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The Impact of Fertility on the Life Expectancy in Rwandan Economy

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Abstract

This study investigated the relationship between fertility rates and life expectancy in Rwanda, a country undergoing significant demographic changes. With a high fertility rate of 4.2 children per woman and concerning maternal mortality rates, Rwanda faces challenges exacerbated by complex health issues like HIV/AIDS. However, initiatives supported by USAID are aiding in combatting these challenges and improving overall healthcare. The study delved into the intricate interplay between fertility patterns and life expectancy dynamics and acknowledged the scarcity of research on this topic specific to Rwanda. Employed quantitative research methods including descriptive, correlation, and causal-comparative analysis. Using data spanning from 1965 to 2020, the study covered significant findings regarding the relationship between fertility and life expectancy. Results revealed an inverse correlation between fertility rates and life expectancy, highlighting the importance of interventions to reduce fertility rates to enhance overall population health and well-being. In conclusion, Rwanda's strides in healthcare infrastructure and social welfare since the devastating genocide have led to a notable increase in life expectancy. Recommendations include continued investment in healthcare systems, focused vaccination programs, targeted interventions to reduce fertility rates, promotion of gender parity and women's health, alignment with Sustainable Development Goals, partnerships with international organizations, and establishing robust monitoring and evaluation mechanisms for evidence-based decision-making. These recommendations aim to further improve healthcare and social welfare, ultimately enhancing life expectancy and fostering sustainable development in Rwanda.

Keywords: Fertility; Life; Life expectancy; Mortality

Introduction

Rwanda is an African country with the most densely populated nation, the fertility rate in Rwanda is high at 4.2 children per woman and maternal mortality is unacceptably high at 210 per 100,000 births. Rwanda is also a challenging complex VIH/AIDS epidemic with a prevalence of 3% among the general population but as high as 50% among the most at-risk populations. However, USAID is supporting the Government of Rwanda to fight VIH/AIDS and malaria, increase the quality and use of family planning and reproductive health services, improve maternally newborn and child health, promote the increase in access to clean water and sanitation, improve nutrition and strengthen to overall health sectors ("Global Health | Rwanda | U.S. Agency for International Development,") [1]. Health improvement is a key determinant of economic development, Hence, the impact of life expectance on economic growth is affected by the level of poverty in any country. Many kinds of research have been conducted on health and economic growth. However, the role of poverty reduction and the threshold of health influence the life expectancy of humankind [2]. Using data from 157 countries, Heath and Lorentzen found that age-specific fertility in women aged 15 to 19 was negatively correlated with life expectancy and positively correlated with infant mortality [3].

Leutscher report similar results for a sample of 98 countries: Nations with longer life expectancies have higher ages at first birth and lower age-specific fertility [4]. Although earlier reproduction is associated with poorer long-term health outcomes, many factors favour earlier reproduction versus delayed reproduction [5]. All else being equal, individuals who reproduce earlier leave more offspring, while those who delay reproduction leave fewer offspring. Delayed reproduction is therefore associated with lower long-term fitness and a greater likelihood of lineage extinction [6]. Mortality is expected to affect fertility patterns even more in humans than in other mammals because human offspring have very long periods of dependency. As a result, adult mortality will reduce an individual's fitness, not only depriving that individual of future reproductive opportunities but also endangering the survival of existing young children. Human life histories may have been selected to respond to local mortality pressures and to adjust sexual behaviour and fertility in adaptive patterns to maximize future reproductive success [4].

Statement of the Problem

Rwanda, undergoing a swift demographic transition, is witnessing notable changes in its population dynamics, particularly regarding fertility rates and life expectancy (NISR) [7]. Despite the crucial role fertility plays in shaping life expectancy, this aspect remains relatively unexplored within Rwanda's demographic context [8]. Although advancements in healthcare, socioeconomic conditions, and public health initiatives have contributed to a consistent rise in life expectancy, the precise influence of fertility on this trend remains ambiguous [9]. Recognizing the significance of understanding the correlation between fertility and life expectancy, policymakers, healthcare practitioners, and researchers are urged to develop targeted interventions aimed at enhancing population health and fostering sustainable development [10]. Nevertheless, the available literature on this subject is scant, necessitating comprehensive studies to unravel the intricate interplay between fertility patterns and life expectancy dynamics specific to Rwanda [11]. This research endeavour endeavours to offer valuable insights to assess the role played by fertility on life expectancy in Rwanda, with the ultimate goal of informing evidence-based policies and interventions designed to enhance population health outcomes and promote sustainable development initiatives within the nation.

Literature Review

The effect on economic growth for countries undergoing the transition in the period of observation is insignificant although it tends to be negative and larger in absolute value and size than the average effect for the full of pre-transition countries [12]. The increase in population growth is the largest for countries shifting from low-income and middle-income transition. This has the largest negative population effect on the income per capita [13]. Concerning the economic transition in crude birth rates, the effect of life expectancy on lower fertility, and lower population growth is positive but insignificant over the shorter horizon, but positive and significant over the longer horizon (Bowser and Hill) [14]. The overall increase in life expectancy represents a significant increase in the probability that a nation undergoes fertility and demographic transition. Improving health, such as reducing child and maternal mortality, will increase the population. These are believed to reduce fertility, stabilize population growth, and, over the long term, generate a demographic dividend through reduced youth dependency. On the contrary, another argument for this may be the increase in population, particularly in sub-Saharan Africa where a large population is a problem. The gains from better health could be offset by falling per capita income if the economy is unable to accommodate the growing population. On the other hand, diseases that do not lead to death but severely affect a person's health and productivity have a negative impact on productivity. Unless proper attention and care are given, HIV AIDS is an example of the previous statement because the disease can make a patient dependent on others. But when people living with HIV/AIDS receive adequate medical treatment and adequate nutrition, they can work, perform and produce. As prepared by Bloom [15].

Adult life expectancy, for example, by encouraging parents to go to school, causes a significant increase in the productivity of workers and a notable decline in fertility. These results are consistent with recent empirical studies by Hansen and Lonstrup, which show that the causal effect of life expectancy on per capita income growth is small and negative before the demographic change, but afterward is very positive [16]. The model follows the approach used in the literature, which explains the decline in fertility by parents replacing the number of children with quality, see, and inter alia [17]. However, this paper makes a clear distinction between the quality provided to children and formal schooling, which in this model is only acquired by parents. Sede and Ohemeng combine time allocation and the trade-off between quantity and quality in a framework for fertility decisions [18]. Children are seen as goods that are both consumed and produced by their parents. Parents must decide how to spend their limited resources on the number and quality of children and other goods and services. The production of children is limited by consumer technology, the income potential of men and women, and the endowment of women with time and their non-labour income. However, unlike the latter, the possibility of a negative value is also taken into account. The impact of the opportunity cost of childcare is considered to be negative on fertility. The birth and care of children are very time-consuming, so the wages or value of women in other non-market jobs should be considered as an opportunity cost of having children. Because higher income is associated with a higher value of female time, a negative relationship between income and fertility is expected. The framework has been further expanded to accommodate a dynamic environment in which decisions about fertility are made at multiple points in time. Muda have criticized the previously presented neoclassical fertility frameworks. These consumer demand attitudes are not appropriate for fertility because fertility is not always controlled. Actual fertility may be higher or lower than desired fertility [19,20].

A framework that analyzes fertility should keep this in mind. Another approach to fertility is through theories that discuss the relationships between fertility, population growth, and income. In Solow's model of economic growth (1956), an increase in population growth causes capital per worker to decrease and thus has a negative impact on capital accumulation and output per worker. High fertility leads to high population growth and therefore lower income. Contrary to the previously presented models, income does not affect fertility, but fertility does negatively affect income. Bleakley combines growth theories and household/labour supply theories to analyze the relationship between economic growth and fertility [21]. A positive loop is discussed. An increase in capital per worker raises women's wages because their productivity is more tied to capital. Increasing women's relative income reduces fertility because it increases the cost of having children through the time women have to spend having them. Low fertility leads to further capital accumulation by the worker and strengthens the process. Low fertility and income growth thus reinforce each other. Myrskyla discovered an inversion of the relationship between HDI and TFR [22]. A negative association was found among low- and medium-HDI countries, as predicted by the household/labour supply models discussed above. In the more developed countries, however, this pattern was reversed, and the more developed countries recorded higher fertility rates. It is proposed to characterize the relationship between HDI and TFR as a J-shape, with a turning point at an HDI of 0.86. Jin fined a similar reversal in the relationship between economic development and birth-robust fertility shift [23]. By decomposing GDP per capita, it is found that female employment is associated with declines in fertility. They also point out that fertility rates can only be partially explained by economic developments and underline the importance of institutional factors. Population growth and high fertility rates in resource-poor environments can pose challenges for both society and individuals. A growing population can affect the well-being of that population in terms of socioeconomic socio-economic development, environmental sustainability, sustainability, and resource supply. Resource-poor countries with growing populations face the challenge of creating jobs for emerging workers while their governments lack the resources to meet the rising demand for services and infrastructure (United Nations Population Fund; 2012). The effects of high fertility are also challenging for individuals. When many children are born to one mother, it places an economic burden on her household and increases the likelihood that her family will fall (JAMA 2006, 295:18091823). In families that do not have sufficient adequate resources for education, nutrition, nutrition, and health care, children - especially girls - may be forced to drop out of school and marry early. High fertility also increases the risk of having a child being born prematurely or with low birth weight and stunting as it grows, and preterm birth increases the maternal health risk for mothers' risks (World Bank; 2005).

Demographic transition describes a widely observed phenomenon where the population transitions from high levels of mortality and fertility to low levels of mortality and fertility. This transition is marked by an initial decline in child morale due to improved infrastructure, health system developments, and socioeconomic improvements, followed years later by a decline in fertility rates. Rwanda was an exception (Popul Dev Rev) [24]. Rapid improvements in health systems, infrastructure, and social programs over the past decade have placed Rwanda in a rapid fertility transition. Between 2005 and 2010, the under-five mortality rate was halved from 152 to 76 deaths per 1000 live births, representing one of the fastest improvements in infant mortality in human history. This decline in fertility and contraceptive use in Rwanda coincides with a significant change in government officials' attitudes toward family planning in the context of economic development policies. Given that Rwanda has the highest population density of any African country (416 people per square kilometer with an annual population growth rate of 2.6% (National Institute of Statistics of Rwanda; 2012), smaller families and limited population growth became priorities for individual well-being and national progress. Officials then launched widespread campaigns to change public attitudes toward acceptance of small families, with the informal goal of bringing the total fertility rate to fewer than 4 children per woman [25]. Following the introduction of compulsory free primary education and in response to the rising cost of living, the government has launched awareness campaigns to encourage couples to have only as many children as the family can feed, raise and support. This was reinforced at the community level with community health workers and community leaders in monthly Community works meetings. Despite this major shift in fertility, there are many families in Rwanda who still have large families; more than 20% of women between the ages of 15 and 49 have currently had five or more births. Rwanda is undergoing a major demographic transition that is setting the course for the country's economic development and bucking trends in a region of slow fertility transition. Understanding predictors of fertility can support the development of policies and interventions that both help families achieve their desired fertility and inform government economic policies and infrastructure development plans. Findings can also inform fertility policies and programming elsewhere in sub-Saharan Africa. This article examines some of the determinants of fertility rates in Rwanda, looking separately at women who have ever been married/living together and women who have never been married.

Research gaps

The empirical review sheds light on various factors influencing fertility rates and their implications for economic growth and population dynamics. However, there is a notable gap in research specifically addressing the impact of fertility on life expectancy in Rwanda. While existing studies have explored the relationship between fertility and economic growth, the focus has primarily been on economic consequences rather than demographic health outcomes such as life expectancy. Economic transitions, including improvements in healthcare and education, influence fertility rates, subsequently affecting economic growth [12]. Despite this, there's limited research directly examining the impact of fertility on life expectancy within Rwanda. Moreover, the review underscores the multifaceted nature of fertility decisions influenced by socioeconomic status, healthcare access, and cultural norms [14]. While some studies suggest a negative association between fertility rates and economic development, others indicate a more nuanced relationship, with factors like women's empowerment and education playing vital roles. The demographic transition in Rwanda, marked by rapid improvements in healthcare and infrastructure, offers a unique context for investigating the fertility-life expectancy relationship. Comprehensive studies focusing on this relationship are needed to fill the research gap and inform evidence-based policies for population health and sustainable development in Rwanda [4].

The demographic transition theory

The Demographic Transition Theory, proposed by Warren Thompson in 1929, offers a framework for understanding the historical shifts in population dynamics as societies undergo economic and social development. According to this theory, societies typically transition through four stages, each characterized by distinct patterns of fertility, mortality, and population growth. In the initial stage, known as Stage 1, both birth rates and death rates are high, resulting in minimal population growth. This stage is typical of pre-industrial societies where limited access to healthcare, sanitation, and education contributes to high mortality rates, particularly among infants and children. As societies progress to Stage 2, improvements in healthcare, sanitation, and living conditions lead to a significant reduction in mortality rates, particularly among infants and children. However, birth rates remain high, resulting in rapid population growth. The transition to Stage 3 occurs as societies experience further economic development, urbanization, and improvements in education and access to contraception. In this stage, birth rates begin to decline as individuals choose to have fewer children due to increased opportunities for education, employment, and urban living [26]. Finally, in Stage 4, both birth rates and death rates are low, resulting in a stable population size or even population decline in some cases. This stage is characterized by advanced healthcare systems, widespread access to contraception, and a high level of urbanization. The Demographic Transition Theory suggests that as societies progress through these stages, fertility declines play a significant role in shaping population age structures and life expectancy [26].

Materials and Methods

Research design

The following quantitative research methods were employed such as descriptive research (it requires a very large sample size and is used to describe a population), correlation research (it explores the relationship between two or more variables), and causal-comparative (it seeks to establish the difference in variables between groups). The methodological approach adopted the descriptive and econometric approaches. The Gross National Income (GNI) per capita is presented as a function of life expectancy and other control variables such as education, mortality, and fertility [27]. The time series were indulged with the unit root problem that makes the error of the time series nonstationary. Co-integration test plays a big role in finding the relationship between variables (Juselius). The vector error correction model (VECM) was used to investigate the effect of fertility on life expectancy in Rwanda from 1965 to 2020. The general assumption in the suggested model is that there is at least one long-run co-integration vector for the variables and the value of the dependable variable can be meant as a function of past values of the dependent variable, past values of the independent variable, and error term.

Population and sample

The life expectancy indicator mostly relies on the number of years of life expectancy at birth. For instance; among the past studies conducted, employed the life expectancy at birth, utilized the total number of years that an individual has to live in a country to gauge the life expectancy variable. The researcher used the number of years of life expectancy at birth (total in men and women) to measure life expectancy in Rwanda. To obtain this measure and annual GDP growth rate, data were collected from the World Bank Database [28].

Data collection procedures

The data were retrieved from The World Bank's World Development Indicators from 1965 to 2020. The data on fertility were used to test the co-integration and causality relationship between life expectancy and fertility in panel data. The researcher used the variable of life expectancy as an indicator of health and employed real per capita GDP as a criterion of economic growth. The study used the annual data and covers the period from 1965 to 2020. The logarithms of variables were employed for empirical analyses. The researcher adopted an empirical specification that allows for different effects of life expectancy on the population. To figure out problems of reverse causality and to investigate the causal effect of fertility on life expectancy. The base sample was relevant to the predicted fertility instrument and life expectancy. In further investigations of the human capital, the channel was tracked based on the population share without schooling and on the average years of schooling in the population of working age constructed by Cohen and Soto [29-32] (Figure 1).

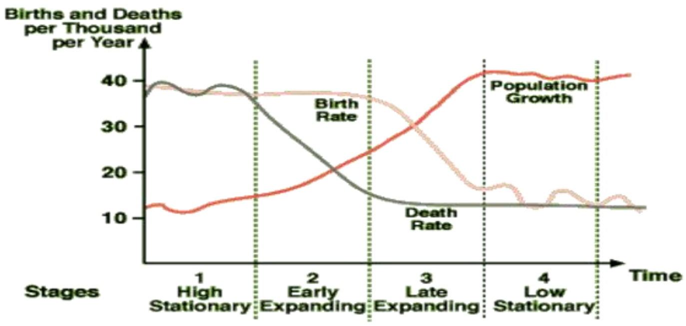

Figure 1: *Demographic Transition Model.*

Data Analysis

The causal effect of fertility on life expectancy

The researcher examined the relationship between fertility and life expectancy:

Fertility art = $\alpha + \beta LE_{art} + \gamma_a + \lambda_r + \eta_t + \theta_{rt} + e_{art}$, (1)

Where a refers to age group, r refers to Rwanda and r refers to the year.

Fertility is the number of children born per 1000 women by age group. LEart is the number of average years an individual is expected to live conditional on surviving to age -group an in year t in Rwanda r. For a woman of a particular age group, mortality shocks that eventually affect older individuals impact her life expectancy but not mortality shocks that impact younger individuals.

Results

In the early 1990s, Rwanda met the tragedy of a 100-day genocide where a million Innocent Tutsis were killed. This destroyed all infrastructure and left millions in deeper poverty. In this period, life expectancy reached a low of 26.2 years in 1993 at the height of the genocide. However, it has risen in 2018 to 68.7 years. Rwanda's projection in 2032, life expectancy will be 71.4 years. Many factors have been put into place to increase life expectancy and social welfare. Therefore, the government of Rwanda has started to invest in healthcare systems such as primary healthcare systems, HIV/AIDS healthcare systems, oncology services, community-based health insurance, and medical education. The potential increase in vaccination activities has been dramatically improving Rwandans' health status. After the genocide against the Tutsis, at least 25% of Rwandan children have been vaccinated against measles and polio. In 2022, Rwandan infants received vaccinations against 10 diseases at the rate of 97%. As Rwanda moves toward development growth, there is a strong decline in deaths from tuberculosis and malaria as well as maternal and child mortality. After the Genocide against the Tutsis, Rwanda experienced the world's highest rate of child mortality. Hence, in 2022, Rwanda has reached the global average. The VIH/AIDS case and death rates have potentially slowed down. The external funds have improved Rwandans 'health. In the year of 1995, Rwanda received \$0.50 per person for healthcare, less than any other country in the continent of Africa. Many organizations like Partners in Health (PIH) played in the increase of the population's access to healthcare and supported Rwanda to rebuild community health systems (Figure 2). Visually presents Rwanda's life expectancy at birth, quantifying the average number of years a newborn is anticipated to live if prevailing mortality trends persist. This metric serves as a crucial indicator of overall societal health and underscores the urgency of targeted interventions to improve longevity and well-being. By providing a snapshot of life expectancy dynamics, Figure 2 offers policymakers and stakeholders valuable insights into the effectiveness of current health initiatives and the areas requiring further attention to ensure sustainable improvements in life expectancy for Rwanda's population.

OLS between life expectancy and fertility

Table 1 highlights how fertility (P=0.0000) is negative and statistically significant on life expectancy at 5%. The coefficient term tells the change in life expectancy for a unit change in fertility this means that if the fertility rises by 1 unit, then life expectancy decreases by -0.7831935. In other words, we need to implement interventions to decrease the fertility rate in order to increase the life expectancy in Rwanda (Table 1).

Vector autoregressive model

The autoregressive model in Table 2 has shown how each variable has an equation modelling its evaluation over time. The below equation includes the variables and their covariates lagged at one year such as life expectancy (p = 0.000), fertility (p = 0.000), mortality (p = 0.000), Urban population growth (annual %) (p = 0.000), and Population density (people per sq. km of land area) (p = 0.000). The prior knowledge required is a list of variables and covariates that can be hypothesized (Null and Alternative hypotheses) to affect each other over a while (Table 2).

Granger causality Wald tests for life expectancy and fertility

Following the results below in (Table 3) where I have tested the causal effect of life expectancy on fertility and its covariates lagged at 1 year.

1. Fertility (p = 0.000), Urban population growth (annual %) (p = 0.000), and Population density (people per sq. km of land area) (p = 0.000) do significantly cause the life expectancy at 5%, while mortality (p = 0.058) does cause life expectancy at 10%.
2. Mortality (p = 0.000), Urban population growth (annual %) (p = 0.007), and Population density (people per sq. km of land area) (p = 0.000) do significantly cause fertility at 5%.
3. Fertility (p = 0.000) and Population density (people per sq. km of land area) (p = 0.000) do significantly cause fertility at 5%.
4. Life expectancy (p = 0.000), Mortality (p = 0.002), and Population density (people per sq. km of land area) (p = 0.027) significantly cause Urban population growth (annual %) at 5%, while fertility (p = 0.063) does cause Urban population growth (annual %) at 10%.
5. Life expectancy (p = 0.000) and Urban population growth (annual %) (p = 0.000) significantly cause Population density (people per sq. km of land area) at 5%.

It's frequently observed that there exists an inverse correlation between life expectancy at birth and the fertility rate.

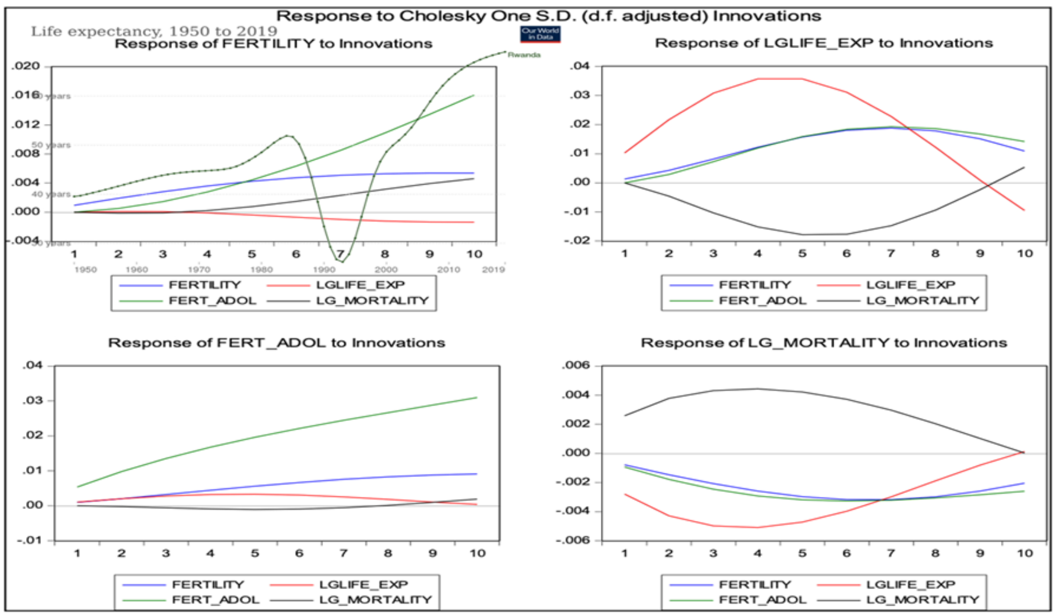

Figure 2: *The trend of life expectancy.*

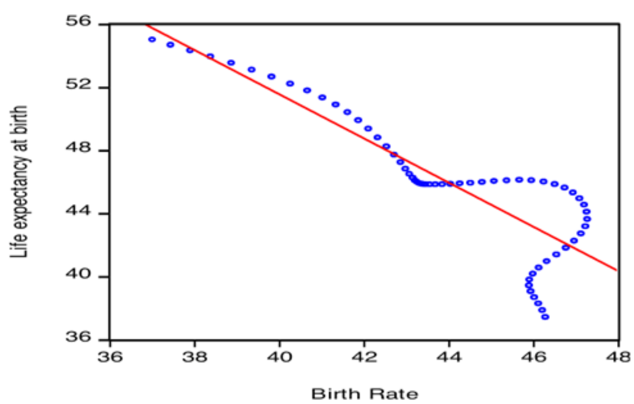

Figure 3: *Scatter plot of birth rate and life expectancy.*

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Table 1: *OLS between Life Expectancy and Fertility.*

Source	SS	df	MS	Number of obs =52		
F(1, 50) = 25.72						
Model	1.11823372	1	1.11823372	Prob > F =0.0000		
Residual	2.1741338	50	0.04348268	R-squared = 0.3396		
Adj R-squared =0.3264						
Total	3.29236752	51	0.06455623	Root MSE =0.20853		
log_lifexp	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
fertility	-0.7831935	0.1544404	-5.07	0.0000	-1.093396	-0.4729908
_cons	6.824362	0.5801407	11.76	0.0000	5.659115	7.989609
Note: denote significance at 5%						

Table 2: *Vector Autoregression Model for life expectancy and fertility.*

Sample: 1970 - 2020	Number of obs = 51			
Log likelihood = 248.0776	AIC = -8.552064			
FPE = 1.34e-10	HQIC = -8.117824			
Det(Sigma_ml) = 4.10e-11	SBIC = -7.415696			
Equation	RMSE	R-sq	chi2	P>chi2
log_lifexp	0.034546	0.9836	3068.036	0.000
fertility	0.004253	0.9995	112758.3	0.000
Mortality	0.037052	0.9895	4790.837	0.000
urb_grow	1.64653	0.8454	278.7801	0.000
Pop_density	3.19474	0.9992	61370.61	0.000

Table 3: *Granger causality Wald tests for life expectancy and fertility.*

Granger causality Wald tests				
Equation	Excluded	chi2	df	Prob > chi2
log_lifexp				
log_lifexp	Fertility	32.672**	1	0.000
log_lifexp	Mortality	3.6017*	1	0.058
log_lifexp	Urb_grow	17.109**	1	0.000
log_lifexp	Pop_density	25.427**	1	0.000
Fertility				
Fertility	Mortality	30.091**	1	0.000
Fertility	urb_grow	7.3439**	1	0.007
Fertility	Pop_density	131.53**	1	0.000
Mortality				
Mortality	Fertility	37.008**	1	0.000
Mortality	Pop_density	22.033**	1	0.000
Urb_grow				
urb_grow	log_lifexp	19.674**	1	0.000
urb_grow	Fertility	3.4512*	1	0.063
urb_grow	Mortality	9.527**	1	0.002
urb_grow	Pop_density	4.8747**	1	0.027
Pop_density				
Pop_density	log_lifexp	53.334**	1	0.000

Pop_density	urb_grow	111.12**	1	0.000
* p < .05 ** p < .01. Akaike Information Criterion was utilized to determine the optimal lag length.				

Table 4: *OLS between Fertility and GPI.*

Source	SS	df	MS	Number of obs =52		
F(1, 50)=53.35						
Model	0.94103	1	0.941	Prob > F=0.0000		
Residual	0.882	50	0.0176	R-squared=0.5162		
Adj R-squared =0.5065						
Total	1.82303	51	0.0357	Root MSE =0.5065		
fertility	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
GPI	-1.91533	0.2622345	-7.3	0.000	-2.442038	-1.388611
_cons	5.58129	0.2511679	22.22	0.000	5.076807	6.085778
Note: denote significance at 5%						

This inference stems from the understanding that as the likelihood of a child's survival increases, parents tend to opt for smaller family sizes, whereas in situations of higher infant mortality, families may compensate by having more children. This nuanced relationship between life expectancy and fertility underscores the intricate dynamics influencing population growth and demographic trends, informing policymakers and researchers about the interplay between healthcare access, socio-economic factors, and reproductive behaviours in shaping societies' demographic trajectories. It is clear that given the fitted line, (Figure 3) expresses an inverse relationship between fertility and life expectancy at birth. The demand for more children also depends on their survival at birth, which is also one of the indicators of life expectancy at birth. Given this, a society with a low life expectancy will have a high birth rate to give the lucky ones a chance to survive, while societies with a long-life expectancy will have a low birth rate.

OLS between fertility and GPI

GPI (P=0.0000) is a negative and statistically significant on fertility at 5% in (Table 4). The coefficient term tells the change in fertility for a unit change in GPI this means that if the fertility decreases by 1 unit, then GPI increases by 1.92. In other words, we need to implement interventions to increase the GPI rate in order to decrease fertility in Rwanda.

Conclusion and Recommendations

Conclusion

Rwanda's post-genocide journey has been marked by remarkable progress in healthcare infrastructure and social welfare. Notably, life expectancy has surged from the depths of tragedy to 68.7 years in 2018, with projections soaring to 71.4 years by 2032. This upward trajectory owes much too strategic investments in healthcare systems, robust vaccination programs, and vital external funding. As a result, mortality rates from diseases like tuberculosis, malaria, and HIV/AIDS have plummeted, signifying tangible improvements in public health outcomes. Furthermore, empirical analyses underscore a significant correlation between fertility rates and life expectancy, shedding light on the intricate dynamics shaping population health. Recognizing this, interventions aimed at reducing fertility rates emerge as pivotal for enhancing overall well-being and sustainability. By empowering individuals with access to reproductive healthcare and education, Rwanda stands poised to further bolster its gains in life expectancy and elevate the quality of life for its citizens. In conclusion, Rwanda's journey towards improved healthcare and social welfare stands as a beacon of resilience and progress. As the nation continues to chart its course towards a brighter future, sustained commitment to inclusive policies and targeted interventions will be essential in ensuring that the gains achieved thus far pave the way for lasting prosperity and well-being for all Rwandans.

Recommendations

Based on the findings presented, several recommendations can be made to further improve the healthcare system and social welfare in Rwanda to improve the life expectancy for Rwandan economic development:

Continued investment in healthcare systems: The government should continue its investment in healthcare infrastructure, including primary healthcare systems, HIV/AIDS healthcare services, oncology services, and community-based health insurance. This will ensure continued access to essential healthcare services for all citizens.

Focus on vaccination programs: Given the significant impact of vaccination activities on improving health outcomes, Rwanda should maintain and expand its vaccination programs to cover a wider range of diseases. This will help further reduce child mortality rates and improve overall population health.

Targeted interventions to reduce fertility rates: Implementing interventions to reduce fertility rates can contribute to increased life expectancy. This could include education and access to family planning services, as demonstrated by the negative relationship between fertility rates and life expectancy.

Promotion of gender parity and women's health: Enhancing gender parity and improving women's health can have positive effects on fertility rates, as evidenced by the relationship between Gender Parity Index (GPI) and fertility. Policies and programs aimed at empowering women, providing access to education and healthcare, and promoting gender equality should be prioritized.

Sustainable development goals alignment: Aligning healthcare and social welfare policies with the Sustainable Development Goals (SDGs) will ensure a holistic approach to development. This includes addressing issues such as maternal and child mortality, infectious diseases, and poverty reduction.

Partnerships and external support: Continued collaboration with international organizations and partners, as demonstrated by initiatives like Partners in Health (PIH), can provide valuable support in strengthening healthcare systems and improving access to essential services.

Long-term monitoring and evaluation: Establishing robust monitoring and evaluation mechanisms to track progress and identify areas for improvement is essential. This will enable evidence-based decision-making and ensure that resources are allocated effectively.

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