

A Work Project, presented as part of the requirements for the Award of a Master's degree in  
Economics from the Nova School of Business and Economics.

DEMOGRAPHY AND ITS CHALLENGES TO GDP GROWTH IN THE WORLD'S MOST  
AND LEAST DEVELOPED COUNTRIES

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16/01/2023

**Abstract:**

By analysing panel data for 11 countries over 46 years, the gender effects of mortality rates, fertility rates, and life expectancies on the economic growth of two economically opposed groups of countries is assessed. The results concluded that the African countries studied are stuck in a trap and must adopt unique and country-specific solutions to fix the problems in their economies. Conclusiveness of the results is granted by Granger tests for the issue of causality prevalent amongst the variables used.

**Keywords:** mortality, fertility, growth, life expectancy, gender, Africa

**Acknowledgements:**

Firstly, I would like to thank my supervisor Maria Eugenia de Almeida Mata for her guidance throughout this project. Secondly, I would like to thank Kene Okonkwo for his help and support in completing this project. And finally, I would like to thank my parents, siblings, and friends, both in Portugal and in the UK, for their continued support and motivation throughout my studies.

This work used infrastructure and resources funded by Fundação para a Ciência e a Tecnologia (UID/ECO/00124/2013, UID/ECO/00124/2019 and Social Sciences DataLab, Project 22209), POR Lisboa (LISBOA-01-0145-FEDER-007722 and Social Sciences DataLab, Project 22209) and POR Norte (Social Sciences DataLab, Project 22209).

## **1. Introduction**

Research has been conducted on the effects that mortality rates have on economic growth, and it seems sufficient enough to form opinions on the matter. For instance, in their paper, Rocco et al (2021) stated that mortality has a negative effect on GDP per capita growth. However, in some instances this is not the case. In his article, Rich Morin (2013) quoted Herbert Rolden, a researcher on vitality and aging, in saying that in some countries, mortality rates actually increase during periods of economic growth. Therefore, there must be many factors that determine whether or not mortality has a positive or negative effect on a country's economic growth.

Mortality rates investigated in published studies are generally regarded as the death rate of the country per 1000 people. This means that the divide between male and female mortality rates is not always identified – despite them likely having different effects on economic growth due to the different roles that men and women play in society. Additionally, in many papers, when mortality rates were considered, life expectancies were too. However, just as with the mortality rates, male and female life expectancies are not separated and instead an overall life expectancy is utilised. Therefore, the effect of gender on economic growth is overlooked.

The Group of Seven (G7) countries are arguably the most dominant countries in the world, possessing the largest liberal democracies and most advanced economies (Wikipedia a.; Government of Canada). These countries are Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States. On the opposite side of this scale, there are some of the least economically advanced countries in the world. When researching these countries, it became apparent that most of them were situated in Africa. There are many factors that could contribute to an African country's poor economy, just as there are many factors that could contribute to a G7 country's rich one. Many of these factors were identified through preliminary research and

subsequently investigated through data made available online. However, it is very important to note that colonisation is likely to have played a significant role in the development of the African countries' economies, as all but 2 African countries (Ethiopia and Liberia) are said to have been colonised. Quantifying colonisation and its effects is difficult to do and therefore, the use of dummy variables as representatives of the presence of colonisation can be employed to account for this.

The aim of this study is to determine the gender-based effects of life expectancy and mortality rates on the GDP growth of two economically opposed groups of countries. Additionally, the effects of human capital indexes (based on years of schooling), capital stock at current PPPs, and exports of goods and services as a percentage of GDP will also be assessed to determine how they too affect economic growth. Results will be obtained by gathering panel data for numerous variables over a 50-year period. This time frame was chosen because it will provide sufficient data for a meaningful analysis to be made.

This paper will be divided into 6 sections. Section 1 is the introduction, and this is followed by a review of relevant literature in section 2. Section 3 details the methodology and process of gathering data before leading into section 4 where the results are presented. These results and reasons for them are then discussed in section 5. And finally, section 6 presents the conclusion of the study and suggestions for future work.

## **2. Literature Review**

In their study, Lorentzen et al (2008) found that a bidirectional causal relationship exists between mortality and poverty. They proposed that in poor countries with limited healthcare services or sanitation, people die at younger ages. On the contrary, they proposed that when people know that they are likely to die at a younger age, because that is the norm in their country, then they

are less willing to save money, educate themselves, and make other choices that would help their country's economy grow. While this aspect of the study is relatively simple to understand, the significance of the study arises when focusing on the relationship between poverty, high adult mortality, and low economic growth. Lorentzen et al (2008) stated that due to the feedback effect taking place amongst these three issues, "poverty leads to high mortality, and this in turn inhibits the growth that would help countries escape poverty".

Unlike previously published research focused on mortality rates and economic growth, Lorentzen et al (2008) differentiated the terms adult mortality, infant mortality, and life expectancy instead of treating them all as identical. They stated that while adult and infant mortality are strongly correlated, the effects of the death of an adult versus an infant, while both devastating, do not have equal effects on the economy. The untimely death of an infant does not seriously affect the economy whereas an adult's untimely death likely implies a loss of life-time human capital, and other investments. Moreover, they suggested that studying the ages at which mortality occurs and the subsequent effects on the economy could aid policymakers in deciding where to spend money on healthcare resources – especially when funds are scarce. Finally, as mentioned previously, life expectancy affects the willingness of a country's inhabitants to establish long-term investments, educate themselves and essentially plan a future – for example, choosing to have children (Lorentzen, McMillan and Wacziarg, 2008).

As such, in this dissertation, adult mortality, infant mortality and life expectancy will be treated individually to determine their respective impacts on economic growth.

Similarly, Pasali et al (2019) studied the effect that maternal, infant and child mortality rates had on the economic growth of 48 African countries between the years 2000 and 2015. They found a negative and significant association between the mortality rates and economic growth and a

positive association between life expectancy and economic growth. Furthermore, Pasali et al (2019) studied the effects of health expenditures on economic growth and found both the direct and indirect effects to be positive and economically significant – a 10% increase in health expenditure was shown to increase the average annual real GDP per capita by 0.24%. The effects of education on economic growth and health outcomes were also studied and it was found to effect both positively and even more so when female education was considered (Pasali, Somé and Kaboine, 2019).

Bakari et al (2018) studied the effects of population growth, proxied by other variables such as fertility rate, GDP, and crude death rate, on economic growth in 53 African countries in their paper. Population growth was found to have a positive impact on economic growth, but fertility rates were found to impact it negatively.

Africa has the highest rate of population growth in the world and its population is estimated to reach 2.4 billion in 2050 from its current standing at 1.4 billion (Worldometer, 2022). Resultantly, over half of the people born in the world between now and 2050 will be born in Africa - even though it is likely that in the future, families will choose to have less children. The reason for this is that the current median age in Africa is 19.7 years old (Worldometer, 2022), implying that a substantial amount of the population is yet to enter their reproductive years (Bakari and Peter, 2018). With this information in mind, it is important to note that the positive impact population growth has on economic growth stems from looking at demographic information and its negative impact stems from simply regarding populations as a whole. As stated in Bakari and Peter's (2018) paper, Bloom et al found that when considered entirely, population growth has negative impacts on economic growth. However, when only the working population is considered, this impact on economic growth becomes strong and positive –

although not for all countries and regions. Therefore, there must be unexplained but unique impacts that certain factors have on economic growth in different countries and geographies. Regarding this, the Malthusian theory of population is an important topic to discuss. This idea, proposed by Thomas Malthus in his 1798 writings, explains that “higher levels of food production created by more advanced agricultural techniques create higher population levels, which then lead to food shortages because the higher population needs to live on land that would have previously been used to grow crops” (Agarwal 2022). In the early days of this theory, it was assumed that population growth was detrimental to economic growth because it added pressure on the resources available and therefore reduced these resources, and income per capita, lowering the quality of life. Since then however, many East Asian countries e.g., China, have showcased that economic growth and high qualities of life can be achieved simultaneously despite having large and growing populations. This achievement was attained by an increase in productivity stemming from the innovation and development of old and new technologies by young and educated members of the population – who made up the majority (Bakari and Peter, 2018).

Moving on from the population effects, Bakari et al also discussed the effects of fertility rate on economic growth. As previously mentioned, these were found to be negative. High fertility rates are common among African countries and drive population growth although fertility rates have fallen ever so slightly in the past 50 years. Poverty and fertility show strong positive correlations in developed countries and create a “the rich get richer, and the poor get children” scenario. The implications of such a scenario are obstructions to per capita economic growth, both macro-economically and micro-economically. From a macroeconomic perspective, there is excess pressure on national resources leading governments to spend less on resources that improve services for the population. From a microeconomic perspective, high fertility levels mean that

there is less investment in children's human capital, e.g., health and education. Bakari et al found the total fertility rate to show a strong and statistically significant negative impact on economic growth (Bakari and Peter, 2018).

Finally, Kiross et al (2020), in their paper on the effects of health expenditure on infant mortality in sub-Saharan Africa, presented estimation techniques that aligned with the aims of this dissertation. They adopted the random effects estimation method to use on panel data for 46 countries and latterly carried out a Breuch-Pagan Lagrange Multiplier test to determine whether OLS or random effects regression was better. Here they rejected the null hypothesis provided by the Breuch-Pagan Lagrange test which was that variances across the countries were zero (no panel effect). This concluded that the random effects method was suitable at the 5% confidence level. Following this, they conducted a Hausman specification test to compare the results obtained from using the fixed effects estimation technique versus the random effects technique. Here the null hypothesis is that the error term shows no correlation to the predictors and again, this was rejected meaning that the random effects method was appropriate at the 5% confidence level (Kiross et al, 2020).

The aforementioned studies aided in the formulation of hypotheses, choosing of variables and estimation techniques, and the gathering of data for this dissertation.

### **3. Methodology**

The aim of this study is to investigate the effects of gender-specific mortality rates and life expectancies on the economic growth (measured in the annual GDP per capita growth rate) of fourteen economically opposed countries. These countries will be split into two groups, the G7 countries and seven African countries, based on the implementation of dummy variables that detect either membership in the Group of Seven or the presence of colonisation. After

estimations have been carried out, the results will be analysed to determine the effects of selected variables on economic growth in all the studied countries. Following this, the variables' effects will be compared for disparities between all the countries investigated, grouped as the G7 countries and the African/colonised countries.

### **3.1 Data and Estimation Technique**

This dissertation used panel data from the years 1972 to 2018 collected for 11 different countries. The data used in this dissertation was obtained mainly from the World Bank World Development Indicators Database. Additional data was also obtained from the Penn World Table, version 10.0.

To begin with, the countries chosen for this study were Canada, France, Germany, Italy, Japan, the United Kingdom, the United States, Burundi, Chad, the Central African Republic, Guinea-Bissau, Mali, Mozambique, and Niger.

Furthermore, the initial plan was for data to be collected for a 50-year period, 1972-2022. However, data was unavailable for 2022 as the end of the year has not yet been reached and, alongside this, there were many other gaps in the data for some of the variables initially selected. Since the time series had missing values, in order to use all of the countries and variables originally intended, interpolation would have to have been adopted. This is not an accurate technique as it assumes a constant rate of change which was not the case for many of the variables. Therefore, although they were collected, the consideration of these variables for econometrics was revealed to be impossible and those variables had to be dropped – but they can be found in the appendix.

As a result of these data issues, changes had to be made to the original variables, time period, and countries planned for use in the investigation.

Germany, Guinea-Bissau, and Mozambique were removed from the countries involved in the regressions because data was largely unavailable for many of the variables being tested.

Additionally, the intended 50-year time period was reduced to 46 years to ensure all available countries had sufficient data available for each variable.

The main variables used in the estimations are described in table 1 below.

**Table 1 - Summary statistics (1972-2018)**

| <b>Variable ID</b><br>(as seen in results) | <b>Variable Definition</b>                                                                         | <b>Variable Source</b> |
|--------------------------------------------|----------------------------------------------------------------------------------------------------|------------------------|
| <b>g_gdp</b>                               | Annual growth in GDP per capita (current US\$)                                                     | World Bank Database    |
| <b>d_crudeddeath</b>                       | Crude death rate per 1000 people                                                                   | World Bank Database    |
| <b>d_exports</b>                           | Exports of goods and services as a percentage of GDP                                               | World Bank Database    |
| <b>d_mortf</b>                             | Adult female mortality rate per 1000 female adults                                                 | World Bank Database    |
| <b>d_mortm</b>                             | Adult male mortality rate per 1000 male adults                                                     | World Bank Database    |
| <b>d_lifexpf</b>                           | Female life expectancy at birth, in years                                                          | World Bank Database    |
| <b>d_lifexpm</b>                           | Male life expectancy at birth, in years                                                            | World Bank Database    |
| <b>d_fert</b>                              | Total fertility rate (births per woman)                                                            | World Bank Database    |
| <b>d2_morti</b>                            | Second difference of the infant mortality rate per 1000 live births                                | World Bank Database    |
| <b>d2_pop</b>                              | Second difference of the population in millions                                                    | Penn World Table       |
| <b>d2_hc</b>                               | Second difference of the human capital index, based on years of schooling and returns to education | Penn World Table       |
| <b>d2_cn</b>                               | Second difference of the capital stock at current PPPs in millions, 2017 US\$                      | Penn World Table       |
| <b>lang_dummy</b><br>or                    | Dummy variable representing the presence, or                                                       | Author's computation   |

|                                                                   |                                                                                                                 |                      |
|-------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|----------------------|
| (depicted in regressions as<br><b>xxx_lang</b> )                  | lack thereof, of colonisation<br>through the adoption of the<br>coloniser's language as an<br>official language |                      |
| <b>g7_dummy</b><br>(depicted in regressions as<br><b>xxx_g7</b> ) | Dummy variable<br>representing membership in<br>G7                                                              | Author's computation |

Source: Author's computation

There is one dependent/outcome variable in this investigation, and this is annual GDP per capita growth (g\_gdp). There are also two dummy variables included in the investigation to represent the presence, or lack thereof, of colonisation in the countries chosen for this dissertation and to be able to study its effects. This first dummy variable is the G7 dummy which is 1 if the country is a member of the Group of Seven countries and 0 if not. The second dummy variable in this study is the coloniser's language dummy. This is 1 if the African country adopted their coloniser's language as their own official language and 0 if this is not the case. With this dummy variable, all the G7 countries have a dummy of 0 as they were colonising countries, and all the African countries have a dummy of 1 as they were both colonised and still have their coloniser's language as their own official language. Using the dummy variables allows for the two sets of countries to be grouped and latterly compared.

The estimation technique used on the panel data obtained was the random effects model, and logarithmic transformations to ensure the stationarity of the variables were undertaken where appropriate. Unit root tests were then carried out to confirm that the panels were stationary. The Hausman specification test was also carried out to compare the estimates obtained using the fixed effects estimation method as opposed to the random effects method and determine which of the two was better to use in this dissertation. The null hypothesis for this test is that random effects is the preferred method meaning that there is no correlation between the regressors and

unique errors in the model (Glen 2022). In the regressions completed for this dissertation, the null hypothesis could not be rejected, suggesting that the random effects model is recommended. Furthermore, as mentioned by Lorentzen et al (2008) a bidirectional causal relationship exists between mortality and poverty. As a result of this, omitted variable bias could be introduced into the estimation. To help fix this issue, the granger-causality test was employed. This test, proposed by Granger in 1969, is a statistical hypothesis test that determines whether one time series forecasts another (Wikipedia d., 2022). Dumitrescu and Hurlin (2012) proposed a way of conducting this test on panel data in Stata allowing it to be applied via the `xtgcause` command. All variables will be tested with a lag order equal to 1 and the null hypothesis is that the independent variable does not granger-cause the dependent variable (GDP).

#### 4. Estimation Results

To begin the results section, the means and minimum/maximum values of the main variables are presented in table 2 below.

**Table 2 - Mean, minimum and maximum values for the variables used in the regression**

| Variable                      | Mean  | Min  | Max   |
|-------------------------------|-------|------|-------|
| <b>Overall</b>                |       |      |       |
| <b>GDP</b>                    | 13500 | 189  | 33000 |
| <b>Crude death rate</b>       | 13.2  | 7.20 | 18.8  |
| <b>Exports</b>                | 20.1  | 8.88 | 30.5  |
| <b>Female mortality rate</b>  | 206   | 54.3 | 410   |
| <b>Male mortality rate</b>    | 260   | 105  | 456   |
| <b>Infant mortality rate</b>  | 56.7  | 4.65 | 127   |
| <b>Fertility rate</b>         | 4.08  | 1.41 | 7.59  |
| <b>Female life expectancy</b> | 65.5  | 48.3 | 82.9  |
| <b>Male life expectancy</b>   | 61    | 46.1 | 77    |

|                               |          |         |          |
|-------------------------------|----------|---------|----------|
| <b>Population</b>             | 52.5     | 1.15    | 268      |
| <b>Human capital index</b>    | 2.35     | 1.14    | 3.5      |
| <b>Capital stock</b>          | 746000   | 5000    | 44400000 |
| <b>G7 Countries</b>           |          |         |          |
| <b>GDP</b>                    | 26600    | 21300   | 33000    |
| <b>Crude death rate</b>       | 9.23     | 7.20    | 11.2     |
| <b>Exports</b>                | 22.4     | 9.90    | 30.5     |
| <b>Female mortality rate</b>  | 68.0     | 54.3    | 90.8     |
| <b>Male mortality rate</b>    | 129      | 105     | 164      |
| <b>Infant mortality rate</b>  | 7.28     | 4.65    | 9.14     |
| <b>Fertility rate</b>         | 1.67     | 1.41    | 1.91     |
| <b>Female life expectancy</b> | 80.8     | 79.1    | 82.9     |
| <b>Male life expectancy</b>   | 75       | 73      | 77       |
| <b>Population</b>             | 96.8     | 29.2    | 268      |
| <b>Human capital index</b>    | 3.19     | 2.65    | 3.50     |
| <b>Capital stock</b>          | 14900000 | 4360000 | 44400000 |
| <b>African Countries</b>      |          |         |          |
| <b>GDP</b>                    | 357      | 189     | 421      |
| <b>Crude death rate</b>       | 17.2     | 14.9    | 18.8     |
| <b>Exports</b>                | 17.7     | 8.88    | 23.6     |
| <b>Female mortality rate</b>  | 343      | 296     | 410      |
| <b>Male mortality rate</b>    | 391      | 337     | 456      |
| <b>Infant mortality rate</b>  | 106      | 95.0    | 127      |
| <b>Fertility rate</b>         | 6.48     | 5.53    | 7.59     |
| <b>Female life expectancy</b> | 50.2     | 48.3    | 52.6     |
| <b>Male life expectancy</b>   | 47.2     | 46.1    | 49.5     |
| <b>Population</b>             | 8.20     | 1.15    | 17       |
| <b>Human capital index</b>    | 1.18     | 1.09    | 1.31     |
| <b>Capital stock</b>          | 22100    | 5000    | 60300    |

Source: Author's computations using raw data from the World Bank Database.

Data in the table shows the mean, minimum and maximum values for the variables assessed in the regressions below based on average values for each country. It should be noted that these values were calculated with the raw data and not the data adjusted for use in the regression. Moreover, the values include data from the original 14 countries chosen for the study.

From table 2, it is evident that the mean of the GDP per capita, for all countries included in the regression, is \$13500. When this value is compared with those obtained for G7 and African countries separately, the mean GDP per capita becomes \$26600 and \$357 respectively. From this it can be seen that the GDP of the African countries is much lower than those of the G7 countries. This is to be expected as the G7 countries have arguably the most advanced economies in the world and were chosen to be studied in this dissertation for that reason. Similarly, the African countries were chosen due to their low economic advancement/s.

The mean crude death rates, male and female mortality rates, and fertility rates of the African countries were also higher than those in the G7 countries. Again, these was to be expected for reasons identified in the literature review such as low health care/expenditure. However, not mentioned in the literature review was the impact of the HIV/Aids epidemic in Africa – particularly sub-Saharan Africa - that contributed to high death rates. These factors were likely to have also impacted the mean male and female life expectancies of the African countries and therefore, on average, they were lower than those of the G7 countries by around 30 years.

The mean African populations were significantly smaller than those of the G7 countries. However, it is also important to remember that their population growth rate is much higher.

The mean value of exports, the human capital index and capital stock of the G7 countries were expectedly higher than those of the African countries.

The results obtained from the random effects regressions can be seen in tables 3 and 4 below.

**Table 3 - Overall regression results**

| <b>Variable</b>      | <b>RE</b>               |
|----------------------|-------------------------|
| <b>d_crudeddeath</b> | 0.0376<br>(0.0371)      |
| <b>d_exports</b>     | -0.0148***<br>(0.00282) |
| <b>d_mortf</b>       | -0.00281<br>(0.00249)   |
| <b>d_mortm</b>       | -0.0000482<br>(0.00209) |
| <b>d2_morti</b>      | 0.356<br>(0.375)        |
| <b>d_fert</b>        | 0.217<br>(0.143)        |
| <b>d2_pop</b>        | -4.86<br>(5.15)         |
| <b>d2_hc</b>         | -6.13<br>(6.07)         |
| <b>d2_cn</b>         | 0.304*<br>(0.160)       |
| <b>d_lifexpf</b>     | 0.0924*<br>(0.0539)     |
| <b>d_lifexpm</b>     | -0.0441<br>(0.055)      |
|                      |                         |
| <b>constant</b>      | 0.0424***<br>(0.00925)  |
| <b>R-squared</b>     | 0.102 (overall)         |

Source: Author's computations

Notes: \*\*\* (\*\*) (\*) denotes significance at the 1 (5) (10) percent level. Standard errors are presented in parentheses.

The coefficient of the exports of goods and services is -0.0148 suggesting that if exports were to increase by 1 unit, the annual GDP per capita growth rate would decrease by 0.0148 units. This value is statistically significant at the 1% level implying a confidence level of 99%.

The coefficient of the female life expectancy is 0.0924 meaning that if the female life expectancy increased by 1 unit, the annual GDP per capita growth rate would increase by 0.0924 units. This coefficient is statistically significant at the 10% level implying a confidence level of 90%.

The coefficient of the capital stock at current PPPs is 0.304 implying that an increase in the capital stock by 1 unit would increase the annual GDP per capita growth rate by 0.304 units. This is as expected since higher capital into a country would increase its GDP per capita (Subramaniam et al, 2012). The coefficient of the capital stock was statistically significant at the 10% level implying a confidence level of 90%.

The following variables were not statistically significant at any level and could therefore be deemed insignificant to annual GDP per capita growth. However, they are included in this section because “a p-value cannot indicate the importance of a finding” (Baker, 2016, p151). This means that these variables may still be important despite being statistically insignificant.

The coefficient of the male life expectancy is -0.0441 suggesting that if the male life expectancy were to increase by 1 unit, the annual GDP per capita growth rate would decrease by 0.0441 units. Here, gender plays a role in whether or not the effects of life expectancy on economic growth are positive or negative. An increase in female life expectancy has over double the effect that an increase in male life expectancy has, and it is also a positive one as opposed to the male’s negative effect. As discussed in the literature review, low and high life expectancies can arise from numerous different factors and have very different effects – even influencing an individual’s actions in life. Moreover, it is worth remembering that only the coefficient of the female life expectancy is statistically significant.

The coefficient of the crude death rate is 0.0376 which suggests that if the crude death rate were to increase by 1 unit, the annual GDP per capita growth rate would increase by 0.0376 units. The crude death rate is simply measured as the number of deaths per 1000 people, not considering any demographic information such as the age or gender of the deceased. Therefore, it essentially looks at the reduction of a population and the 0.0376 unit increase in annual GDP

per capita growth rate that would be experienced due to an increase in the crude death rate is actually a result of a decrease in population.

The coefficient of the female mortality rate is -0.00281 which suggests that if the female mortality rate increased by 1 unit, the annual GDP per capita growth rate would decrease by 0.00281 units. The coefficient of the male mortality rate is -0.0000482 meaning that if the male mortality rate decreased by 1 unit, the annual GDP per capita growth rate would decrease by 0.0000482 units. The coefficient of the infant mortality rate is 0.356 which suggests that if the infant mortality rate were to increase by 1 unit, the annual GDP per capita growth rate would increase by 0.356 units. Both female and male mortality rates have a negative effect on the annual GDP per capita growth rate. Increases in each of them lead to decreases in economic growth. Notably, an increase in the male mortality rate has less of a negative effect on economic growth than an increase in the female mortality rate. On the contrary, the coefficient of the infant mortality rate is positive and therefore has a positive effect on the rate of annual GDP per capita growth. As mentioned when discussing the crude death rate, the increase in infant mortality translates to a decrease in population and therefore the effects depicted are those of a population reduction.

The coefficient of the fertility rate is 0.217 implying that if the fertility rate were to increase by 1 unit, the annual GDP per capita growth rate would increase by 0.217 units. Similarly to the male and female mortality rates, this seems to contradict the coefficients obtained for the crude death rate and infant mortality rate as an increase in fertility rates leads to an increase in population. However, there are many factors that could explain why a higher fertility rate could increase economic growth.

The coefficient of the population variable is -4.86 implying that if the population were to increase by 1 unit, the annual GDP per capita growth rate would decrease by 4.86 units. As mentioned in both the literature review and when outlining the effects of the crude death rate and infant mortality, an increase in the overall population is said to have a negative effect on economic growth.

The coefficient of the human capital index is -6.13 suggesting that if the human capital index were to increase by 1 unit, the annual GDP per capita growth rate would decrease by 6.13 units. The human capital index is based on years of schooling and returns to education and therefore, it would be expected that human capital has a positive effect on GDP per capita growth. However in the following section, reasons why this may not always be the case will be discussed.

The overall effects of the variables in table 3 on the annual GDP per capita growth rate have been outlined above. In the following part of the paper, they will be outlined again based on their effects on the annual GDP per capita growth rate in the G7 and the African/colonised countries respectively. Subsequently, in the discussion section, reasons for these effects will be introduced and assessed.

**Table 4 – Regression results using coloniser’s language dummy variable**

| <b>Variable</b>                       | <b>Dummy = 0<br/>(G7 countries)</b> | <b>Dummy = 1<br/>(Colonised/African<br/>countries)</b> |
|---------------------------------------|-------------------------------------|--------------------------------------------------------|
| <b>cololang_dummy#c.d_crudeddeath</b> | -0.0591<br>(0.0483)                 | 0.263**<br>(0.122)                                     |
| <b>cololang_dummy#c.d_exports</b>     | -0.0231***<br>(0.00497)             | -0.0119***<br>(0.00340)                                |
| <b>cololang_dummy#c.d_mortf</b>       | -0.0109<br>(0.00772)                | -0.00141<br>(0.00336)                                  |
| <b>cololang_dummy#c.d_mortm</b>       | -0.00363<br>(0.00483)               | 0.00108<br>(0.00248)                                   |
| <b>cololang_dummy#c.d2_morti</b>      | 0.0687<br>(0.443)                   | -0.500<br>(0.709)                                      |
| <b>cololang_dummy#c.d_fert</b>        | -0.0381<br>(0.181)                  | 0.934***<br>(0.271)                                    |
| <b>cololang_dummy#c.d2_pop</b>        | -10.2<br>(12.7)                     | -7.87<br>(5.96)                                        |
| <b>cololang_dummy#c.d2_hc</b>         | -4.32<br>(9.25)                     | -5.53<br>(7.93)                                        |
| <b>cololang_dummy#c.d2_cn</b>         | 0.387*<br>(0.209)                   | 0.211<br>(0.229)                                       |
| <b>cololang_dummy#c.d_lifexpf</b>     | 0.0431<br>(0.0602)                  | 0.235<br>(0.177)                                       |
| <b>cololang_dummy#c.lifexpm</b>       | -0.118*<br>(0.0681)                 | 0.00755<br>(0.166)                                     |
|                                       |                                     |                                                        |
| <b>constant</b>                       | 0.0566***<br>(0.0111)               |                                                        |
| <b>R-squared</b>                      | 0.151 (overall)                     |                                                        |

Source: Author’s computations

Notes: \*\*\* (\*\*) (\*) denotes significance at the 1 (5) (10) percent level. Standard errors are presented in parentheses. The *cololang\_dummy* coefficient on the variables represents the coloniser’s language dummy variable which, as previously mentioned, is 0 for the G7 countries as they were colonisers, and 1 for the African countries as they were colonised.

In table 4 we can see the outcomes of the random effects regressions with the presence of the coloniser’s language dummy variable. This allows the G7 and African/colonised countries to be assessed as individual groups and for the effects of the previously studied variables to be determined on these two groups.

The coefficient of exports for goods and services for the G7 countries is -0.0231 suggesting that if exports were to increase by 1 unit, the annual GDP per capita growth rate of the G7 countries would increase by 1 unit. This coefficient was statistically significant at the 1% level implying a confidence level of 99%.

The coefficient of exports for goods and services for the African countries is -0.0119 suggesting that if exports were to increase by 1 unit, the annual GDP per capita growth rate of the African countries would increase by 1 unit. This coefficient was statistically significant at the 1% level implying a confidence level of 99%.

The coefficient of the fertility rate for the African countries is 0.934 implying that if the fertility rate were to increase by 1 unit, the annual GDP per capita growth rate of the African countries would increase by 0.934 units. This coefficient was statistically significant at the 1% level implying a confidence level of 99%.

The coefficient of crude death for the African countries is 0.263, meaning that if the crude death rate were to increase by 1 unit, the annual GDP per capita growth rate for the African countries would increase by 0.263 units. This coefficient was statistically significant at the 5% level implying a confidence level of 95%.

The coefficient of the capital stock for the G7 countries is 0.387 suggesting that if the capital stock were to increase by 1 unit, the annual GDP per capita growth rate of the G7 countries would increase by 0.387 units. This coefficient was statistically significant at the 10% level implying a confidence level of 90%.

The coefficient of the male life expectancy for the G7 countries is -0.118 implying that if the male life expectancy increased by 1 unit, the annual GDP per capita growth rate of the G7

countries would decrease by 0.118 units. This coefficient was statistically significant at the 10% level implying a confidence level of 90%.

Similarly to the documenting of the results from table 3, the following coefficients were not statistically significant at any level but have been included in this section because they may still be important despite being statistically insignificant.

The coefficient of crude death for the G7 countries is -0.0591 suggesting that if the crude death rate were to increase by 1 unit, the annual GDP per capita growth rate for the G7 countries would decrease by 0.0591 units.

The coefficient of the female mortality rate for the G7 countries is -0.0109 suggesting that if the female mortality rate were to increase by 1 unit, the annual GDP per capita growth rate of the G7 countries would decrease by 0.0109 units. The coefficient of the female mortality rate for the African countries is -0.0119 suggesting that if the female mortality rate were to increase by 1 unit, the annual GDP per capita growth rate of the African countries would decrease by 0.0119 units.

The coefficient of the male mortality rate for the G7 countries is -0.00363 suggesting that if the male mortality rate were to increase by 1 unit, the annual GDP per capita growth rate of the G7 countries would decrease by 0.00363 units. The coefficient of the male mortality rate for the African countries is 0.00108 suggesting that if the male mortality rate were to increase by 1 unit, the annual GDP per capita growth rate of the African countries would increase by 0.00108 units.

The coefficient of the infant mortality rate for the G7 countries is 0.687 suggesting that if the infant mortality rate were to increase by 1 unit, the annual GDP per capita growth rate of the G7 countries would increase by 0.687 units. The coefficient of the infant mortality rate for the

African countries is -0.500 suggesting that if the infant mortality rate were to increase by 1 unit, the annual GDP per capita growth rate of the African countries would decrease by 0.5 units.

The coefficient of the fertility rate for the G7 countries is -0.0381 implying that if the fertility rate were to increase by 1 unit, the annual GDP per capita growth rate of the G7 countries would decrease by 0.0381.

The coefficient of population for the G7 countries is -10.2 suggesting that if the population were to increase by 1 unit, the annual GDP per capita growth rate of the G7 countries would decrease by 10.2 units. The coefficient of population for the African countries is -7.87 which suggests that if the population were to increase by 1 unit, the annual GDP per capita growth rate of the African countries would decrease by 7.87 units.

The coefficient of the human capital index for the G7 countries is -4.32 implying that if the human capital index increased by 1 unit, the annual GDP per capita growth rate of the G7 countries would decrease by 4.32 units. The coefficient of the human capital index for the African countries is -5.53 implying that if the human capital index increased by 1 unit, the annual GDP per capita growth rate of the African countries would decrease by 5.53 units.

The coefficient of the capital stock for the African countries is 0.211 suggesting that if the capital stock were to increase by 1 unit, the annual GDP per capita growth rate of the African countries would increase by 0.211 units.

The coefficient of the female life expectancy for the G7 countries is 0.0431 implying that if the female life expectancy increased by 1 unit, the annual GDP per capita growth rate of the G7 countries would increase by 0.0431 units. The coefficient of the female life expectancy for the African countries is 0.235 implying that if the female life expectancy increased by 1 unit, the annual GDP per capita growth rate of the African countries would increase by 0.235 units.

The coefficient of the male life expectancy for the African countries is 0.00755 implying that if the female life expectancy increased by 1 unit, the annual GDP per capita growth rate of the African countries would increase by 0.00755 units.

The effects of the investigated variables on the annual GDP per capita growth rate of both the G7 and African/colonised countries have been outlined above. In the following section, the reasons for these effects will be discussed.

However, it is important to note that the dummy variable implemented in the table 4 regression could be capturing the effects of other variables outside colonisation (such as those in Appendix 2) that impact the G7 and African countries differently, leading to omitted variable bias. As previously mentioned, these variables could not be included in the regression due to insufficient data for the chosen time period and the need for interpolation if used, but, they were initially chosen due to their relevance when considering a country's economic growth and development.

The following table has the results from the granger-causality test applied to the variables used.

**Table 5 – Granger-causality test results**

| <b>Variables</b>  | <b>Z-bar tilde value</b> |
|-------------------|--------------------------|
| gdp – crudeddeath | 0.6365                   |
| gdp - exports     | 4.8199***                |
| gdp – mortf       | 3.0100**                 |
| gdp – mortm       | 1.4455                   |
| gdp - morti       | 2.4687                   |
| gdp - fert        | 1.705                    |
| gdp – lifexpf     | 1.8349                   |
| gdp - lifexpm     | 1.7634                   |
| gdp - pop         | 2.9557**                 |
| gdp - cn          | -0.2039                  |

Source: Author's computations

Notes: \*\*\* (\*\*) denotes significance at the 1 (5) percent level.

The Granger-causality test studied the causality of the independent variables on the dependent variable GDP.

Results with a p-value less than 0.05 (5% significance level) require the null hypothesis to be rejected and as such, those values are said to Granger-cause GDP for at least one panel. Results with p-values above this level mean the null hypothesis cannot be rejected and therefore, they do not Granger-cause GDP. In this dissertation, exports, population, and female mortality rates are considered to Granger-cause GDP.

However, using the term ‘causality’ when regarding these results could be deemed incorrect. Granger himself in 1977 said that Granger-causality is better described as ‘temporally related’ or ‘precedence’ (Wikipedia d., 2022). Therefore, what is being tested by the Granger causality test is whether the independent variable forecasts the dependent. Moreover, Granger causality does not take into consideration latent confounding effects.

## **5. Discussion**

The crude death rate has opposing effects in the G7 and African countries. In the G7 countries, a higher crude death rate is detrimental to economic growth whereas in the poorer and colonised African countries, a higher crude death rate has positive effects on economic growth. As previously stated, the increase in the crude death rate translates to a decrease in the population. Since the death demographics are not considered in the crude death rate, an equal decrease in all demographics is assumed. The G7 countries, although they have larger populations, have lower fertility rates and experience lower population growth rates so a decrease in population brought about by an increase in crude deaths would mean that there would be fewer people in the countries to facilitate economic growth. There would be fewer people working, spending, saving, and investing, technological progress would decrease, and basic services would decline (Akintunde, Olomola and Oladeji, 2013). In general, these economies would shrink as a result of the increase in crude deaths. On the contrary, an increase in the crude death rate would mean

something entirely different for the African countries who have smaller populations and higher population growth rates. In these already tailing economies, a decrease in population through an increase in crude death rates would mean that there is less pressure on them, and less money would need to be spent on housing, feeding, and generally caring for the population. However, observations made on the effect of the crude death rate on annual GDP per capita growth, to be significant, need to include information on the ages that experienced the highest death rates. The median ages of these groups of countries are very different and therefore would have very different effects on economic growth.

Similarly to the crude death rate, the fertility rate coefficients for both the G7 and African countries show opposing effects on the annual GDP per capita growth rate. For the G7 countries, an increase in the fertility/birth rate leads to a decrease in economic growth. One reason for this could be that the time required to look after children while they are young is substantial and in more advanced economies, this is costly as it requires taking time off work. Fertility rates also tended to be lower in these economies, possibly because more education is required to be successful, and this is also costly (Vandenbroucke 2016). Families likely choose to have fewer children so that there are then fewer financial implications on them. However, the negative effect of increased fertility rates in these countries is relatively low and this could again be due to the population demographics. In the G7 countries, people live longer, meaning the median ages are higher, and combined with low fertility rates, this can lead to aging populations. Therefore, while an increase in birth rates would still be costly and put pressure on the economy, it could help to stop the phenomenon of an aging population, which is another detrimental issue in itself.

In the African countries, the overall fertility rate was a lot higher, and this is likely due to higher infant mortality rates – people have more children because the chance of them surviving is lower.

Moreover, low contraceptive use, the Caldwell theory of wealth flows and the old-age-security hypothesis are all likely to have had an effect on fertility rates in these countries (Akintunde, Olomola and Oladeji, 2013). The Caldwell theory of wealth explains how declines in fertility rates are due to rational decisions made by parents based on the direction of intergenerational transfers. In areas experiencing high fertility, this theory suggests that children produce more than they consume and thus provide net wealth to their parents – although this has not been proven empirically. What has been proven is the opposite which explains the effects of fertility on the G7 countries; when children are expensive, parents want less of them (Snopkowski and Kaplan, 2015). Going back to the reasons for high fertility rates in African countries, the old-age-security hypothesis must also be discussed. This hypothesis states that in old age, parents view their children as sources of income and personal services (Wikipedia b. 2022). Therefore, to ensure a better quality of life as they get older, people may choose to have more children. Again, this theory also explains the effects of fertility on the G7 countries. When there is a pension system as imposed by the state, birth rates and investments in children's human capital decline. The increase in the annual GDP per capita growth rate experienced when the fertility rates in African countries increase is therefore, likely caused by the economic opportunities that children bring.

This closely relates to the infant mortality rate. For the African countries, an increase in the infant mortality rate led to a decrease in economic growth. On the other hand, an increase in the infant mortality rate for the G7 countries had a positive effect on economic growth. Both of these results can be explained by the old-age-security hypothesis and Caldwell theory of wealth as discussed above.

An increase in the female mortality rates of both the G7 and African countries leads to relatively low decreases in the annual GDP per capita growth rate. This is likely due to women's ability to bear children. While the effects of high/low fertility rates have already been discussed, the need for children to keep the population going is fundamental. Furthermore, the G7 countries experience an increased negative effect on economic growth when female mortality is higher likely because women in these economies are paid higher salaries than those in the African countries. The average percentages of female labour are higher in the African countries – as depicted in AP.1 Figure 16 - but as mentioned, they are likely paid less and therefore their impact on economic growth is decreased. AP.1 Figure 26 shows the average percentage of female workers that receive a salary/ wage and the figures for the African countries are much lower than those of the G7 countries – this could further explain these results since it means that even though, on average, more women in the African countries work, the likelihood that they are paid is substantially lower.

The effects of an increase in the male mortality rates on the annual GDP per capita growth rate were positive for the African countries and negative for the G7 countries. Regarding the G7 countries, an increase in the male mortality rate understandably lessens economic growth. Men tend to earn more money than women in these economies, thus contributing more towards the economy and therefore, less men in the population would lead to a decrease in economic growth. In the African countries, the slightly positive effect of an increase in the male mortality rate on economic growth could simply be explained by a reason such as a higher percentage of males within the population. However, there is also the possibility that gender preferences come into play here as preferences for daughters were found to prevail in many societies in Fuse's (2010) paper on gender preferences across 50 less-developed countries. In turn, this could explain why

female life expectancies are higher than the males' in these countries and their mortality rates are lower.

An increase in the female life expectancy in both the G7 and African countries has positive effects on the annual GDP per capita growth rate. As discussed in the literature review, an increase in life expectancy will encourage people to invest more time into planning their future – they will save more, invest more money, and maybe even have (more) children. However, an increase in the male life expectancy in the G7 countries has a negative effect on economic growth and in the African countries it still has a positive effect. In the African countries, again, it is likely due to the encouragement to invest in their futures. Life expectancies in the African countries are considerably shorter than those in the G7 countries – especially for the men – and therefore, an increase in them is likely to lead to more economically conscious decisions. In the G7 countries, life expectancies are already relatively high. Increasing them further, could push them towards the flatter end of the Preston curve. The Preston curve suggests that income influences life expectancy and states that richer countries have higher life expectancies. However, as the life expectancy gets higher and higher, the link between itself and income flattens (Wikipedia c. 2022). Moreover, as people in these countries get older, and live longer, they will grow more dependent on the health systems around them – costing money to be looked after. In the African countries, because of their old-age-security mindset, they depend on their children, so economic pressure on the community around them is reduced.

The coefficient for exports of goods and services is negative for both the G7 and African countries. As shown in AP1 figure 11, the average values for exports in the G7 and African countries (as percentages of their respective GDP's) do not show the same drastic differences as many of the other variables do. Therefore, it is understandable that the regression results do not

show very different effects. There are numerous factors that affect the exports of a country – and there are many different goods/services that a country could export. For instance, Africa's largest exports are reported to be precious metals/minerals and oil whereas in Europe, the United States and Canada, it is mainly machinery/transportation and electronics (Myers 2016). All of these exports are dependent on factors such as currency exchange rates, demand, social/consumer behaviour and political circumstances (The Economic Times, 2019). However, concerning the estimation coefficient results of this dissertation, exports are shown to negatively affect GDP. This seems to go against most economic understanding of exports and their effect on the economy. However, in his paper, Dodaro (1993) challenged the notion that exports support economic growth and found that actually, GDP promoted export growth. Their study, like this one, implemented a Granger-causality test to establish the direction of causality between GDP and export growth and they found the results of GDP's impact on exports to be stronger than the opposite. Therefore, the coefficient obtained in this dissertation could similarly be reflecting this causality issue.

The coefficients for the human capital index are negative for both the G7 and African countries and are more negative for the African countries implying a stronger negative effect on the annual GDP per capita growth rate. The human capital index was measured based on years of schooling and returns to education so it could be expected that increases in this variable would lead to an increase in economic growth and in general, it does. However, the effects of increasing the human capital index are likely to negatively impact economic growth because it is costly to do so. Moreover, in an African country, increasing the human capital index would have even more of a negative impact on economic growth since less of their populations partake in formal education. Appendix 1 documents three variables that were investigated to determine the educational attainment achieved in each of the studied countries – graphical representations of

these are seen in AP1 figures 6-8. These variables assessed the educational attainment of the total population aged 25+ at three stages: primary school level, upper secondary school level, and bachelor's degree level or equivalent. The highest level of educational attainment for all countries was the primary school level – in many of the G7 countries, this level of education is compulsory and therefore, high percentages of the population were expected to have achieved it. This was the case as all the G7 countries had primary school attainment levels over 90%. On the other hand, the maximum primary school attainment level for the African countries was 33.44% (Mozambique) and the lowest was 10.12% (Central African Republic). Here the disparity between the education levels of the two groups of countries is very apparent and this disparity continues as the education levels increase. By the time bachelor level educational attainment is reviewed, the peaks of the G7 and African countries are 33.86% (United Kingdom) and 1.27% (Mali) respectively. This supports the theory that African countries would suffer more from an increase in the human capital index as less of their populations utilise education services.

The effects of an increase in the capital stock (at current PPPs in mil. 2017US\$) have positive effects on the annual GDP per capita growth rate for both the G7 and the African countries. This is to be expected as an increase in capital flows will ultimately lead to an increase in economic growth – depending on how the money is used. The positive effect in the G7 countries is higher than in the African countries and it could be speculated that this is due to corruption in African governments – an issue that was labelled 'Africa's undeclared pandemic' in Mhaka's (2022) article from earlier this year.

The discrepancies between the regression results obtained from the G7 countries and the African countries make it clear to see that colonisation has had an effect on the studied colonised countries. However, the reasons for these effects require a much more in-depth study of

colonisation, what it entailed for each country and how the country was left once independence was gained - if independence was gained. Moreover, the issues of omitted variable bias, autocorrelation and even multicollinearity are possible limitations of this study due to the variables and countries investigated and could arise due to statistical issues within the dataset. Additionally, the 11 countries involved in the regressions are not representatives of all economically advanced or all economically regressed countries. Growth models are generally difficult to analyse as many factors can explain growth – for instance, luck, which is hard to observe, or geography. This would explain why the R-squared (goodness of fit) values for the regressions in tables 3 and 4 are considerably low. Despite this, it can be concluded that the colonised countries are stuck in a trap and in order for GDP per capita to grow, they must adopt their own strategies for economic development rather than imitating those of the world's leading economies. Each country has its own unique problems and therefore, each one needs its own unique solutions to solve them, as touched upon in Bakari and Peter's (2018) paper.

Additionally, while it was already briefly mentioned in this dissertation, the effect that demography – specifically age – has on economic growth needs to be examined further. The median age in the African countries is a lot lower than that in the G7 countries. This will likely impact many factors investigated in this dissertation and could explain some of the discrepancies presented. Furthermore, assessing the percentage of the population that each gender makes up could explain why an increase in the mortality rate in one gender could have an opposing effect to the increase in mortality rate of the other. Adding to the further examination of demographics, a study could also be conducted on Asian countries such as China, where populations are very large, but economies are still strong. Finally, more work is needed, through more detailed data and models, to truly understand the causal relationship between the variables studied and economic growth and to consolidate the conclusions reached in this dissertation.

## **6. Conclusion and Future Work**

The aim of this investigation was to determine the effects of numerous factors on the economic growth (measured by annual GDP per capita growth rate) of two different sets of countries – the G7 countries, chosen for their advanced economies, and 7 colonised African countries, chosen for their underdeveloped economies. From preliminary research undertaken for this dissertation, variables were identified, along with estimation techniques and findings from previous studies. These variables generally related to birth rates, death rates and life expectancies. After collecting data and overcoming the aforementioned issues surrounding this, it was decided to focus on birth and death rates, life expectancies, fertility rates, exports, population the human capital index and capital stock. This dissertation also began to look at the role that gender played in the effects of these variables. Moreover, the effect of these variables in the G7 and African countries were compared, by using a dummy variable that detected the presence of colonisation (based on the adoption of a coloniser's language as the African country's official language), to determine whether there were discrepancies there and try to justify them. The results obtained showed that both gender and the presence of colonisation play a role in the effects that the chosen variables have on a countries economic growth. The economic growth impacts of the variables were often opposing for both male and female effects and for the G7 and African/colonised countries. Many reasons for these differences were introduced and assessed in this study but further analysis is needed to obtain conclusive results. However, a conclusion that could be made was that the African countries are stuck in a trap and instead of trying to imitate the strategies implemented in the G7 and other economically advanced countries, they require unique and country-specific solutions to fix their economies.

To develop this study further, a qualitative study into the impact that colonisation, or the lack of colonisation, had on these countries would provide a lot of insight into the behaviours adopted by their inhabitants. Moreover, adding more variables, such as those listed in appendix 2, could be beneficial in determining more factors that explain the trends in economic growth of these economically opposed countries. Investigating a larger timeframe may be required for this as it will ensure that there is sufficient data to analyse. Additionally, a closer look into country demographics – specifically age – could further explain why the investigated variables affect economic growth in the way that they do in their respective countries. Finally, to deem the results of this study conclusive, the causality and autocorrelation effects raised in this study need to be assessed further through subsequent investigations with more detailed data and models.

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## Appendix 1 (AP.1)

**AP.1 Table 1 - Correlation coefficients for the variables used in the regression**

|               | g_gdp   | d_crude~h | d_expo~s | d_mortf | d_mortm | d2_morti | d_fert  | d_life~f | d_life~m | d2_pop | d2_hc  | d2_cn  |
|---------------|---------|-----------|----------|---------|---------|----------|---------|----------|----------|--------|--------|--------|
| g_gdp         | 1.0000  |           |          |         |         |          |         |          |          |        |        |        |
| d_crudeddeath | -0.0735 | 1.0000    |          |         |         |          |         |          |          |        |        |        |
| d_exports     | -0.2387 | 0.0288    | 1.0000   |         |         |          |         |          |          |        |        |        |
| d_mortf       | -0.1520 | 0.5249    | 0.0018   | 1.0000  |         |          |         |          |          |        |        |        |
| d_mortm       | -0.1267 | 0.4308    | -0.0345  | 0.8356  | 1.0000  |          |         |          |          |        |        |        |
| d2_morti      | 0.0224  | 0.1192    | 0.0389   | 0.0129  | 0.0065  | 1.0000   |         |          |          |        |        |        |
| d_fert        | 0.0481  | 0.1206    | -0.0027  | 0.0453  | -0.0461 | -0.0086  | 1.0000  |          |          |        |        |        |
| d_lifexpf     | 0.1208  | -0.8496   | 0.0033   | -0.6659 | -0.5312 | -0.0923  | -0.1512 | 1.0000   |          |        |        |        |
| d_lifexpm     | 0.0984  | -0.8246   | 0.0116   | -0.6420 | -0.5618 | -0.0948  | -0.0969 | 0.9326   | 1.0000   |        |        |        |
| d2_pop        | -0.0233 | -0.2130   | -0.0010  | -0.0454 | 0.0167  | 0.0041   | 0.1089  | 0.2072   | 0.2402   | 1.0000 |        |        |
| d2_hc         | -0.0394 | -0.1303   | 0.0476   | -0.1321 | -0.0764 | 0.0284   | 0.0013  | 0.0917   | 0.0875   | 0.0370 | 1.0000 |        |
| d2_cn         | 0.0881  | -0.0213   | -0.0194  | -0.0092 | -0.0716 | -0.0657  | 0.0289  | 0.0042   | 0.0212   | 0.0380 | 0.0271 | 1.0000 |

**AP.1 Table 2 - Descriptive Statistics for the variables used in the regression**

| Variable      | Mean        | Std. Dev. | Min        | Max       | Obs.    |
|---------------|-------------|-----------|------------|-----------|---------|
| g_gdp         | 0.0527133   | 0.1216618 | -0.3864568 | 0.5620331 | N = 506 |
| d_crudeddeath | -0.01432628 | 0.2679776 | -0.8       | 0.9       | N = 506 |
| d_exports     | 0.1673576   | 2.41952   | -8.538488  | 26.37589  | N = 506 |
| d_mortf       | -1.875125   | 4.347618  | -15.476    | 19.213    | N = 506 |
| d_mortm       | -2.584569   | 4.656561  | -12.582    | 51.412    | N = 506 |
| d2_morti      | 0.000448    | 0.134755  | -0.0936513 | 0.096468  | N = 495 |
| d_fert        | -0.187816   | 0.0415905 | -0.16      | 0.11      | N = 506 |
| d_lifexpf     | 0.2823063   | 0.3037245 | -0.7       | 1.1       | N = 506 |
| d_lifexpm     | 0.2977549   | 0.2690965 | -0.591     | 1         | N = 506 |
| d2_pop        | 0.0000359   | 0.0010694 | -0.0040272 | 0.0050598 | N = 495 |
| d2_hc         | -0.0000149  | 0.0008795 | -0.0059373 | 0.0080844 | N = 450 |
| d2_cn         | -0.0002448  | 0.445474  | -0.4596252 | 0.3030353 | N = 495 |
| gdp_g7        | 0.0324993   | 0.0804611 | -0.1938054 | 0.4782515 | N = 506 |

|                         |            |           |            |           |         |
|-------------------------|------------|-----------|------------|-----------|---------|
| <b>crudeddeath_g7</b>   | 0.0013399  | 0.155586  | -0.8       | 0.9       | N = 506 |
| <b>morti_g7</b>         | 0.000463   | 0.0115169 | -0.0512933 | 0.0512933 | N = 495 |
| <b>mortm_g7</b>         | -1.21032   | 1.965506  | -8.956     | 4.202     | N = 506 |
| <b>mortf_g7</b>         | -0.6192075 | 1.100496  | -5.771     | 3.803     | N = 506 |
| <b>fert_g7</b>          | -0.0070563 | 0.0313147 | -0.16      | 0.11      | N = 506 |
| <b>lifexpf_g7</b>       | 0.1049407  |           | -0.7       | 1.1       | N = 506 |
| <b>lifexpm_g7</b>       | 0.1249012  | 0.1841547 | -0.48      | 1         | N = 506 |
| <b>pop_g7</b>           | -0.0000688 | 0.0004259 | -0.0013971 | 0.0025773 | N = 495 |
| <b>hc_g7</b>            | -0.0000805 | 0.0005666 | -0.0047891 | 0.0024334 | N = 450 |
| <b>cn_g7</b>            | -0.0002781 | 0.0239392 | -0.1684494 | 0.1716309 | N = 495 |
| <b>gdp_lang</b>         | 0.20214    | 0.0982043 | -0.3864568 | 0.5620331 | N = 506 |
| <b>crudeddeath_lang</b> | -0.1446028 | 0.2172941 | -0.696     | 0.321     | N = 506 |
| <b>morti_lang</b>       | -0.00015   | 0.0069955 | -0.0936513 | 0.96468   | N = 495 |
| <b>mortm_lang</b>       | -1.255917  | 4.599293  | -12.582    | 51.412    | N = 506 |
| <b>mortf_lang</b>       | -.1255917  | 4.387381  | -15.476    | 19.213    | N = 506 |
| <b>fert_lang</b>        | -0.0117253 | 0.0302483 | -0.11      | 0.052     | N = 506 |
| <b>lifexpf_lang</b>     | 0.1773656  | 0.3026167 | -0.652     | 0.895     | N = 506 |
| <b>lifexpm_lang</b>     | 0.1728538  | 0.2859454 | -0.591     | 0.884     | N = 506 |
| <b>pop_lang</b>         | 0.0001047  | 0.0009735 | -0.0040272 | 0.0050598 | N = 495 |
| <b>hc_lang</b>          | 0.0000656  | 0.0006647 | -0.0059373 | 0.0080844 | N = 450 |
| <b>cn_lang</b>          | 0.0000332  | 0.0375681 | -0.4596252 | 0.3030453 | N = 495 |

Source: Author's computation on stata

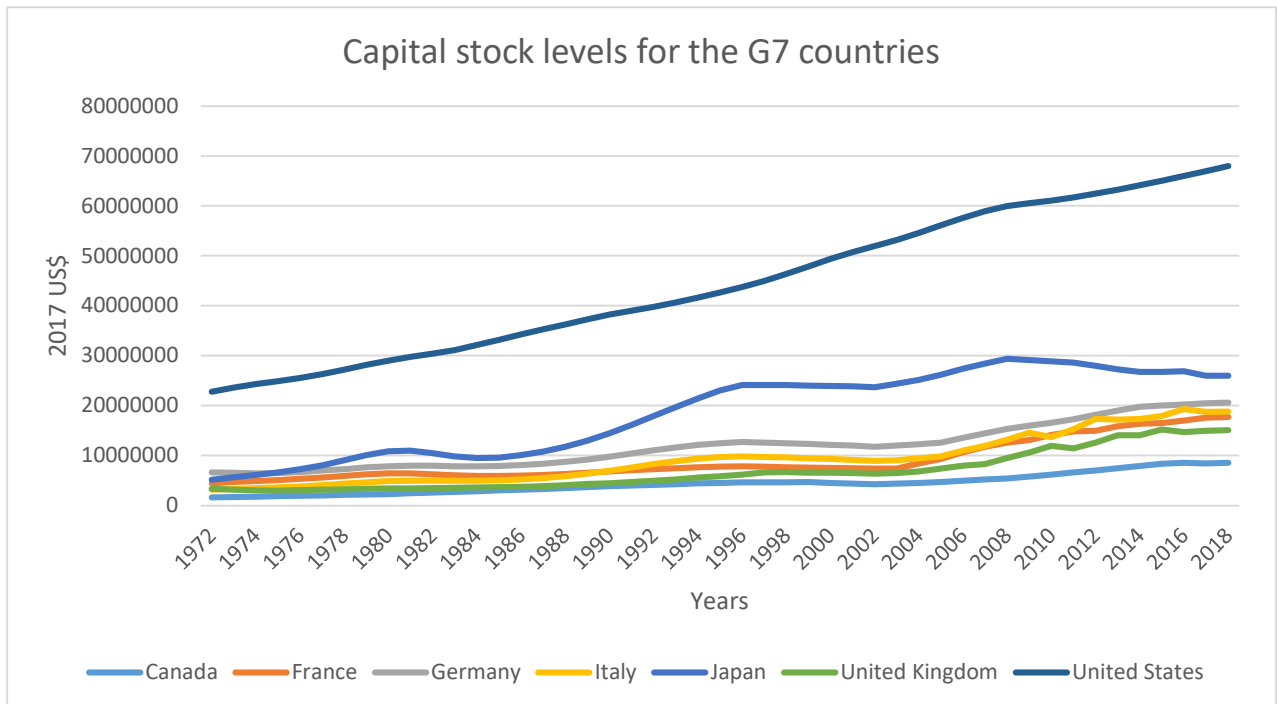
**AP.1 Table 3 –Variables investigated and mentioned in the text**

| <b>No.</b> | <b>Description of Variable</b>                                                                    | <b>Data Source</b> |
|------------|---------------------------------------------------------------------------------------------------|--------------------|
| 1          | Capital stock at current PPPs (in mil. 2017US\$)                                                  | Penn World Table   |
| 2          | Death rate, crude (per 1000 people)                                                               | World Bank         |
| 3.1        | Educational attainment, at least Bachelor's/ equivalent, population 25+, total (%), cumulative    | World Bank         |
| 3.2        | Educational attainment, at least completed upper secondary, population 25+, total (%), cumulative | World Bank         |
| 3.3        | Educational attainment, at least completed primary, population 25+, total (%), cumulative         | World Bank         |
| 4          | Exports of goods and services (% of GDP)                                                          | World Bank         |
| 5          | Fertility rate, total (births per woman)                                                          | World Bank         |
| 6          | GDP per capita (current US\$)                                                                     | World Bank         |
| 7          | Human capital index, based on years of schooling and returns to education                         | Penn World Table   |
| 8          | Labour force, female (% of total labour force)                                                    | World Bank         |
| 9          | Life expectancy at birth, female (years)                                                          | World Bank         |
| 10         | Life expectancy at birth, male (years)                                                            | World Bank         |
| 11         | Mortality rate, adult, female (per 1000 female adults)                                            | World Bank         |
| 12         | Mortality rate, adult, male (per 1000 male adults)                                                | World Bank         |
| 13         | Mortality rate, infant (per 1000 live births)                                                     | World Bank         |
| 14         | Population (in millions)                                                                          | Penn World Table   |
| 15         | Wage and salaried workers, female (% of female employment) (modelled ILO estimate)                | World Bank         |

**Graphical representations of the variables in AP.1 Table 3**

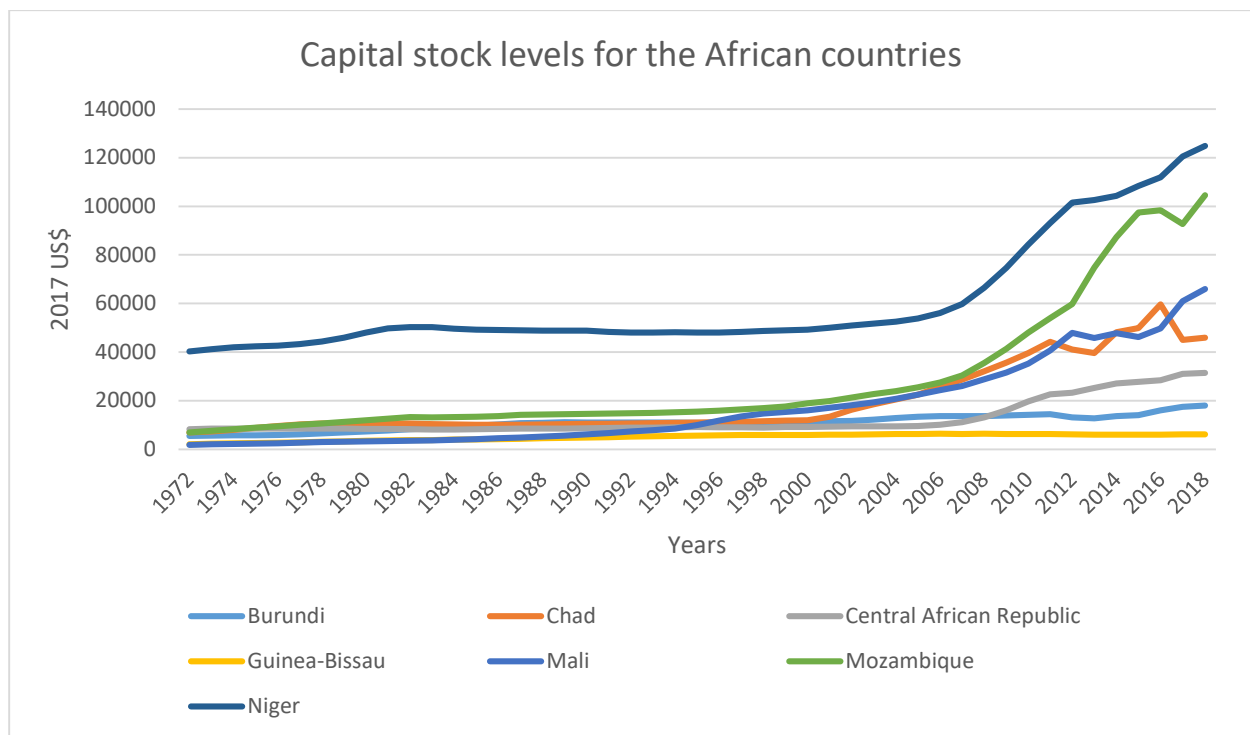
Disclaimer: Data for all variables was collected for an intended 50-year time frame in order to make adequate comparisons and observations. However, data was not available for every intended year, therefore, data used for the regressions was adjusted to ensure availability (and efficiency) for all testing variables.

## 1. Capital stock at current PPPs (in mil. 2017US\$)



AP1. Figure 1: Penn World Tables Data

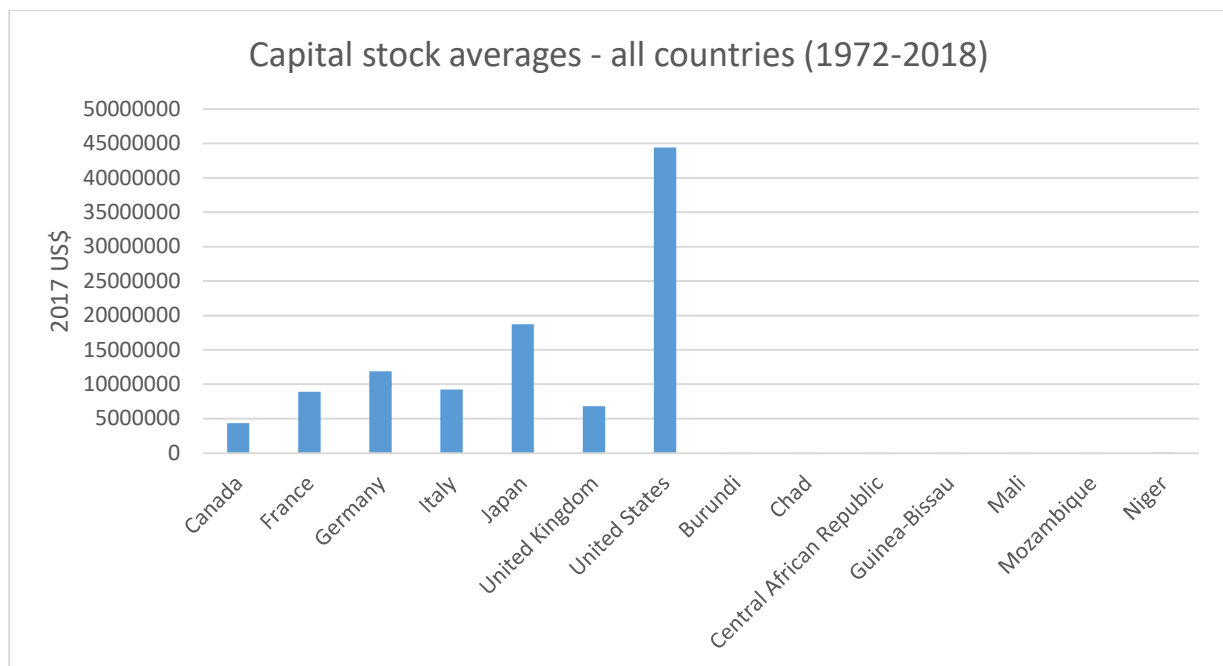
All the G7 countries experienced an increase in capital stock levels over the 46-year period as shown in AP1. figure 1, however, the data for the United States started at a higher level and experienced a substantially larger increase than the other countries. From the start of the 1990s, Japan also experienced a larger increase in capital stock than the remaining G7 countries (Canada, France, Italy, Germany, and the United Kingdom) however current levels seem to be dropping back down to re-join the other countries.



AP1. Figure 2: Penn World Tables Data

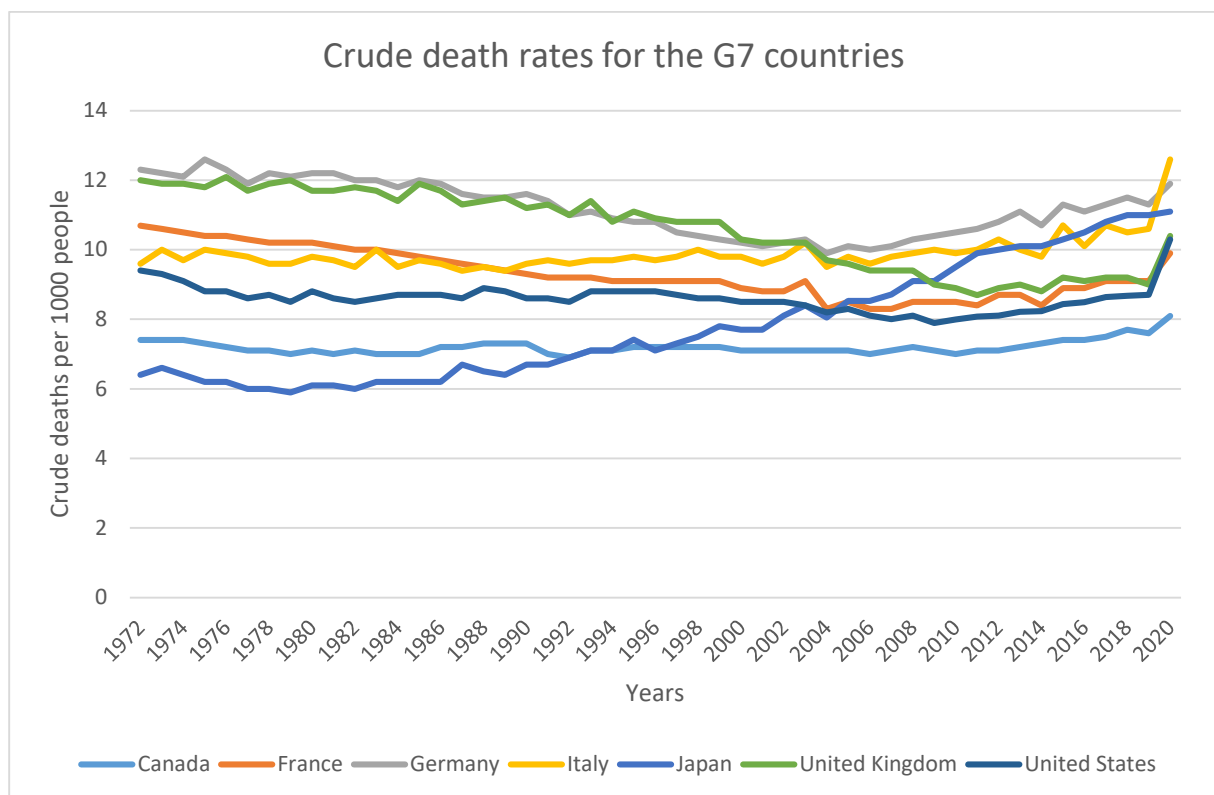
There was a general increase in capital stock for all the African countries except Guinea-Bissau who did not experience much growth at all. Substantial increases in growth started around 2008 for Niger, Mozambique, Chad, and Mali. These increases were considerably smaller for the Central African Republic and non-existent for Burundi and Guinea-Bissau. Like the United States, Niger led the African countries in capital stock levels, but Mozambique's capital stock grew rapidly and considerably from 2006 putting them very close to Niger's levels.

However, the levels of capital stock experienced by the African countries are nowhere near those of the G7 countries as shown in AP1 figure 3 below where the average capital stock levels of the African countries are negligible on the graph depicting the average levels of all 14 countries.



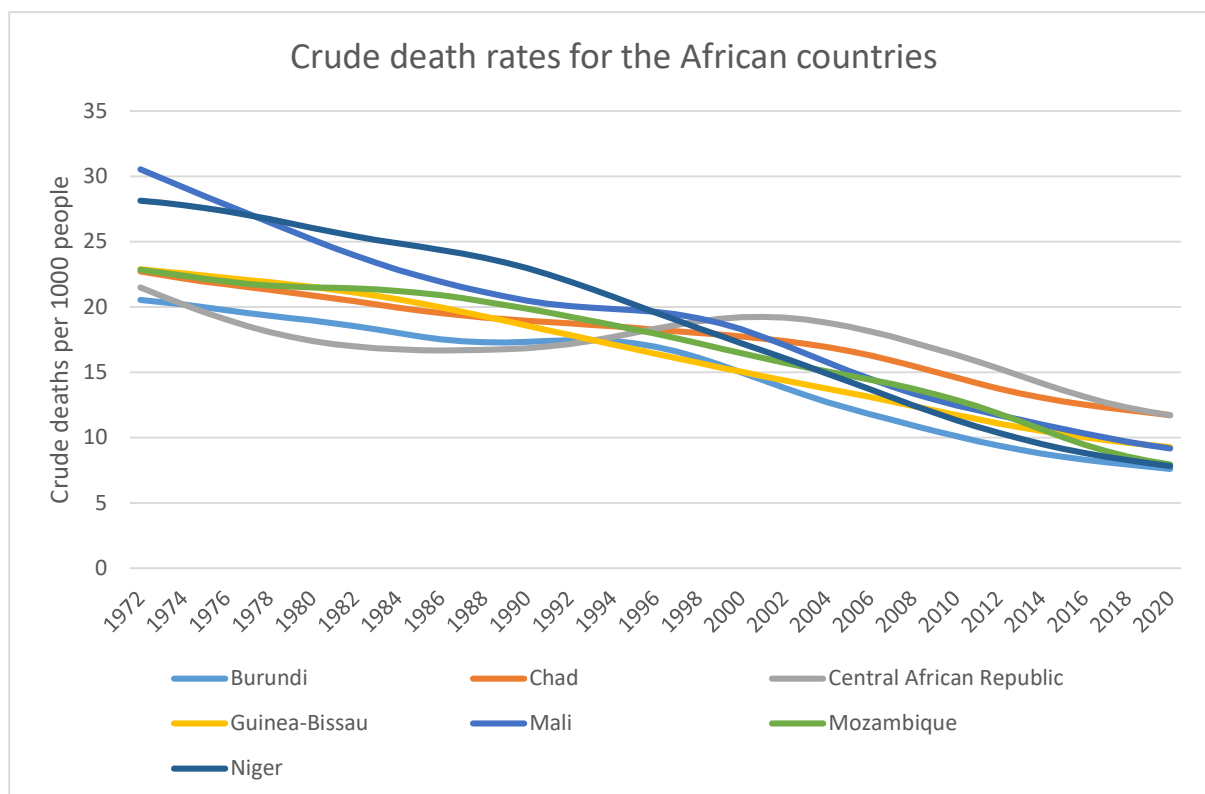
AP1. Figure 3: Penn World Tables Data

## 2. Death rate, crude (per 1000 people)



AP1. Figure 4: World Bank Data

The trend in death rates for the G7 countries was fairly stable, although Japan experienced quite an increase over the years, going from the lowest death rate in 1972 to the third largest in 2020. Additionally, the rise in death rate seen for all of the countries in 2019 can be attributed to the Covid-19 global pandemic.



AP1. Figure 5: World Bank Data

The African countries show an overall decrease in the death rate for all countries involved. Levels decreased from being nearly double those experienced in the same period by the G7 countries to being around the same amount 50 years later.

Many of the countries experienced a stagnation around 1996 which could have been due to the 1996 African Cup of Nations.

Moreover, compared to the G7 countries, the African countries did not experience the sharp increase in death rate in 2019 following the start of the Covid-19 global pandemic. Speculation

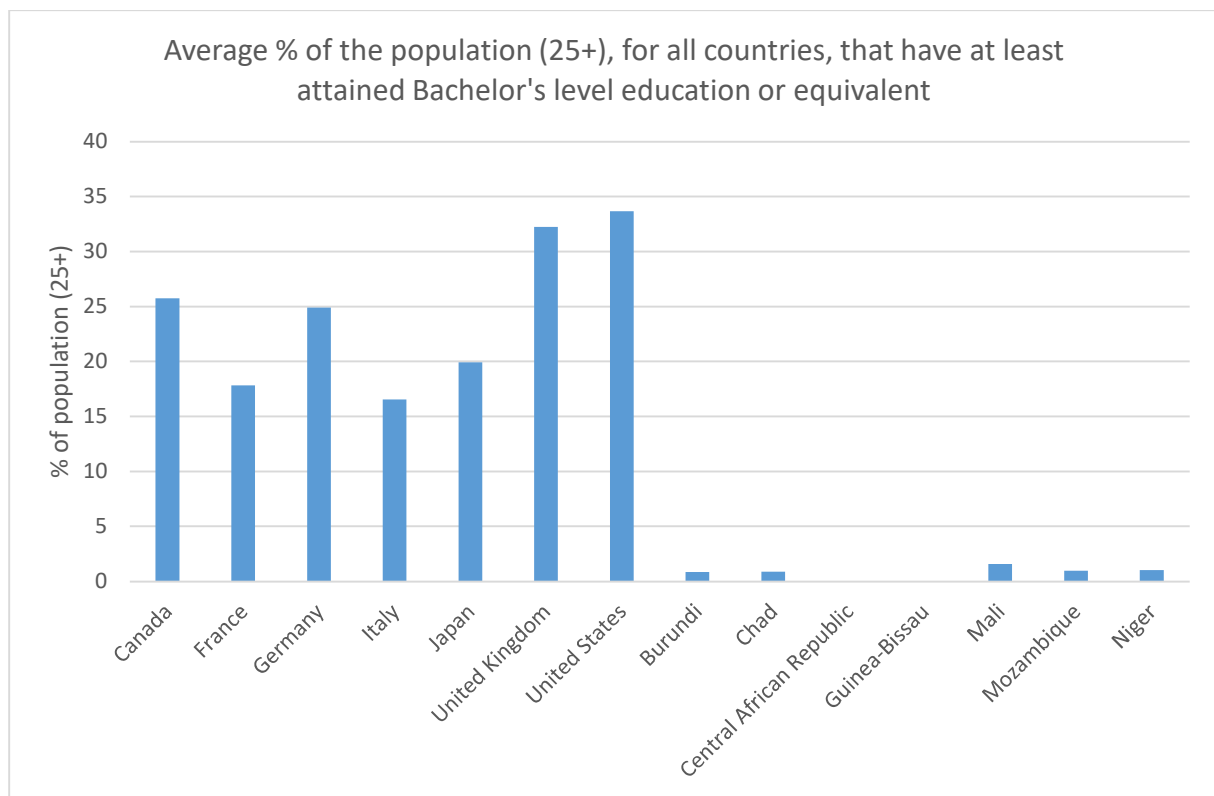
has risen over why this happened – were covid cases/deaths not being reported or did it just do less damage in Africa? Upon researching the topic, it seems most likely that Covid cases were not tested for, thus not reported, and subsequently, no deaths were registered. Although the younger demographics, high temperatures, lower population densities, and lack of public transport infrastructure have also been suggested as reasons why Covid-19 had less of an effect there (Nolen 2022).

### **3. Educational attainment**

Data collected for the educational attainment variables (completion of bachelor's degree/equivalent, completion of upper secondary school, and completion of primary school) was illegible when all 50 years were represented graphically, due to extremely limited data entries. As such, the averages of the data provided have been calculated for each country and those values were plotted instead – as seen in the relevant sections below.

It is important to note that in many African countries, children from the upper strata are sent abroad – notably to the United States and the United Kingdom - for better educational opportunities.

#### **3.1. Educational Attainment, at least Bachelor's/equivalent, population 25+, total (%) (cumulative)**



AP1. Figure 6: World Bank Data

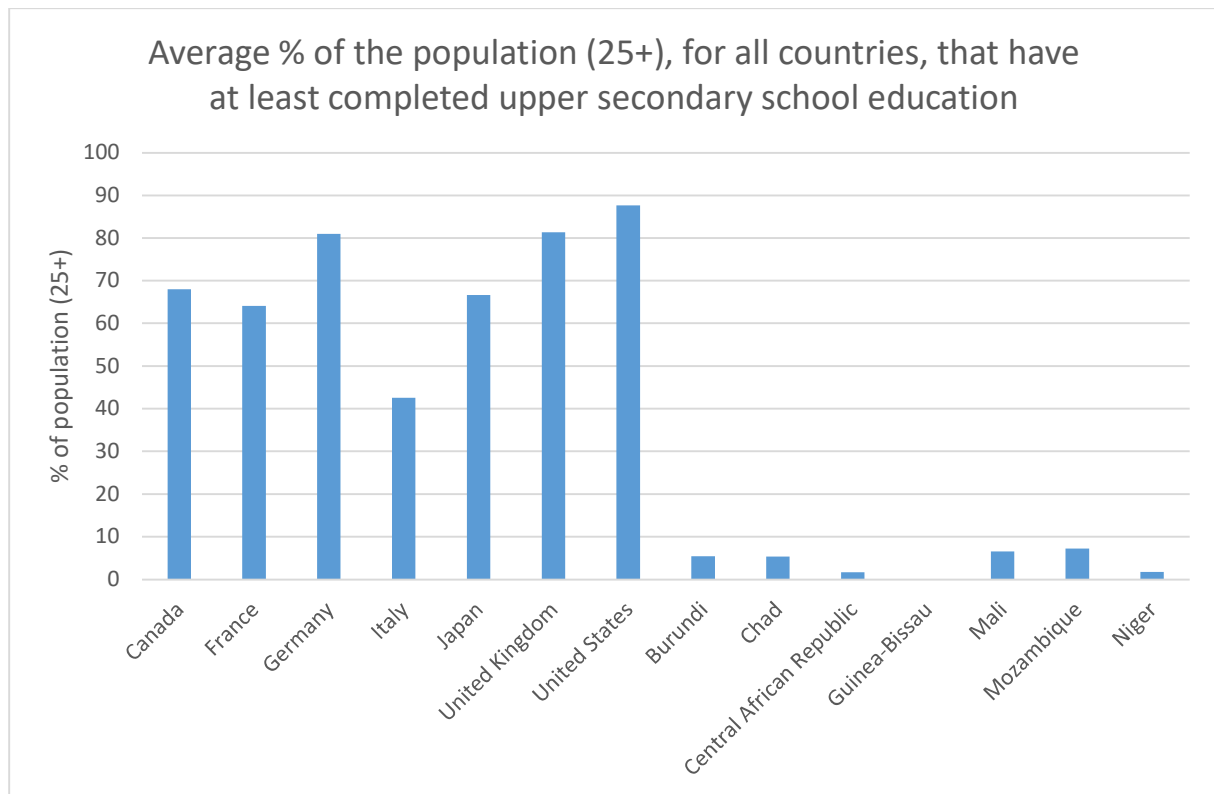
No data was unavailable for the Central African Republic and Guinea-Bissau.

The United States and United Kingdom lead the countries in the average percentage of their 25+ population that have achieved bachelor's level education or equivalent at 33.68% and 32.23% respectively.

At the other end, all the African countries (with data available) had average bachelor education attainment levels below 2%. The highest value was Mali's at 1.57%.

Bachelor level education had the lowest of all the educational attainment values.

### **3.2. Educational Attainment, at least completed upper secondary, population 25+, total (%) (cumulative)**



AP1. Figure 7: World Bank Data

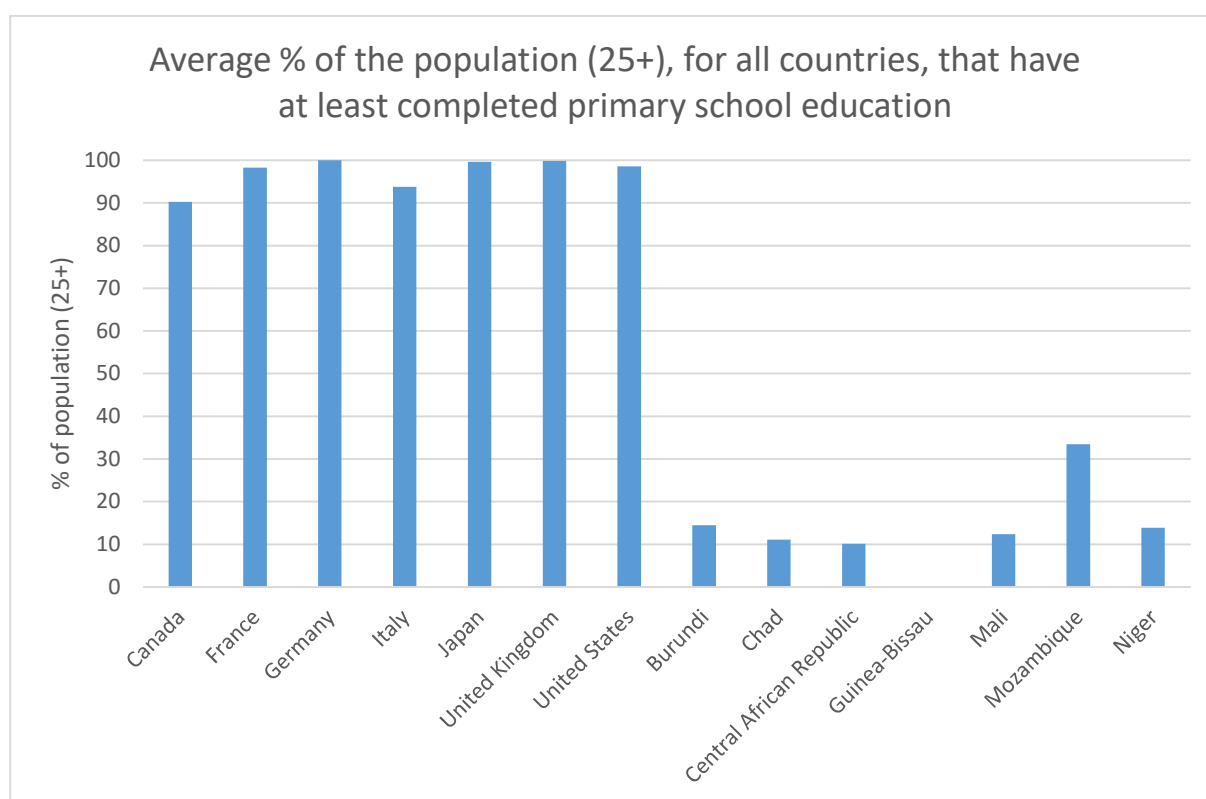
No data was available for Guinea-Bissau.

On average, less of the 25+ populations completed upper secondary school than completed primary, but more completed upper secondary than bachelor's level education.

For the G7 countries, average attainment was achieved by above 60% of the population for all countries except Italy which was 42.59%.

For the African countries, all (except Guinea-Bissau where there was still no data available) experienced an increase in educational attainment levels compared to those of the bachelor/equivalent levels. Mali remained high, now reaching 6.52% of the population achieving this education level, but Mozambique surpassed it at 7.21% attainment. Data for the Central African Republic was available here and it had the lowest value at 1.64%, closely followed by Niger at 1.74%.

### 3.3. Educational Attainment, at least completed primary, population 25+, total (%) (cumulative)



AP1. Figure 8: World Bank Data

No data was available for Guinea-Bissau.

All G7 countries had primary school level educational attainment achieved by over 90% of their 25+ populations. In many western countries, this level of education is compulsory and therefore, such high figures would be expected.

The African countries also experienced higher levels of educational attainment with a peak at 33.44% for Mozambique and a low of 10.12% for the Central African Republic.

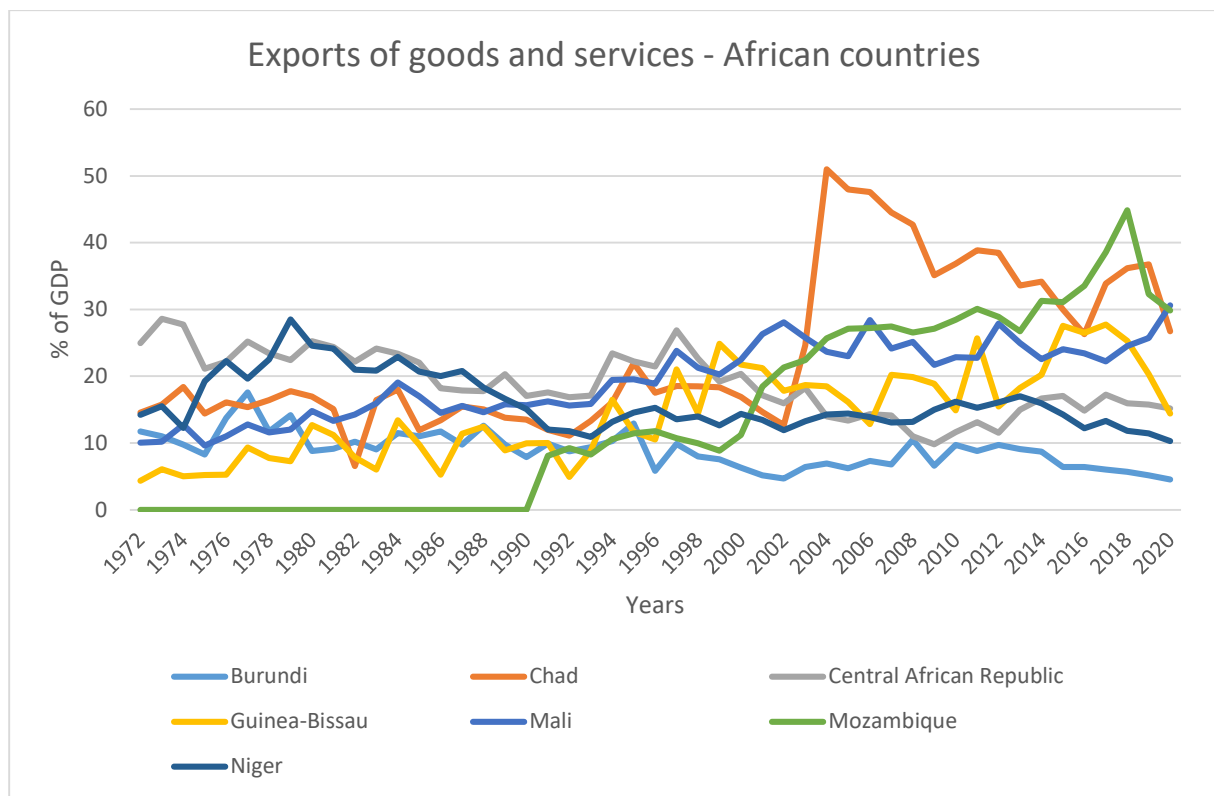
Primary level education had the highest educational attainment values for all countries.

### 4. Exports of Goods and Services (% of GDP)



AP1. Figure 9: World Bank Data

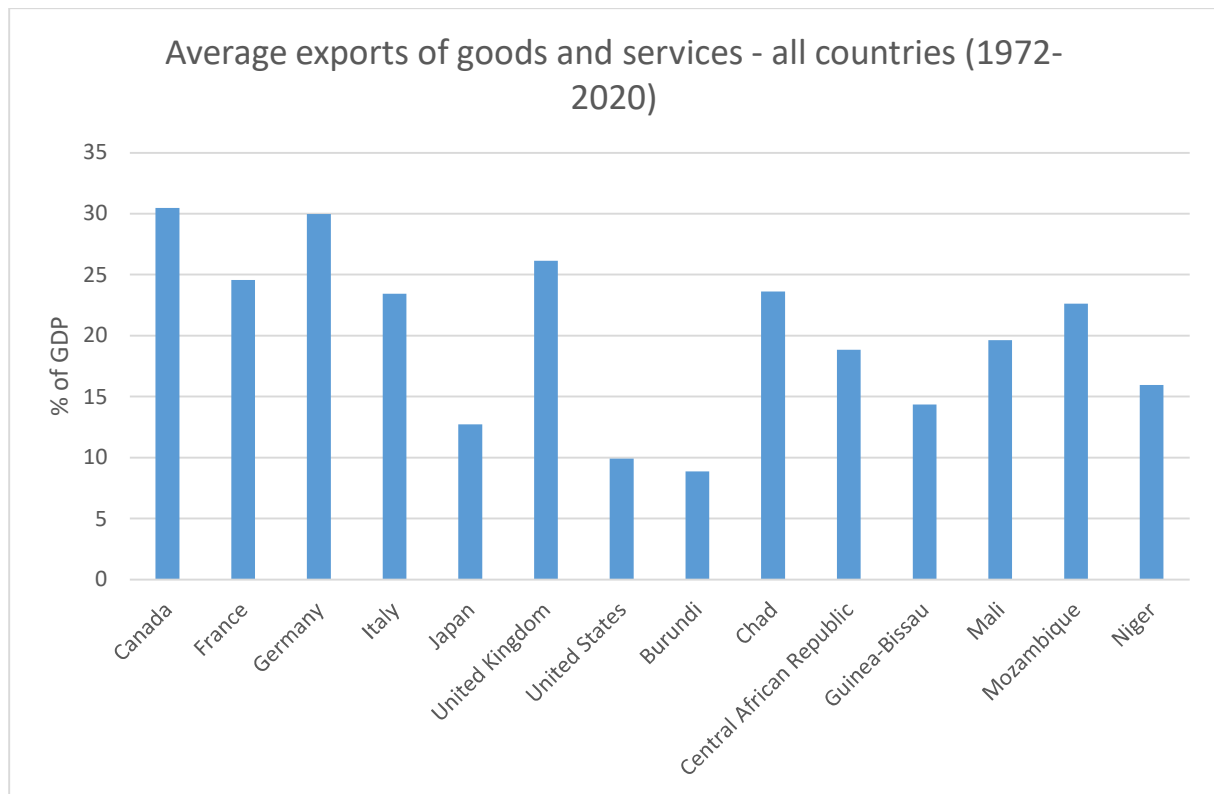
Germany shows the highest level of growth in exports of goods and services of all the G7 countries. While many of their values tended to fluctuate, significant growth was not really achieved by the remaining countries – besides Canada that reached considerably high levels around the year 2000 before dropping back down to its normal levels.



AP1. Figure 10: World Bank Data.

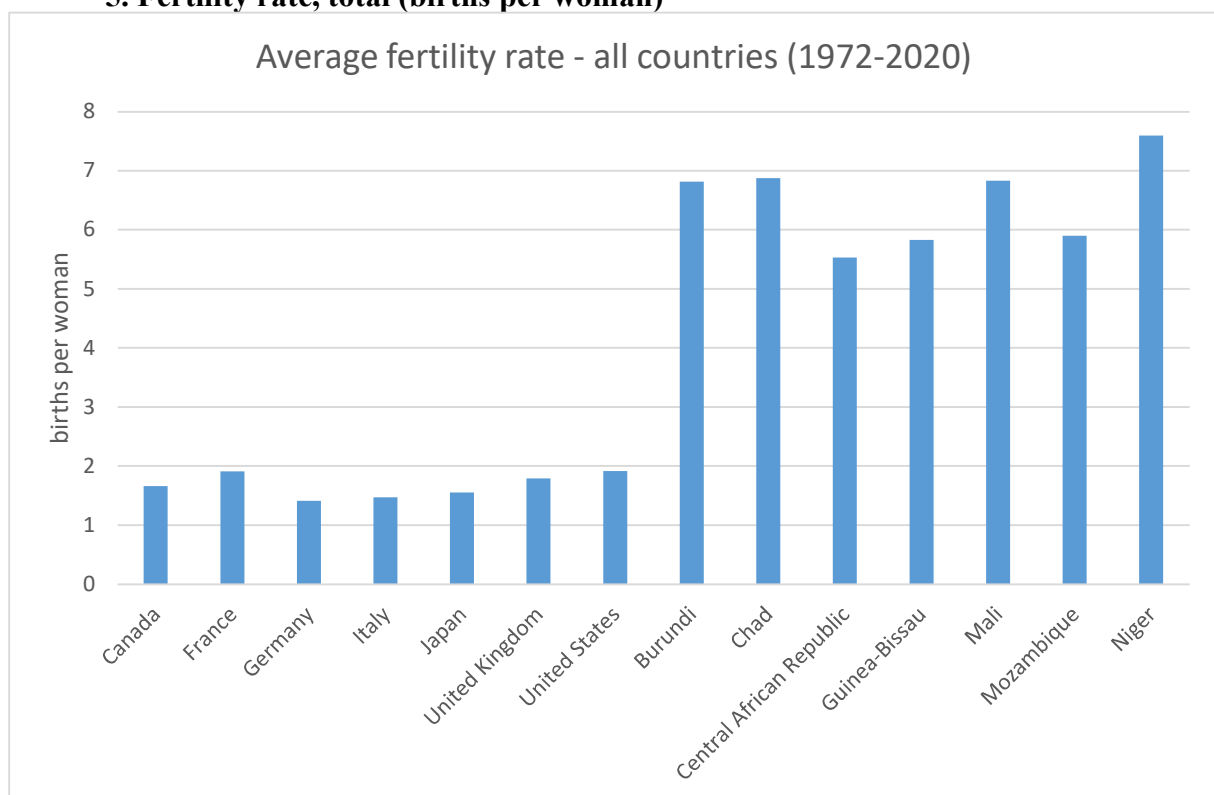
Data for Mozambique was not available until 1991.

Like the G7 countries, growth in exports of goods and services did not really occur and fluctuations were rampant. Chad, Mozambique, Mali, and Guinea-Bissau all show increases, and the Central African Republic, Burundi and Niger all show decreases (although slight).



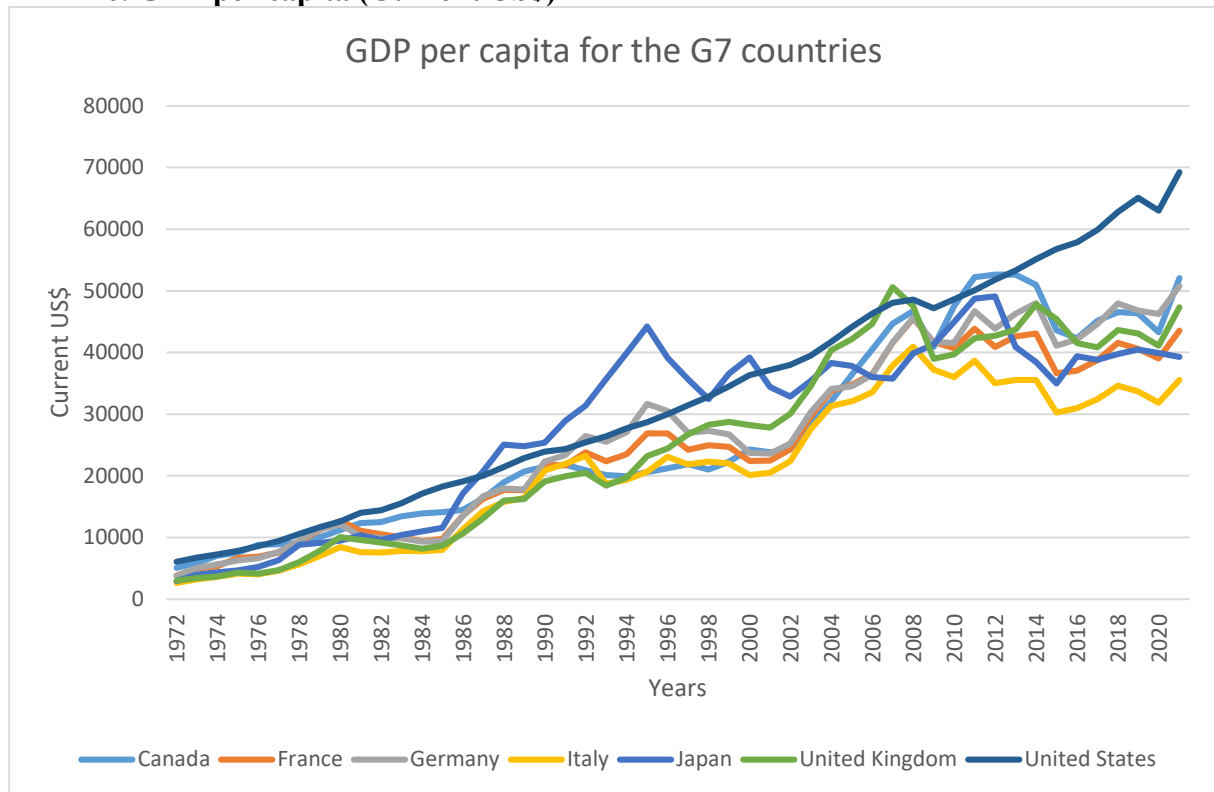
AP1. Figure 11: World Bank Data.

### 5. Fertility rate, total (births per woman)



AP1. Figure 12: World Bank Data.

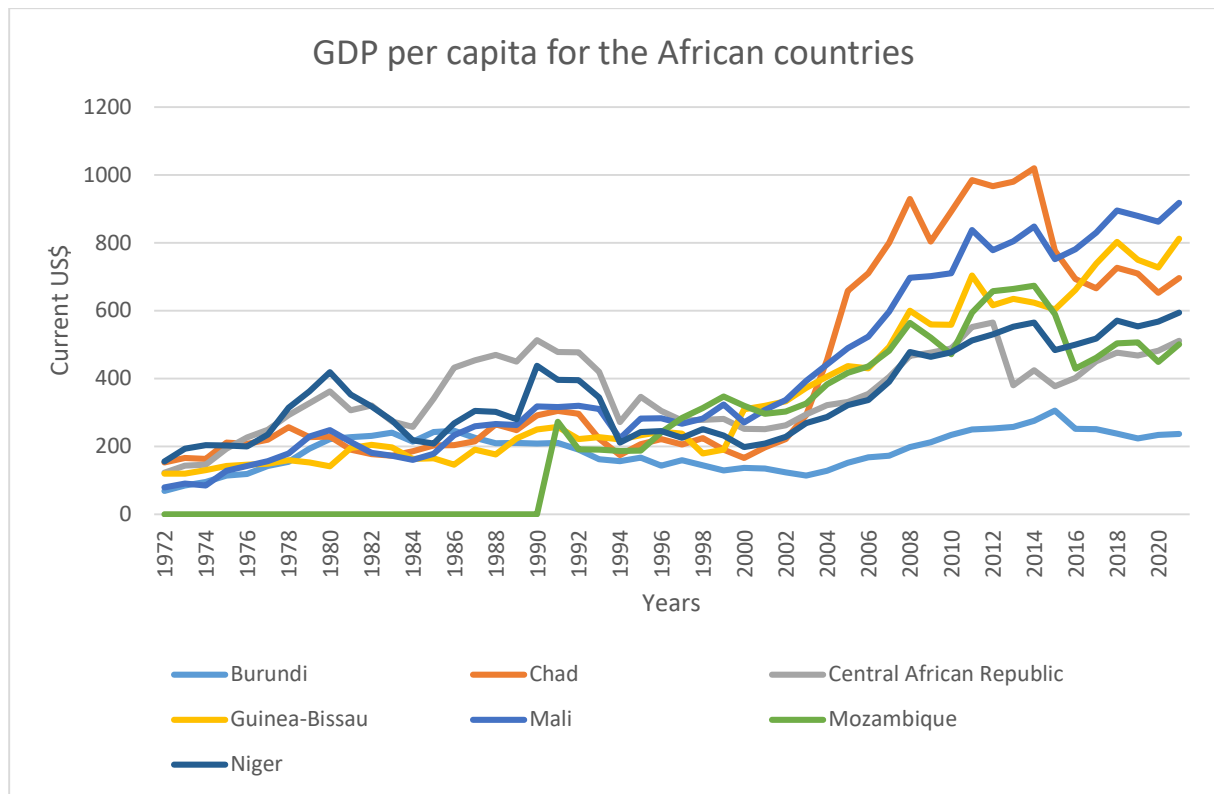
## 6. GDP per capita (Current US\$)



AP1. Figure 13: World Bank Data.

In general, it is evident that the G7 countries have experienced increases in their GDP per capita since 1972. The US shows the most stable and consistent growth while the other countries followed roughly the same pattern of growth but in different magnitudes.

In 2020, and again due to the covid-19 global pandemic, there was a dip in GDP per capita levels for all countries except Japan who experienced this dip in 2021. For the other countries however, by 2021, the dip in GDP per capita had recovered and rates were increasing once again.



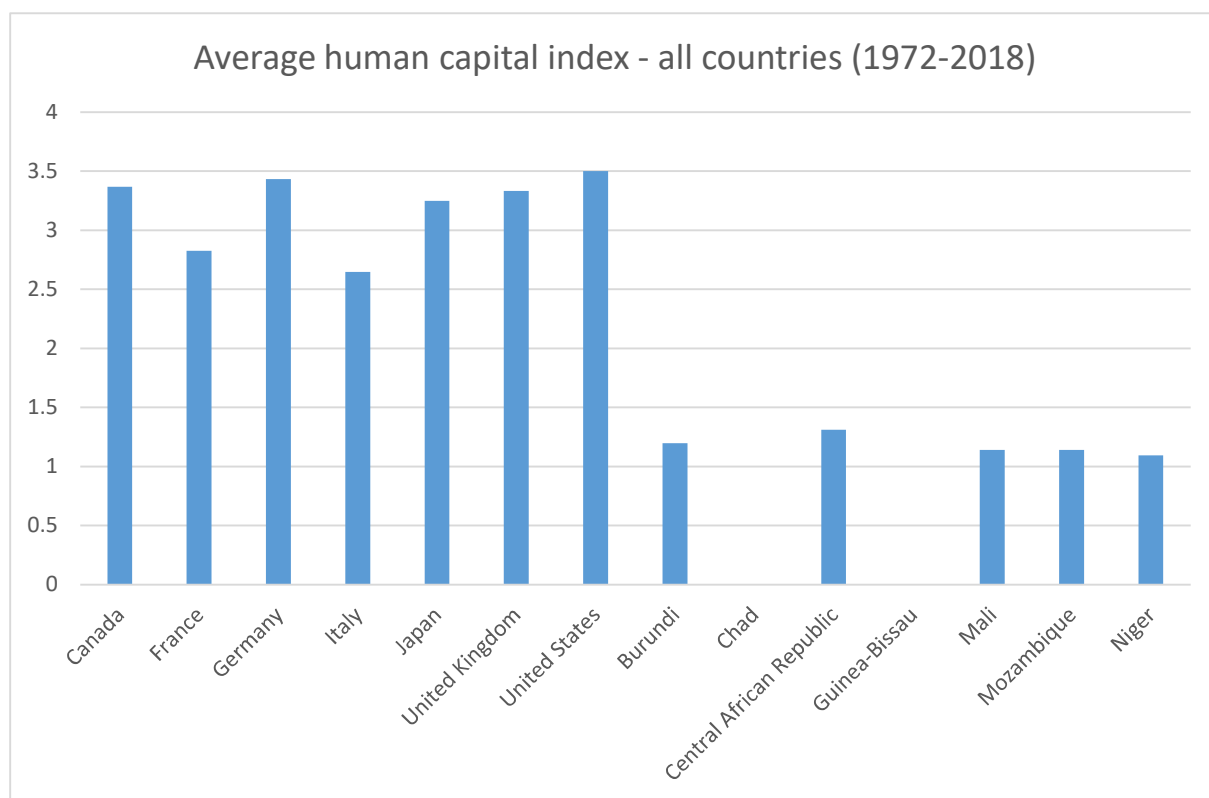
AP1. Figure 14: World Bank Data.

Data for Mozambique was not available until 1991.

All of the African countries have also experienced an increase in GDP per capita levels since 1972 (excluding Mozambique for which there was no data until 1991). These increases are significantly lower than the G7 countries' though and their current GDP per capita levels are well below the G7 level with none of the African countries at over \$1000 in 2021. In fact, the lowest GDP per capita rate for the G7 countries (Italy at \$35551.28) is still nearly 37 times larger than the highest GDP per capita rate for the African countries (Mali at \$917.91).

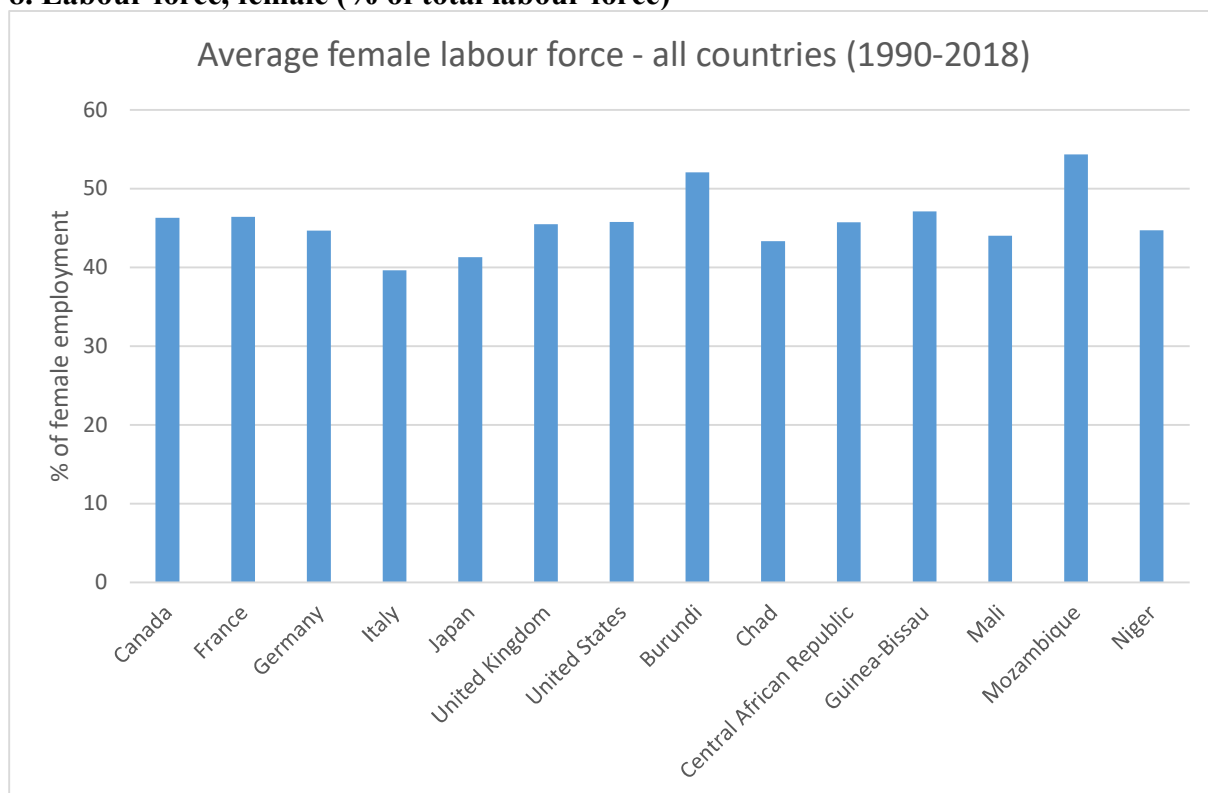
Similarly to most of the G7 countries, the African countries roughly followed the same pattern of growth but in different magnitudes. Burundi however, experienced much lower growth rates and GDP levels stayed relatively low, increasing from \$69.13 in 1972 to \$236.80 in 2021.

## 7. Human capital index, based on years of schooling and returns to education



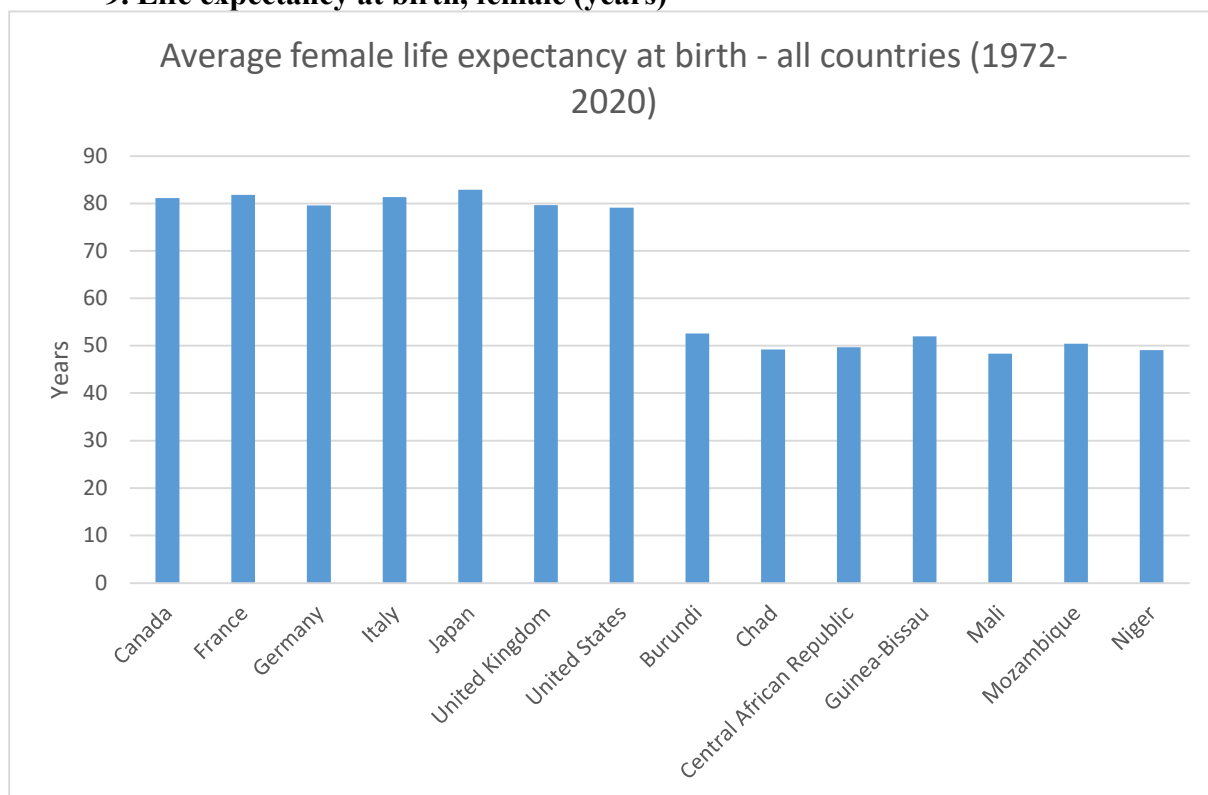
AP1. Figure 15: Penn World Tables Data.

## 8. Labour force, female (% of total labour force)



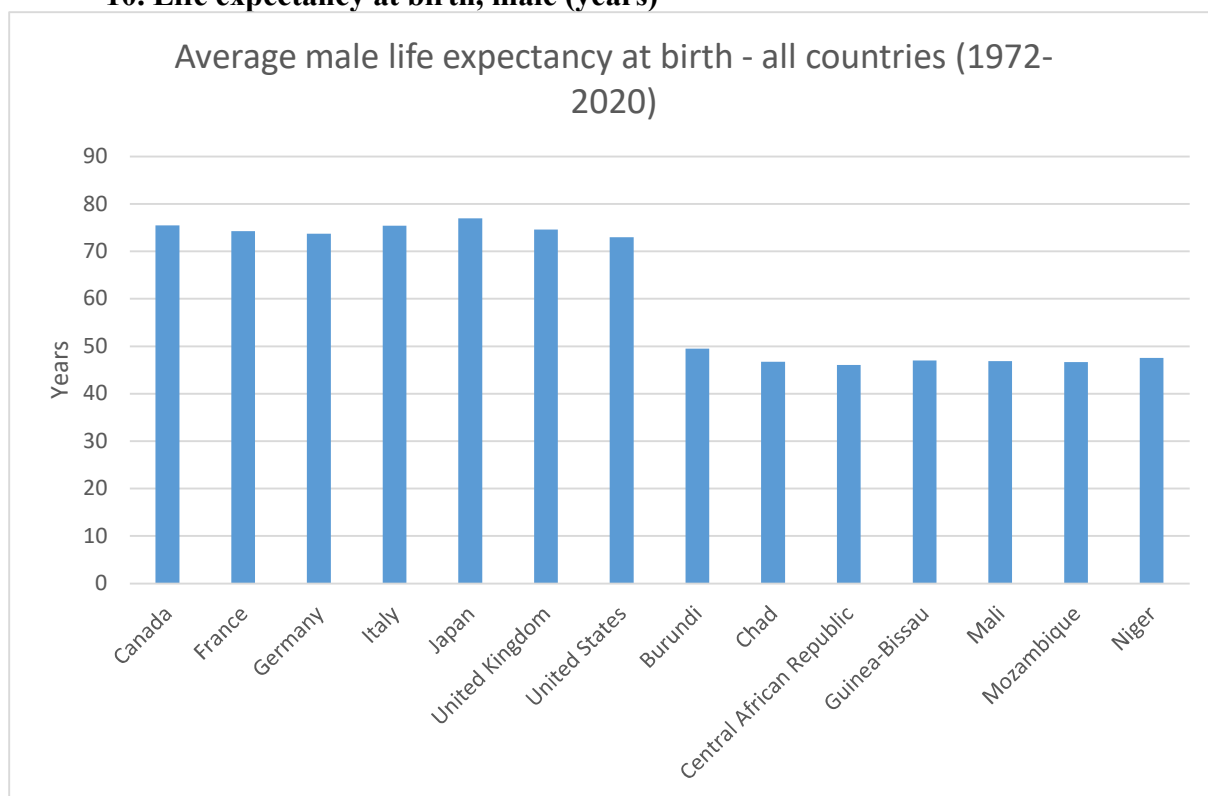
AP1. Figure 16: World Bank Data.

## 9. Life expectancy at birth, female (years)



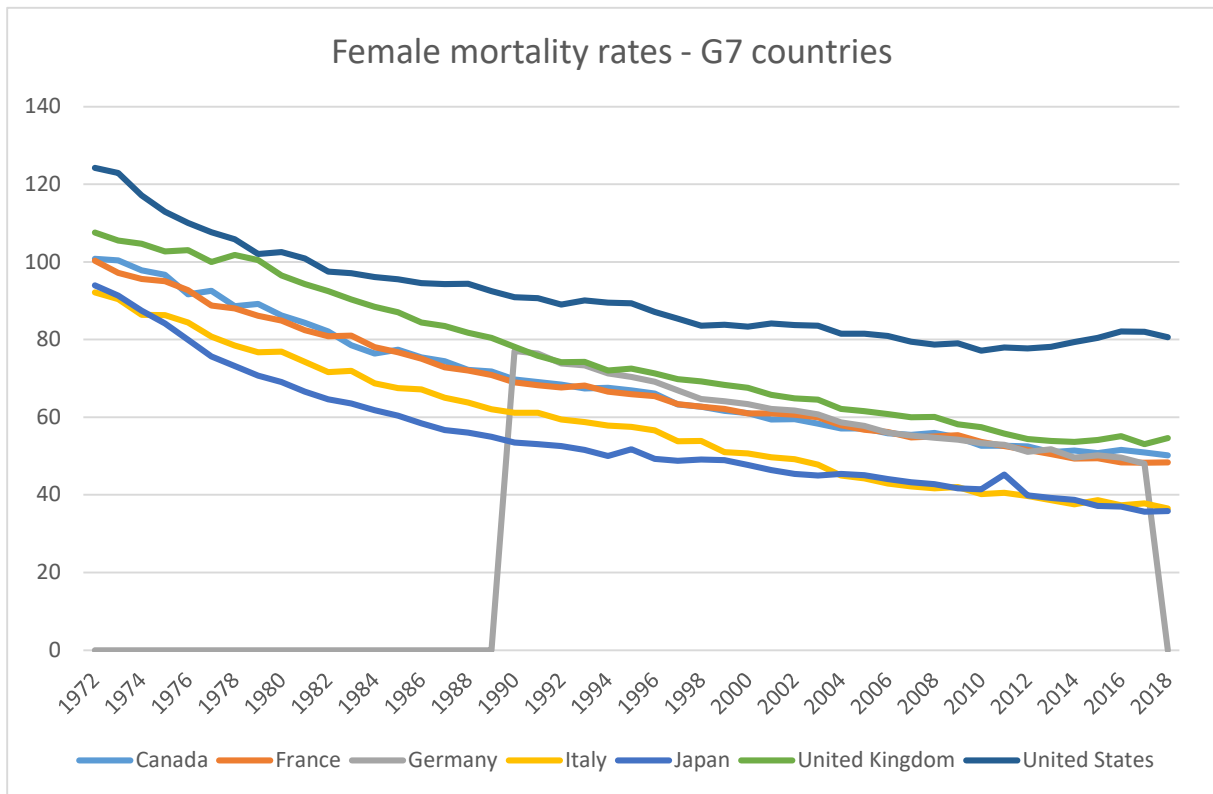
AP1. Figure 17: World Bank Data.

### 10. Life expectancy at birth, male (years)



AP1. Figure 18: World Bank Data.

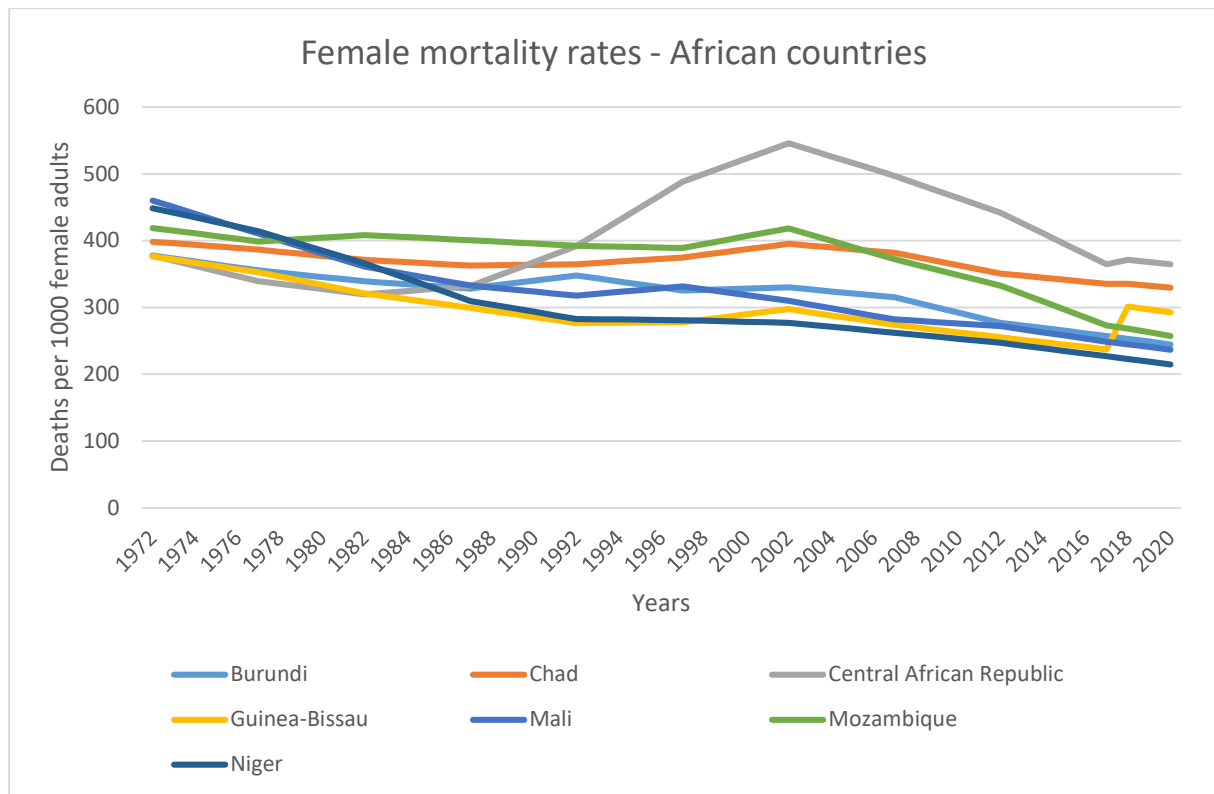
### 11. Mortality Rate, adult, female (per 1000 female adults)



AP1. Figure 19: World Bank Data.

Data for Germany was unavailable until 1990.

Overall, the female mortality rate declined over time for all countries however Japan experienced a small spike in 2011, likely due to the Tohoku earthquake and tsunami that occurred then. The United States has the highest death rate of the G7 countries but as their population is also significantly larger, this is to be expected.



AP 1. Figure 20: World Bank Data.

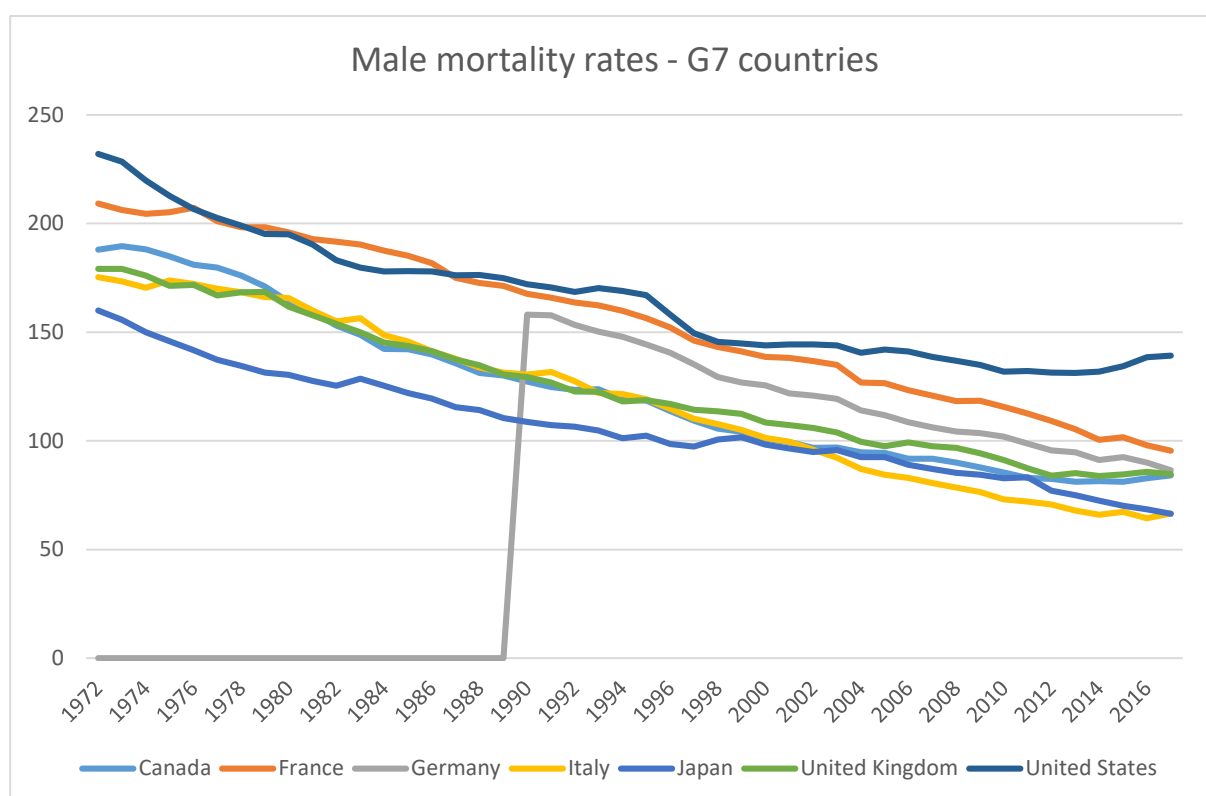
The African countries also show an overall decrease in female deaths per 1000 female adults despite this being a much smaller decrease than the G7 countries. The death count is also a lot higher than the G7 countries, with the peak death count for the African countries being 546 deaths in the Central African Republic in 2002 compared to the peak in G7 countries in the United States at 124 deaths in 1972.

The Central African Republic experienced a huge number in female deaths per 1000 female adults in 2002 – the aforementioned peak death count of all the African countries. The increase in death rate began around 1987, which coincided with the time that the country was looking to move to democracy following a series of autocratic rulers, and appointed Ange-Félix Patassé as president in the first multi-party democratic election since their independence from France in 1960. However, in 2003, General François Bozizé removed Patassé in a coup and started the

Central African Republic Bush War (Wikipedia e. 2022). Surprisingly, death rates actually started to decrease at this time and despite civil war still ensuing today, death rates have not reached those high levels since – although they still remain the highest of the African countries.

Guinea-Bissau experienced a small increase in the female mortality rate in 2018 yet it is unsure what caused this as there were no outbreaks, rebellions, uprisings, or natural disasters.

## 12. Mortality Rate, adult, male (per 1000 male adults)

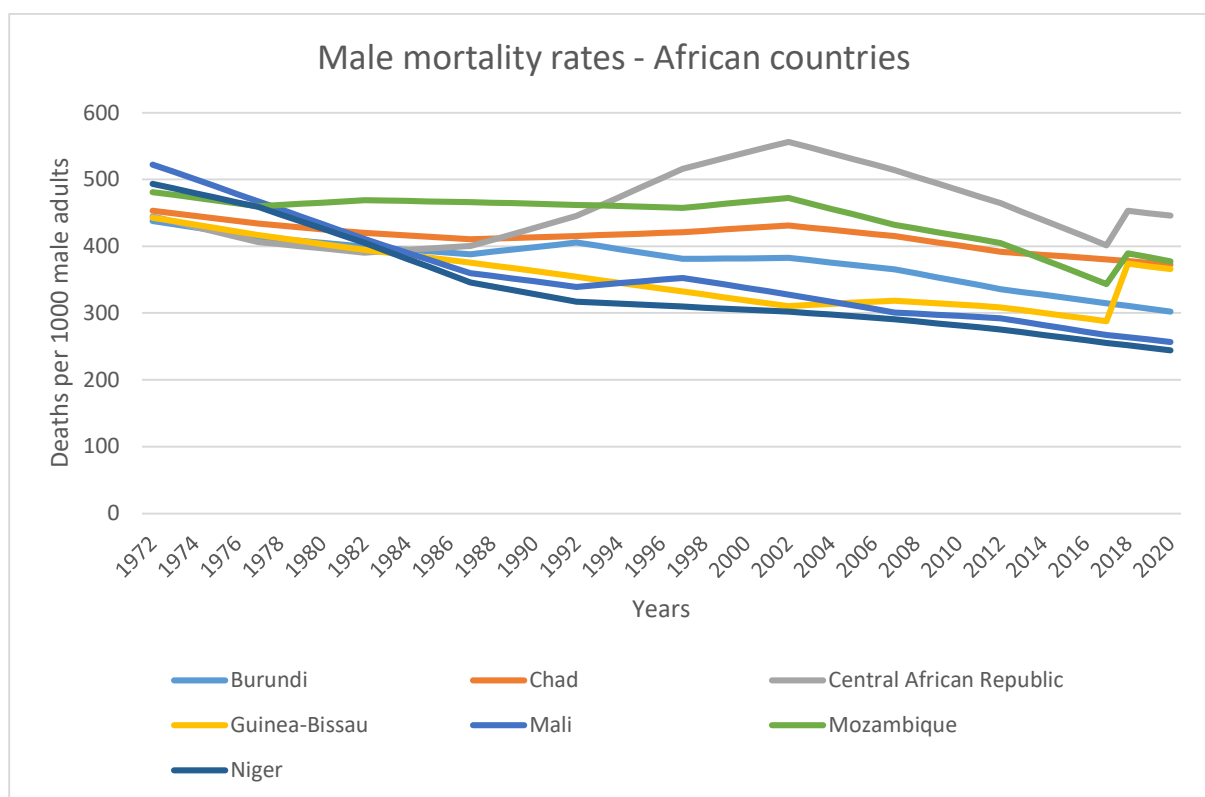


AP1. Figure 21: World Bank Data.

Data for Germany was unavailable until 1990.

Again, the mortality rates have been decreasing over time but with the male mortality rate, the discrepancies between the United States and the rest of the G7 countries are not as significant.

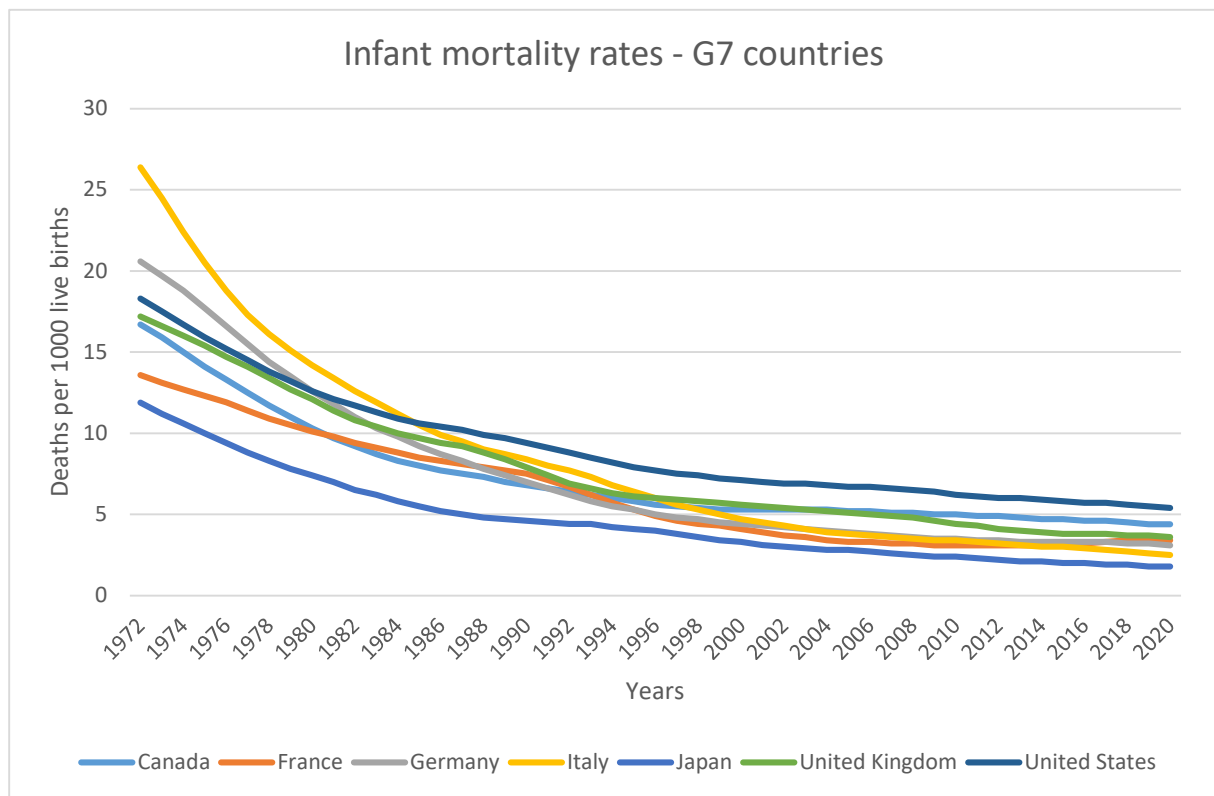
France experienced very similar levels of male mortality as the US until around 1998 where their rates diverged.



AP1. Figure 22: World Bank Data.

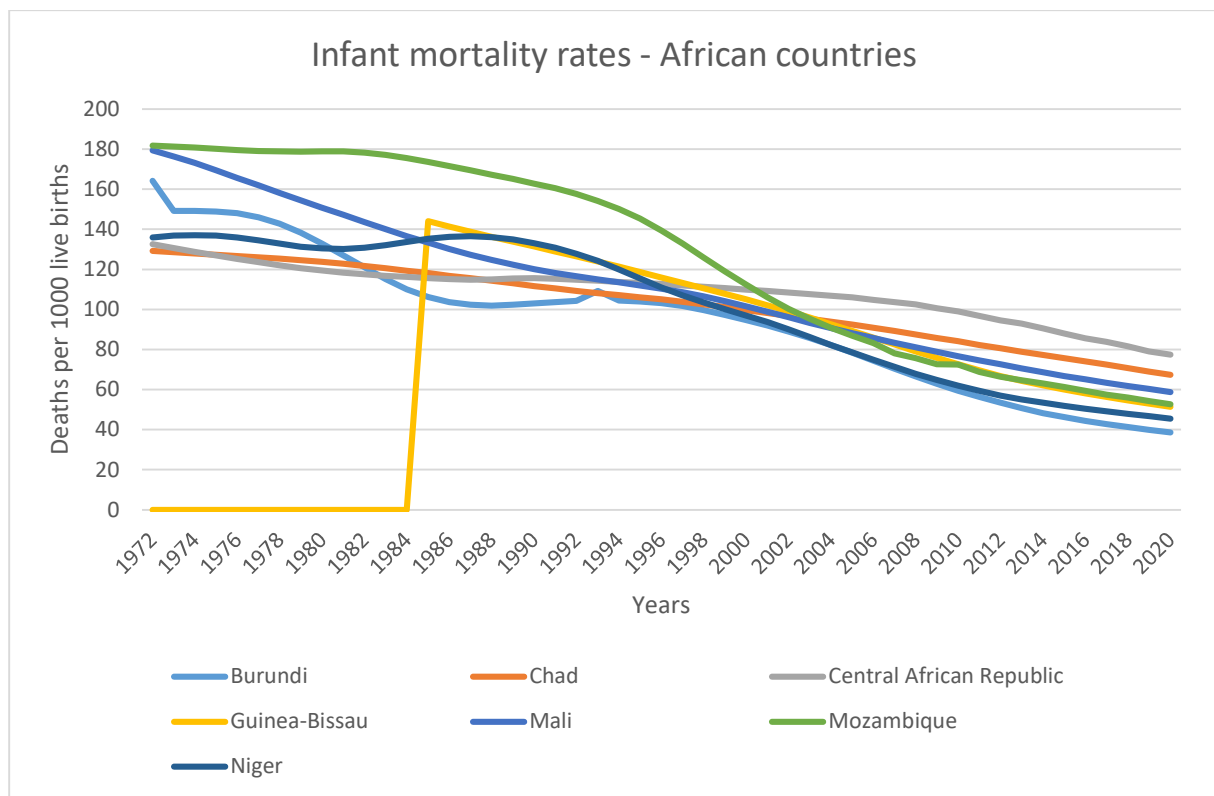
Analysis of the African countries male mortality rate is essentially the same as the females except that the peak in female mortality experienced by only Guinea-Bissau in 2018 was also experienced by Mozambique and the Central African Republic when it came to male mortality rates. Again, there is no apparent reason for these peaks in the male mortality rate.

### 13. Mortality Rate, infant (per 1000 live births)



AP1. Figure 23: World Bank Data.

Infant mortality rates for the G7 countries were significantly lower than the adult mortality rates and Italy overtook the United States as having the highest initial death rate. In 2020 the highest death rate was 5.4 deaths per 1000 live births in the United States and the lowest was 1.8 deaths per 1000 live births in Japan. The decline in the infant mortality rate is most likely attributed to advances in healthcare and medicine, and safer birthing experiences.

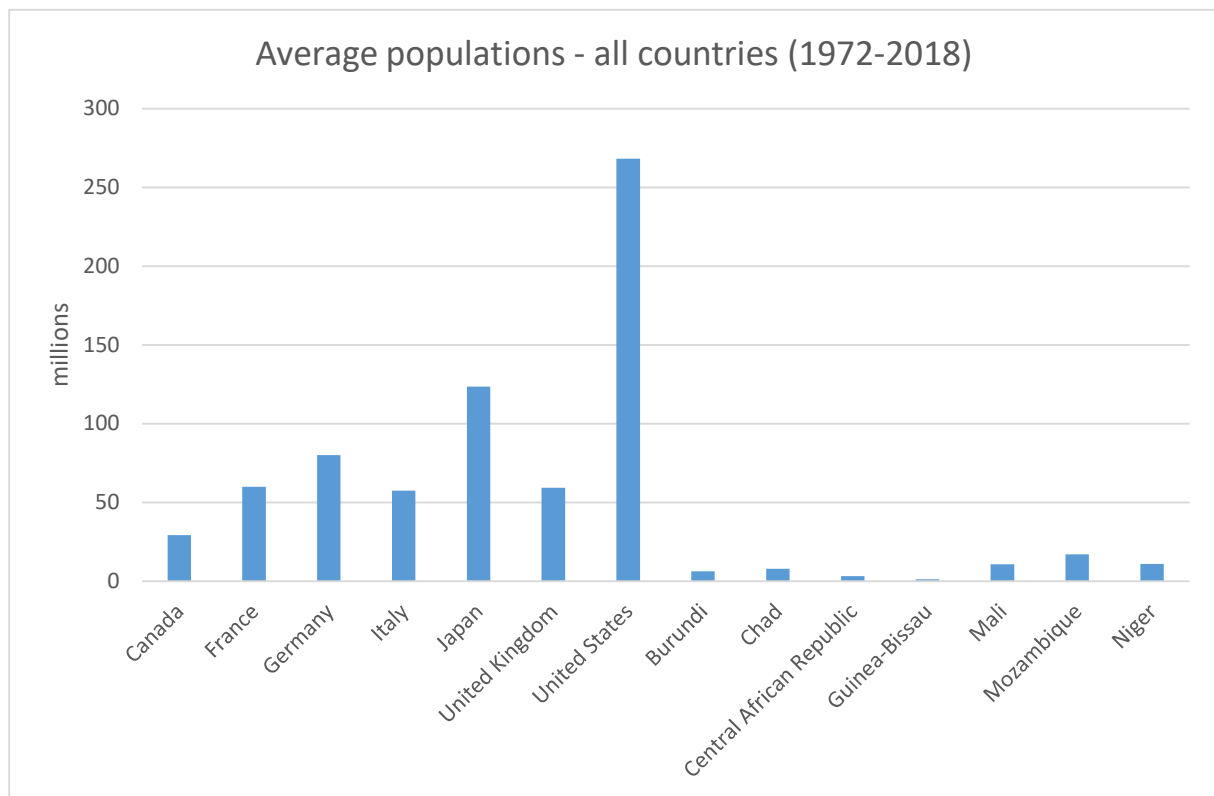


AP1. Figure 24: World Bank Data.

Data for Guinea-Bissau was not available until 1985.

Within the African countries, birth rates also decreased over time but current levels remain well above the G7 countries. Mozambique had the highest infant mortality rate until 2000-2003 where it converged with the other African countries. Mali started out with similarly high rates, but by 1985 it had aligned itself with the rest of the African countries. Chad, Mali and Guinea-Bissau (from 1985 when data became available) had the most linear decreases in their infant mortality rates.

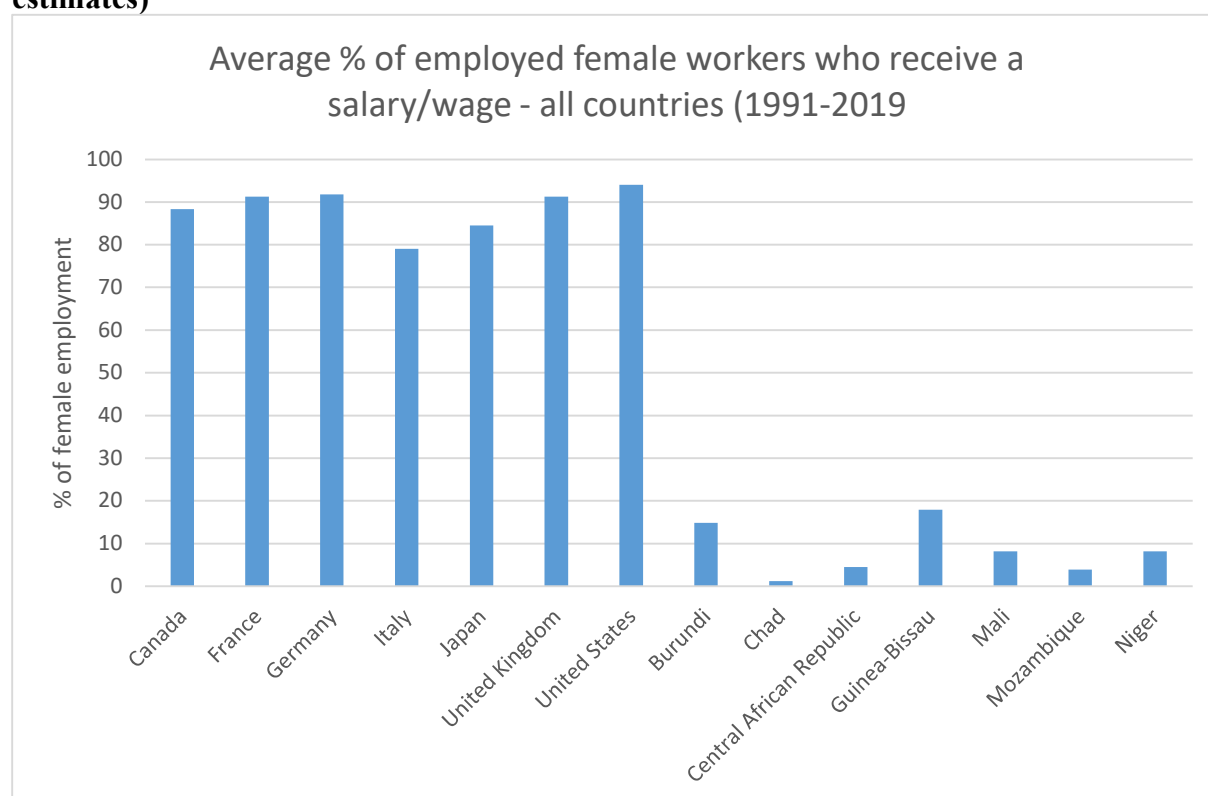
#### 14. Population (in millions)



AP1. Figure 25: Penn World Tables Data.

AP1. Figure 25 showcases the drastic differences in population size for the investigated countries. The United States' average population was significantly higher than all of the other countries at 268 million and Guinea-Bissau's was so much smaller that it is nearly illegible on the graph (1.15 million).

**15. Wage and salaried workers, female (% of female employment) (modelled ILO estimates)**



AP1. Figure 26: World Bank Data.

This variable looked at the percentage of employed females who received a wage or salary. In the G7 countries, the lowest percentage, on average, was Canada's at 88.3%. This is still relatively high as is expected from the world's leading countries. Contrarily, the lowest average percentage for the African countries was Chad's at 1.19% and the highest was only 17.94% (Guinea-Bissau).

## Appendix 2 (AP.2)

All of the data in the following appendix was gathered for intended use in the estimations carried out for this dissertation but due to lack of sufficient data, they were removed.

**AP.2 Table 1 –Variables investigated but not mentioned in the text**

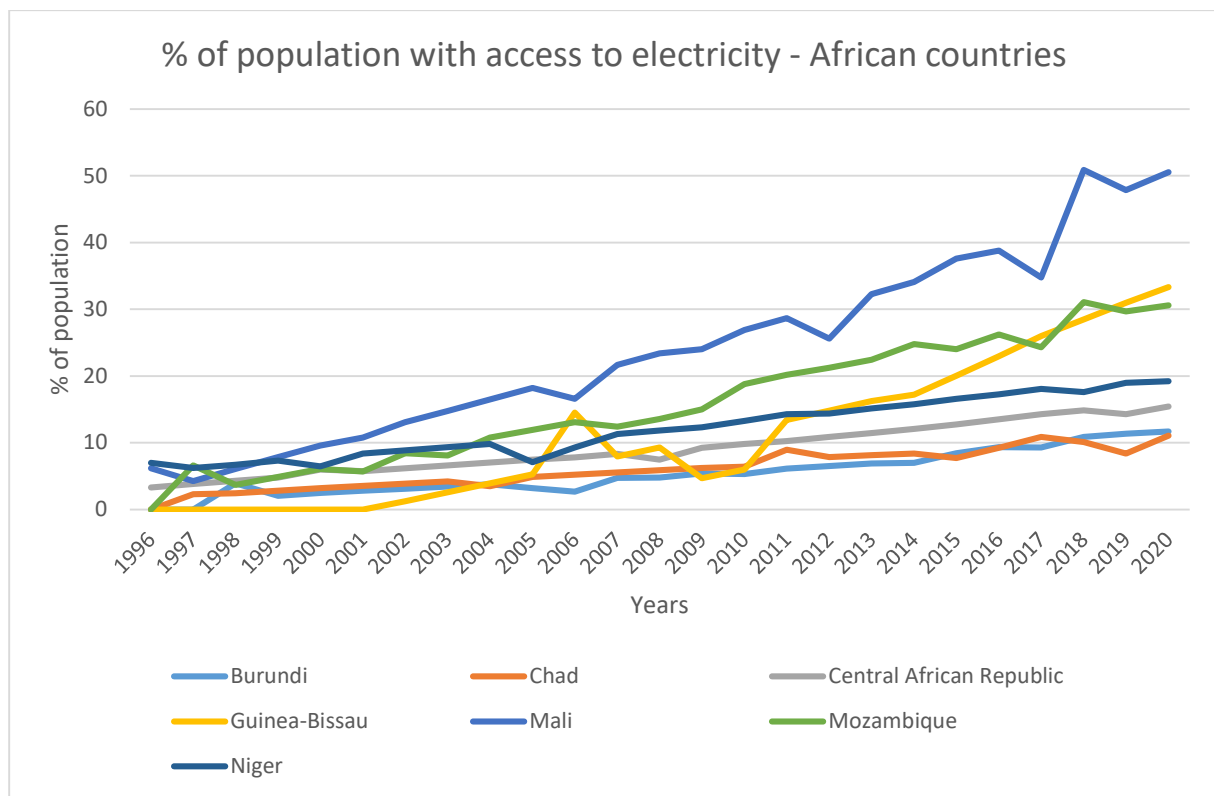
| No. | Description of Variable                                                                     | Data Source |
|-----|---------------------------------------------------------------------------------------------|-------------|
| 1   | Access to electricity (% of population)                                                     | World Bank  |
| 2   | Air transport (passengers carried)                                                          | World Bank  |
| 3   | Average precipitation in depth (mm per year)                                                | World Bank  |
| 4   | Contributing family female workers, female (% of female employment) (modelled ILO estimate) | World Bank  |
| 5   | Current account balance (% of GDP)                                                          | World Bank  |
| 6   | Current health expenditure (% of GDP)                                                       | World Bank  |
| 7   | People using at least basic drinking water services (% of population)                       | World Bank  |
| 8   | Physicians per 1000 inhabitants                                                             | World Bank  |
| 9   | Rail lines (total route-km)                                                                 | World Bank  |
| 10  | Railways, passengers carried (million passenger-km)                                         | World Bank  |

### Graphical representations of the variables in AP.2 Table 1

Disclaimer: Data for all variables was collected for an intended 50-year time frame in order to make adequate comparisons and observations. However, sufficient data was not available.

#### 1. Access to Electricity (% of population)

100% of all the G7 countries' populations had access to electricity from 1990 when the data started until 2020 when it ended. This is to be expected as they are the leading countries in the world.



AP2 Figure 1: World Bank Data

On the other hand, all but one of the African countries' have over 60% of their population without access to electricity - but all countries have seen growth, however small, since 1996 when data began.

Mali is the African country with the highest amount of their population able to access electricity, standing at 50.56% in 2020 and compared to 6.2% in 1996. One possible reason for these 'high' rates is the implementation of hybrid solar mini-grids in Mali as part of an initiative to provide clean electricity to numerous rural villages in the country. These sun-powered mini-grid systems create the energy needed to run water pumps and machines needed for farming and other industrial processes which, in turn, generate opportunities for economic growth for households and businesses (IRENA 2022).

Guinea-Bissau and Mozambique follow Mali when it comes to electricity access although only 33.34% and 30.6% of their respective populations had access to electricity in 2020 – these values were up from 1.25% for Guinea-Bissau in 2002 and 6.6% for Mozambique in 1997. Guinea-Bissau’s growth in the last decade has doubled very steadily, despite political turmoil, due to a reform strategy implemented in 2010 that focused on increasing capacity and improving operational performance (USAID n.d.). However, poor maintenance and planning had thwarted the potential of Guinea-Bissau’s electrical grid, causing outages, and amounting to technical/commercial losses of 47%. As a result of this, the African Development Bank, along with Guinea-Bissau, have adopted a new approach to tackling Guinea-Bissau’s development issues in the years to come (African Development Bank Group 2022). This approach is documented in the Country Strategy Paper 2022-2026 and should mean that the country’s access to electricity continues to increase.

Mozambique had a slightly more turbulent last decade than Guinea-Bissau and currently falls just short of their electricity levels – despite there being six functional hydropower stations across the country. The largest of these stations is the Hidroeléctrica de Cahora Bassa (HCB) that is responsible for up to 88% of the country’s consumed power. However, due to low demand for power in Mozambique, most of this energy is exported to South Africa. The main cause of this low energy demand is the fact that over half of Mozambique’s population still lives in rural areas – and in 2019 only 5% of the total rural population had access to electricity. Mozambique’s Fundo de Energia (FUNAE) is a public foundation who is responsible for off-grid rural electrification with a focus on renewable energies. Despite this, Mozambique’s state-owned utility service, Electricidade de Mozambique (EDM), which was founded in 1977 with the intention of promoting industrial and agricultural development and improving the reach and quality of household electricity, does not cover the cost of FUNAE’s

electrification programmes and since electricity users cannot afford them, FUNAE is left dependent on external investments and donations. Both the lack of funding and the rural-ness of Mozambique's population means that access to electricity growth is low and slow, but Mozambique is still striving to attain its goal of electrifying all households by 2030 (Energypedia 2022).

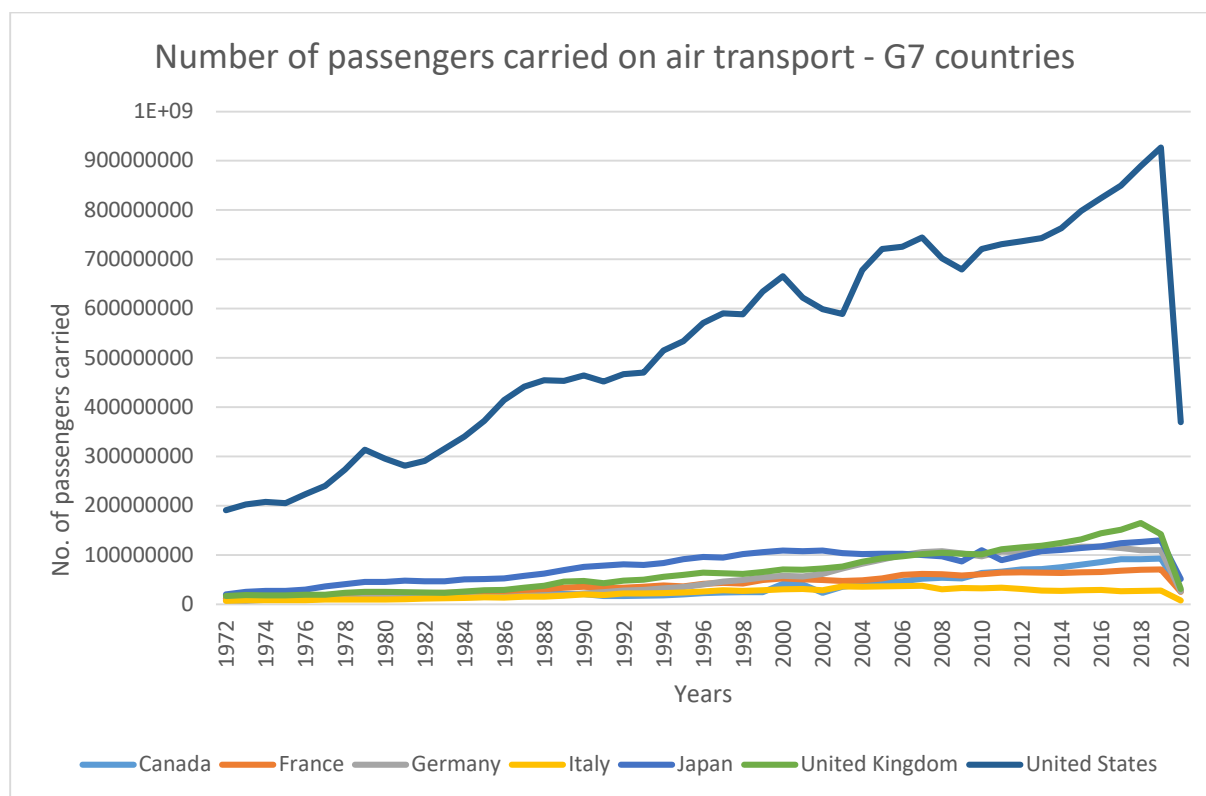
Burundi and Chad tailed the other African countries with their populations access to electricity at 11.74% and 11.08% respectively in 2021. These were increases from 3.9% in 1998 for Burundi and 2.3% for Chad in 1997.

Burundi depends heavily on hydroelectric power, accounting for 95% of its limited 39MW installed capacity. As of 2020, supply deficits were between 12.9MW in the wet season and 23.5MW in the dry season and imports from Ruzizi I and II in Congo were not sufficient to mitigate these deficits. As such, outages are rampant and act as significant hinderances to the country's economic growth. The outages and lack of cash flows/investments following the civil war have meant that Burundi's transmission network is run-down and needs upgrading to make sure it can work with some of the hydropower plant projects employed by nearby and surrounding countries. In 2020, the Power Generation Master Plan in Burundi was appraised by SEFA (Sustainable Energy Fund for Africa) with the aim of highlighting the vast range of renewable energy options that Burundi has to offer and utilizing them to meet the energy challenges they are facing (African Development Bank Group 2020).

In March 2022, the World Bank (2022) approved a grant worth \$295 million from the International Development Association (IDA) to aid Chad in increasing its populations access to energy. Over 6 million people are meant to benefit from the electricity services that will be provided by this project, the Chad Energy Access Scale Up Project (PAAET), and

schools and medical centres, both in rural and urban areas, will benefit too (World Bank 2022). Previous lack of financing and aged infrastructure had meant Chad lacked the capacity – human and technical – to meet the growing demand for electricity that it was facing - evident in 2016 where the capacity for installed electricity generation was only 48,000 kW (International Trade Administration 2020). With the new PAAET project, Chad’s access to electricity should increase considerably over the coming years, strengthening its capacities for generation, storage, and distribution.

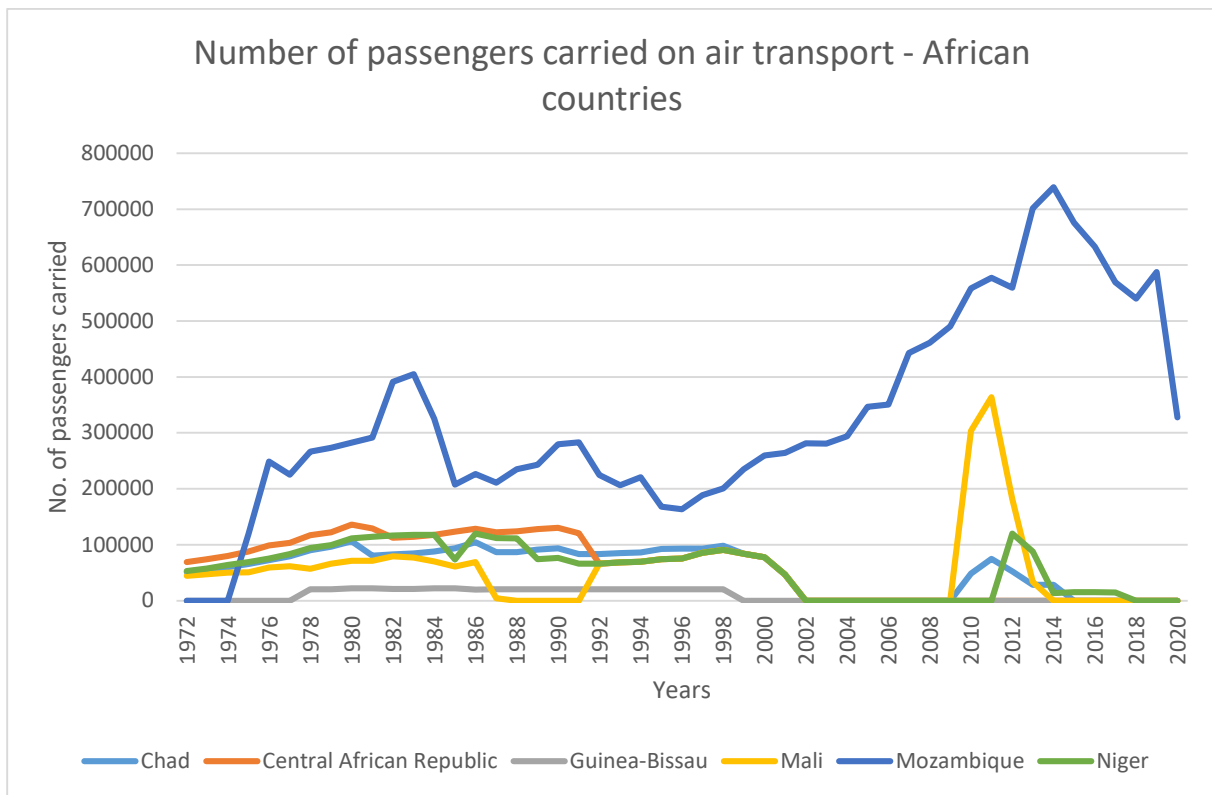
## 2. Air transport, passengers carried



AP2 Figure 2: World Bank Data

While the United States is clearly in the lead with the number of passengers carried by the G7 countries over the last 50 years - arguably because it has a significantly larger population

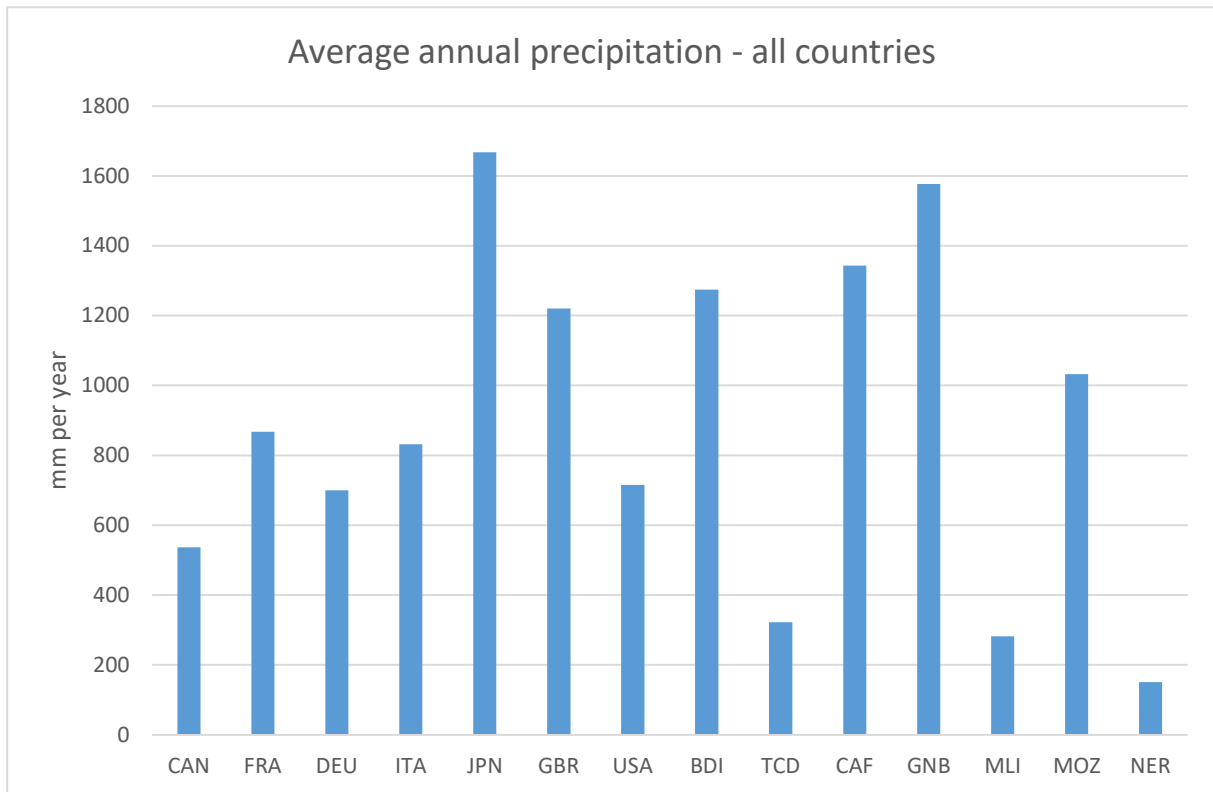
size - all countries experienced growth of some kind followed by a sharp decline in 2020 as a result of global lockdowns and travel restrictions due to the Covid-19 pandemic.



AP2 Figure 3: World Bank Data

Mozambique led the seven least developed countries when it came to the number of passengers carried over the last 50 years. Many of the countries lacked data for multiple years throughout the 50-year time range but most tend to experience periods of growth around the same time – despite experiencing varying levels of the growth. For instance, around 2010 and the following years, there was a spike in the number of passengers carried in Mozambique, Mali, Niger and Chad, possibly as a result of the 2010 World Cup in South Africa. Around 2014, these spikes dropped off, potentially due to the outbreak of Ebola.

### 3. Average precipitation in depth (mm per year)



AP2 Figure 4: World Bank Data

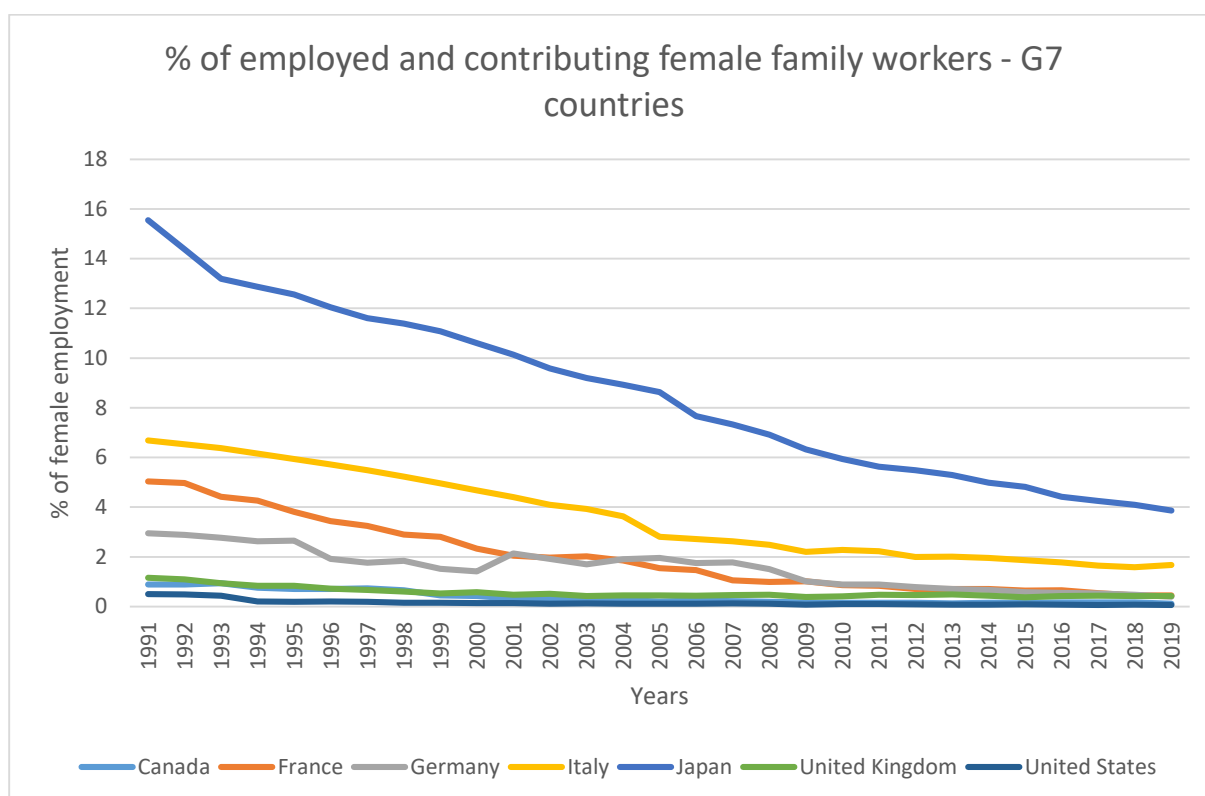
Data for the average precipitation (measured by depth in millimetres, mm) were documented sporadically throughout the 50-year timeframe and the values were the same for each set. Therefore, the values have been plotted in a bar chart to compare the levels for each country since they do not vary throughout the chosen period.

Precipitation is an extremely important factor when it comes to agriculture and agriculture is the largest economic activity in Africa. Two-thirds of Africa's working population is said to be employed in the agricultural sector and it contributes roughly between 30% and 60% of the gross domestic product for each country, and around 30% of exports (Britannica n.d.).

Chad, Mali, and Niger stand out on the graph above as countries with significantly low rainfall. Whereas, Burundi, the Central African Republic, and Guinea-Bissau all have relatively high amounts.

Precipitation levels, when too low or too high, pose problems to agriculture. If there is excess rainfall, improper irrigation/drainage, or crops are left too wet, there is the possibility of them becoming mouldy, collecting fungus, and even spreading disease amongst themselves. This is likely to be detrimental to the harvest yield or even the whole field, rendering it unusable. If the environment is too dry, nutrients present in soil could be cut off from reaching the plants root and lead to stunted growth or poor overall health (Sigfox 2018). It would be beneficial to look at data monthly over one year to determine whether there are periods of intense rain/drought and to better imagine the impact of a country's precipitation on their agriculture industry. However, from the data provided, the extremities can be highlighted as being likely unfavourable conditions for agriculture.

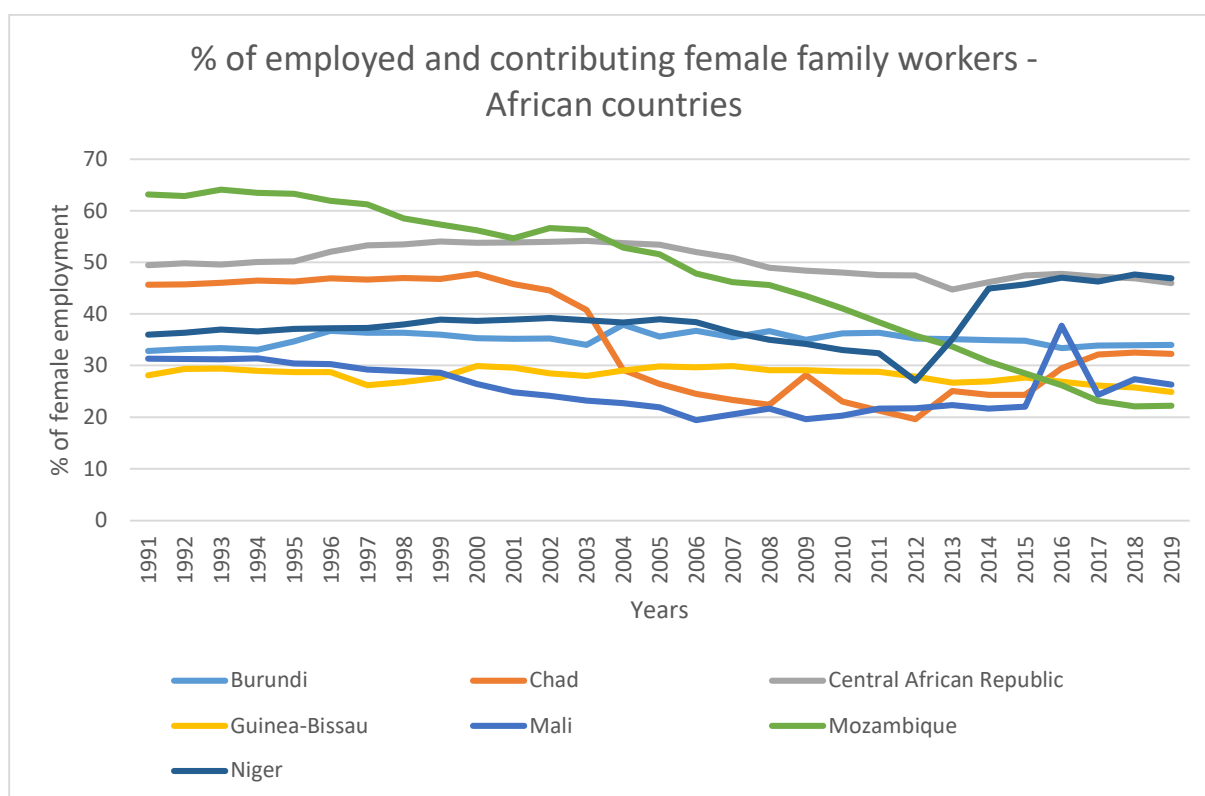
#### 4. Contributing family workers, female (% of female employment)



AP2 Figure 5: World Bank Data

From the graph above, it is evident that, over time, there has been a decline in the number of contributing female family workers.

Japan had and continues to have the highest amount of contributing female family workers despite the number declining drastically from 15.55% in 1991 to 3.87% in 2019. It is important to note that Japan is the country furthest east, so while it has followed the trend of the west and the other G7 countries, it remains different in this way.



AP2 Figure 6: World Bank Data

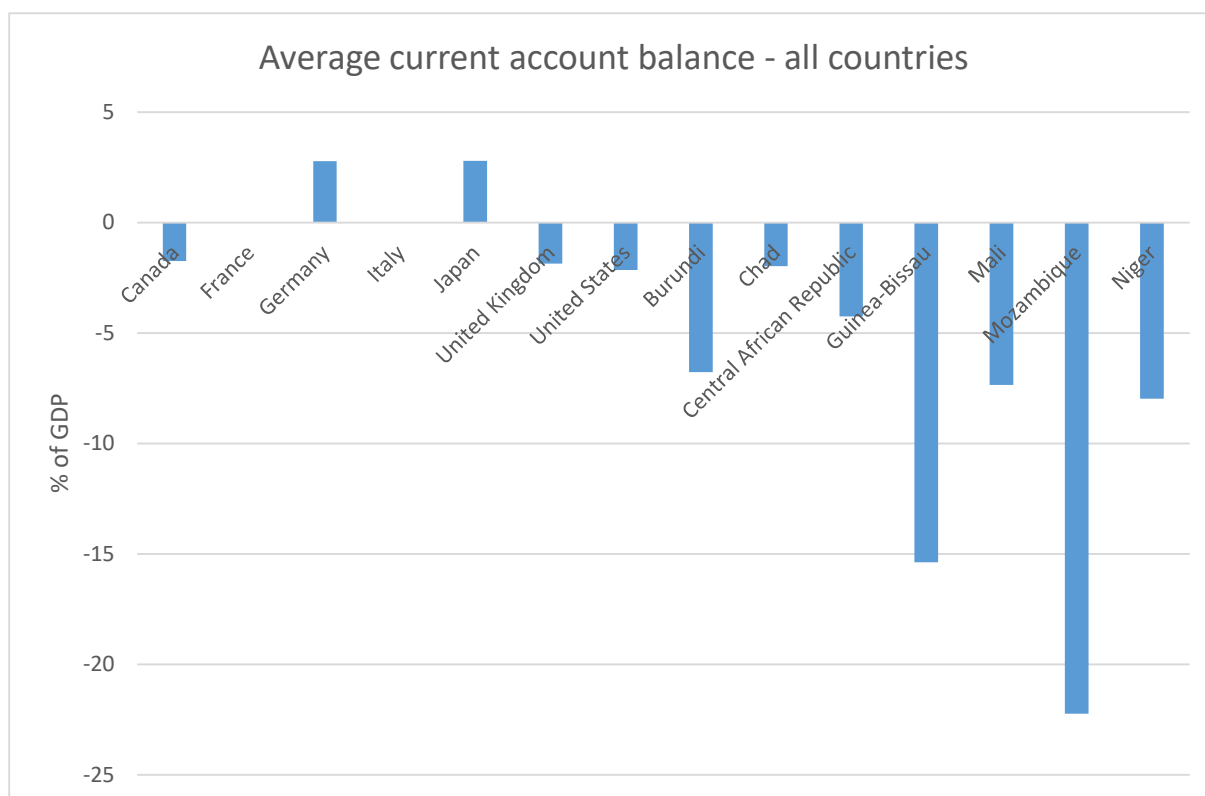
Unlike with the G7 countries, there is no clear pattern in the number of contributing female family workers within the African countries - although the maximum values reached are notably higher.

Mozambique showed a reasonably consistent decline from 1991 to 2019, going from having the highest percentage of employed females also being contributing family workers, at 63.15%, to having the lowest, 22.20%. Notably, Mozambique was also at the tail end of a 15-year civil war in 1992 which could explain why the contributing female family worker rate was so high and then began to decline.

Chad also showed a decrease in contributing female family workers although the majority of this decrease took place between the years 2000 and 2008. Following that period, Chad experienced intermittent periods of increasing and declining rates until 2017 where rates levelled out. Again, it is worth noting that Chad was experiencing a civil war between December 2005 and January 2010. In the years leading up to and following this period there were generally higher levels of contributing female family workers.

Niger, on the other hand, was fairly consistent in its level of contributing female family workers until 2006 when a decline started, worsening in 2011, and then drastically turning around in 2012 with a sharp increase which spanned over two years and then levelled out. Shortly after the initial decline began, in February 2007, Niger and Mali experienced the Tuareg Rebellion as a result of insurgency. This lasted until May 2009 and, similarly to Mozambique and Chad, may have had an effect on the percentage of contributing female family workers in the years to come. Despite this, Niger currently has the highest level of contributing female family workers.

## 5. Current Account Balance (% of GDP)



AP2 Figure 7: World Bank Data.

Data for this variable was widely unavailable and averages were plotted due to the illegibility of individual values on a line graph. The available years are documented in AP2. Table 2.

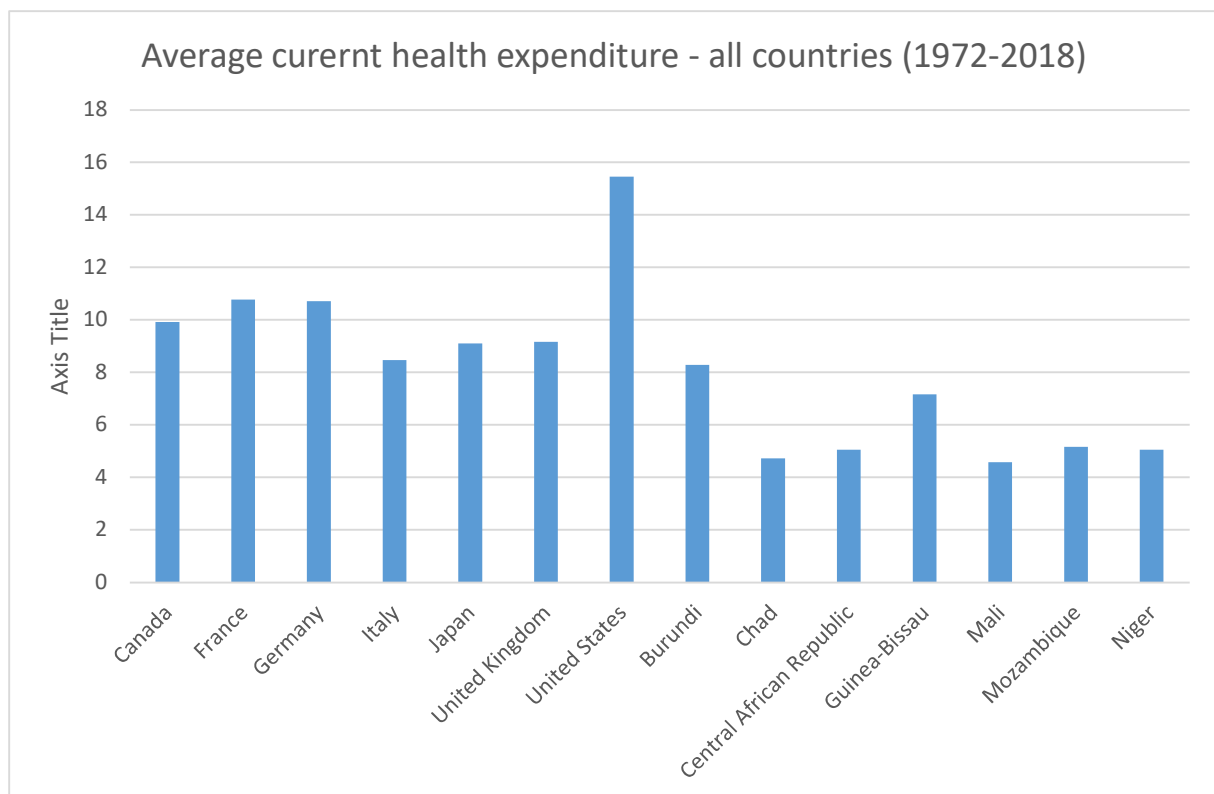
**AP2. Table 2 - Years included in the calculation of average current account balance for the 14 countries studied**

| Country                  | Years       |
|--------------------------|-------------|
| Canada                   | 1972 – 2021 |
| France                   | 1975 – 2021 |
| Germany                  | 1972 – 2021 |
| Italy                    | 1972 – 2021 |
| Japan                    | 1996 – 2021 |
| United Kingdom           | 1972 – 2021 |
| United States            | 1972 – 2021 |
| Burundi                  | 1985 – 2018 |
| Chad                     | 1977 -1994  |
| Central African Republic | 1977 -1994  |
| Guinea-Bissau            | 1982 - 2020 |
| Mali                     | 1975 - 2020 |

|            |             |
|------------|-------------|
| Mozambique | 2005 – 2020 |
| Niger      | 1974 – 2020 |

From AP2. Figure 7, it is evident that the African countries, on average, experienced much lower current account balances than the G7 countries however, data was very scarce for these variables as seen in AP2 table 2 where the years available are noted.

## 6. Current Health Expenditure (% of GDP)

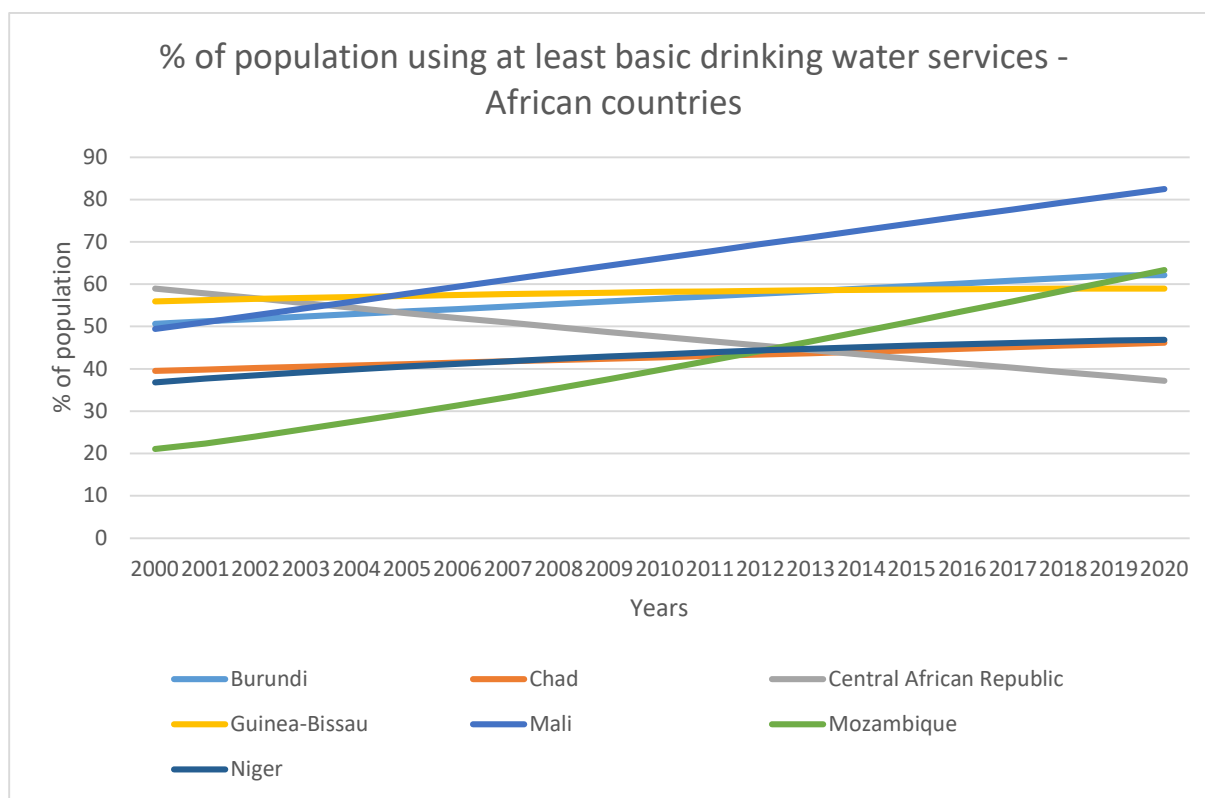


AP2 Figure 8: World Bank Data.

Average levels of current health expenditure were notably higher for the G7 countries when compared to the African countries. However, the average levels in Burundi and Italy were very close in value. Health expenditure would significantly affect mortality rates and higher levels in the G7 countries likely explain why their mortality rates are lower.

## 7. People using at least basic drinking water services (% of population)

All the G7 countries had averages above 98% meaning that essentially all of their populations have had access to basic drinking water services over the past 20 years.



AP2 Figure 9: World Bank Data.

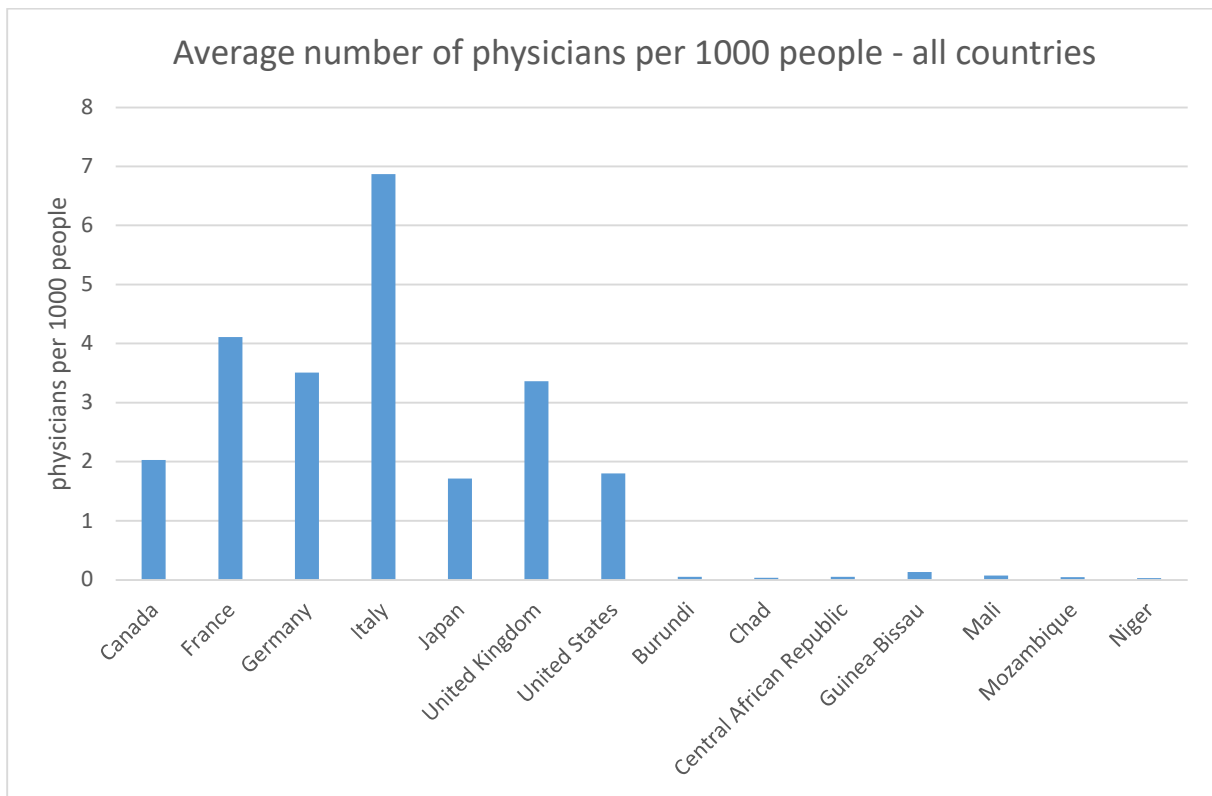
Mali and Mozambique show the most prolific growth in their populations' access to basic drinking water services.

Guinea-Bissau, Burundi, Chad, and Niger all had relatively constant levels of basic drinking water service access. Although access did increase, it was not as significantly as Mali and Mozambique experienced.

On the contrary, the Central African Republic experienced a decline in their populations access to basic drinking water services. Rates decreased from 59.01% of the population having access in 2000 to only 37.20% in 2020, the lowest rate of all the countries.

## 8. Physicians per 1000 inhabitants

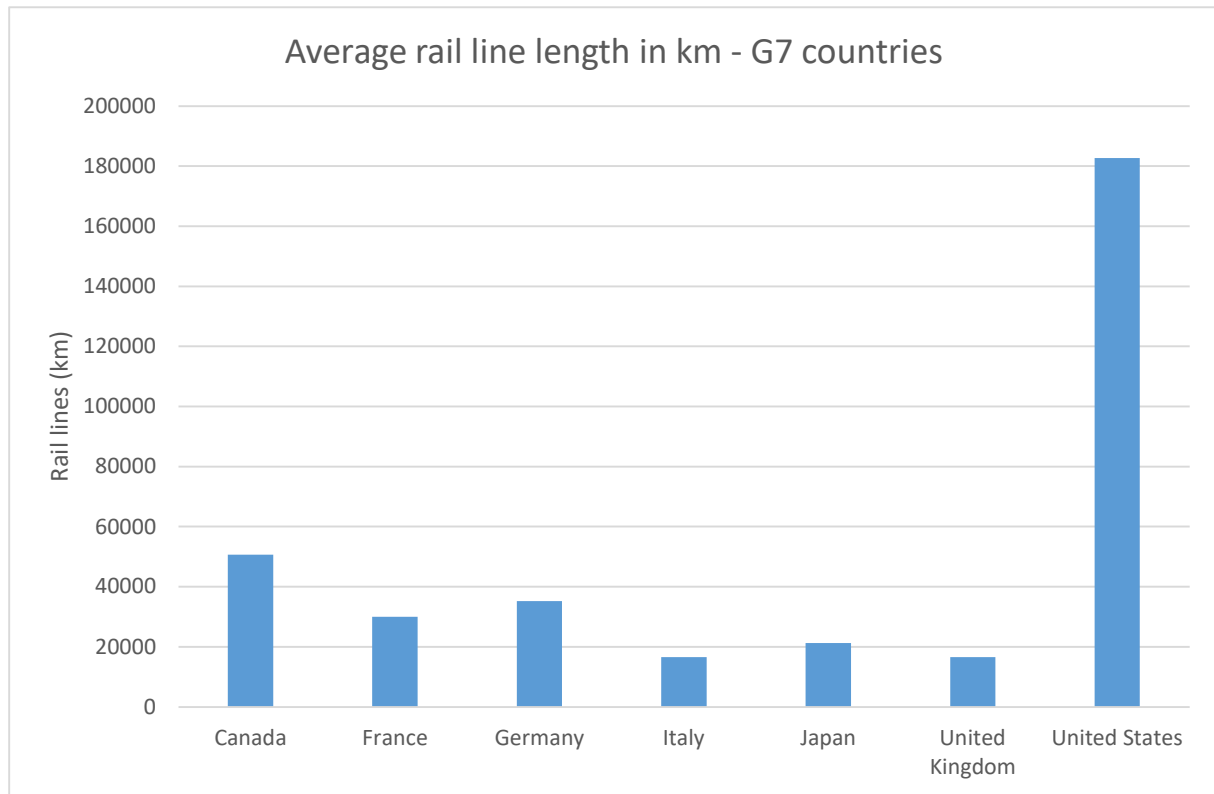
Data collected for the number of physicians per 1000 inhabitants was illegible when all 50 years were represented graphically due to limited data entries. As such, the averages of the data were calculated for each country and those values were plotted instead.



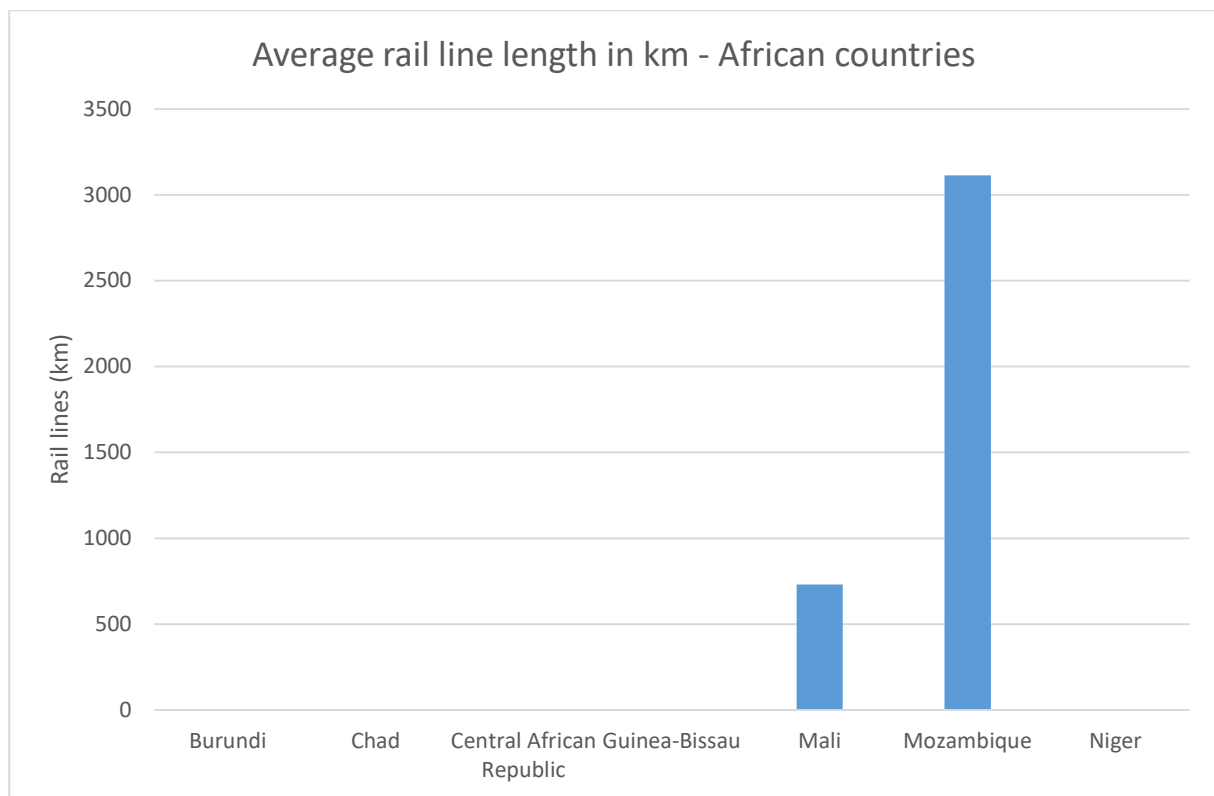
AP2 Figure 10: World Bank Data.

Comparing all the countries together, it is evident that there is a serious lack of physicians in the African countries – every one of them reported that, on average, there are less than 0.14 physicians per 1000 people. Contrastingly, in the G7 countries have a minimum of 1.7 physicians, on average, per 1000 people (Japan) and a maximum of 6.9 physicians per 1000 people (Italy).

## 9. Rail lines (total route-km)



AP2 Figure 11: World Bank Data.



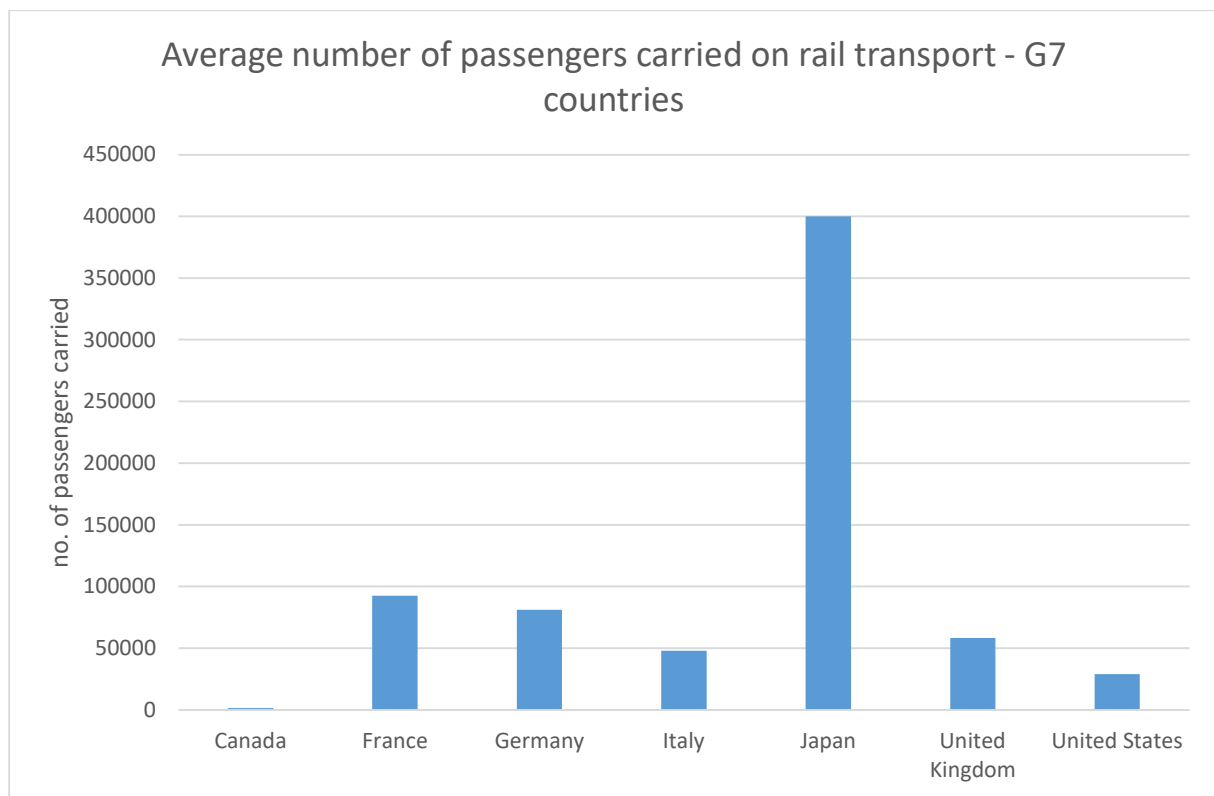
AP2 Figure 12: World Bank Data.

No data was available for Burundi, Chad, the Central African Republic, Guinea-Bissau, or Niger.

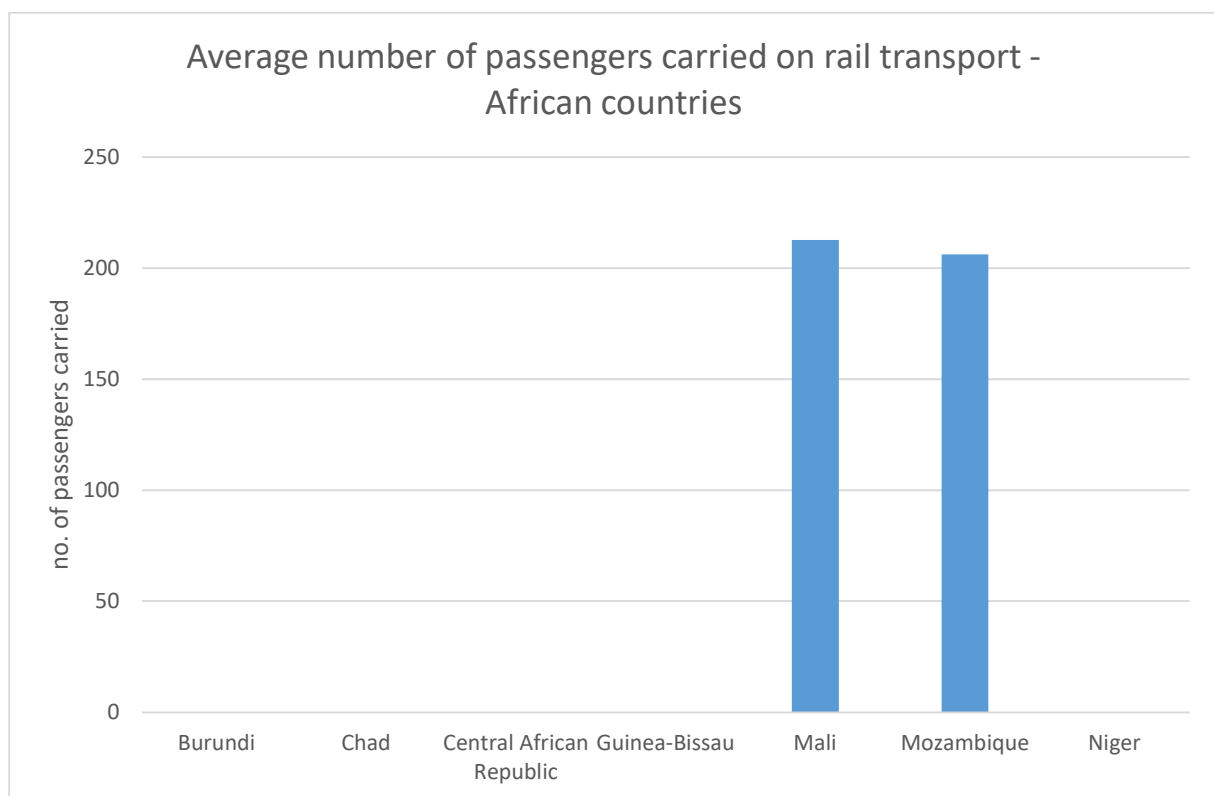
Comparing all of the countries, it is apparent that the African countries do not have nearly as much rail transportation infrastructure when compared the G7 countries. Although Mozambique was the African country with the highest amount, averaging at 3113.13km, this was not much when compared to the lowest amount for the G7 countries which belonged to Italy and averaged at 16526.65km.

Since a lot of African populations still live in rural areas, it could be expected that they have lower levels of rail transportation infrastructure.

## 10. Railways, passengers carried (million passengers-km)



AP2 Figure 13: World Bank Data.



AP2 Figure 14: World Bank Data.

No data was available for Burundi, Chad, the Central African Republic, Guinea-Bissau, or Niger.

The results for the number of passengers carried by rail transport for each of the countries are surprising. Starting with the G7 countries, Japan took the lead with 400112 passengers carried on average, despite having the third lowest amount of rail lines (in km). Canada had the least passengers carried at 1453 and the United States was close behind at 28907 passengers – despite having the highest amount of rail lines.

Moreover, compared to Mali, Mozambique had a significantly higher amount of rail lines – over 4 times more – however, the number of passengers carried in Mali surpassed those of Mozambique.