

Forecasting Total Fertility Rate (TFR) in Morocco Using an Artificial Neural Network Approach

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Abstract - In this research article, the ANN approach was applied to analyze TFR in Morocco. 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 Morocco. The results of the study indicate that annual total fertility rates in Morocco are generally likely to remain around 2.4 births per woman throughout the out-of-sample period. Therefore, the authorities in Morocco are encouraged to continue improving access to sexual and reproductive health (SRH) services among adolescents and young adults to prevent adverse SRH outcomes, and empowerment of women.

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

I. INTRODUCTION

Sexual and reproductive health rights are critical for economic development. As agreed during the International conference on Population and development in Cairo, Egypt in 1994, signatories to the conference are supposed to ensure universal access to SRH services especially for adolescent girls and young woman. The conference recognized the sexual and reproductive rights of every individual or couple, however women's sexual and reproductive rights became a big issue as there is rampant violation of their rights across the globe. Women must be accorded their rights to choose their sexual partners, number of children they wish to have and time of childbearing. They must have equal access to health information, education and SRH services. Many adolescent girls and women in Sub-Saharan Africa are at high risk of unwanted pregnancies, unsafe abortions, and STIs (Newman et al, 2015; Vos et al, 2013; Chinsebu, 2009). Lack of comprehensive knowledge on SRH services increases the risk of poor SRH outcomes (Newton-Levinson et al, 2016; Elkak, 2013; Aquaiz et al, 2012; Kahhalch, 2009; Dejong et al, 2007). In 2016 Morocco recorded 22 000 people living with HIV (UNAIDS, 2016) and 4800 adolescents were living with HIV in MENA countries (UNICEF, 2018). El Kazdoui et al (2019) revealed that successful intervention programs should target the multifaceted factors affecting the adolescent's sexual behaviors, from the individual to the societal level. Coast et al (2019) examined early adolescent understandings and experiences of sexual and reproductive health (SRH) in Ethiopia and Rwanda, drawing on a multisite qualitative research study with 10- to 12-year-old and 14- to 15-year-old male and female adolescents and a range of adult participants. The authors concluded that there is need for program designers and implementers to address the role of underlying social norms in a more strategic and context-specific way to help young people navigate their sexual and reproductive lives. Pearce (2019) explored adolescent access to reproductive health services through the experiences of adolescent girls and healthcare providers in Namibia by conducting a qualitative case study. The data was collected through interviews with adolescent girls and key-informants who are experienced healthcare providers. The findings showed that the girls have access to SRHS. However, they lack a comprehensive understanding of their sexual and reproductive health rights (SRHR).

Morocco has recorded a decline in TFR over the years from 7.1 births per woman in 1965 to 2.4 births per woman in 2020. The country reported an infant mortality of 16.1 infant deaths per 1000 live births in 2020 (Worldometer, 2020). The aim of this study is to project TFR in Morocco using a machine learning algorithm. The findings of the study are expected to reveal the fertility trends in the out of sample period to facilitate planning and resource mobilization for health, education and employment 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 Morocco.

Data Issues

This study is based on annual total fertility rate (births per woman) in Morocco 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 | M |
| 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 | 0.043744 |
| MSE | 0.013046 |
| MAE | 0.086803 |

Residual Analysis for the Applied Model

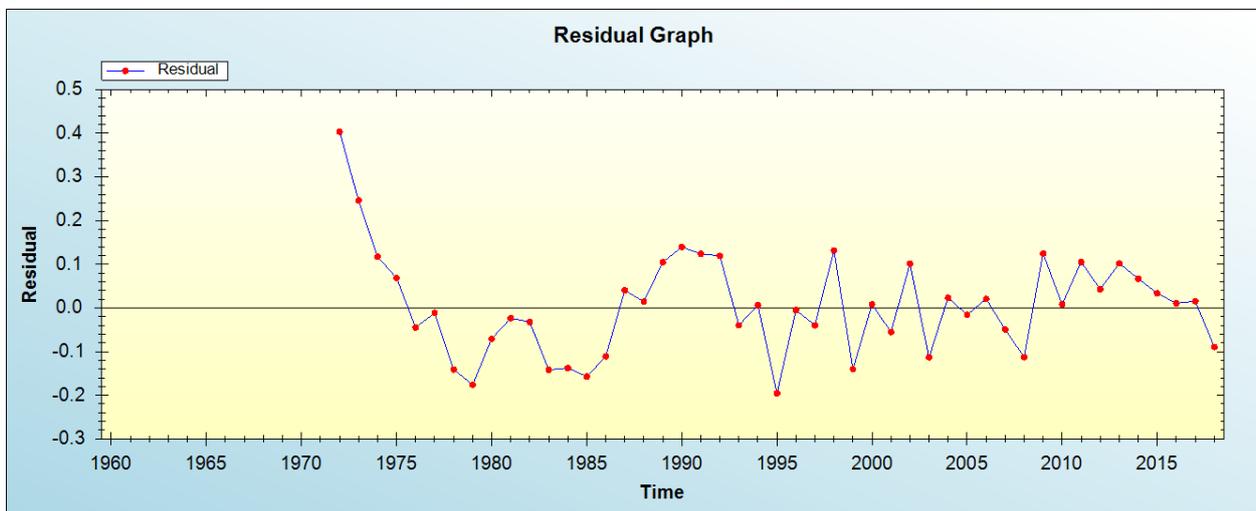


Figure 1: Residual analysis

In-sample Forecast for M

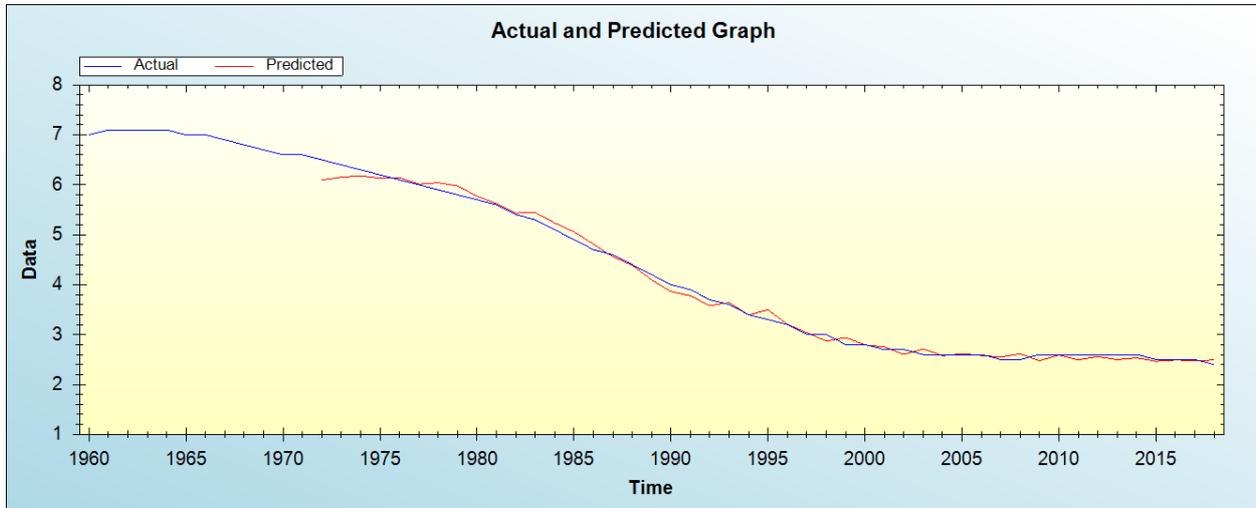


Figure 2: In-sample forecast for the M series

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

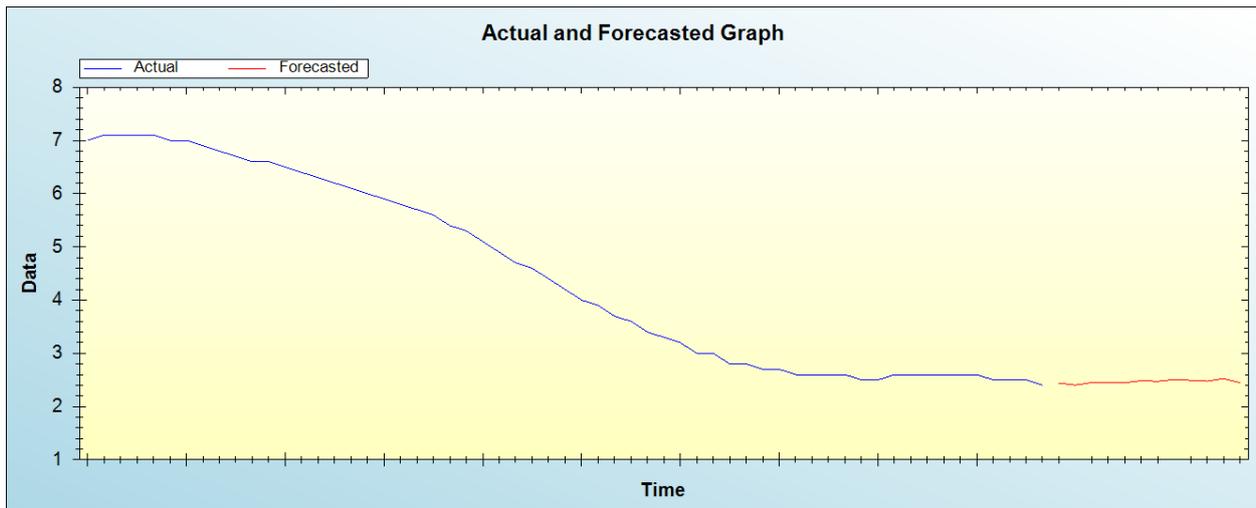


Figure 3: Out-of-sample forecast for M: actual and forecasted graph

Out-of-Sample Forecast for M: Forecasts only

Table 2: Tabulated out-of-sample forecasts

| Year | Forecasts |
|------|-----------|
| 2019 | 2.4412 |
| 2020 | 2.4021 |
| 2021 | 2.4518 |
| 2022 | 2.4569 |
| 2023 | 2.4467 |
| 2024 | 2.4842 |
| 2025 | 2.4733 |
| 2026 | 2.5066 |
| 2027 | 2.4913 |
| 2028 | 2.4760 |
| 2029 | 2.5258 |
| 2030 | 2.4486 |

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 Morocco are generally likely to remain around 2.4 births per woman throughout the out-of-sample period.

IV. CONCLUSION & RECOMMENDATIONS

Total fertility rates have been declining over the past years in Morocco alongside a decrease in infant and child mortality rates. In this paper we applied an artificial neural network approach to predict TFR in Morocco and the ANN model projections revealed that annual total fertility rates in Morocco are generally likely to remain around 2.4 births per woman throughout the out-of-sample period. Therefore the Moroccan government is advised to continue improving access to sexual and reproductive health (SRH) services among adolescents and young adults to prevent adverse SRH outcomes and empowerment of women.

REFERENCES

- [1] Worldometer (2020). Morocco demographics. <https://www.worldometers.info>
- [2] Newman L., Rowley J., Vander Hoorn S., Wijesooriya NS., Unemo M., & Low N (2015). Global estimates of the prevalence and incidence of four curable sexually transmitted infections in 2012 based on systematic review and global reporting. *PLoS One*. 2015; 10:e0143304.
- [3] Chinsembu KC (2009). Sexually transmitted infections in adolescents. *Open Infect Dis J*. 2009; 3:107–17.
- [4] Vos T., Barber RM., Bell B., Bertozzi-Villa A., Biryukov S., Bolliger I (2015). Global, regional, and national incidence, prevalence, and years lived with disability for 301 acute and chronic diseases and injuries in 188 countries, 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013. *Lancet*. 2015;386:743–800
- [5] DeJong J., Shepard B., Roudi-Fahimi F., Ashford LS (2007). Young people's sexual and reproductive health in the Middle East and North Africa; 2007. p. 8.
- [6] Newton-Levinson A., Leichter J S., & Chandra-Mouli V (2016). Sexually transmitted infection Services for Adolescents and Youth in Low- and middle-income countries: perceived and experienced barriers to accessing care. *J Adolesc Health*. 2016; 59:7–16.
- [7] El-Kak F (2013). Sexuality and sexual health: constructs and expressions in the extended Middle East and North Africa. *Vaccine*. 2013; 31:G45–50.
- [8] Alquaiz AM., Almuneef MA., & Minhas HR (2012). Knowledge, attitudes, and resources of sex education among female adolescents in public and private schools in Central Saudi Arabia. *Saudi Med J*. 2012; 33:1001–9.
- [9] Kakhaleh J., El Nakib M., & Jurjus A (2009). Knowledge, attitudes, beliefs and practices in Lebanon concerning HIV/AIDS, 1996–2004
- [10] UNAIDS (2016). Country factsheets Morocco. Geneva: UNAIDS. <http://www.unaids.org/en/regionscountries/countries/morocco/>.
- [11] United Nations Children's Fund (UNICEF) (2018). Monitoring the situation of children and women. Children, HIV and AIDS Regional snapshot: Middle East and North Africa. New York: UNICEF Data; 2018. Available at: <https://data.unicef.org/wp-content/uploads/2018/11/MENA-Regional-snapshot-2018.pdf>.

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