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Early Identification of Abnormal Future Trends of Adolescent Fertility for Benin Using the Artificial Neural Network Approach

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***Abstract* - This research article uses annual time series data on adolescent fertility rate for Benin 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 is expected to increase and also remain high throughout the out of sample period. Therefore, we encourage the government of Benin to create more adolescent friendly facilities, strictly enforce laws to prevent child marriages and sexual abuse of women, and promote girl child education and fund empowerment programs for youths.**

Keywords: ANN, Forecasting, adolescent fertility rate.

I. INTRODUCTION

Adolescent pregnancy is a serious public health problem affecting mainly low and middle income countries with Sub-Saharan Africa leading the pace (Parsons *et al.* 2015; WHO, 2014; Ganchimeg *et al.* 2014). Unintended pregnancies more often are associated with maternal, neonatal and child adverse health outcomes (Walker, 2012). Voluntary and forced child marriages, and sexual abuse of teenage girls in the community are among the leading causes of adolescent pregnancies (Shalini & Singh, 2020). Many adolescent girls in Sub-Saharan Africa are driven into commercial sex-work, early child marriages and premarital sex by harsh economic situations aggravated by existing poverty and persistent civil conflicts. Previous researchers highlighted that delay in accessing family planning services is attributed to lack of adequate comprehensive SRH knowledge and health system related structural barriers (Braeken & Rondinelli, 2012; Kennedy *et al*. 2011; Crawford *et al*. 2009; Wilson *et al*. 1994). In addition, delay in reporting sexual abuse cases of teenage girls in remote communities often leads to unintended pregnancies, STIs, HIV, mental trauma to victims of rape and school dropouts. Weaknesses or gaps in the legal system can enable perpetrators of sexual violence (rape) to escape punishment thereby encouraging potential future sexual offenders to commit the same crime. Health education among communities should be continuous and must utilize existing traditional community administrative structures. There must be permanent linkages between local health facilities and the community so that appropriate family planning services are offered to adolescents whenever they need them. Training of traditional leadership structures, learners and teachers in schools and law enforcement arms of the state on women's rights and gender based violence will improve early identification, management, and prevention of child marriages and sexual abuse of adolescent girls. In line with Agenda 2030 for sustainable development, this paper applies a machine learning algorithm to project future trends of adolescent fertility in Benin. Forecast results will depict the future burden of adolescent births and thereby trigger authorities in the country to revisit existing policies and legal instruments to improve on the protection of women's rights and end child marriages.

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 Benin.

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Data Issues

This study is based on annual adolescent fertility rate in Benin for the period 19 – 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.

III. FINDINGS OF THE STUDY

ANN Model Summary

Table 1: ANN model summary

Variable	B
Observations	49 (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	0.007893
MSE	0.206513
MAE	0.327001

Residual Analysis for the Applied Model

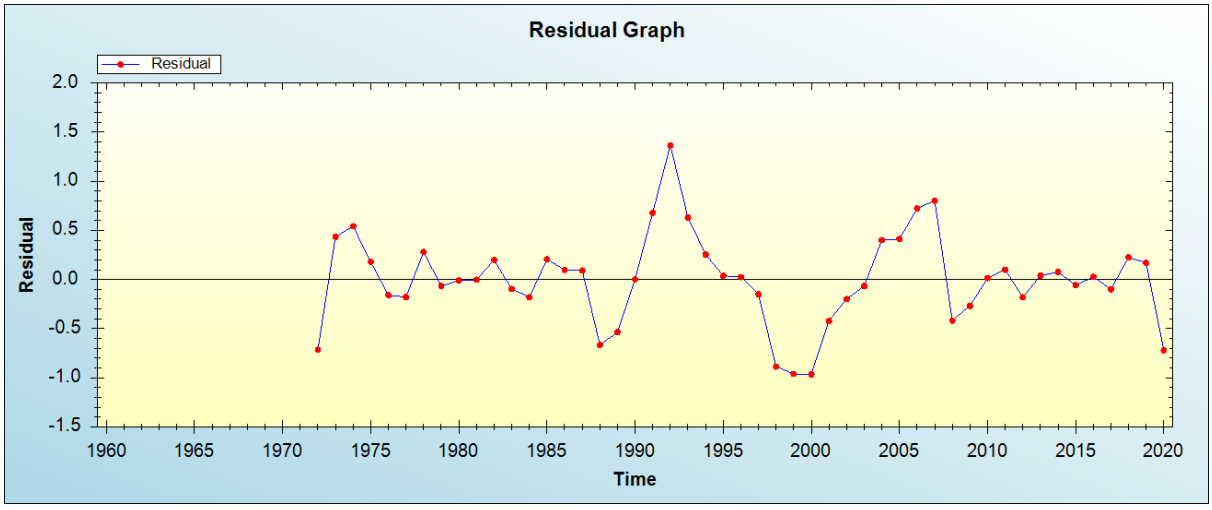

Figure 1: Residual analysis

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In-sample Forecast for B

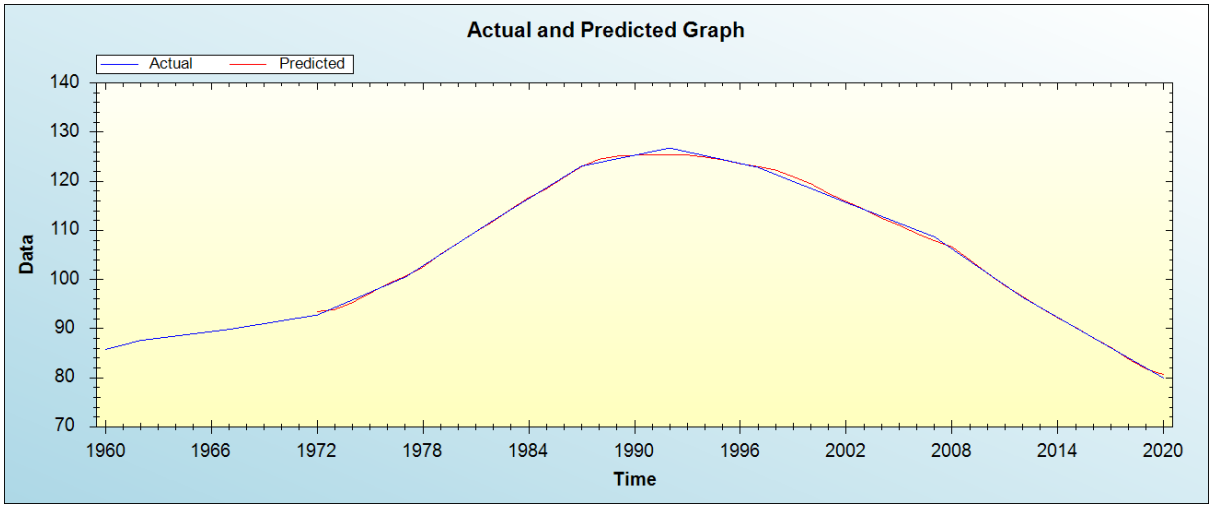

Figure 2: In-sample forecast for the B series

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

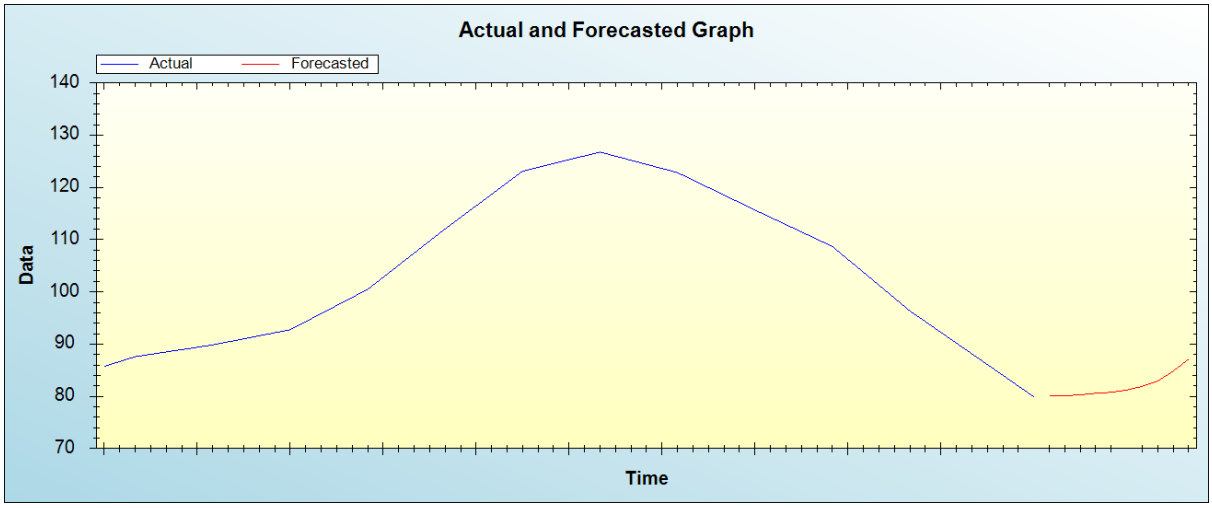

Figure 3: Out-of-sample forecast for B: actual and forecasted graph

Out-of-Sample Forecast for B: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasting adolescent fertility rate
2021	80.0520
2022	80.0910
2023	80.3185
2024	80.5982
2025	80.7879
2026	81.1976
2027	81.9319
2028	82.9569
2029	84.8407
2030	87.1515

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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 will generally expected to increase and remain high throughout the out of sample period.

IV. POLICY IMPLICATION & CONCLUSION

Adolescent fertility in Benin has been gradually declining during the period 1992-2020 due to robust government measures which include the national family planning program, improvements in the education sector and public awareness campaigns. This research paper applied a machine learning technique to forecast adolescent fertility for Benin. Our study findings revealed that adolescent fertility is likely to increase and also remain high throughout the out of sample period. Therefore, the government must create more adolescent friendly facilities, strictly enforce laws to prevent child marriages and sexual abuse of women, and promote girl child education and fund empowerment programs for youths.

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