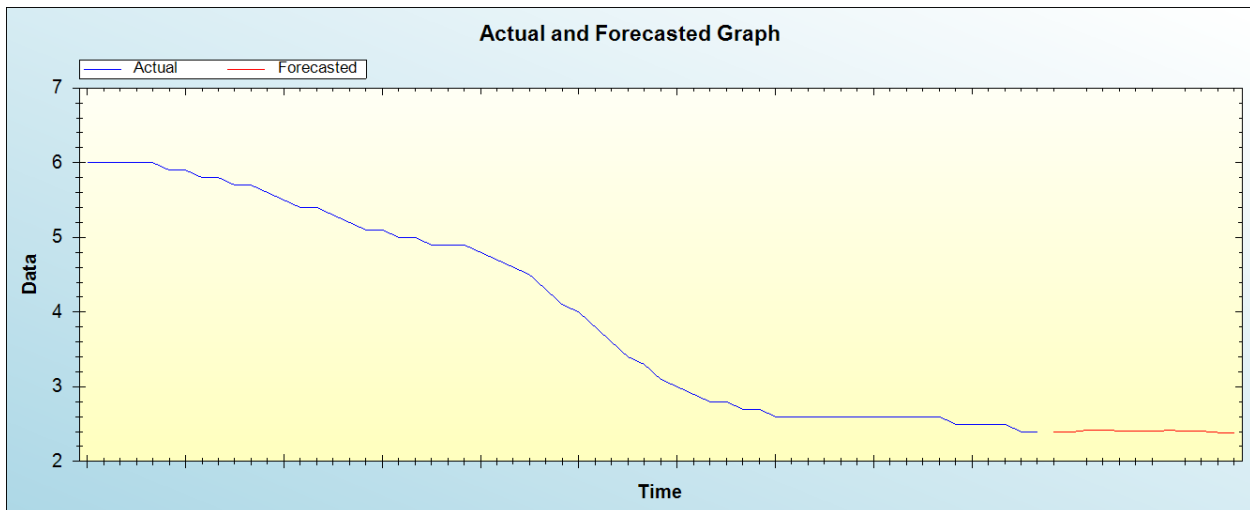


Figure 3: Out-of-sample forecast for S: actual and forecasted graph

Out-of-Sample Forecast for E: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecast
2019	2.4006
2020	2.3913
2021	2.4194
2022	2.4159
2023	2.4129
2024	2.4113
2025	2.4006
2026	2.4186
2027	2.4060
2028	2.4071
2029	2.3883
2030	2.3823

The main results of the study are shown in table 1. It is clear that the model is stable as confirmed by evaluation criterion as well as the residual plot of the model shown in figure 1. It is projected that annual total fertility rates in South Africa are likely to remain around 2.4 births per woman over the out-of-sample period.

IV. CONCLUSION & RECOMMENDATIONS

Adolescents and young adults in South Africa continue to be involved in risky sexual behaviors which put them at a higher risk to adverse SRH outcomes. Lack of comprehensive knowledge on SRH, lack of access, fear and attitude of health workers have been found to be some of the reasons why adolescents and young adults indulge in risky sexual behaviors. In this study we proposed, a machine learning approach to predict TFR in South Africa. The ANN model predictions revealed that annual total fertility rates in South Africa are likely to remain around 2.4 births per woman over the out-of-sample period. Therefore, the South African government is advised to create more demand for family planning, HIV testing and antiretroviral therapy (ART) services, address challenges being faced by adolescents and young adults when seeking health services and continuously fund women empowerment program initiatives.

REFERENCES

- [1] Worldometer (2020). South Africa demographics. <https://www.worldometers.info>
- [2] Naomi Lince-Deroche., Adila Hargey., Kelsey Holt and Tara Shochet (2013). Accessing Sexual and Reproductive Health Information and Services: A Mixed Methods Study of Young Women's Needs and Experiences in Soweto, South Africa, *Young Women's Access to SRH African Journal of Reproductive Health* March 2015; 19 (1): 73
- [3] Jewkes R., Morrell R., & Christofides N (2009). Empowering teenagers to prevent pregnancy: lessons from South Africa. *Cult Health Sex.* 2009; 11:675–688.
- [4] Jewkes R., Vundule C., & Maforah F (2001). Relationship dynamics and teenage pregnancy in South Africa. *Soc Sci Med.* 2001; 52:733-744.
- [5] Panday S., Makiwane M., Ranchod C (2009). Teenage pregnancy in South Africa: with a specific focus on school-going learners (Child, Youth, Family and Social Development, Human Sciences Research Council). Pretoria: Department of Education 2009:1- 96.
- [6] MOH (2015). South Africa Antenatal survey 2015.
- [7] Harrison A., Cleland J., Gouws E., & Frohlich J (2005). Early sexual debut among men in rural South Africa: Heightened vulnerability to sexual risk? *BMJ* 2005; 81: 259-261.

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