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Adolescent Health Policy-Making in Paraguay Using Empirical Evidence from Holt's Double Exponential Smoothing Technique

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***Abstract* - This study uses annual time series data of adolescent fertility rate for Paraguay from 1960 to 2020 to predict future trends of adolescent fertility rate over the period 2021 to 2030. The study utilizes Holt's linear exponential smoothing model. The optimal values of smoothing constants α and β are 0.9 and 0.3 respectively based on minimum MSE. The results of the study indicate that annual adolescent fertility will continue to decline throughout the out of sample period. Therefore, we encourage authorities in Paraguay to tirelessly enforce laws that safeguard sexual and reproductive health rights of women and girls, promote girl child education and improve the quality, affordability and accessibility of adolescent sexual and reproductive health services.**

Keywords: Exponential smoothing, Forecasting, adolescent fertility rate.

I. INTRODUCTION

Pregnancy during the adolescence stage is regarded as a global public health issue of concern (Darroch *et al.* 2016). Studies conducted in the past highlighted that complications emanating from teenage pregnancy can be immediate or long term. Immediate adverse SRH outcomes include pregnancy induced hypertension, antepartum hemorrhage, preterm delivery and low birth weight (Brosens *et al.* 2019; Bokslang *et al.* 2016;Medhi *et al.* 2016). On the other hand long term complications such as mental disorders and repeat cycle of poverty can occur (Mathewos &Mekuria, 2018). Many researchers identified risk factors of teen pregnancy such as living in poverty, lack of formal education, having family members who have experienced adolescent pregnancy, first sexual contact at young age, multiple sexual partners, inconsistent use of condoms; parental absence, child headed families, single parent household, peer pressure, lack of comprehensive SRH knowledge and exposure to pornographic material on social media (WHO, 2020; Bain *et al.* 2020; Reed *et al.* 2019; Makiwane *et al.* 2018;Smith *et al.* 2018;Yakubu & Salisu, 2018;Guilamo-Ramos*et al.* 2016; Diaz& Fiel, 2016;Azevedo *et al.* 2015; Lang& Weinstein, 2015). Paraguay is a South American country with greater than 33 percent of its population living in poverty thus increasing the risk of adolescence pregnancy (Dongarwar & Salihu, 2019; Reed *et al.* 2019). Pregnancy rates are still high in Paraguay and it is not surprising to witness high adverse SRH outcomes which are related to adolescence pregnancy (Reed *et al.* 2019). Adolescent pregnancy rates are approximately 70% in rural Paraguay and teenage pregnancy costs the government over 63 million dollars per year (Palmer *et al.* 2019). According World Bank reports, adolescent fertility steadily declined from 92 births per 1000 women in 1990 to 58 births per 1000 women in 2014. In 2016 adolescent fertility rate in Paraguay was 57 births per 1000 women aged 15-19 years old which was similar to regional counterparts like Uruguay, Bolivia, Argentina, Chile and Peru. This decline in adolescent fertility is attributed to the increased prevalence of modern contraceptive use and improvement in knowledge levels among adolescents. Despite significant progress in the reduction of teenage pregnancy, the burden of unintended pregnancies among teenagers still persists and is more prevalent in the rural areas.

This paper applies Holt's double exponential smoothing technique to model and forecast future trends of adolescent fertility in Paraguay. The findings of this research are envisioned to highlight the future burden of adolescent fertility in the out of sample period. This will inform policies, planning and resource distribution to teenage pregnancy prevention programs in the country.

II. METHODOLOGY

This study utilizes an exponential smoothing technique to model and forecast future trends of adolescent fertility rate in Paraguay. In exponential smoothing forecasts are generated from the smoothed original series with the most recent historical

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values having more influence than those in the more distant past as more recent values are allocated more weights than those in the distant past. This study uses the Holt's linear method (Double exponential smoothing) because it is an appropriate technique for modeling linear data.

Holt's double exponential smoothing method is specified as follows:

Model equation

$P_t = \mu_t + \rho_t \mathbf{t} + \varepsilon_t$

Smoothing equation

$L_t = \alpha P_t + (1-\alpha)(L_{t-1} + b_{t-1})$

$0<\alpha<1$

Trend estimation equation

$b_t = \beta (L_t - L_{t-1}) + (1-\beta) b_{t-1}$

$0<\beta<1$

Forecasting equation

$f_{t+h} = L_t + \mathrm{h} b_t$

P_t is the actual value of adolescent fertility rate at time t

ε_t is the time varying **error term**

μ_t is the time varying mean (**level**) term

ρ_t is the time varying **slope term**

t is the trend component of the time series

L_t is the exponentially smoothed value of adolescent fertility rate at time t

α is the exponential smoothing constant for the data

β is the smoothing constant for trend

f_{t+h} is the h step ahead forecast

b_t is the trend estimate at time t

b_{t-1} is the trend estimate at time period t-1

Data Issues

This study is based on annual adolescent fertility rate in Paraguay 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

Exponential smoothing Model Summary

Table 1: ES model summary

Variable	P
Included Observations	61
Smoothing constants	
Alpha (α) for data	0.900
Beta (β) for trend	0.300
Forecast performance measures	
Mean Absolute Error (MAE)	0.290374
Sum Square Error (SSE)	19.443982
Mean Square Error (MSE)	0.318754
Mean Percentage Error (MPE)	0.020779
Mean Absolute Percentage Error (MAPE)	0.320049

Residual Analysis for the Applied Model

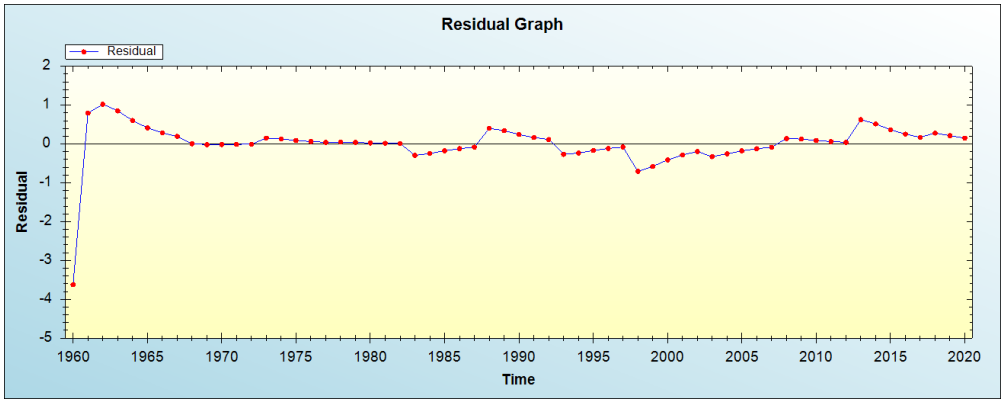

Figure 1: Residual analysis

In-sample Forecast for P

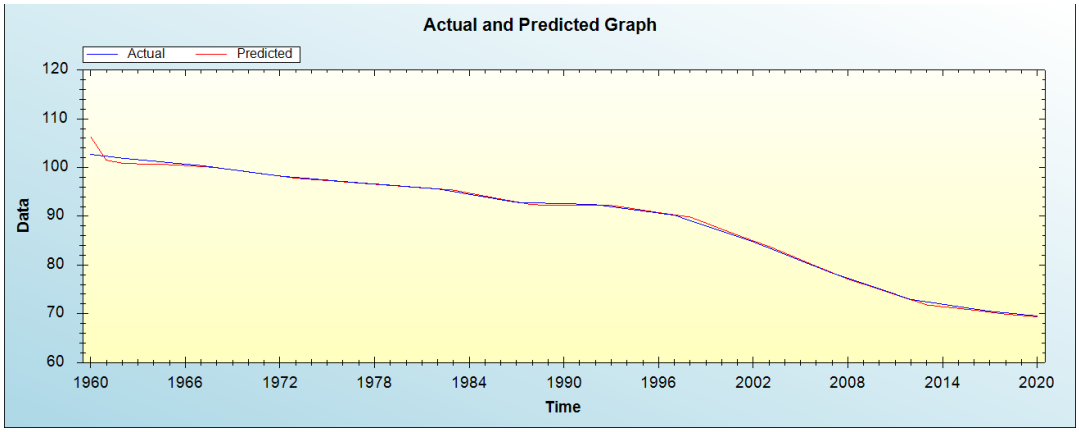

Figure 2: In-sample forecast for the P series

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Actual and Smoothed graph for P series

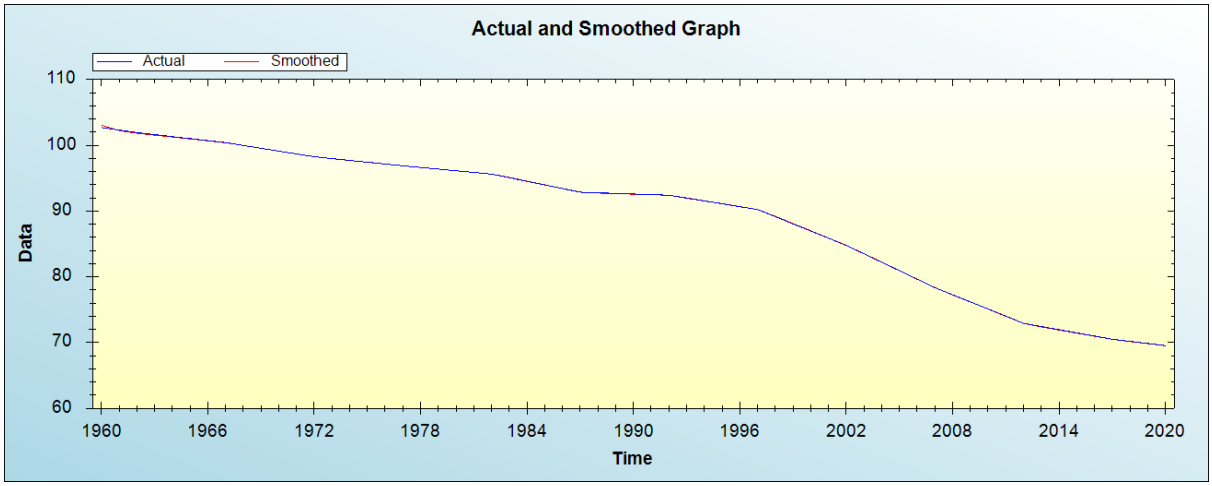

Figure 3: Actual and smoothed graph for P series

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

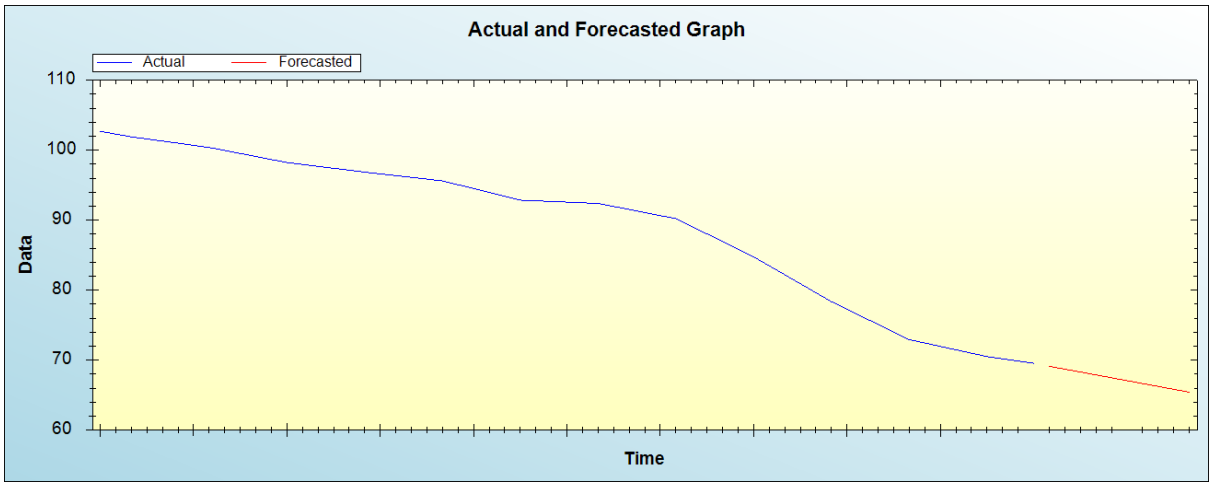

Figure 4: Out-of-sample forecast for P: actual and forecasted graph

Out-of-Sample Forecast for P: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted adolescent fertility rate
2021	69.1136
2022	68.7031
2023	68.2926
2024	67.8822
2025	67.4717
2026	67.0612
2027	66.6507
2028	66.2403
2029	65.8298
2030	65.4193

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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 rate will continue to decline throughout the out of sample period.

IV. POLICY IMPLICATION & CONCLUSION

Teenage pregnancy rates are still high in Paraguay and they are associated with high adverse SRH outcomes. There is a geographic variation in teenage pregnancy with rural arrears reporting more numbers than urban settings. According World Bank reports, adolescent fertility steadily declined from 92 births per 1000 women in 1990 to 58 births per 1000 women in 2014. This decline in adolescent fertility is attributed to the increased prevalence of modern contraceptive use and improvement in knowledge levels among adolescents. This study applied Holt's double exponential smoothing technique to forecast future trends of adolescent fertility for Paraguay. Study findings suggested that adolescent fertility will continue to decline throughout the out of sample period. Therefore, we encourage authorities in Paraguay to tirelessly enforce laws that safeguard sexual and reproductive health rights of women and girls, promote girl child education and improve the quality, affordability and accessibility of adolescent sexual and reproductive health services.

REFERENCES

[1] Azevedo W. F. D., Diniz M. B., Fonseca E. S. V. B. D., Azevedo L. M. R. D., and Evangelista C. B(2015). Complications in adolescent pregnancy: systematic review of the literature. Einstein (São Paulo) 13(4), 618-626.

[2] Makiwane M., Gumede N. A., and Molobela L (2018). Initiation of sexual behavior and early childbearing: Poverty and the gendered nature of responsibility amongst young people in South Africa. Journal of International Women's Studies, 2018; 19(5), 209–226. http://awdibrary.org:8080/handle/123456789/697

[3] Smith C., Strohschein L., & Crosnoe R (2018). Family histories and teen pregnancy in the United States and Canada. Journal of Marriage and Family, 2018; 80(5), 1244–1258.https://doi.org/10.1111/jomf.12512

[4] Yakubu I., & Salisu W. J (2018). Determinants of adolescent pregnancy in sub-Saharan Africa: A systematic review. Reproductive Health, 15(1), 15. https://doi.org/10.1186/s12978-018-0460-4

[5] Diaz C. J., and Fiel J. E (2016). The effect(s) of teen pregnancy: Reconciling theory, methods, and findings. Demography. 53(1), 85–116. https://doi.org/10.1007/s13524-015-0446-6

[6] Lang K., and Weinstein R (2015). The consequences of teenage childbearing before Roe v. Wade. American Economic Journal: Applied Economics, 2015; 7(4), 169– 97. http://dx.doi.org/10.1257/app.20130482

[7] Dongarwar D., and Salihu H. M (2019). Influence of sexual and reproductive health literacy on single and recurrent adolescent pregnancy in Latin America. Journal of Pediatric and Adolescent Gynecology, 2019; 32(5), pp 506-513. http://dx.doi.org/ 10.1016/j.jpag.2019.06.003

[8] Guilamo-RamosV.,LeeJ.J., and JaccardJ (2016).Parent-adolescentcommunicationabout contraceptionandcondomuse.JAMAPediatr2016;170:14–6.doi:10.1001/ jamapediatrics.2015.3109

[9] World Health Organization (2020). Adolescent pregnancy. https://www.who.int/news-room/fact-sheets/detail/adolescent-pregnancy.

[10] Bain L.E., Muftugil-Yalcin S., Amoakoh-Coleman M., Zweekhorst M.B., Becquet R., and de Cock Buning T (2020).Decision-making preferences and risk factors regarding early adolescent pregnancy in Ghana: stakeholders' and adolescents' perspectives from a vignette-based qualitative study. Reprod Health. 2020, 17:141. 10.1186/s12978-020-00992-x

[11] Brosens I., Muter J., Ewington L., Puttemans P., Petraglia F., Brosens J.J., and Benagiano G (2019). Adolescent preeclampsia: pathological drivers and clinical prevention. Reprod Sci. 2019, 26:159-71. 10.1177/1933719118804412

[12] Bokslag A., van Weissenbruch M., Mol B.W, de Groot C.J (2016). Preeclampsia; short and long-term consequences for mother and neonate. Early Hum Dev. 2016, 102:47-50. 10.1016/j.earlhumdev.2016.09.007

[13] Medhi R., Das B., Das A., Ahmed M., Bawri S., and Rai S (2016). Adverse obstetrical and perinatal outcome in adolescent mothers associated with first birth: a hospital-based case-control study in a tertiary care hospital in NorthEast India. Adolesc Health Med Ther. 7:37-42. 10.2147/AHMT.S91853

[14] Darroch J., Woog V., Bankole A (2016). Adding it up: costs and benefits of meeting the contraceptive needs of adolescents. New York: Guttmacher Institute.

[15] Mathewos S., and Mekuria A (2018). Teenage pregnancy and its associated factors among school adolescents of Arba Minch town, southern Ethiopia. Ethiop J Health Sci 2018; 28:287–98.

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[16] World Bank (2016). Adolescent fertility rate. https://data.worldbank.org/indicator/sp.ado.tfrt?end=2016&start=2010.
[17] Palmer S., Heaston S., and Trujillo R (2019). Student Perspectives on Teaching Adolescents Maturation and Reproductive Health in Rural Paraguay, 30th INTERNATIONAL NURSING RESEARCH CONGRESS Sigma Theta Tau International.

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