Global Decline in Fertility Rates: Trends, Influencing Factors, and Future Projections

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***Abstract*—Global fertility rates have significantly declined in recent years, falling below the replacement level of 2.1 children per woman in many developed countries, while rising populations due to increased life expectancy strain natural resources and heighten concerns about a shrinking labor force and the economic burden of an aging demographic. This study examines the trends and factors influencing declining fertility rates, including GDP per capita, inflation, unemployment, female labor force participation, urbanization, and child mortality. Utilizing regression analysis to create a predictive model, the research assesses how changes in these variables might affect future fertility rates, and it employs time series analysis on historical birthrate data to project trends for the coming years.**

***Index Terms*—fertility rate, population, decline, socio-economic, factors**

I. Introduction

The global decline in fertility rates has emerged as a significant demographic challenge, with many countries reporting fewer births over the past few decades. This decline raises concerns about aging populations, workforce shortages, and potential economic stagnation, as the replacement level of 2.1 children per woman is no longer met in many developed nations. Understanding the factors contributing to this decline is crucial for policymakers and researchers aiming to address its socio-economic implications and ensure long-term sustainability.

Several key factors have been linked to falling birthrates. Economic conditions such as unemployment, income levels, and the high cost of living deter couples from having larger families, especially in developed countries. Additionally, improved healthcare access has led to reduced child mortality and increased family planning options, allowing individuals more control over their reproductive choices. Higher educational attainment, particularly among women, is another major contributor, as it correlates with delayed childbearing and smaller families. Urbanization further exacerbates these trends by offering better job opportunities but also higher living costs and limited space for larger households.

The aim of this study is to analyze how factors such as GDP per capita, inflation, unemployment, female labor force participation, urbanization, and child mortality affect fertility rates. Using regression analysis, the study develops a predictive model to quantify the impact of these variables on birthrates. Additionally, time series analysis will be employed to forecast future fertility trends, providing insights into the potential demographic shifts that countries may face in the coming years.

This study provides actionable insights for policymakers by identifying key factors driving fertility decline and recommending targeted interventions such as economic incentives, improved healthcare, education, and public awareness. A multidisciplinary approach is emphasized to promote sustainable population growth and socio-economic stability.

II. Literature Review

The World Bank defines the fertility rate as the average number of children a woman would have based on the age-specific fertility rates of a particular year. This rate has long been a critical demographic indicator, especially in assessing population growth and socio-economic health. However, recent decades have seen a global decline, particularly in developed countries, raising concerns about its impact on labor markets, healthcare systems, and economic stability.

Shaw (2024) [1] explored the implications of falling birth rates, particularly in industrialized nations, and found that declining fertility negatively impacts economic stability. With people living longer and birth rates dropping below replacement levels, countries like Japan, South Korea, and Italy face shrinking working populations and increased healthcare costs, leading to economic strain.

Similarly, Roser [2] discussed global fertility trends, showing that as societies modernize, fertility rates have decreased from 4.5–7 children per woman to around 2.4. He identified three main drivers: women's empowerment through education and labor participation, declining child mortality, and the rising cost of raising children, which have collectively reduced birth rates. Roser [2] also highlighted how increased education for women correlates with lower fertility rates, creating a feedback loop where declining birth rates allow more opportunities for education. This trend was historically different when children were seen as contributors to family income, particularly in agricultural societies.

Alvarez [3] echoed these findings, pointing out that declining fertility rates, coupled with longer life expectancies, are leading

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to an aging population. This dynamic presents economic risks, such as higher healthcare costs and the pressure on a shrinking workforce to support retirees, which could lead to economic slowdown.

Nargund [4] analyzed declining birth rates in developed countries, focusing on subfertility caused by lifestyle factors and urban living conditions. She proposed a range of policy interventions, including better reproductive health education, fertility assessments, and improved access to child care and flexible job options to encourage family planning. The effects of economic downturns on fertility rates were explored by Matysiak et al. [5], who found that rising unemployment and GDP decline during the Great Recession contributed to lower fertility rates across Europe, with regional differences suggesting the need for nuanced economic policies to counteract fertility declines.

Sabermahani et al. [6] emphasized the role of marriage, education, unemployment, and family planning policies in fertility rates. Higher marriage rates correlated with higher fertility, while higher education for women led to delayed childbearing. Policies promoting education and access to contraception further reduced birth rates. In the Middle East and North Africa, a systematic review by Pourreza et al. [7] identified similar factors influencing fertility decline. Healthcare, cultural changes, economic uncertainty, and social policies like family planning programs have collectively contributed to lower fertility rates in the region.

Kato [8] examined fertility trends across OECD countries and confirmed that government policies, such as social spending and maternity leave, significantly impact fertility rates. His study showed that while GDP growth encourages higher fertility, longer maternity leave can have a counterproductive effect.

Lastly, Jeong et al. [9] studied South Korea's fertility policies and found that despite significant financial investment, the country's fertility rate continued to decline. The research suggests that targeted, customized approaches are needed rather than broad, financially heavy policies, as many current measures failed to address regional variations.

This study's findings align with previous research showing a negative relationship between GDP per capita and fertility rates, as highlighted by Roser [2] and Alvarez [3]. Similarly, trends in female labor force participation and urbanization driving fertility declines in high-income countries, such as Spain, mirror findings by Nargund [4] and Jeong et al. [9]. In contrast, factors like child mortality and healthcare access, significant in lower-income countries like the Philippines, are consistent with studies by Sabermahani et al. [6] and Pourreza et al. [7]. The study's unique contribution lies in its time series projections, which complement prior research by offering actionable insights into future demographic shifts.

III. Mehtodology

Data Source: The data for this study was obtained from the World Bank and spans from 1960 - 2022. It includes variables such as: GDP per capita, Inflation (Consumer Prices), Unemployment, Female Labor Force Participation Rate, Urbanization, Child Mortality

Exploratory Data Analysis (EDA): • Examined the distribution and trends of the fertility rates across various income groups and regions throughout the world.

ARIMA Time Series Analysis: • Applied to historical birthrate data to forecast future fertility trends for countries that belonged to various income groups. • The ARIMA model was fitted and validated through diagnostic checks to ensure that it met the assumptions required for time series forecasting.

Regression Analysis: • A multiple regression model was built to quantify the influence of socio-economic and demographic factors on fertility rates for countries that belonged to various income groups. • The model identified significant predictors and assessed their relationship with fertility rate declines.

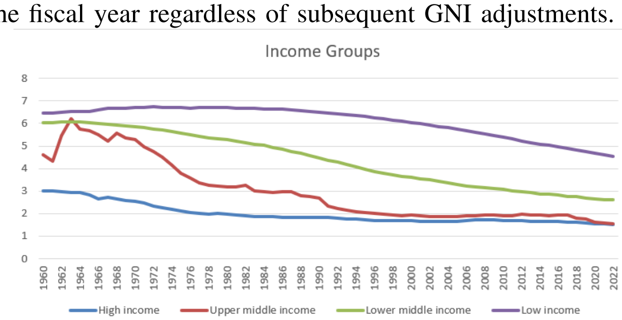
The analysis encompasses a wide range of countries, making the findings broadly applicable. However, fertility rate data may suffer from reporting inaccuracies, delays, and inconsistencies, particularly in low- and middle-income regions. These issues, along with outdated definitions or measurement methods in historical data, could bias the results and affect the precision of the regression and time series models. These limitations should be considered when interpreting the study's outcomes.

IV. Analysis of Results

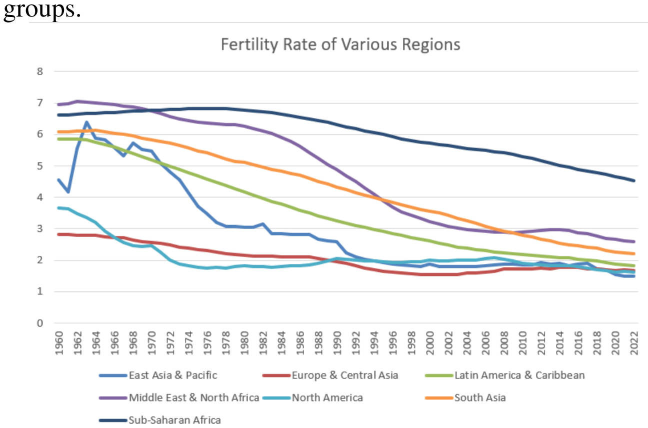
A. Exploratory Data Analysis

Of the 217 economies listed, 114 have fertility rates below replacement level, indicating a trend where more than half of countries have rates below 2.1 children per woman. Globally, fertility rates have declined significantly from around 5 in 1960 to just above 2 by 2022. The sharp decline observed between the 1960s and early 2000s has slowed in recent years, stabilizing around a rate of 2 since approximately 2010. This suggests that the global population is nearing replacement-level fertility, where population stability can be achieved without substantial immigration. The world bank classifies countries into 3 major groups, Income, Region and Operational Lending Categories. This study utilized the Income Groups and Regions to classify countries.

Income Groups Economies are classified into four income groups—low, lower-middle, upper-middle, and high—based on GNI per capita, using the World Bank Atlas method. These classifications, updated annually on July 1, remain fixed for the fiscal year regardless of subsequent GNI adjustments.



The graph shows the trends in fertility rates across different income groups from 1960 to 2022. High Income: Fertility rates in high-income countries have steadily declined over the period. The decline starts from about 3 children per woman in 1960 and drops to below 2 children per woman by 2022, indicating a move towards replacement-level fertility. Upper Middle Income: The fertility rate in upper middle-income countries initially increased slightly in the early 1960s before beginning a significant and steady decline from around 5 children per woman. By 2022, this rate drops to close to 2 children per woman, similar to the trend in high-income countries but starting from a higher level. Lower Middle Income: Lower middle-income countries also exhibit a clear downward trend in fertility rates, though starting at a higher rate of about 6 children per woman in 1960. The decline is slower compared to upper middle-income countries but still significant, reaching around 2.5 children per woman by 2022. Low Income: The fertility rates in low-income countries start at a very high level, around 7 children per woman in 1960. Although there is a gradual decline, it is less steep compared to the other income groups. By 2022, the fertility rate remains the highest among all income groups, but it has decreased to around 4 children per woman. Overall, the graph highlights the global trend of declining fertility rates, with more significant declines occurring in higher-income groups compared to lower-income groups.



The World Bank forms its geographic groupings based on regions used for administrative purposes. There are two main variants: one which includes all economies, and one which excludes high-income economies.

The East Asia and Pacific region, with over 2.3 billion people, includes countries like China and Japan. Of the 36 countries, 15 have fertility rates below replacement level. China's rate dropped from 6 in the 1960s to about 1.5 in the late 1990s due to policies, while Japan's fell to 1.4 in 2022. The majority of lower-middle-income countries also show declines from high fertility rates to around 2 children per woman, reflecting significant socio-economic changes.

Europe and Central Asia has about 900 million residents, featuring countries like Germany and Russia. Of the 56 countries, 50 have fertility rates below replacement level, averaging about 1.5. The decline from approximately 3 in 1960 highlights shifts in reproductive behavior due to socio-economic factors. Countries in Northern Europe typically have slightly higher rates, while some Central Asian nations exhibit regional variations influenced by cultural norms.

Home to about 650 million people, Latin America and the Caribbean includes Brazil and Mexico. Of the 41 countries, 28 have fertility rates below replacement level, currently around 2.0. This decline is attributed to improved education and healthcare access. The countries with fertility rates above replacement level are more evenly distributed among income levels, indicating broader changes in socio-economic conditions across the region.

With approximately 500 million people, the Middle East and North Africa includes Egypt and Saudi Arabia. Of the 20 countries, 8 have fertility rates below replacement level, with the average around 2.5. The decline from about 7 in 1960 reflects urbanization and education. Cultural norms significantly impact fertility rates, especially in higher-income countries, while civil unrest affects access to healthcare and education.

North America, with a population of around 370 million, consists of the U.S., Canada, and Mexico. All three countries belong to the high-income level. Fertility rates are low, below 2 in the U.S. and Canada, while Mexico's rates are higher but declining. Overall, the fertility rate dropped from about 3.5 in 1960 to below 2 by 2022, with recent stabilization suggesting an equilibrium in influencing factors.

South Asia, home to over 1.8 billion people, includes India and Pakistan. Of the 8 countries, 6 have fertility rates below replacement level, with the average around 2.3. Lower-middle-income countries primarily drive the decline, while Pakistan maintains higher rates influenced by socio-political conditions. Regional differences persist, with nations like the Maldives exhibiting unique fertility behaviors.

Sub-Saharan Africa has a population of around 1.1 billion, including Nigeria and Kenya. Of the 47 countries, 2 are below replacement level, while the average fertility rate is about 4.5. Mauritius and Cabo Verde show significant declines, while many countries with high rates are in lower-income groups. Recent trends suggest stabilization in some areas, reflecting changing cultural and economic dynamics.

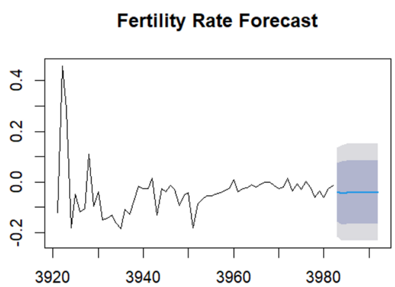
Overall, the analysis shows a consistent decline in fertility rates across all regions from 1960 to 2022, with the sharpest decreases in areas that initially had higher rates, such as Sub-Saharan Africa, the Middle East and North Africa, and South Asia. In contrast, fertility rates in Europe, Central Asia, and North America have stabilized at low levels, reflecting aging populations and a preference for smaller families. East Asia and the Pacific has also seen a significant decline, approaching the lowest fertility rates among the regions studied.

B. Time Series Analysis

World Fertility Rate Analysis: The ARIMA analysis confirmed that fertility data was initially non-stationary ($p = 0.6294$) but became stationary after differencing ($p = 0.01$). Two models were tested:

ARIMA(0, 0, 2): Included two MA terms (ma1 = 0.4048, ma2 = -0.1754) and a slight negative mean (-0.0408). It demonstrated low residual variance (sigma² = 0.008015) and AIC (-118.03) but showed high MAPE (258.25%), indicating unstable forecasts. ARIMA(0, 0, 1): Featured one MA term (ma1 = 0.5098) and a negative intercept (-0.041). Similar metrics were observed, with sigma² = 0.007931 and AIC (-117.64), but MAPE remained high (227.85Both models captured the differenced data structure effectively, though high MAPE values suggested the need for refinement. Diagnostic checks showed residuals fluctuating around zero, with some lag correlations and outliers. A Box-Ljung test (p = 0.4047) indicated no significant autocorrelation.

Forecasting Future Fertility Rates:

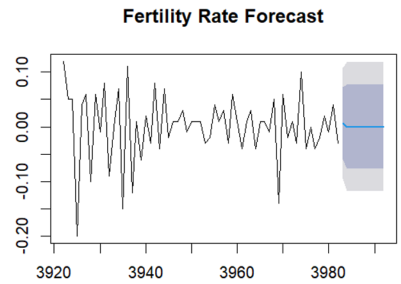


Forecasts for the next 10 years suggested slightly negative fertility rates (around -0.0407), with variability in confidence intervals highlighting challenges in prediction. While ARIMA(0, 0, 1) fit the data well, the high MAPE and negative forecasts warrant further exploration or alternative modeling approaches for better accuracy.

Spain Fertility Rate

The ARIMA analysis of Spain's fertility rate showed the series was initially non-stationary (p ¿ 0.05), but became stationary after two rounds of differencing (p ¡ 0.05). The chosen model, ARIMA(0, 0, 1), featured a negative moving average coefficient (ma1 = -0.6022), indicating that past positive errors lead to negative current changes. The model demonstrated a good fit with low residual variance (sigma² = 0.002661) and a favorable AIC (-185.12). Training Set Error Measures confirmed strong predictive accuracy: ME close to zero, indicating no systematic bias. RMSE (0.0512) and MAE (0.0391) reflected high accuracy. MASE (0.4943) showed improved performance compared to naive forecasts. ACF1 (-0.0021) indicated uncorrelated residuals. Diagnostic checks revealed randomness in residuals, with no significant patterns or autocorrelation (Box-Ljung p-value = 0.9556), supporting model adequacy.

Forecasting Future Fertility Rates:



Forecasts for the next 10 years suggested slight positive fertility rates, but with significant variability in confidence intervals.

In conclusion, the ARIMA(0, 0, 1) model effectively captured the second-differenced fertility data structure for Spain. Low error measures and robust diagnostics highlighted its strong performance, though the negative moving average coefficient underscored the influence of past forecast errors.

Philippines' Fertility Rate

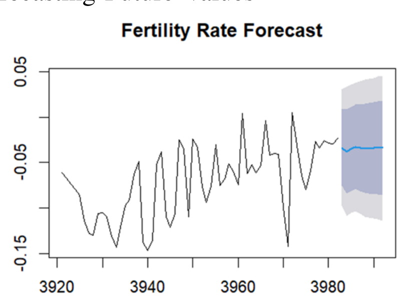
The fertility rate data was initially non-stationary (ADF test: p = 0.9211), requiring differencing. After differencing, the data became stationary (ADF test: p = 0.01). The selected model, ARIMA(2,1,1), included two autoregressive terms (AR1 = 0.2079, AR2 = -0.3538) and one moving average term (MA1 = -0.7484), indicating a significant negative effect of past shocks.

Fit Statistics confirmed a strong model fit:

Residual variance (sigma² = 0.001072) was low, and AIC (-237.88) and log likelihood (122.94) supported the model's adequacy. Error Measures reflected good predictive performance:

ME (0.0026) showed minimal bias. RMSE (0.0317) and MAE (0.0240) indicated accurate predictions. MASE (0.8724) suggested improved performance over naive forecasts. However, high MAPE (113.44%) called for caution in interpretation. Diagnostic Tests showed no significant autocorrelation, with Ljung-Box test results (p = 0.4663) and manual confirmation (p = 0.737) indicating residuals behaved like white noise.

Forecasting Future Values



Forecasting for the next 10 years predicted negative fertility rates, highlighting a potential decline, though confidence intervals indicated substantial uncertainty.

In conclusion, the ARIMA(2,1,1) model effectively captured the fertility rate data patterns, with robust diagnostics validating its forecasting adequacy despite some limitations in error metrics.

C. Regression Analysis on Fertility Rate

This analysis investigates the determinants of fertility rate from 1960 to 2022, utilizing socio-economic and demographic variables deemed relevant based on theory and data availability. The dependent variable is the fertility rate, while the independent variables include:

GDP per Capita: Higher GDP per capita is expected to negatively correlate with fertility rates due to increased education and family planning access in wealthier nations.

Inflation (Annual %): Higher inflation may negatively impact fertility by affecting household purchasing power and creating economic uncertainty.

Unemployment Rate: High unemployment is hypothesized to correlate negatively with fertility, as economic instability can delay childbearing.

Female Labor Force Participation: Increased female labor participation is expected to negatively correlate with fertility rates, as working women may have fewer or delayed children.

Urban Population: A strong negative correlation is anticipated between urban population and fertility rates, reflecting better access to education and family planning in urban areas.

Mortality Rate (Under 5): Higher infant mortality rates may positively correlate with fertility, as families may have more children to offset mortality risk.

The multiple linear regression model incorporates these variables to analyze their effects on fertility rates:

y = $\beta 0 + \beta 1X1 + \beta 2X2 + 3X3 + \beta 4X4 + \beta 5X5 + \beta 6X6$

This model aims to quantify how these factors influence fertility rates across different contexts.

Spain Regression

For the regression analysis of Spain, the dataset used 46 rows of data after removing 16 years due to missing values (1960-1969, 1971-1976). The regression equation includes GDP per capita, inflation, unemployment, female labor force participation, urban population percentage, and under-5 mortality rate as independent variables. Key findings from the analysis are:

• Model Fit: The adjusted R^2 is 0.9527, meaning that 95.27% of the variation in fertility rates is explained by the independent variables, indicating a very strong model fit. The F-test confirms the model is statistically significant.

y = 2.410 5.356e06x1 + 3.408e02x2 1.161e03x3 + 3.497e02x4 3.889e02x5 + 7.240e02x6

• Interpretation of Coefficients: o GDP per capita has a negative but very small effect on fertility rates. o Inflation, female labor force participation, and under-5 mortality have positive effects on fertility, while unemployment and urban population percentage show negative effects. • Significance of Variables: o GDP per capita, inflation, urban population %, and under-5 mortality are highly significant. o Female labor force participation is not statistically significant. • Model Validation: o A partial F-test shows that the full model is better than the reduced one. o The residuals suggest slight non-normality and heteroscedasticity, but these issues are not severe enough to invalidate the model. • Correlations: o Negative correlations exist between GDP per capita and fertility rate, unemployment, and urban population percentage. o Strong positive correlations are found between inflation, under-5 mortality, and fertility rates.

Philippines Regression For the regression analysis of the Philippines, the dataset used 43 rows of data after removing 18 years due to missing values (1960-1974, 1977, 1979, 1981, 1982, 1984, 1986). The regression equation includes GDP per capita, inflation, unemployment, female labor force participation, urban population percentage, and under-5 mortality rate as independent variables.

Key findings from the analysis are:

• Model Fit: The adjusted R^2 is 0.9874, meaning that 98.74% of the variation in fertility rates is explained by the independent variables, indicating a very strong model fit. The F-test confirms the model is statistically significant.

y = 5.576 0.000256X1 0.004148X2 + 0.03295X3 0.002214X4 0.05333X5 + 0.02262X6

• Interpretation of Coefficients:

GDP per capita has a small but negative effect on fertility rates. Inflation has a negative effect on fertility, though it is not statistically significant. Unemployment and under-5 mortality have positive effects on fertility, with unemployment being statistically significant. Female labor force participation and urban population percentage have negative effects on fertility, with urban population being statistically significant. • Significance of Variables:

GDP per capita, unemployment, urban population %, and under-5 mortality are statistically significant. Inflation and female labor force participation are not statistically significant. • Model Validation:

A partial F-test shows that the full model is better than the reduced one. The residuals are roughly normally distributed with slight skewness, and there is no clear pattern in homoscedasticity, suggesting the model is valid. • Correlations:

A negative correlation exists between GDP per capita and fertility, as well as between urban population and fertility. Strong positive correlations are found between under-5 mortality and fertility, with moderate positive correlations for inflation and unemployment.

V. Discussion

Fertility rates exhibit global declines influenced by GDP growth, urbanization, and improved healthcare, aligning with demographic transition theory. However, country-specific dynamics, such as those in Spain and the Philippines, reveal how these factors uniquely shape societal norms and reproductive behavior. In Spain, regression analysis indicates that declining fertility is primarily influenced by GDP per capita, female labor force participation, and urbanization. Increased workforce participation among women has shifted social norms, reducing family sizes, while improvements in healthcare have stabilized child mortality rates. These trends align with those observed in other high-income countries, where economic and social factors dominate fertility decisions. Conversely, the Philippines exhibits a strong positive relationship between child mortality and fertility, reflecting the influence of health risks on reproductive behavior. While GDP per capita negatively impacts fertility, urbanization and unemployment have a lesser effect compared to Spain. This highlights how the Philippines' fertility trends are shaped more by public health challenges than purely economic factors, underscoring the critical role of healthcare in middle- and low-income countries.

Addressing these dynamics requires targeted and multi-faceted policy interventions. High-income countries like Spain can mitigate fertility decline by incentivizing childbirth through financial measures such as subsidies, tax breaks, and child allowances. Improving work-life balance is equally critical; policies like flexible schedules, paid parental leave, and innovative approaches, such as a four-day workweek, demonstrate how workplace reforms can support family life. Additionally, investing in elder care services can reduce caregiving burdens on families, enabling a greater focus on childbearing. For low- and middle-income countries like the Philippines, addressing public health and education challenges is essential. Investments in reproductive health services, early childhood education, and quality healthcare can reduce child mortality rates and empower informed family planning decisions.

While this study provides valuable insights, several limitations must be acknowledged. The regression analysis assumes linear relationships between variables, potentially oversimplifying complex interactions. Additionally, focusing on quantitative metrics may overlook significant qualitative factors such as cultural shifts, societal values, and lifestyle changes. The time series analysis assumes historical patterns will persist, limiting its ability to predict unprecedented events like global pandemics or major policy changes. These limitations highlight the need for future research to explore alternative approaches that better capture the nuances of fertility dynamics.

Overall, these findings emphasize the need for policies tailored to specific socioeconomic and cultural contexts. High-income countries like Spain should focus on improving work-life balance and elder care, while low- and middle-income nations like the Philippines require healthcare and education reforms. Targeted interventions addressing these unique challenges are crucial to promoting sustainable population growth and socio-economic resilience.

VI. Conclusion

This study explores the complex relationship between fertility rates and socioeconomic variables, highlighting both global trends and country-specific dynamics. In Spain, fertility decline is driven by urbanization, rising GDP per capita, and increased female workforce participation. In contrast, the Philippines' fertility patterns are influenced more by public health issues like child mortality, reflecting the different stages of economic development.

Regional and income-based trends show high-income regions like Europe and North America experiencing steep fertility declines, stabilizing at or below replacement levels, while middle- and low-income regions face gradual declines, influenced by public health and education. Policies should be tailored to regional and cultural contexts, with developed nations focusing on work-life balance and elder care, while developing countries must invest in healthcare and education for informed family planning.

Future research should explore sociocultural and policy factors alongside advanced techniques such as machine learning to better capture the complexities of fertility dynamics. By addressing these challenges with innovative methodologies, researchers can develop actionable strategies to mitigate the economic and social pressures of declining fertility rates and contribute to sustainable population growth.

References

[1] S. Sackur and S. J. Shaw, "Bbc news - hardtalk, stephen j shaw - data scientist and demographer," May 2024.

[2] M. Roser, "Fertility rate," *Our World in Data*, Mar 2024.

[3] P. Alvarez, "What does the global decline of the fertility rate look like?," Jun 2022.

[4] G. Nargund, "Declining birth rate in developed countries: a radical policy re-think is required," *Facts, Views Vision in ObGyn*, vol. 1, no. 3, p. 191–193, 2009.

[5] A. Matysiak, T. Sobotka, and D. Vignoli, "The great recession and fertility in europe: A sub-national analysis," *European Journal of Population*, vol. 37, p. 29–64, Apr 2020.

[6] A. Sabermahani, R. Goudarzi, and S. Nasiri, "Factors affecting fertility rate in iran (panel data 1966-2013): A survey study," *Journal of Family Reproductive Health*, vol. 11, p. 138–145, Sep 2017.

[7] A. Pourreza, A. Sadeghi, M. Amini-Rarani, R. Khodayari-Zarnaq, and H. Jafari, "Contributing factors to the total fertility rate declining trend in the middle east and north africa: a systemic review," *Journal of Health, Population and Nutrition*, vol. 40, Mar 2021.

[8] H. Kato, "Total fertility rate, economic–social conditions, and public policies in oecd countries," *SpringerBriefs in population studies*, p. 51–76, Jan 2021.

[9] K. Jeong, J. Yoon, H. J. Cho, S. Kim, and J. Jang, "The relationship between changes in the korean fertility rate and policies to encourage fertility," *BMC Public Health*, vol. 22, Dec 2022.

[10] J. Chapman, "The long-term decline in fertility—and what it means for state budgets," Dec 2022.

[11] J. Grant, S. Hoorens, S. Sivadasan, J. DaVanzo, L. Hale, S. Gibson, and W. Butz, "Population implosion?: Low fertility and policy responses in the european union," 2019.

[12] P. K. Rai, S. Pareek, and H. Joshi, "Regression analysis of collinear data using r-k class estimator: Socio-economic and demographic factors affecting the total fertility rate (tfr) in india," *Journal of Data Science*, vol. 11, p. 323–342, Jul 2021.

[13] W. Bank, "Fertility rate, total (births per woman) — data," 2021.

[14] M. Quiroz-Gutierrez, "Tokyo is turning to a 4-day work week in a desperate attempt to help japan shed its unwanted title of "world's oldest population"," Dec 2024.

[15] J. Grant, J. Grant, S. Hoorens, S. Hoorens, S. Sivadasan, S. Sivadasan, van, van, J. DaVanzo, J. DaVanzo, L. Hale, L. Hale, S. Gibson, S. Gibson, W. Butz, and W. Butz, "Low fertility and population ageing," 2009.

[16] H. Khan and R. Raeside, "Factors affecting the most recent fertility rates in urban-rural bangladesh," *Social Science Medicine*, vol. 44, p. 279–289, Feb 1997.

[17] F. Lin, "[social and economic factors affecting china fertility transition]," *Ren Kou Yan Jiu = Renkou Yanjiu*, p. 15–21, Jan 1987.

[18] Y. Matsumoto and S. Yamabe, "Family size preference and factors affecting the fertility rate in hyogo, japan," *Reproductive Health*, vol. 10, Jan 2013.

[19] H. M. Wallace, *Health and Welfare for Families in the 21st Century*. Jones Bartlett Learning, 2003.

[20] Youtube, Feb 2023. https://youtu.be/A6s8QlIGanA?si=$_b7yTJd1eo6lLo0L$.