The Shifting Distribution of the Global Population in the Twenty-First Century: An Econometric Analysis of the Projected Fortunes of Nigeria and Japan, with Policy Recommendations for Sustainable Development

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Contents

Equations

Figures

Tables

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Abstract

This report presents the findings of an analysis aiming to examine the causes and consequences of demographic change in Nigeria and Japan from an economic perspective. It expresses determinants of population growth in Nigeria in the form of an econometric model subject to multivariate regression analysis. Moreover, the challenges faced by Nigeria in the twenty-first century are discussed and policies are proposed in response to them. Sustainable development objectives are considered from a heterodox approach of meeting social foundations without compromising ecological boundaries. Subsequently, the roots of Japan's contrasting population decline are scrutinised, and linked to the exhibited effects on labour markets. Finally, policies to address these unprecedented challenges faced by Japan are assessed.

Section I: Introduction

Changes in the size and structure of populations affect virtually all development objectives, including the UN Sustainable Development Goals (SDGs), that are at the top of national and international development agendas. This incorporates, but is not limited to, the impacts on migration patterns (both international and intranational), resource management, labour markets and public policy.

Nigeria, with a population in July 2022 of 218.5 million (United Nations, 2022), and Japan, with a population of 125.9 million (Japan Ministry of Internal Affairs and Communications, 2022), are the world's sixth and eleventh most populous countries respectively. However, the two are at opposite stages in their demographic transition.

Nigeria is currently going through Stage 2 of the Demographic Transition Model developed by Warren Thompson in 1929 (Thompson, 1929) and expanded upon in the 1930s and 1940s by Adolphe Landry (Population Council, 1987) and Frank Notestein (Notestein, 1945). There are very high birth rates in Nigeria, of 36.44 per 1000 people in 2022 (The World Bank, 2022), but rapidly falling death rates due to improvements in public health and food supply which prolong life expectancy. The increase in food supply arises because of higher yields resulting from crop rotation, selective breeding and technology replacing manual labour. Meanwhile, the improvements in public health are not necessarily improvements in medicine, but rather through better sanitation, clean water supplies and sewerage systems. The rate of natural increase in Nigeria, which differs from total population in that it ignores net migration, is also very high, at 26.1% between 2015 and 2020. (United Nations Department of Economic and Social Affairs, 2016) This is the twenty-sixth fastest rate of natural increase in the world, and may be classified as a '*population explosion'*.

Japan, conversely, is at Stage 5 of the Demographic Transition Model with very low birth rates and low, but rising, death rates. Birth rates have dropped to below replacement level (Harper S. , The Grey Burden, 2016), leading to population decline. This creates divergent challenges, but also opportunities, to population growth. The large population born during Stage 2 of the Demographic Transition Model ages, putting an economic burden on the shrinking working population. This has distorted

dependency ratios since the proportion of Japan's population over the age of 65 quadrupled between 1950 and 2005 (from 5% to 20% of the population). Japan also has limited immigration to expand the labour market. (Komine, 2018)

Japan is being followed by many Asian countries such as Malaysia and Thailand who are rapidly passing through the Demographic Transition Model due to fast social and economic change. In contrast, Nigeria is like many other Sub-Saharan African nations in being stuck in Stage 2 of the Demographic Transition Model due to hindered development and the effects of prominent diseases such as malaria and, to a lesser extent, AIDS on life expectancy.

The findings from this research have profound policy implications which will assist governments and international organisations on how to address the challenges, and harness the opportunities, of population dynamics to promote sustainable development. Migration may not be used to prevent labour supply shortages in certain countries if the overall global population were to be shrinking. Global population growth is projected to slow by the end of the century. (Rosling, Rosling Rönnlund, & Rosling, 2018) Therefore, governments need to have innovative policies to mitigate negative fiscal implications and resolve issues such as the 'pension time bomb'.

Furthermore, I anticipate that whilst the policy recommendations will originate from looking at the causal factors of Nigeria's rapid population growth and Japan's expected rapid population decline, the recommendations will be transferable to other countries experiencing the same transition. For example, Tanzania's population will grow concurrently with Nigeria's; and countries currently in Stage 4 and Stage 5 of the Demographic Transition Model such as Spain and Italy will ultimately follow in Japan's footsteps.

As previously mentioned, population change will affect how we fulfil the UN Sustainable Development Goals. Demographic transition will affect city-level governments who need to provide safe housing for all under SDG Goal 11: 'Make cities inclusive, safe, resilient and sustainable' (United Nations, 2017) Governments also need to maintain access to high quality education and healthcare for all.

Moreover, the primacy of this research is elevated by the fact that the world is at an unprecedented stage in demographic transition. After many years of exponential population growth, as evident from the world population approximately quadrupling in the last century from two billion in 1927 to eight billion anticipated on 15th November 2022 (United Nations, 2022), global population growth is widely predicted to stagnate before the end of this century. One such estimate is from Washington University, which anticipates that the global population may peak at around 9.7 billion in 2064 before falling to 8.8 billion by the end of the century. (Institute for Health Metrics and Evaluation (IHME), 2020) Meanwhile, the UN's latest estimates in 2022 have a 95% confidence interval that the world population will be between 8.9 and 12.4 billion in 2100. (World Population Prospects 2022, 2022)

Many countries will face declining populations due to natural increase becoming negative, with death rates exceeding birth rates, as fertility rates fall below the replacement rate. The replacement fertility rate is considered 2.1 births per woman in most developed economies (Gietel-Basten & Scherbov, 2019), but is up to 3.5 births per woman in less developed economies, and is 2.77 in West Africa (Espenshade, Guzman, & Westoff, 2003). Population declines in individual countries are both advantageous and disadvantageous, reducing pressure on resources but straining labour markets and making it difficult to care for ageing populations.

Contrastingly, countries such as Nigeria will still be growing in 2100, with a population which is expected to be the second largest after India at 790.7 billion (World Economic Forum, 2020). Countries which fall in this category need to develop policies that harness the demographic dividend in a way where the working-age population is sizeable, in good health, with high quality education and employment opportunities and with a relatively low proportion of young dependents, thus emphasising child quality not quantity (Population Reference Bureau, 2013). Modelling from the Institute for Health Metrics and Evaluation (IHME) suggests that Japan's population will fall by 58% by the turn of the century to 53 million. (Ghosh, 2020) This is illustrated in *Figure 1* below.

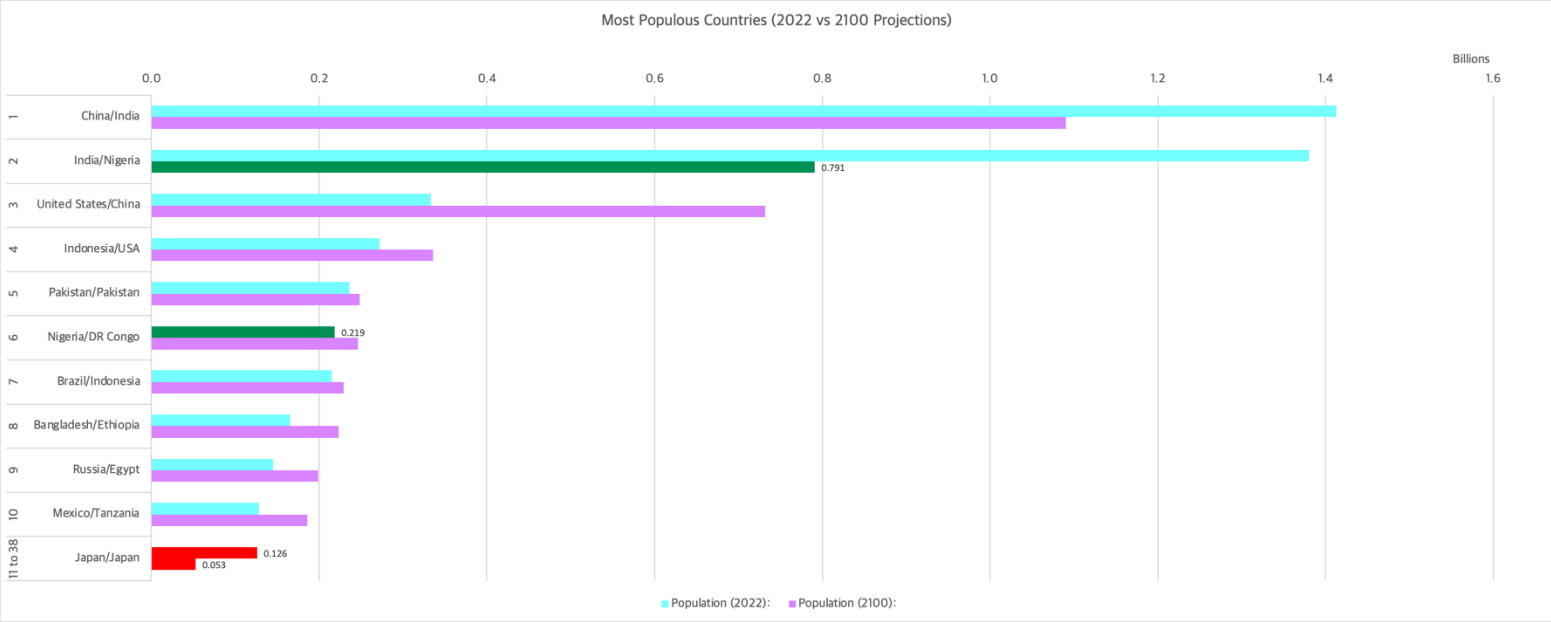

Figure 1 - Most Populous Countries (2022 vs 2100 Projections) - IHME Data (Vollset, et al., 2020)

This report will explore the challenges and opportunities facing Nigeria and Japan in greater depth, addressing the research questions below in Sections II and III:

- RQ1: To what extent can population growth be harnessed to achieve sustainable economic development? An examination of Nigeria's prospects this century
  - RQ1a: Which factors are the most significant drivers for Nigeria's population growth?
  - RQ1b: What will be the effects of rapid population growth on the Nigerian economy?
  - RQ1c: What policy recommendations should be adopted in Nigeria to fulfil sustainable economic development objectives?

- RQ2: To what extent is rapid population decline a cause for concern? A time-series forecast of Japan's fate
  - RQ2a: What are the core causal factors for Japan’s anticipated population decline?
  - RQ2b: What will be the effect of Japan's population decrease?

- RQ2c: What policy recommendations should be adopted in Japan to fulfil sustainable economic development objectives?

This Laidlaw research project is constrained to a six-week timeframe so is limited to answering these questions, however further extensions to this research may be possible in future periods of research. Section IV concludes.

Section II: To what extent can population growth be harnessed to achieve sustainable economic development? An examination of Nigeria's prospects this century

Nigeria currently has a young population, with 41.7% of the population below the age of 14. Moreover, 20.3% are of early working age, aged 15-24. The median age is consequently a mere 18.1. (Worldometer, 2022) A further 30.6% are of prime working age (25-54 years old) and 4.13% of mature working age (55-64 years old). As highlighted in *Figure 2*, this leaves just 3.3% of the population over the age of 65. It is thus seen that the brunt of the dependency ratio stems from caring for children – best achieved by improving access to education – as opposed to caring for the elderly.

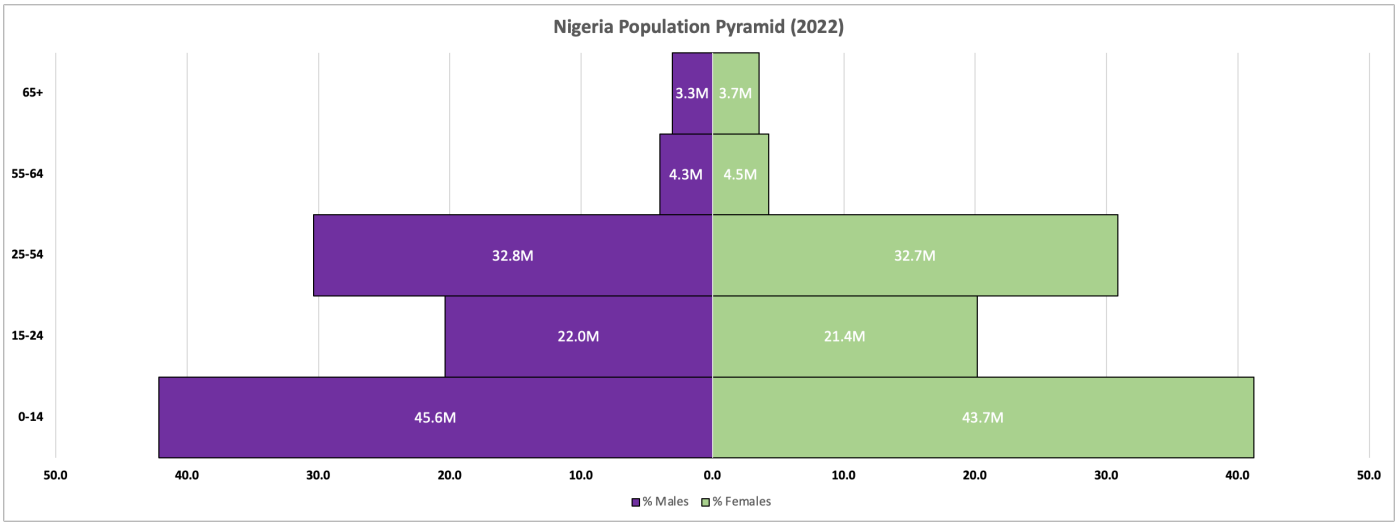

Figure 2 - Nigeria Population Pyramid (2022)

Demographic trends in Nigeria are typical of emerging Middle Eastern and North African (MENA) economies. Nationally, Total Fertility Rate (TFR) is falling rapidly, and it is lower

in urban areas than rural areas. Furthermore, fertility and income are negatively related, with fertility rates at their lowest amongst the most affluent.

Life expectancies in Nigeria are on the rise, with life expectancy at birth – given current mortality conditions – being 55 in 2020. This is a nine-year improvement (19.6%) compared to the 2000 average life expectancy of a mere 46. In line with the rest of the world, there are disparities between male and female life expectancies at birth. Between 2000 and 2020, average male life expectancy at birth rose from 45 to 54 whilst for females it increased from 47 to 56. In 2020, 52% of females and 47% of males were living to the age of 65. This indicates that the mean life expectancy is significantly lower than the median, on account of high infant mortality rates and severe inequalities in access to healthcare and the quality of healthcare provision. (World Bank, 2022)

Overall, 78% of Nigerians live within ten kilometres of some form of health facility but this figure is 88% in the urban South-West and only 67% in the predominately rural North-West. Over half (50.4%) of Nigerians in urban areas use general hospitals as their primary healthcare facility, compared to just 16.2% of those living in rural areas where small clinics and dispensary are more common. (Sofo, Akpajiak, & Pyke, 2003) These increases in life expectancy are outstripping the provisions of institutions to support the rising number of elderly dependents. However, the elderly remains a relatively small fraction of the overall population, and a high percentage of the population are of productive age.

Demographic transition drives urbanisation. In Nigeria, over half of the population lived in urban areas for the first time in 2018. The growth in urbanisation between 2011 and 2021 is shown in *Figure 3*. (World Bank, 2022)

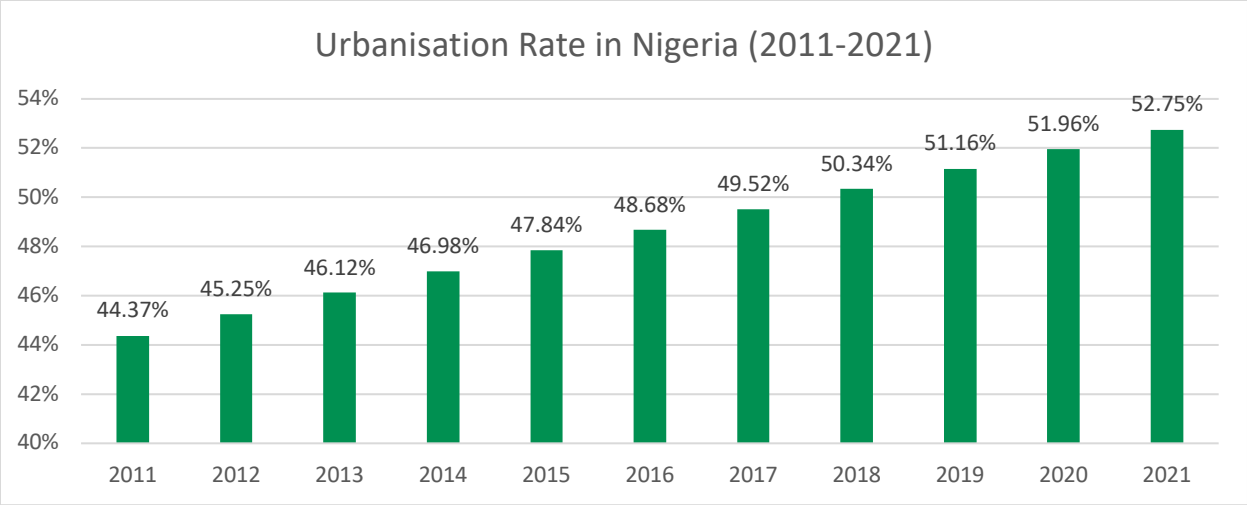

Figure 3 - Urbanisation Rate in Nigeria (2011-2021)

By 2050, the Nigerian urban population is expected to reach 300 million. Currently there is one megacity in Nigeria, Lagos, with an urban population of 15.4 million (World Population Review, 2022) and metropolitan area population of 23.5 million in 2022. (Lagos Government, 2022) There are a further nine millionaire cities, *id est*, cities with a population of at least one million. This includes the capital Abuja, which had a metropolitan area population of 3.65 million in 2022 and is growing at approximately 6% year-on-year. (Macro Trends, 2022) A total of forty-nine Nigerian cities have a population in excess of 300,000. Other cities growing rapidly as a result of demographic transition include Kano, Ibadan, Port Harcourt, Onitsha and Kaduna. It is estimated that 700,000 housing units need to be built each year to keep up with the growing urban population. (URBANET, 2018) The rapid rate of urbanisation is also accompanied by high rates of unemployment (Endsjö, 1973), particularly amongst the youth. In Nigeria, youth unemployment – amongst 15–24-year-olds – has soared in recent years to 19.67% in 2020, up from 8.22% just four years prior. (International Labour Organisation, 2022) This rapid increase is highlighted by *Figure 4*.

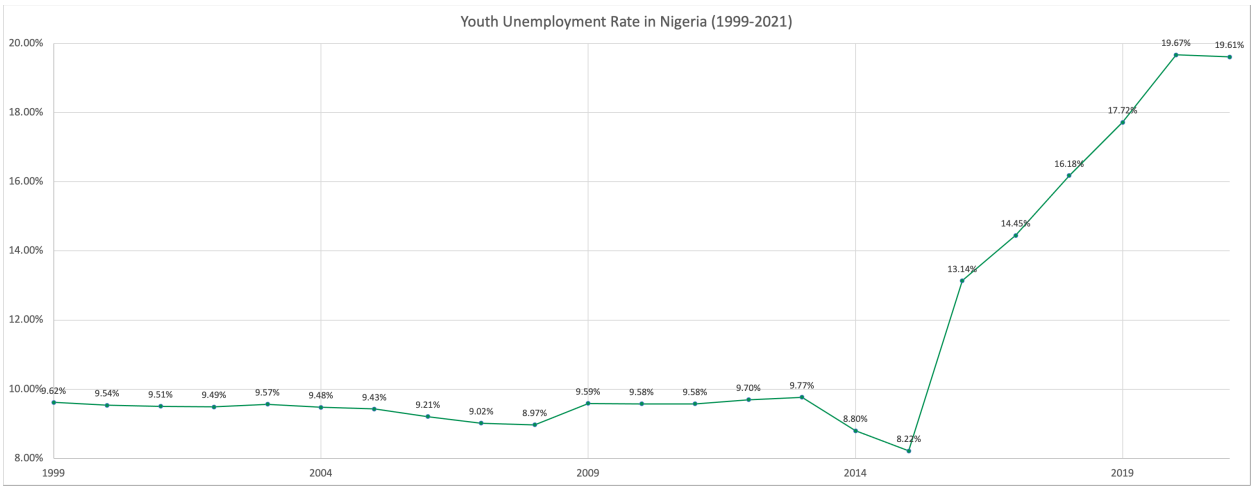

Figure 4 - Youth Unemployment in Nigeria (1999-2021)

Urbanisation in Nigeria, and rural-urban migration in particular, is the culmination of many 'pull' and 'push' factors. (Okpala, 1990) It is primarily demographically driven but has created many challenges including the rise of shanty settlements, increased pressure on supplies of safe water, and material issues with waste management. In Lagos alone there is 255,556 tonnes of urban solid waste per month. (Aliyu & Amadu, 2017) The five Nigerian cities with the largest volumes of waste are listed in *Table I*.

Table I - Nigerian Cities by Volume of Waste (2017)

City	Urban Solid Waste (Tonnes per Month)
Lagos	255,556
Kano	156,676
Ibadan	135,391
Port Harcourt	117,825
Kaduna	114,433

These issues all combine to create an increased burden of disease, increasing the risk of contagion and exacerbating epidemics, as seen during the 2014 Ebola outbreak and the COVID-19 pandemic. The full extent of the impacts in Nigeria of the latter are yet to be seen due to limited data. (Ritchie, et al., 2022)

Increased populations in cities also increases the demand for transport. Local governments need to increase provisions, and the accessibility, of public transport, or face increased road traffic with the associated environmental costs. Currently, nearly all (95%) of urban transport journeys made in Nigeria are by road, with *circa* seven in every ten journeys involving public transport. (Asiyanbola, 2010)

It is arguable that twenty-first century international security depends not on total population but on the composition and distribution of population. This affects the occurrence of conflict, terrorism, and state-sponsored violence. (Harper S. , Youth: Peril or Dividend, 2016)

Both the postponement of childbearing and, perhaps contrastingly, high levels of desired fertility are rational responses to uncertainty many Nigerian women and families face from personal and institutional perspectives. It is unclear what quality of education their children may be able to receive, what employment opportunities there will be in the future, and what welfare provisions will be implemented by the regional and national governments. (Dodoo, Horne, & Dodoo, 2014) In rural areas and shanty towns on the fringe of cities there is also the question of property rights which must be considered before committing to large families. (Moultrie, Sayi, & Timæus, 2012)

Many families in Nigeria choose to have many children due to the security incentive. As countries develop, fertility rates typically fall as prospective parents re-evaluate the marginal costs and benefits of having an additional child, effectively considering the trade-offs between child ‘quality’ and ‘quantity’. (Liefbroer, 2005) There are many downsides of having many children. Children are disproportionately affected by chronic poverty, with malnourishment and undernourishment responsible for around one-third of child deaths and one-fifth of maternal deaths, as well as stunted growth in adolescents. (Harper, Alder, & Pereznieto, 2011) There is also strong intergenerational transmission of poverty in Nigeria, and the UN Sustainable Development Goals target to eliminate chronic poverty requires national commitments and international cooperation to make the needed policy changes to fulfil this goal.

Nigeria is a rapidly growing economy, with 3.6% GDP growth in 2021 and average GDP growth of 5.23% this century up to now. (World Bank, 2022) This led to Nigeria being

included in the MINT acronym of Mexico, Indonesia, Nigeria and Turkey, identified in 2011 as the successors to Jim O'Neill's BRIC countries, the term coined in 2001 to refer to the fastest growing developing economies. (Boesler, 2013) However, the potential for economic growth is held back by the severe number of young dependents. Growth in GDP per capita in the years to come should be substantial if countries capitalise on the demographic dividend. Achieving the UN medium fertility variant would boost per-capita income by 6.5% in Nigeria by 2040. (Population Action International, 2013) The high proportion of child dependents compared to the working population means that human capital spending on health and education per child is low compared with other countries. Therefore, many households must pay for their own children's schooling, and are often selective about which children are sent to school, which prolongs gender inequality as boys are prioritised over girls in receiving education. (Karra, Canning, & Wilde, 2017) As a consequence, in 2018, the female adult literacy rate in Nigeria was 52.7%, compared to 71.3% for males. (World Bank, 2022) Strong policies on women's education can have significant effects on fertility and economic growth. (Canning, Raja, & Yazbeck, 2015)

As mentioned in the introductory *Section I*, it is widely expected that Nigeria will become the second most populous country by the end of the century. There are a plethora of factors that may drive this population growth, including: fertility rates, mortality rates, the initial age profile of population, migration, and religion. Within these factors are many sub-determinants – for instance, fertility rates are in turn affected by use of contraception, maternal age at childbearing, and desired family size.

Section IIa: Which factors are the most significant drivers for Nigeria's population growth?

Population growth in Nigeria may be modelled in relation to its determinants:

Equation A - Population Growth Model (Nigeria)

$$\frac{\Delta P_N}{\Delta T} = \beta_0 + P_0(\alpha F - \gamma M) + \theta I + \varepsilon_i$$

This means the population growth rate ($\frac{\Delta P_N}{\Delta T}$), the dependent variable, is dependent on the independent variables, including the initial population (P_0), which is positively

correlated with the total fertility rates (F) and negatively correlated with mortality rates (M). It is also affected by net international migration levels (I). β_0 is the intercept parameter and ε_i is the error term. It is possible to find estimates for the values of the intercept and slope parameters, α, γ, and θ, using multivariate regression analysis. Unfortunately, the absence of reliable data for Nigeria, and the time constraints for this research period, make this outside the scope of this study.

There are also many factors to consider that affect fertility rates. Fertility rates may be expressed as a function of its determinants:

Equation B - The Determinants of Fertility Rates

$$F = f(C, Mat_1, D)$$

Equation B is a simple formulation which suggests that fertility rates are influenced by the prevalence of contraception use (C), maternal age at childbearing (Mat_1), and desired family size (D). Generally, fertility rates fall with increased contraceptive use. (Committee on Population, 2016) Meanwhile, delaying the age of first childbearing, and having larger intergenerational gaps, helps to reduce fertility rates. (Beaujouan & Berghammer, 2019)

The economic concept of rationality may be applied to the decision of building a family. Gary Becker, the 1992 winner of the Nobel Prize in Economics, extended the domain of microeconomic analysis to a wide range of human behaviour and interaction, including non-market behaviour. Children may be seen objectively as similar to a consumer durable – whilst consumer durables yield consumers a stream of utility, children can yield parents a stream of utility. Children may also be viewed as inferior goods, goods which people choose to have fewer of as their incomes rise. It is empirically proven that parents choose to have fewer children as per capita income rises. (Vandenbroucke, 2016) Meanwhile, parents can generally be assumed to be rational decision makers who aim to maximise utility, weighing up the costs and benefits of their actions. Choosing an optimal family size is effectively an exercise in utility maximisation subject to constraint. The key benefits to parents of having an additional child are three-fold:

Equation C - The Utility of an Additional Child

$$U_{Ci} = U_{Ci}[U_C, U_W, U_S]$$

Equation C expresses that the benefits of an additional child depend on the consumption utility (U_C), the work utility (U_W) and the security utility (U_S). The consumption utility may be defined as the raw intrinsic pleasure for a parent of having children. This utility may be modelled as a constant stream. Work utility is more of a financial motive. Child labour has sadly been a feature of nearly all economies during their development. The implementation of better laws protecting children and measures to reduce poverty, both of which occur as an economy develops, reduce this work utility to parents. The security utility refers to children being an investment – children can look after their parents in their old age. In developing economies, child mortality is also higher. The child mortality rate (deaths of children under the age of five) in Nigeria in 2020 was high at 113.8 deaths per 1000 live births, but had halved in fifty years. (Knoema, 2020) Hence having more children is also due to parental risk aversion, in case the dreaded happens.

In contrast, the costs of having children can be direct or indirect. The most prominent direct costs are the costs of feeding, housing, schooling, and healthcare. These costs stack up for each additional child. Additionally, there are the costs of clothing and entertainment, both of which have diminishing marginal costs as parents have more children. On the other hand, there are indirect costs such as the opportunity cost of the primary caregiver's time. This has led to low female labour force participation in many less developed economies. Increasing female schooling in Nigeria has been proven to reduce fertility. (Osili & Long, 2008) Thus, as a country becomes more developed, benefits decrease whilst costs rise.

Globally, mortality has fallen materially since the middle of the 20th Century. Reductions in mortality rates, as Nigeria progresses through Stage 3 of the Demographic Transition Model, will account for population growth through natural increase. Infant mortality rates – defined as the deaths of children under the age of one – have fallen by 132.1% between 1980 and 2022. (Macrotrends, 2022)

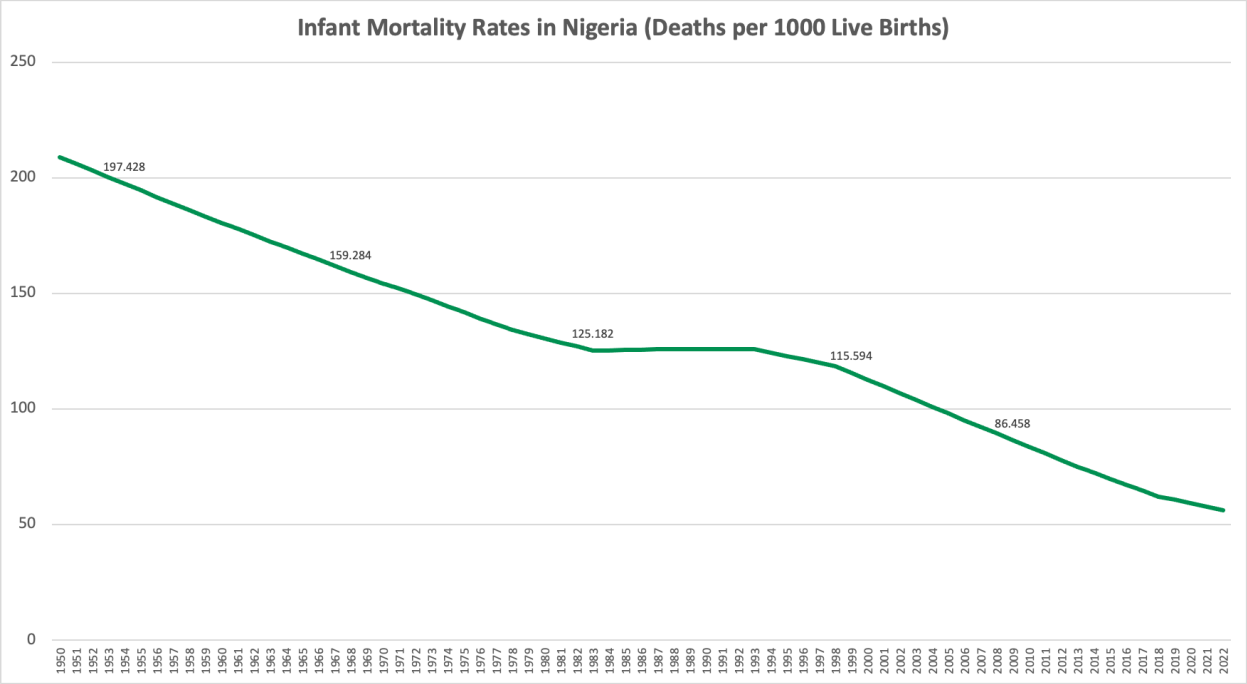

Figure 5 – Infant Mortality Rates in Nigeria (Deaths per 1000 Live Births)

More widely, death rates have fallen by 131.0% between 1960 and 2020. (World Bank, 2022)

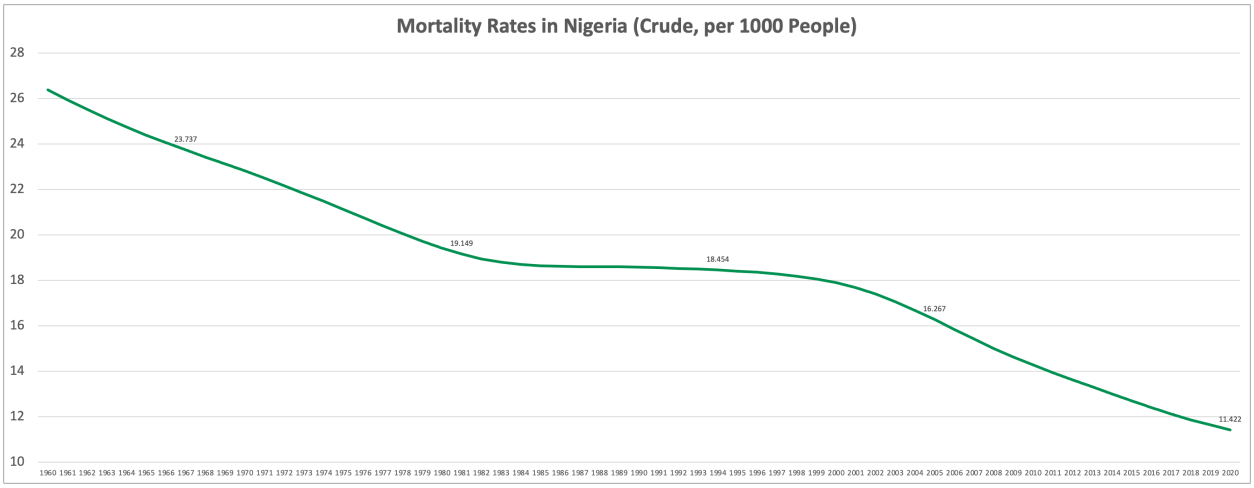

Figure 6 - Mortality Rates in Nigeria (Crude, per 1000 People)

The rate of population growth depends on the initial age profile of population. As shown in *Figure II* of *Section II*, Nigeria has a very young population, with 41.7% under fourteen, therefore not being of working age, with a further 20.3% being under 24. These young people are dependent on a workforce of just over one-third of the population, with 34.7% being aged 25-64. (Index Mundi, 2022)

International migration plays a smaller part to natural increase in population growth, but nonetheless it has had a sizeable impact on population change in Nigeria. Nigeria has experience both large intranational (rural-urban) and international migration flows in recent decades. In the 1970s, the oil boom led to net immigration into Nigeria, but by the 1980s there was net emigration as a result of political instability and an uncertain economic outlook. Since the 1980s, net emigration has remained, but the structure of the population has changed. There was a huge peak in emigration as West African migrants were deported from Nigeria in January 1983 by President Shehu Shagari. Over half of the two million deported were Ghanaian nationals. (Daly, 2022) In recent years, migration levels have been very consistent at net emigration of 2-3% per year for the last decade. (Nigeria Net Migration Rate 1950-2022, 2022)

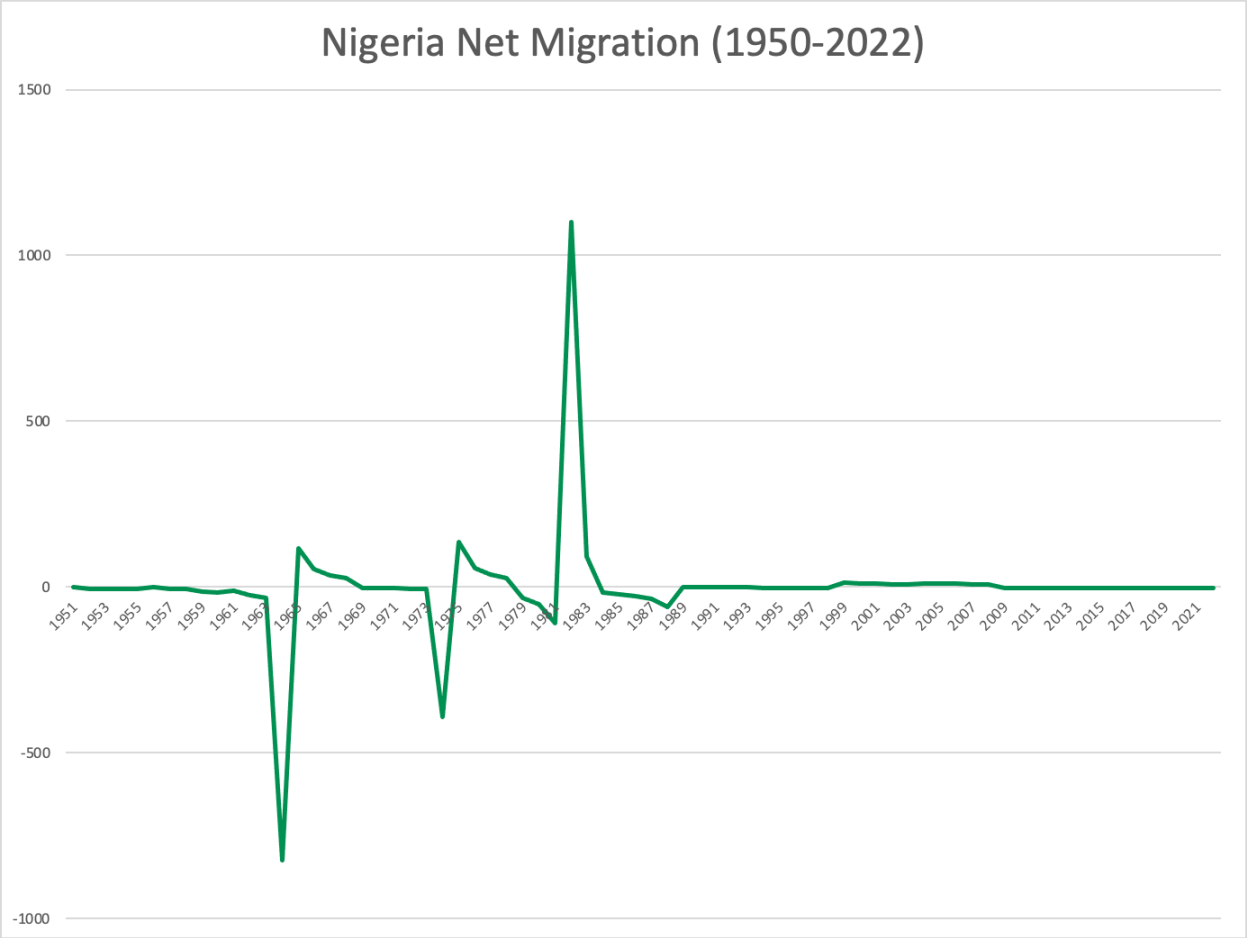

Figure 7 - Nigeria Net Migration (1950-2022)

Religious affiliation has the potential to affect population growth in a country. Looking at the world's largest religions, Islam had the highest Total Fertility Rate between 2010 and 2015, with an average worldwide of 3.1 children per woman. This is one factor driving growth in the global Muslim population which is growing both in absolute terms and relative terms, comprising an ever-larger percentage of the world's population. This affects population projections, with slight differences in religious composition being highly consequential. In the case of Nigeria, there are currently approximately equal numbers of Muslims and Christians, however there are disparities in the fertility rates within religious groups. Nigerian Christians on average have 4.5 children per woman, whilst for Nigerian Muslims this figure is 6.5 children per woman. Hence by 2050, *ceteris paribus*, the share of Christians in Nigeria's population will shrink to just 39%, whilst Muslims will make up about 59%. (Pew Research Center, 2015) Another caveat to consider is that populations within different religious groups may have different life expectancies, but the data for the projections above assumes all religious groups to have the average life expectancy for Nigeria. Furthermore, globally, Muslim populations are the most youthful, with over one-third (34%) of Muslims under the age of fourteen. These dependents below working age must be supported but counteracting this is that only 7% of Muslims are over the age of 60. This is shown in *Figure 8* below.

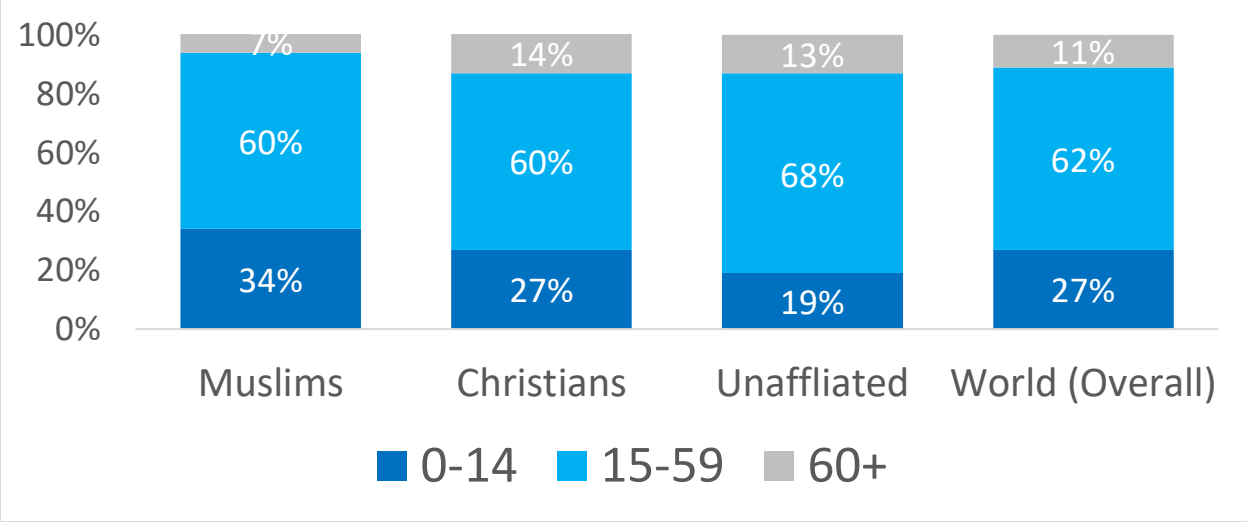

Figure 8 - Religious Groups by Age Distribution Globally

Not only are fertility rates higher amongst Muslim populations than amongst Christian populations, but there are also stark differences in religious switching, with an expected net 3.22 million people switching to Islam worldwide between 2010 and 2050. Contrastingly, 106 million people are expected to leave Christianity during this time with only an estimated 40 million switching in. Nigeria, and Sub-Saharan Africa more widely are likely to be a microcosm of this trend, with roughly equal numbers joining Islam as leaving Christianity. (Espenshade, Guzman, & Westoff, 2003)

There are other factors which could affect Nigeria's rate of population growth in Nigeria. One such is the status of LGBTQ+ rights. Fertility rates fall as LGBTQ+ rights improve. (Carroll & Schumm, 2017) Currently, homosexuality is illegal in Nigeria and punishable by up to 14 years of prison under federal law. Under Shari'a Law it is punishable by death. (Human Dignity Trust, 2022) Depending if and when homosexuality is legalised this century, or even more significantly if same-sex marriage is legalised, population growth could be slowed.

The size and structure of Nigeria's population is also influenced by policy. An early start in childbearing plays a significant role in rapid population growth, with the median age at first birth for women in Nigeria being just 20.4 years old in 2018. There are also disparities between rural (19.0) and urban (22.3) areas, and between cities, for example, women in Lagos begin childbearing at 24.8 years old, 7.3 years later than in Katsina. (Nigeria National Population Commission, 2018) The early onset of childbearing directly affects fertility through increasing the duration of time a woman can bear children before reaching menopause, as well as indirectly. Reproduction can come at the expense of education and work, and shorter inter-generational gaps compounds population growth rates. (Ezeh & Feyissa, 2019) Delaying the onset of childbearing would slow population growth, particularly since 22.5% of Nigerians have unmet need for family planning. (United Nations Department of Economic and Social Affairs, 2017)

Policies can range from being gentle behavioural nudges (Hansen & Jespersen, 2013) to coercive policies such as the one child policy in China (Ebenstein, 2010) or involuntary sterilisation in India (Ioannou, 2014) at the other extreme. More subtle policies include financial incentives to promote family planning; cash transfer

programmes have been trialled in Kenya, Malawi and Zambia. (Dake, et al., 2018) Nigeria first adopted a population policy in their Second National Development Plan of 1970-1974. However, there was not much support for contraception from the governments, and what family planning services were available were only provided through Family Planning Council of Nigeria clinics, pharmacies, or private maternity homes. (National Research Council, 2017) Ultimately, fertility rates are lower where there are stronger family planning programs in place. (Jain & Ross, 2012) Nigeria has a medium Family Planning Program Effort Index score, and a weak social setting score, the latter of which contributes to its high fertility rates. This relationship may be seen in *Appendices I* and *II*, with cross-tabulation analysis in *Appendix III*.

However, population policies have not always been successful, as has been seen across Sub-Saharan Africa. Kenya (in 1967) and Ghana (in 1969) were the first countries to announce population policies. A further thirty – mostly West and Southern - African countries, including Nigeria, adopted such programmes in the late 1980s. However, the failure of these policies may be attributed to ulterior motives. One possible explanation is that Kenya and Ghana, as traditional countries, adopted family planning policies first to promote the perception that they had a modern outlook, thus attracting both bilateral and multilateral foreign aid. Their neighbours subsequently followed suit. (Sullivan, 2007)

Section IIb: What will be the effects of rapid population growth on the Nigerian economy?

Rapid population growth in Nigeria is both the result of and a cause of changing migration patterns. It can also affect labour markets, public policy, and resource management. Whilst net emigration generally has limited effect on population size and structure in countries growing rapidly, including Nigeria, minimising the adverse causes and underlying structural factors that prompt young people to leave is critical. (United Nations, 2019)

As Nigeria's population has grown, education levels have risen. Literacy rates are now as high as 86.4% for males and 74% for females in urban areas. (Statista, 2022) In

2018, primary school enrolment was 68.3%. (EPV Blog, 2021) The same year, meanwhile, secondary school enrolment was 44%, up by thirteen percentage points in the preceding decade. (World Bank, 2022) Approximately one-in-eight (12.1%) of eligible Nigerians were enrolled in tertiary education. (Trading Economics, 2022) If more people are pursuing tertiary education as the population grows, this will lead to a more skilled workforce. However, in a globalised world where the flow of labour between countries is relatively mobile, skilled workers are likely to emigrate overseas to reap the rewards of higher wages. Unfortunately, even with the remittances associated with this, Nigeria loses out compared to a scenario in which these skilled workers remained in their home country. Parallels may be drawn between Nigeria and Ethiopia, Africa's second most populous country, where the 'brain drain' is so severe that the nation's health minister infamously argued that there are more Ethiopian doctors in Chicago than in Ethiopia itself. (University of Michigan, 2013) To reduce the negative impacts from the 'brain drain', and to harness the increased volume and proportion of skilled workers, governments must invest in training and development schemes.

Rapid population growth can also put pressure on meeting the UN Sustainable Development Goals (SDGs). Policies to fulfil these goals will be explored in *Section IIc*. Whether the SDGs can be met depends most on how well the needs of vulnerable people are addressed. To harness the demographic dividend, Nigeria needs to promote good health and well-being, including through preventative medicine, provide quality education for all (SDG 4) and alleviate social barriers to young people. (Kharas, McArthur, & Ohno, 2020)

In many developing economies with rapidly growing populations, women and girls often miss out on formal education and employment to provide care instead. In such circumstances, policies promoting better educational and employment outcomes for women not only result in lower fertility levels, curbing population growth in the long-run, but ensure greater gender equality and sustained economic growth. (International Labour Organisation, 2017)

Rapid population growth often goes hand-in-hand with poverty, leading to a 'vicious cycle' of poverty. (Dworak, Prskawetz, & Feichtinger, 2012) In the next few decades,

extreme poverty is projected to be increasingly concentrated in areas of rapid population growth. (World Bank, 2018) In the longer-run, however, greater access to quality education, healthcare and family planning, which will gradually reduce fertility rates and with it bring economic growth and reduce extreme poverty and inequality. (Bloom, 2020); (Das Gupta, Bongaarts, & Cleland, 2011); (Stover, 2016); (Wietzke, 2020)

Food insecurity and hunger rise in line with poverty, so is an indirect consequence of rapid population growth in Nigeria in the short-run. Food insecurity can lead to malnutrition and stunting of growth amongst children and adolescents. (Akombi, 2017) In the 2021 Global Hunger Index, Nigeria ranked 103rd out of 116 countries who provided adequate data, with a score of 28.3 deemed 'serious'. (Global Hunger Index, 2022)

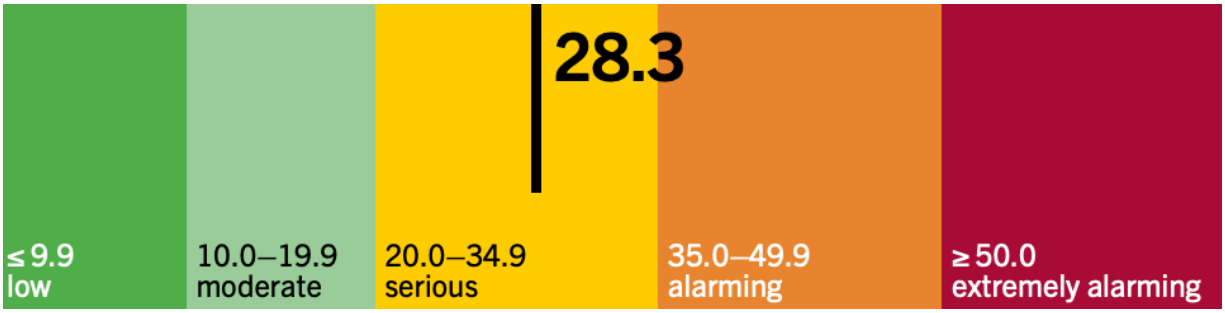

Figure 9 - Global Hunger Index (Nigeria, 2021)

Hunger is, however, on a downwards trend in Nigeria, down from an 'alarming' score of 39.5 back in 2000.

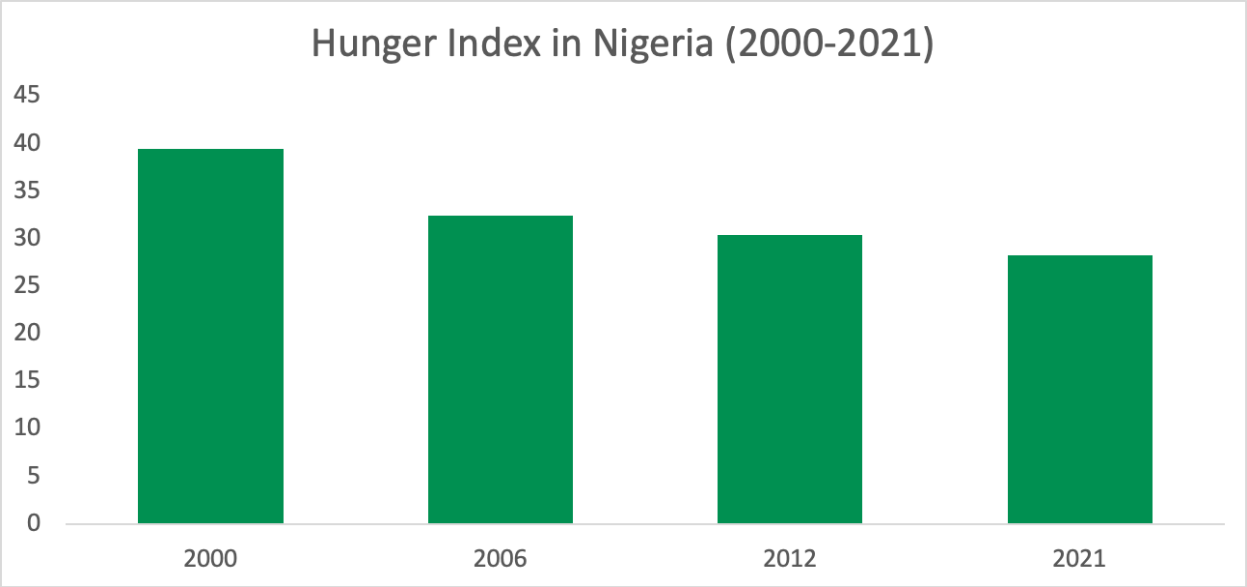

Figure 10 - Hunger Index in Nigeria (2000-2021)

This measure of hunger is comprised of data on inadequate food supply and undernourishment (weighted one-third), child undernutrition (wasting and stunting each weighted one-sixth) and child mortality (weighted one-third). The first of these is important to consider as it affects both children and adults. The second considers more than just calorie availability, additionally accounting for diet quality, and the latter represents the most serious consequence of hunger, with children being the most vulnerable. In Nigeria, malnutrition is the cause of 45% of deaths of children under-five. Furthermore, Nigeria has the second highest proportion of children with stunted growth worldwide, with 32% prevalence in children under-five. (UNICEF, 2022) It is also the worst in Africa. (Obinna & Busari, 2022) There are many organisations aimed at challenging hunger levels in Nigeria, including The Red Cross (2022) and Action Against Hunger. (Action Against Hunger, 2022) The latter's work reached 2.4 million Nigerians in 2020, including 1.5 million through Nutrition and Health Programs, 682,000 through Water, Sanitation and Hygiene Programs, and 227,000 through Food Security and Livelihoods Programs. Food insecurity has also increased in Northeastern Nigerian, as a consequence of political instability due to conflict with armed insurgent groups since 2012. Increased population growth, and therefore a greater number of young children in the population, makes the threat of food insecurity more severe.

Very simply, a larger population means a greater strain on resources and the environment. Economic processes of production and consumption that lead to economic growth also cause environmental damage, such as air and water pollution, and habitat destruction. Population growth exacerbates these negative impacts. (Helbling, 2010) In Nigeria, environmental issues accompanying population growth include air pollution, water pollution, oil spillage, deforestation, desertification, erosion, and flooding. (Government of Nigeria, 1997) These are driven greatly by anthropogenic factors. (Pona, Xiaoli, Ayantobo, & Tetteh, 2021) The United Nations Environmental Program is also cautious of oil disasters in the country (Nigeria, 2022) after the two Bodo oil spills of 2008 where 560,000 barrels of oil were spilled by Shell into the Bodo community's land. (Leigh Day, 2022) These environmental issues all arise despite Nigeria having a tropical climate with two distinct – wet and dry – seasons. (Future Learn, 2021)

Section IIc: What policy recommendations should be adopted in Nigeria to fulfil sustainable economic development objectives?

'The Doughnut' economic model, devised by Kate Raworth, is a diagrammatic framework for sustainable development. (Raworth, 2017) It explores the need to meet social foundations, without exceeding an 'ecological ceiling' crossing planetary boundaries. Between these two boundaries is a 'safe and just space for humanity' and the economy can be regenerative and distributive. The classic Doughnut economic model is shown in *Figure 11* below.

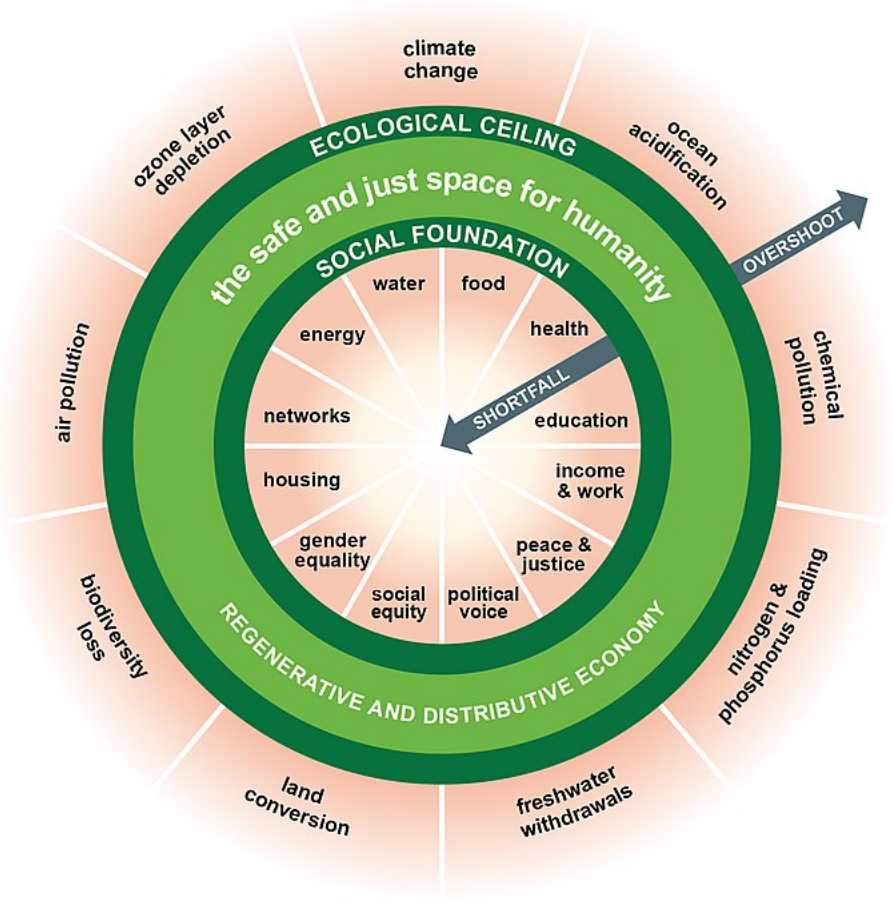

Figure 11 - The Doughnut Economic Model

On a global scale, we are falling short of some social foundations whilst overshooting normatively judged acceptable targets for certain environmental issues. These errors are shown in red in *Figure 12*.

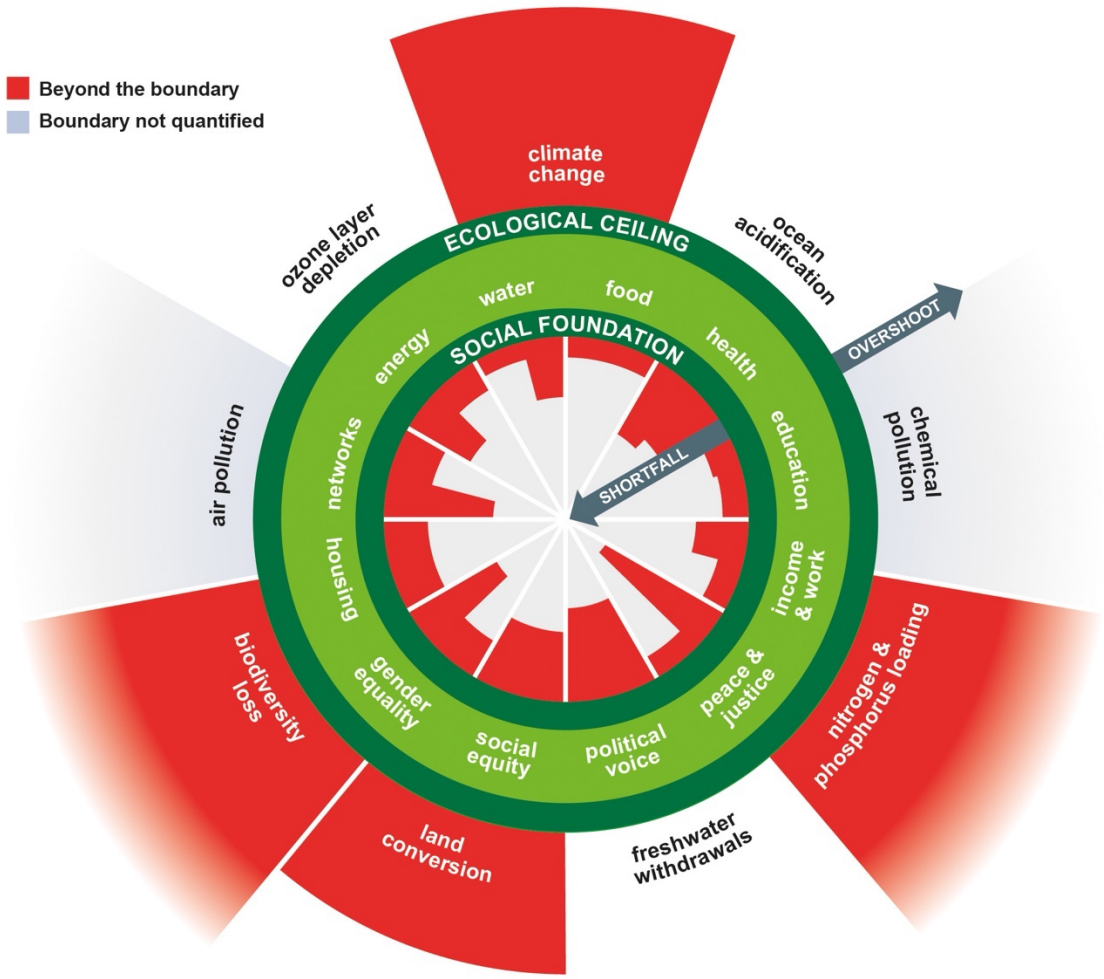

Figure 12 - The Doughnut Model (Overshoot and Shortfall)

Unlike the SDGs, the doughnut model is founded on the synchronicity between economic, environmental, and social policy. (Smart City Hub, 2021) More recently, through the Doughnut Economics Action Lab (DEAL), the doughnut model is being translated from theory into practice. (Raworth, So you want to downscale the Doughnut? Here's how., 2022); (DEAL, 2020) This was initially done on a city basis, starting in Amsterdam and later Berlin, Brussels, Cambridge, and Copenhagen (Lazard, 2022), and now the attention has shifted to country level. A version of Amsterdam's doughnut model is shown in *Figure 13* below. (Boffey, 2020)

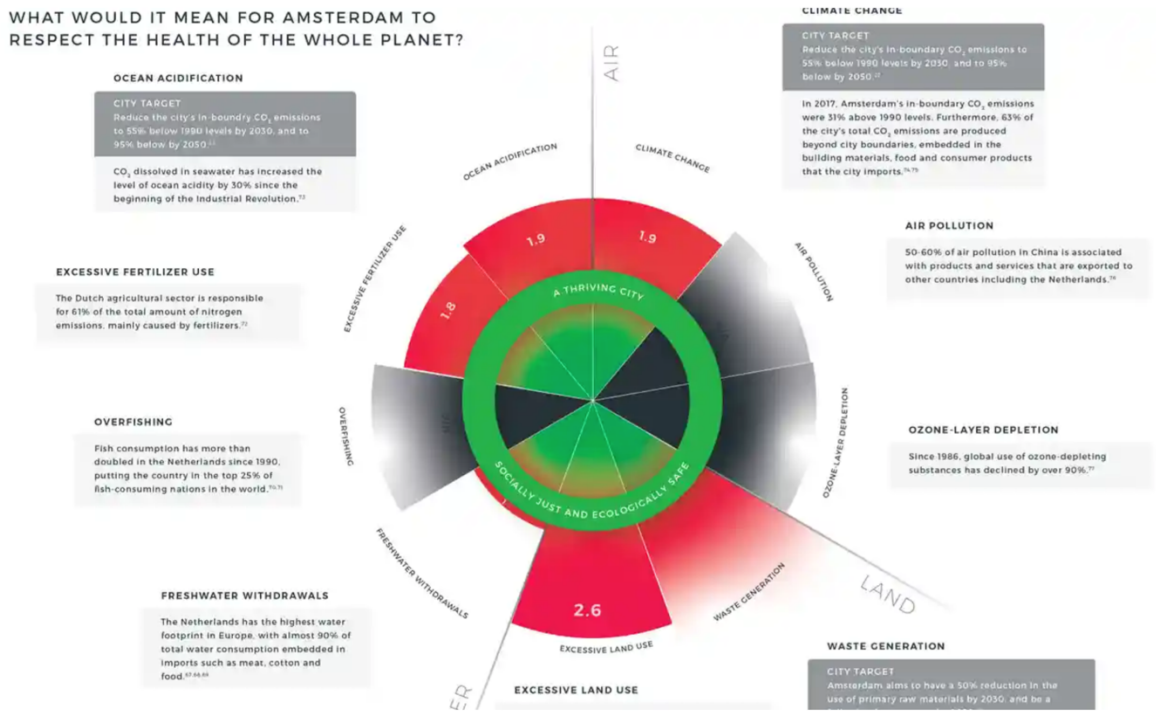

Figure 13 - Amsterdam Doughnut Model

Policy in Nigeria should focus on social foundation targets and ecological ceiling boundaries to fulfil sustainable development. *Table II* lists suggested social foundation targets for Nigeria, whilst *Table III* lists suggested ecological ceiling barriers.

Table II - Social Foundations for Nigeria

Social Foundations	Control Variable (Indicator)	Target	Current
Food	Population undernourished	0%	13%[1]
Health	Child (under-five) mortality	25 per 1000 live births	113.8 per 1000[2]
Education	Adult literacy rate	100%	62%[3]
Income and Work	Population living under international poverty line of $3.10 per day	0%	39.1%[4]
Water and Sanitation	Population with access to adequate drinking water	100%	73%[5]
Energy	Population lacking access to electricity	0%	43%[6]
Networks	Population with access to internet	100%	12.1%[7]
Housing	Proportion of population living in slum housing	0%	54%[8]
Gender Equality	Gender pay gap	0%	54%[9]
Social Equity	Palma ratio (the ratio of the income share of the top 10% of people to that of the bottom 40%)	<2	2.17[10]
Political Voice	Voice and Accountability Index	>0.5	-0.59[11]
Peace and Justice	Corruption Perceptions Index	>50%	24%[12]

[1] According to World Bank Data for 2020
[2] According to data from Knoema for 2020
[3] According to World Bank Data for 2018
[4] According to World Bank Data for 2021
[5] According to UNICEF data for 2021
[6] According to World Bank Data for 2021
[7] According to data from The Guardian Nigeria for 2022
[8] According to World Bank Data for 2018
[9] According to data from The Guardian Nigeria for 2018
[10] According to Inequality Index data for 2021
[11] According to data from TheGlobalEconomy.com
[12] According to data from Transparency International for 2022

Table III - Ecological Ceilings for Nigeria

Ecological Ceiling	Control Variable (Indicator)	Boundary	Current
Climate Change	Atmospheric carbon dioxide concentration, parts per million (ppm)	350ppm	400ppm
Ocean Acidification	Average saturation of aragonite (calcium carbonate) at the ocean surface, as a percentage of pre-industrial levels	At least 80% of pre-industrial saturation levels	84%
Chemical Pollution	No measure agreed	N/A	N/A
Nitrogen Loading	Reactive nitrogen applied to land as fertiliser (million tons per year)	At most 62 million tons per year	150 million tons per year
Phosphorus Loading	Phosphorus applied to land as fertiliser (million tons per year)	At most 6.2 million tons per year	14 million tons per year
Freshwater Withdrawals	Blue water consumption, cubic kilometres per year	At most 4000 cubic kilometres per year	2600 cubic kilometres per year
Land Conversion	Area of forested land as a proportion of forest-covered land prior to human alteration	At least 75%	62%
Biodiversity Loss	Rate of species extinction per million species per year	At most 10	100-1000 estimated
Air Pollution	No measure agreed	N/A	N/A
Ozone Layer Depletion	Concentration of ozone in the stratosphere, in Dobson Units	At least 275 DU	283 DU

Section III: To what extent is rapid population decline a cause for concern? A time-series forecast of Japan's fate

Japan is the typical example for an ageing society, with a median age of 48.4 today. (International Monetary Fund, 2020) Japan's demographic transition can be analysed through its history. Before the Meiji Restoration in 1868, Japan was in a pre-industrial

period. The population was stable, at around 30 million, because high birth rates and high death rates roughly cancelled each other out. (Karan, 2005) As Japan opened to international trade, its population increased rapidly from 1868 to 1920. Industrialisation included advances in science and technology which helped reduce mortality significantly, whilst birth rates remained high for a period. From 1920 to 1950 birth rates started to fall as well. (Stewart, 2007)

Following the Second World War, birth rates began to fall much more rapidly, resulting in Japan having the lowest childbearing levels in the world for the time. Total fertility rates fell below replacement levels as early as the late 1950s, falling to 1.5 in the 1990s and falling further to 1.30 in 2005. This has stabilised, and potentially on a gentle upwards trend, recorded as 1.36 in 2020. (World Bank, 2022)

Life expectancy – which is defined under the assumption of present mortality conditions – is 80 for men and 86 for women. Meanwhile, life expectancy at 60 is 23 for men and 28 for women. Japan's ageing population will only become more intense in the future. The median age of death for Japanese babies born in 2007 is expected to be 107. (Christensen, Doblhammer, Rau, & Vaupel, 2009)

Table IV - Oldest age at which at least 50% of a birth cohort is still alive in Japan

Year	Median Age of Death
2000	104
2001	105
2002	105
2003	105
2004	106
2005	106
2006	106
2007	107

Some demographers are concerned that due to demographic inertia, very low fertility rates – named '*Shoshika*' could be irreversible. Technological advances catalyse changes in the labour market and alter the costs and benefits of marriage and childbearing. This is termed the 'low fertility trap'. (Lutz, Skirbekk, & Testa, 2005) In Japan, the effect can be self-fulfilling as there will be both fewer mothers in the future and sociologically the ideal family size for younger generations is declining as a consequence of the lower childbearing they see in previous generations. Since total fertility rates are very low (1.36 in 2020), and families with one child or no children at all become more normalised, it will be very difficult to raise fertility again without direct policy which would, of course, have other trade-offs. (McDonald, 2008)

There are some contrasting causes for optimism, however. It is generally accepted that there is a negative relationship between economic growth and fertility rates – as countries become more developed, their TFR falls. (Lesthaeghe, 2010) Yet, there is evidence that the long-standing negative relationship between fertility and economic development might turn positive at high levels of development. (Fox, Klüsener, & Myrskylä, 2019) This may be because the opportunity cost of having children increases when a country becomes more developed. In this way, women are more likely to work and earn a high salary. This can lead to the postponement of childbearing, rather than not having children altogether. (Bongaarts & Sobotka, 2012) Geriatric mothers are also more likely to have twins and multiple-birth pregnancies. (Myrskylä & Fenelon, 2012) There are different names given to this theory, including 'the income/development-fertility reversal'; 'the inverse J-shaped association'; or 'convex relationship between income/development and fertility'. Dual-earner couples, more prominent in more developed countries, are more likely to postpone, but not abstain from, childbearing, leading to the development-fertility reversal effect. (de Meester & van Ham, 2009) This theory may also be criticised, though, as potentially only applying to WEIRD (Western, Educated, Industrialised, Rich and Democratic) societies and thus the findings may not transfer to all countries.

Section IIIa: What are the core causal factors for Japan's anticipated population decline?

Like for Nigeria, we may model Japan's population growth in relation to its determinants:

Equation D - Population Growth Model (Japan)

$$\frac{\Delta P_J}{\Delta T} = \beta_0 + P_0(\mu F - \upsilon M) + \pi I + \varepsilon_i$$

Where the population growth rate ($\frac{\Delta P_J}{\Delta T}$), the dependent variable, is dependent on the independent variables, which include the initial population (P_0), positively correlated with the total fertility rates (F) and negatively correlated with mortality rates (M). I represents net international migration levels which has the power to affect population growth. β_0 is the intercept parameter and ε_i is the error term. It is possible to find estimates for the values of the intercept and slope parameters, μ, υ, and π, for Japan using multivariate regression analysis. Unfortunately, constraints mean it is not possible to calculate these during this research period, however it would be expected that $\frac{\Delta P_J}{\Delta T}$ would be negative, converse to $\frac{\Delta P_N}{\Delta T}$, whilst μ would be a smaller coefficient than α in *Equation B*. υ would be very similar to γ in *Equation B* (on account of both Japan and Nigeria currently having death rates of around 11 per 1000 people) and π would be smaller in magnitude than θ in *Equation B* but π would be positive whilst θ would be negative.

As mentioned previously, under the *ceteris paribus* assumption of no net migration, in order to maintain a constant population, a country must have a total fertility rate above the replacement ratio (approximately 2.1 children per woman). In Japan, fertility rates have been consistently below this for the last sixty years. (World Bank, 2022) In fact, the population has been shrinking at a faster rate than predicted, with just 840,832 babies born in 2020, a fall of 2.8% from the year before and the lowest since records began in 1899. (Bateman, 2022) This leads to a negative skew in the age distribution of the Japanese population. Life expectancy is increasing, but at a slower rate, so in the years to come the population will shrink as the elderly die.

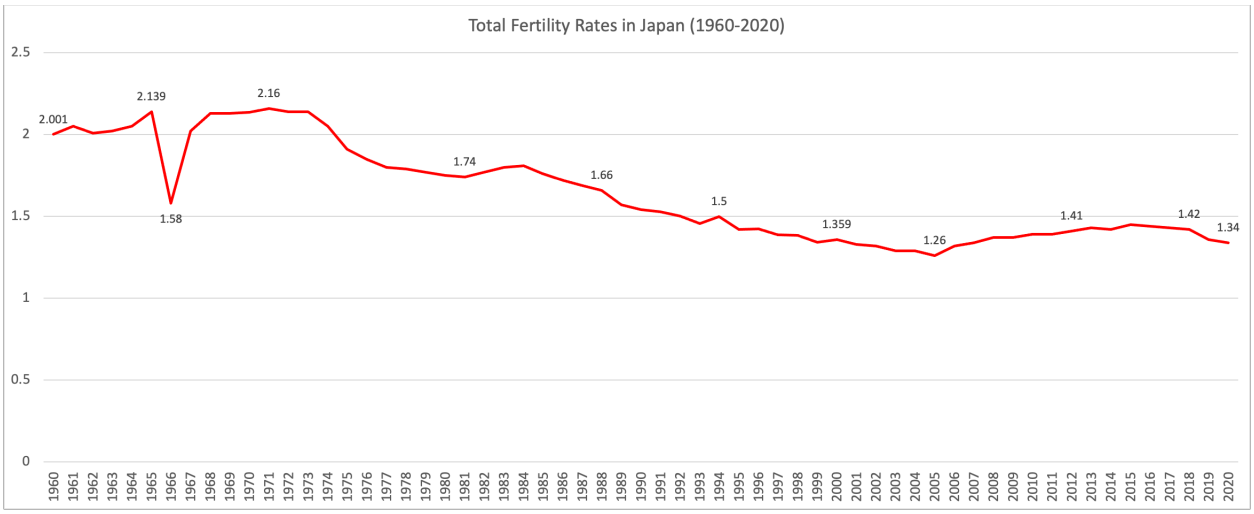

Figure 14 - Total Fertility Rates in Japan (1960-2020)

In contrast to Nigeria, intergenerational gaps are larger, since the average Japanese woman is having their first child at the age of 30.9. This is above what the average age was for a woman to have their third child forty years ago. (Nippon, 2022) Other factors contributing to the declining birth rate in Japan include the declining marriage rate, an increase in the average age of those getting married, economic burden and issues with childcare provision. (Iijima & Yokoyama, 2018) Contraception is widely used – condoms remain the most commonly used contraceptive with 83.4% of sexually active women aged 16-49 years using them in 2014. Oral contraceptive pills (OCPs) are less commonly used, at only 3%, but are on the rise in Japan. (Yoshida, et al., 2016)

From a social perspective, more Japanese women are choosing to pursue careers and postpone childbearing. In 1975, 12.7% of women in Japan had a college degree, but this rose to 64% by 2019. (OECD, 2022) As of 2021, women make up 44.4% of the workplace in Japan (World Bank, 2022) Traditionally, work culture in Japan emphasises extreme dedication to one's job. (Japan Dev, 2022) Internationally, 'karoshi' (過労死) – death from overwork – is an infamous stereotype, although this mainly applies to young men, and Japan ranked last in the 2016 Job Happiness Index out of 35 countries which provided data. (Indeed, 2016) In reality, however, Japanese workers work on average 136.1 hours per month. (MHLW (Japan), 2022)

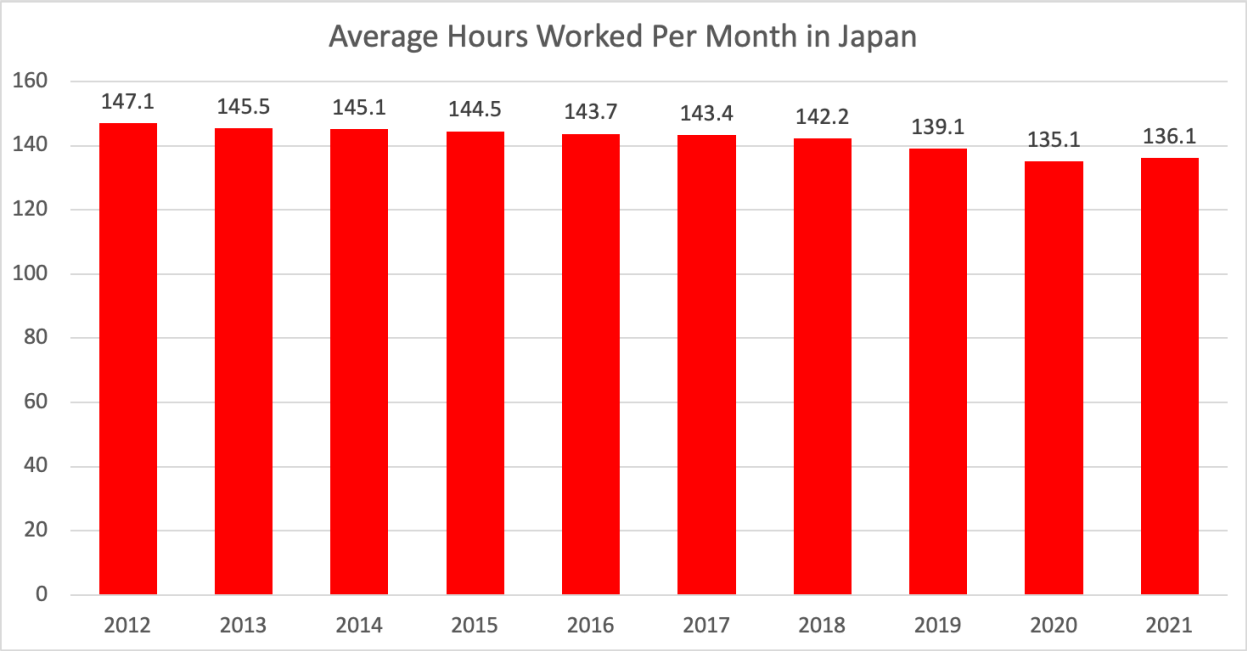

Figure 15 - Average Hours Worked Per Month in Japan

The bottom line is, though, that Japanese women are choosing work over childbearing. Lastly, desired family sizes are becoming smaller not only to fit in with the status quo but because of financial burdens. Living space in densely populated cities such as Tokyo is at a premium, so it is hard to live somewhere with more than one child.

Mortality is the dominant cause of Japan's declining population size. Crude death rates have been consistently on the rise since 1979. In 2021, they were at 11.1 per 1000 people. This is an 88.1% increase from its nadir in 1979 at 5.9 per 1000 people. (World Bank, 2022)

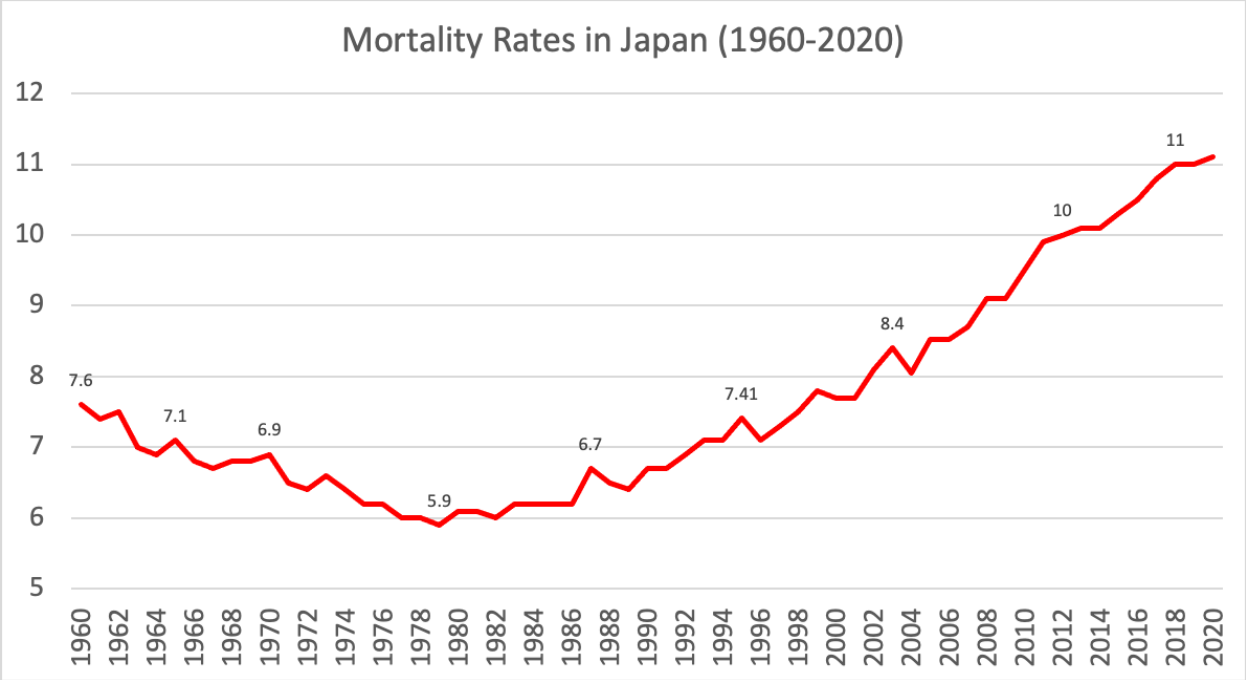

Figure 16 - Mortality Rates in Japan (1960-2020)

With death rates exceeding birth rates, the only way for Japan to maintain the size of its labour force is to have net immigration. Out of 125.57 million people in Japan in 2020, 2.76 million (2.29%) were foreign-born. (Statistics Japan, 2021) However, generally, Japan has adopted an isolationist stance on immigration historically, with roots in *Sakoku*. In recent times, politicians have become increasingly aware of the implications of the ageing population on the labour market, and in late 2015, following labour shortages in industries such as IT, construction and healthcare, short-term trainee programs were proposed to expand foreign labour pools. (Sekiguchi, 2015)

In 2019, Japan received 138,000 new immigrants on a long-term or permanent basis, a significant 18.4% rise from 2018. Approximately 60% of these were labour migrants, 26.2% were accompanying family members, and just 0.1% were humanitarian migrants. (OECD, 2022) Japan accepts very few refugees. (Kyodo News, 2022) The top five inflows of migrants were from Vietnam, China, The Philippines, Republic of Korea and Indonesia, followed by the United States. Conversely, the top destinations for Japanese nationals to emigrate were Germany, Republic of Korea, the United States, New Zealand, and the Netherlands.

Section IIIb: What will be the effect of Japan's population decrease?

Public policy and the government's fiscal policy must adapt in response to the rapidly shrinking population. In direct response, in attempt to boost birth rates, the Japanese government started paying parents the equivalent of $3400 per year per child they have. (Alexander, 2022) Meanwhile, 'Abenomics' involves flexible fiscal policy, monetary easing and structural – particularly labour market – reforms. The challenge is to balance short-term fiscal stimuli with long-term fiscal sustainability. Increasing training and career opportunities, and increasing the availability of childcare, will help raise labour productivity and wages. (International Monetary Fund, 2020)

Demographic trends also have effects on monetary policy, and research has found that demographic trends are closely tied to low interest rates. In Japan, and other ageing economies, before retirement individuals seek to increase savings for retirement whilst investment remains restrained due to a weak outlook, leading to pressure for lower base interest rates. Keeping interest rates low depresses the profitability of financial institutions and incentivises them to invest in riskier assets to seek higher returns. Thus, demographic change has a significantly negative impact on the natural rate of interest. (Han, 2019)

The housing market has been, and will continue to be, affected significantly by demographic change. The fall in demand has created excess supply in many regions, and the market forces have created a weakening in house prices. This has knock-on effects to both households and, critically, banks. Consequently, the stability of Japan's financial sector is thrown into doubt. (Hashimoto, Hong, & Zhang, 2020)

Since a significant proportion of the current generation are entering into retirement, the number of retirees materially exceeds the replacement of incoming workers. A successful transition to automation could offset up to 60% of the anticipated slowdown in economic growth attributable to demographic decline. (Colacelli & Fernández Corugedo, 2018) Additionally, a smaller labour force implies less tax money is available for the government to take care of its citizens. Furthermore, consumer spending currently comprises 60% of Japan's GDP, and since the elderly consume less, this will have a severe impact on long-term economic growth (as measured by GDP at least).

(Bank of Japan, 2022) Japan has already been overtaken by China as the world's second largest economy, back in 2010 (BBC News, 2011), and adjusted for Purchasing Power Parity it could slip to eighth place by 2050. (PwC, 2017) The demographic shift is pretty much inevitable, so it is political and economic policy that must reform in response.

As such, the rapid population decline in Japan has put pressure on social care schemes. Building on the rapid recovery from the Second World War, Japan had established universal healthcare and pension systems. This was originally founded on a large accumulated reserve fund, but in 1995 Japan shifted to a pay-as-you-go system. This retirement scheme involves the plan beneficiaries deciding how much they wish to contribute either by arranging for the specific amount to be deducted from their paycheck regularly or by contributing the desired amount in a lump sum. (Harper S. , The Grey Burden, 2016, p. 65)

More recently in 2004, the Japanese government introduced a system of fixed contributions and reduced benefits to secure the future stability of the scheme in light of extreme ageing. Nonetheless, the social security system now faces serious financial problems, as the number of beneficiaries is increasing at a time when the working age population is declining, hence there has been a fall in revenues and simultaneous increase in payments. Likewise, the government has also introduced a system of long-term care insurance whilst attempting to curb the upward spiralling of medical care costs. (Harper S. , The Grey Burden, 2016, p. 66)

Yet, the general pressure on social care stemming from the ageing population has led to a unique phenomenon where the elderly are committing petty crimes in order to go to prison. The basic state pension is hard to live on, and if they can not or do not want to depend on their children, then they can commit a small petty crime such as shoplifting and stay in prison for a while, where they have shelter and food provided for them. (BBC News, 2019) Over 65s are now accountable for one-fifth of crimes in Japan. (Japan Ministry of Justice, 2019)

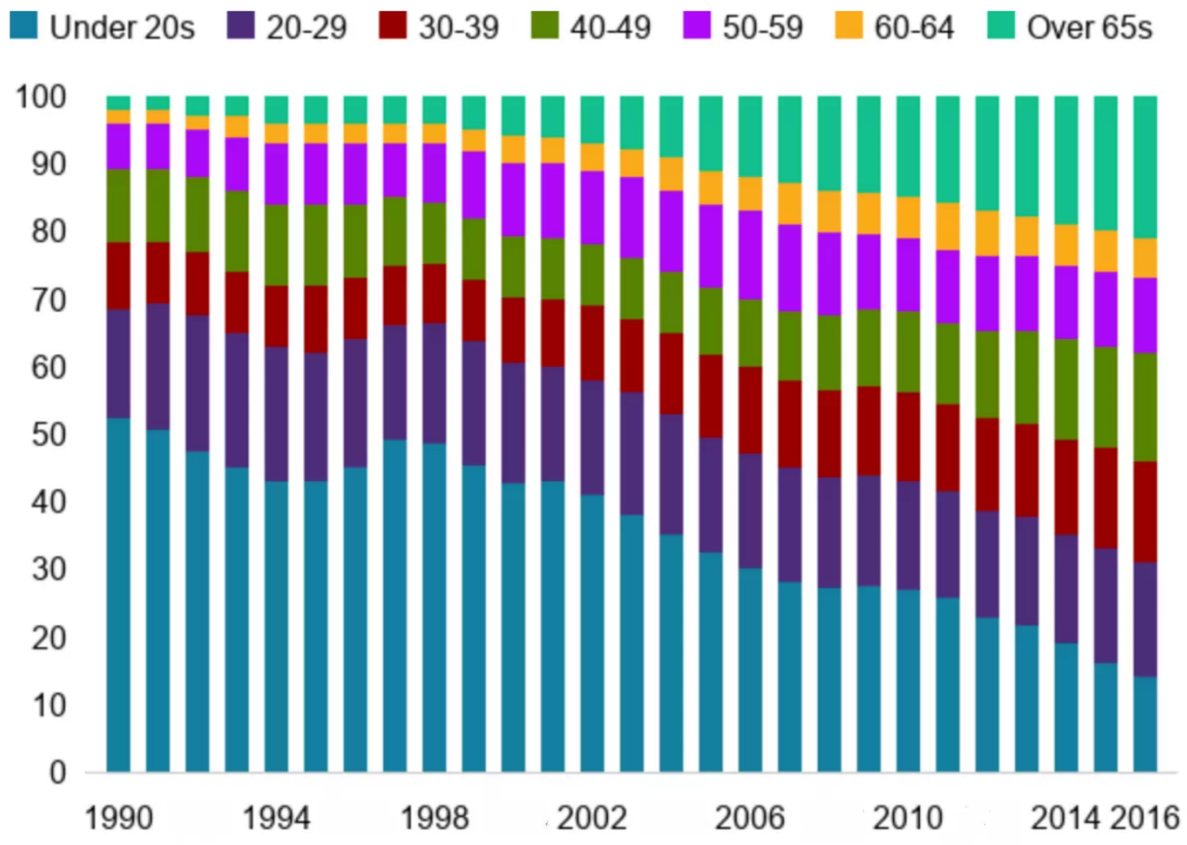

Figure 17 - Older Japanese people are committing an increasing proportion of offences - % of penal code offences committed by age group

However, these major concerns in terms of public spending on pensions, high dependency ratios between workers and non-workers, increases in healthcare costs, declining availability of family-based care, and a slowdown in consumption due to an increase in the population of older people and fall in the population of younger people are based on assumptions developed from the behaviours and characteristics of current older populations. Whilst some of these fears are supported by evidence, many may merely be speculative. In practice, social and economic behaviour are complex and the ability of societies and individuals to adapt to changing circumstances should not be underestimated. In practice, it is very probable that future generations of older adults will have higher levels of human capital and education levels and thus retirement and dependency, even what is considered the definition of old age, will be pushed back. New issues can be solved by evolving policy.

The population decline in Japan will also raise issues of equity, in particular inter-generational equity. It may be argued that the economic boom experienced by Japan in the 1960s was related to its demographic dividend. Japan's proportion of producers grew consistently from the end of the Second World War up to the 1980s, parallel to the rise of the demographic dividend, and outstripping the proportion of consumers in the populations. (Ogawa, Matsukura, & Chawla, 2011) However from the 1990s onwards Japan's ageing population took centre stage; having experienced a fourfold increase in the percentage of the population aged over 65 in 55 years (5% in 1950 to 20% by 2005). With limited immigration, its population began to decline in size. Japan's situation demonstrates that the context to the economic challenge is the structural change in the population, *id est*, the changing composition of ages within its population.

Section IIIc: What policy recommendations should be adopted in Japan to fulfil sustainable economic development objectives?

Japan has progressed through its demographic transition as it has grown economically. A side effect of this economic growth is environmental damage. Following the 1992 United Nations Conference on Environment and Development, the Japanese government passed the Basic Environment Act in 1993 and formulated the Basic Environment Plan in 1994. (Ministry of the Environment, Government of Japan, 2022) Japan is prone to natural disasters, with a prominent example being the 2011 Tohoku earthquake and tsunami. Architectural regulations have made skyscrapers in large cities such as Tokyo earthquake-resistant, but coastal areas are still vulnerable to tsunamis. The Dregg's model suggests that hazard risk only matters when there is overlap between the strong probability of a hazard and a vulnerable proportion. In order to minimise risk to its population, population decline could be an opportunity for more people to live away from coastal areas and thus reduce hazard risk.

Just like for Nigeria, it is possible to see how close Japan is to achieving sustainable development through the doughnut economic model, an alternative to the SDGs which considers how to meet social foundations without exceeding ecological ceilings. It may be seen that Japan has fulfilled lots of social foundations criteria, and is close to achieving others, therefore population decline should not threaten the ability of Japan to

meet social foundations without compromising the needs of future generations by exceeding ecological boundaries.

Table V - Social Foundations for Japan

Social Foundations	Control Variable (Indicator)	Target	Current
Food	Population undernourished	0%	3.2%[13]
Health	Child (under-five) mortality	25 per 1000 live births	2.5 per 1000 live births[14]
Education	Adult literacy rate	100%	99%[15]
Income and Work	Population living under international poverty line of $3.10 per day	0%	0%[16]
Water and Sanitation	Population with access to adequate drinking water	100%	98.57%[17]
Energy	Population lacking access to electricity	0%	0%[18]
Networks	Population with access to internet	100%	6%[19]
Housing	Proportion of population living in slum housing	0%	0%[20]
Gender Equality	Gender pay gap	0%	22.1%[21]
Social Equity	Palma ratio (the ratio of the income share of the top 10% of people to that of the bottom 40%)	<2	1.3[22]
Political Voice	Voice and Accountability Index	>0.5	0.99[23]
Peace and Justice	Corruption Perceptions Index	>50%	73%[24]

[13] According to data from the World Bank for 2021
[14] According to data from the World Bank for 2020
[15] According to data from Index Mundi for 2021
[16] According to data from the UN SDGs for 2022
[17] According to data from Macrotrends for 2020
[18] According to data from the World Bank for 2020
[19] According to data from DataReportal for 2022
[20] According to data from the World Bank for 2022
[21] According to data from the OECD for 2021
[22] According to data from the OECD for 2016
[23] According to data from the TheGlobalEconomy.com for 2020
[24] According to data from Transparency International for 2021

Table VI - Ecological Ceiling for Japan

Ecological Ceiling	Control Variable (Indicator)	Boundary	Current
Climate Change	Atmospheric carbon dioxide concentration, parts per million (ppm)	350ppm	400ppm
Ocean Acidification	Average saturation of aragonite (calcium carbonate) at the ocean surface, as a percentage of pre-industrial levels	At least 80% of pre-industrial saturation levels	84%
Chemical Pollution	No measure agreed	N/A	N/A
Nitrogen Loading	Reactive nitrogen applied to land as fertiliser (million tons per year)	At most 62 million tons per year	150 million tons per year
Phosphorus Loading	Phosphorus applied to land as fertiliser (million tons per year)	At most 6.2 million tons per year	14 million tons per year
Freshwater Withdrawals	Blue water consumption, cubic kilometres per year	At most 4000 cubic kilometres per year	2600 cubic kilometres per year
Land Conversion	Area of forested land as a proportion of forest-covered land prior to human alteration	At least 75%	62%
Biodiversity Loss	Rate of species extinction per million species per year	At most 10	100-1000 estimated
Air Pollution	No measure agreed	N/A	N/A
Ozone Layer Depletion	Concentration of ozone in the stratosphere, in Dobson Units	At least 275 DU	283 DU

Section IV: Conclusion

This paper has contributed to the existing literature in the field of Demographic Economics, having considered the causes of Nigeria's rapid population growth and Japan's opposing fate. Comprehension of these underlying causes helps to analyse the effects of demographic change and identify the manifold problems that need to be addressed, as well as the benefits to capitalise on.

For Nigeria, it has been seen that high fertility rates are the main cause for population growth, driven by very short intergenerational gaps and desired large families to account for high levels of child mortality, as well as the low prevalence of contraceptive use and other social and religious factors. Rapid population growth has exacerbated poverty levels in Nigeria in the short run. These have resulted in challenges for Nigeria in meeting many of its social foundations whilst not negatively impacting the environment. Population growth also leads to economic growth, and as Nigeria's national income grows it will progress along the Environmental Kuznets Curve, eventually prioritising the environment. (Yasin, Ahmad, & Chaudhary, 2020)

Conversely for Japan, it has been seen that large intergenerational gaps, on account of high levels of female labour force participation and low desired family sizes, are the main causes of low fertility rates and, by extension, population decline. This has primarily affected labour markets and public policy. The Japanese government is pursuing an 'Abenomics' approach to fiscal and monetary policy to help Japan thrive within the circumstances it faces. However, policies responding to Japan's demographic crisis are not expected to threat its sustainable development, currently fulfilling criteria for most social foundations, and not exceeding ecological ceilings.

There is scope for further research on this topic, particularly the econometric methodology, given a longer timeframe.

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Section VI: Appendices

Section VIa: Appendix I – Total Fertility Rates by Family Planning Program Effort and Social Setting Score

Table VII - Total Fertility Rates in 40 Developing Countries with a Recent Demographic and Health Survey, by Social Setting, according to 2004 Family Planning Program Effort Score

Family Planning Program Effort Score / Social Setting Score	Strong (≥54)	Moderate (46.0-53.9)	Weak (<46)	All
Good (≥57)	Namibia 3.6 Egypt 3.0 Indonesia 2.6 Morocco 2.5 **Mean 2.9**	Jordan 3.8 Cambodia 3.4 Philippines 3.3 India 2.7 Colombia 2.4 Dominican Rep. 2.4 **Mean 3.0**	Congo 4.8 Bolivia 3.5 Honduras 3.3 **Mean 3.9**	**3.2**
Medium (48.0-56.9)	Benin 5.7 Pakistan 4.1 Ghana 4.0 Nepal 3.1 Bangladesh 2.7 **Mean 3.9**	Madagascar 4.8 Kenya 4.6 Lesotho 3.5 **Mean 4.3**	Uganda 6.7 Nigeria 5.7 Tanzania 5.7 Cameroon 5.0 Haiti 3.9 Swaziland 3.9 **Mean 5.2**	**4.5**
Poor (<48)	Burkina Faso 5.9 Mozambique 5.5 **Mean 5.7**	Mali 6.6 Malawi 6.0 Guinea 5.7 Senegal 4.9 **Mean 5.8**	Niger 7.0 Chad 6.3 DR Congo 6.3 Zambia 6.2 Liberia 5.9 Rwanda 5.5 Ethiopia 5.4 **Mean 6.1**	**5.9**
All	**3.9**	**4.2**	**5.3**	**4.5**

Section Vib: Appendix II – Indicators of Family Planning Program Effort Scores and Socioeconomic Development for 40 Developing Countries, Ranked in Descending Order of Total Fertility Rate

Table VIII - Indicators of Family Planning Program Effort Scores and Socioeconomic Development for 40 Developing Countries, Ranked in Descending Order of Total Fertility Rate

Country	Year of DHS	Total Fertility Rate	Program Effort Score	Infant Mortality Rate	Poverty	Female Education	HDI Score	Sub-Saharan Africa?
Niger	2006	7.0	27.0	81.4	85.6	10.4	33.0	Yes
Uganda	2006	6.7	43.0	71.1	75.6	28.0	49.4	Yes
Mali	2006	6.6	53.3	95.8	77.1	18.3	36.1	Yes
Chad	2004	6.3	29.0	101.7	83.3	11.0	39.4	Yes
DR Congo	2007	6.3	31.6	91.8	79.5	42.8	37.0	Yes
Zambia	2007	6.2	37.0	70.4	81.5	42.9	46.6	Yes
Malawi	2004	6.0	51.1	76.1	90.4	19.1	47.6	Yes
Burkina Faso	2003	5.9	58.6	81.4	81.2	13.5	36.7	Yes
Liberia	2009	5.9	38.0	72.6	94.8	23.5	42.7	Yes
Benin	2006	5.7	54.0	67.0	75.3	33.0	48.2	Yes
Guinea	2005	5.7	46.1	91.4	87.2	21.7	42.6	Yes

Nigeria	2008-09	5.7	41.6	75.3	83.9	58.8	49.9	Yes
Tanzania	2004	5.7	45.1	68.0	96.6	10.8	51.0	Yes
Mozambique	2003	5.5	55.5	100.7	90.0	13.6	39.0	Yes
Rwanda	2007-08	5.5	37.0	62.3	90.3	6.4	44.9	Yes
Ethiopia	2005	5.4	37.0	77.0	77.5	15.8	39.1	Yes
Cameroon	2004	5.0	41.8	74.1	57.7	45.4	52.0	Yes
Senegal	2008-09	4.9	46.9	53.6	60.3	18.4	46.0	Yes
Congo	2005	4.8	26.3	75.5	74.4	55.1	60.0	Yes
Madagascar	2008-09	4.8	48.4	47.9	89.6	40.1	53.2	Yes
Kenya	2009	4.6	49.2	51.7	39.9	29.8	53.0	Yes
Pakistan	2006-07	4.1	55.2	77.7	60.3	43.0	55.5	No
Ghana	2008	4.0	56.0	50.3	53.6	64.7	51.2	Yes
Haiti	2005-06	3.9	35.8	57.3	72.1	40.0	52.6	No
Swaziland	2006	3.9	40.1	85.5	81.0	54.9	56.7	Yes

Jordan	2009	3.8	50.1	23.1	3.5	97.3	76.4	No
Namibia	2006-07	3.6	55.0	46.1	62.2	68.1	67.2	Yes
Bolivia	2008	3.5	36.1	49.8	30.3	70.2	72.3	No
Lesotho	2004	3.5	47.6	91.0	62.2	37.5	50.8	Yes
Cambodia	2005	3.4	46.0	65.6	68.2	42.1	57.5	No
Honduras	2005	3.3	45.2	23.4	29.7	49.1	72.5	No
Philippines	2008	3.3	46.9	24.9	45.0	84.9	74.4	No
Nepal	2006	3.1	57.4	47.9	77.6	53.8	53.7	No
Egypt	2008	3.0	54.2	24.5	18.4	85.2	69.6	No
Bangladesh	2007	2.7	64.4	51.5	81.3	68.9	52.7	No
India	2005-06	2.7	48.7	57.0	75.6	64.7	59.6	No
Indonesia	2007	2.6	56.4	34.2	52.4	78.8	72.3	No
Morocco	2003-04	2.5	59.5	40.4	14.0	46.0	64.0	No
Colombia	2005	2.4	50.0	18.7	27.9	84.0	79.5	No

Dominican Republic	2007	2.4	46.2	32.1	15.1	67.3	76.5	No

Section Vic: Appendix III – Cross-Tabulation Analysis: Coefficients from Regression Analysis of Relationship of Socioeconomic Factors and Family Planning Program Effort Scores with Total Fertility Rates in 40 Developing Countries

Table IX - Cross-Tabulation Analysis: Coefficients from Regression Analysis of Relationship of Socioeconomic Factors and Family Planning Program Effort Scores with Total Fertility Rates in 40 Developing Countries

Indicator	Correlation Coefficient	Regression Coefficient				
		Model 1	Model 2	Model 3	Model 4	Model 5
Human Development Index	-0.822	-0.054	n/a	n/a	n/a	n/a
Poverty	0.664	n/a	0.044	n/a	n/a	n/a
Infant Mortality Rate	0.730	n/a	0.006	0.008	n/a	0.019
Female Education	-0.757	n/a	-0.017	-0.018	-0.021	-0.026
Program Effort Scores	-0.456	-0.031	-0.026	-0.026	-0.028	-0.032
Sub-Saharan Africa	0.807	1.071	1.247	1.279	1.409	n/a
Constant (a)		**8.246**	**5.109**	**5.239**	**5.897**	**6.017**
R^2		**0.802**	**0.777**	**0.775**	**0.768**	**0.683**

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