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Detection of Future Trends of Adolescent Fertility for Cuba Using the Artificial Neural Network Technique

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***Abstract* - This study uses annual time series data on adolescent fertility rate for Cuba from 1960 to 2020 to predict future trends of adolescent fertility rate over the period 2021 to 2030. The forecast evaluation criteria of the applied model indicate that the ANN (12, 12, 1) model is stable. The neural network model projections revealed that adolescent fertility will hover around 50 births per 1000 women aged 15-19 throughout the out of sample period. Therefore, we encourage the Cuban government to increase awareness campaigns among communities, create adolescent friendly healthcare facilities, fund youth empowerment programs and strictly enforce laws to protect women's rights.**

Keywords: ANN, Forecasting, adolescent fertility rate.

I. INTRODUCTION

Adolescent pregnancy is the conception that occurs among girls between the ages of 10 and 19, where the majority are unintended pregnancies (Ganchimeg *et al.* 2014).Approximately 15 percent of teenagers below 18 years gave birth globally in 2015, and at least 90 percent of such deliveries occur in developing countries (UNICEF, 2021; Ganchimeg *et al.* 2014). One in every five adolescent girls has given birth globally, and the risk goes up to about one in every three adolescent girls in developing nations (WHO, 2014).The World Health Organization (WHO) revealed that nearly 21 million girls of aged 15-19 get pregnant every year. Around 5.6 million with experience abortion, of which 3.9 million are reported as unsafe in low and middle income countries (WHO, 2020). Sub-Saharan Africa is number one in terms of reporting adolescent pregnancies hence more resources must be channeled to this region to urgently address this problem (UNICEF, 2021; WHO, 2016). Previous studies reported early marriage, substance abuse, sexual violence, non-use of contraceptives, relatives with a history of adolescent birth, early sexual activity, lack of health services, limited maternal education, poverty, lack of parental guidance, child of a broken family, religious beliefs, social media, and pornography as significant risk factors for adolescent pregnancy (Edward *et al.* 2022; Moyano *et al.* 2021; Bain *et al.* 2020; WHO, 2020; Abebe *et al.* 2019;Kyei-Nimakoh*et al.* 2017). Teenage pregnancy is still an important public challenge in Cuba. According the World Bank, adolescent fertility declined from 103 births per 1000 women aged 15-19 in 1960 to 51 births per 1000 women aged 15-19 in 2020. These figures indicate that there is need to review current legislation and policies regarding women's rights and child marriages with a goal of ending child marriages and teen pregnancies. The purpose of this paper is to model and forecast future trends of adolescent fertility in Cuba using double exponential smoothing technique. Research findings are expected to highlight future trends of adolescent fertility in the out of sample period. This will facilitate policymaking, planning and allocation of adequate resources to teenage pregnancy prevention programs.

II. METHODOLOGY

The Artificial Neural Network (ANN) approach, which is flexible and capable of nonlinear modelling; 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 adolescent fertility rate for Cuba.

Data Issues

This study is based on annual adolescent fertility rate in Cuba for the period 1960 – 2020. The out-of-sample forecast covers the period 2021 – 2030. All the data employed in this research paper was gathered from the World Bank online database.

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III. FINDINGS OF THE STUDY

ANN Model Summary

Table 1: ANN model summary

Variable	C
Observations	49
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	0.007270
MSE	0.725397
MAE	0.619758

Residual Analysis for the Applied Model

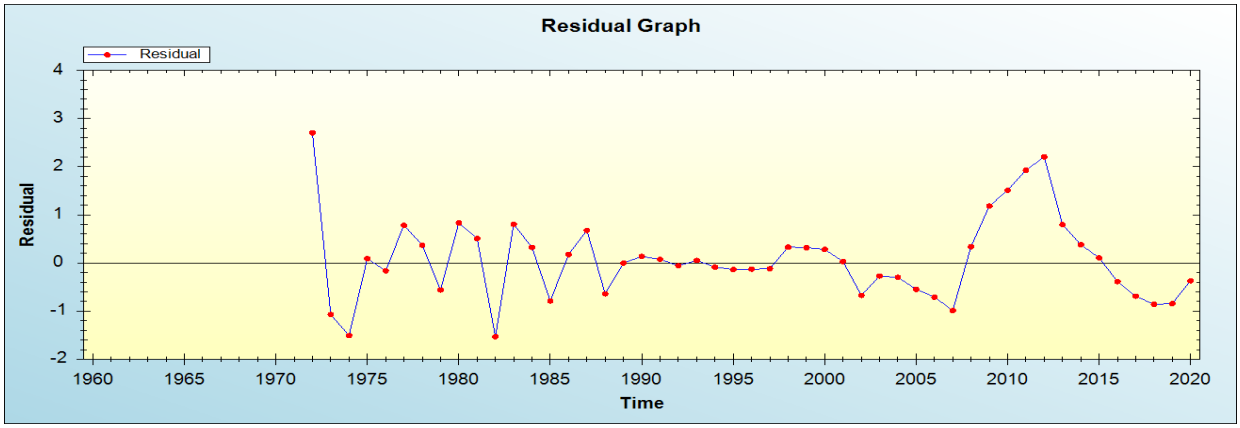

Figure 1: Residual analysis

In-sample Forecast for C

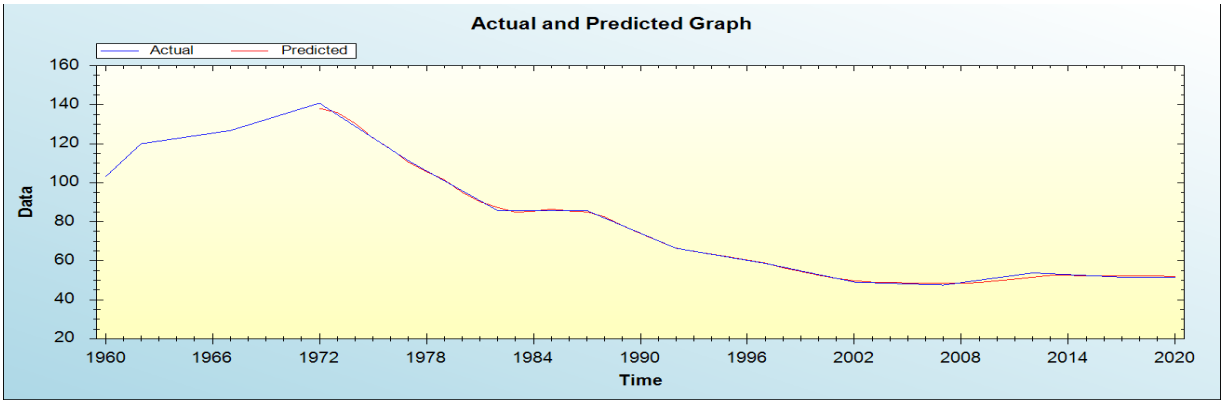

Figure 2: In-sample forecast for the C series

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

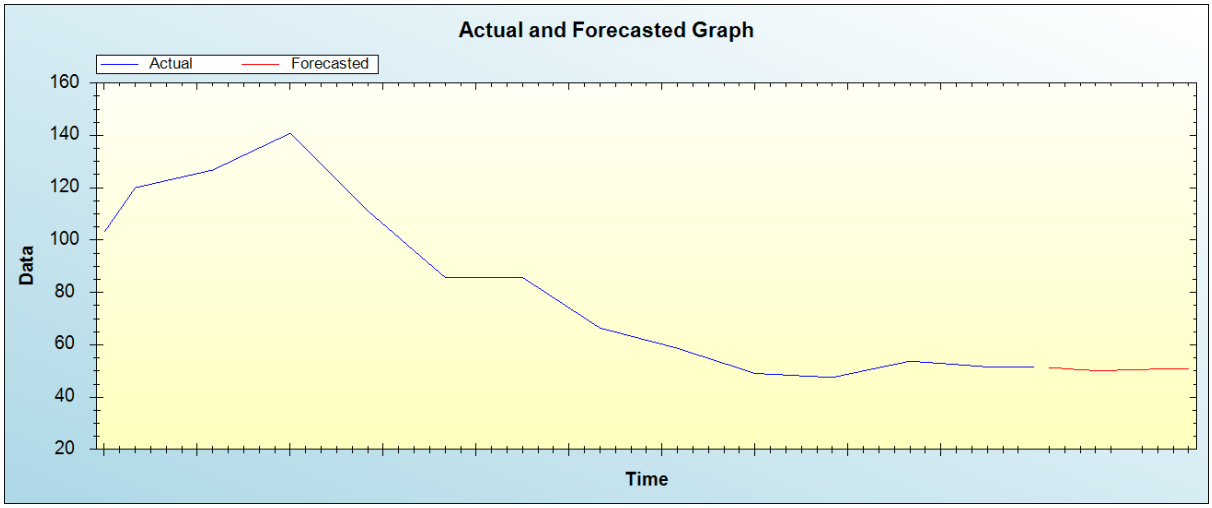

Figure 3: Out-of-sample forecast for C: actual and forecasted graph

Out-of-Sample Forecast for C: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted adolescent fertility rate
2021	51.2598
2022	50.9170
2023	50.4476
2024	50.2019
2025	50.2327
2026	50.3777
2027	50.5687
2028	50.7767
2029	50.8710
2030	50.8598

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 adolescent fertility rate will hover around 50 births per 1000 women aged 15-19 throughout the out of sample period.

IV. POLICY IMPLICATION & CONCLUSION

Teenage pregnancy is still an important public health challenge in Cuba. adolescent fertility steadily declined from 103 births per 1000 women aged 15-19 in 1960 to 51 births per 1000 women aged 15-19 in 2020. These figures indicate that there is need to review current legislation and policies regarding women's rights and child marriages with a goal of ending child marriages and teen pregnancies. This study applied a machine learning technique to predict adolescent fertility for Cuba. Our study findings revealed that adolescent fertility will hover around 50 births per 1000 women aged 15-19 years throughout the out of sample period. Therefore, the Cuban government must increase awareness campaigns among communities, create adolescent friendly healthcare facilities, fund youth empowerment programs and strictly enforce laws to protect women's rights.

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