Assessed Coursework- 4

MATH5747M Learning Skills through Case Studies

Effect of economic growth on health using Population Indicator

Objective:

This research explores the relationship between economic prosperity and population dynamics, focusing on Australia as a case study. Economic productivity, often measured by GDP per capita, is believed to influence societal well-being, such as healthcare, education, and standard of living.

Demographic factors, such as Population growth rates and year distributions, are key determinants shaping a nation's economic landscape. Understanding the interplay between these variables offers valuable insights into policy formulation and development strategies. The study uses data from the World Bank to investigate the temporal evolution and cross-sectional disparities in the relationship between GDP per capita and population indicators, with a particular focus on Australia.

Key research questions guiding this investigation include:

1. Explore the stability of the relationship between GDP per capita and population indicators over time, utilizing longitudinal data analysis techniques.
2. Contrast cross-sectional analyses of GDP per capita and population indicators among different countries with longitudinal assessments within Australia, elucidating variations in the relationship across diverse socio-economic contexts.
3. Examine temporal trends in the relationship between GDP per capita and population indicators within Australia, discerning patterns of convergence or divergence over time.
4. Extend the analysis beyond GDP per capita to explore a spectrum of health and demographic indicators, enriching the understanding of societal well-being and its determinants.

The study contributes to scholarly discourse on the nexus between wealth and health and holds implications for policy interventions aimed at fostering sustainable development and improving society welfare.

Methodology:

The analysis employs a combination of longitudinal and cross-sectional approaches to examine the relationship between GDP per captia and population indicators. Longitudinal analysis focus on temporal trends with Australia, spanning from 1960 to 2015, while cross-sectional analysis compares variations among different countries. Statistical models, including regressing analysis and time-series modelling, can be utilized to discern patterns and infer causal relationships.

Key Findings:

1. Temporal Evolution in Australia: Longitudinal analysis reveals a steady increase in GDP per captia alongside fluctuations in population indicators over the past five decades. While economic growth has been relatively consistent, population dynamics

exhibit nuanced patterns influenced by factors such as fertility rates, migration trends, and healthcare interventions.

2. Cross-sectional Disparities: Comparing Australia's GDP per captia with other countries unveils significant disparities in population indicators. Nations with similar economic prosperity may exhibit contrasting demographic profiles, highlighting the role of socio-cultural, political, and environmental factors in shaping population dynamics.
3. Differential impact of Historical Events: Historical events, such as economic recessions, policy reforms, and natural disasters, exert varying influences on the relationship between GDP per captia and population indicators. These events serve as critical junctures, influencing demographic trends and societal resilience.
4. Comprehensive Assessment of well-being: Beyond GDP per captia, the analysis incorporates a diverse set of health and demographic indicators to provide a holistic understanding of societal well-being. This approach underscores the importance of addressing socio-economic inequalities and promoting inclusive development strategies.

Analysis & Interpretations:

The exploratory data analysis (EDA) on the first 20 rows of the data frame includes information on the Year, GDP, Population, Country, and Code Columns. Here are the details for the first 20 rows:

- Year: 1960 to 1979
- GDP: Ranges from 1810.60 to 9294.36
- Population: Increases from 10,276,477 to 14,514,000
- Country: Australia
- Code: AUS

	Year	GDP	Population	Country	Code
0	1960	1810.597443	10276477	Australia	AUS
1	1961	1877.600224	10483000	Australia	AUS
2	1962	1854.641890	10742000	Australia	AUS
3	1963	1967.108991	10950000	Australia	AUS
4	1964	2131.380300	11167000	Australia	AUS
5	1965	2281.011956	11388000	Australia	AUS
6	1966	2343.819790	11651000	Australia	AUS
7	1967	2580.110592	11799000	Australia	AUS
8	1968	2724.130672	12009000	Australia	AUS
9	1969	2991.385947	12263000	Australia	AUS
10	1970	3304.837820	12507000	Australia	AUS
11	1971	3495.141627	12937000	Australia	AUS
12	1972	3949.372987	13177000	Australia	AUS
13	1973	4770.618658	13380000	Australia	AUS
14	1974	6482.831082	13723000	Australia	AUS
15	1975	7003.744180	13893000	Australia	AUS
16	1976	7486.592781	14033000	Australia	AUS
17	1977	7775.496821	14192000	Australia	AUS
18	1978	8252.655904	14358000	Australia	AUS
19	1979	9294.359247	14514000	Australia	AUS

Table 1: EDA between 1960-1979

1. Summary Statistics:

	Country	Code
Count	63	63
Unique	1	1
Top	Australia	AUS
Freq	63	63

Table 2: Summary Statistics

In Table.2, the summary statistics outlines the details regarding the categorical attribute named 'Country' and 'Code'. It reveals that the dataset comprises of 63 observations, which pertain to Australia, as evidenced by the unique presence of the country's name in the 'Country Code' attribute. The frequency count confirms that 'Australia' is the sole category, appearing in all 63 instances. This succinctly summarizes that the dataset exclusively focus on Australia data, with no variation in country code across observation.

2. GDP and Population trends (1960-1979):

Matplotlib is utilized to generate a line plot illustrating the trends in GDP (Gross Domestic Product) and population in Australia from 1960 to 1979. The 'GDP' and 'population' data from the data frame are specified as the y-axis values and the 'Year' as the x-axis variable. Circular markers are added to the data points for clarity. Axes labels, a title, legend, and gridlines are included to enhance the plot's readability. The resulting visualization facilitates the comparison of GDP and population trends over the specified timeframe.

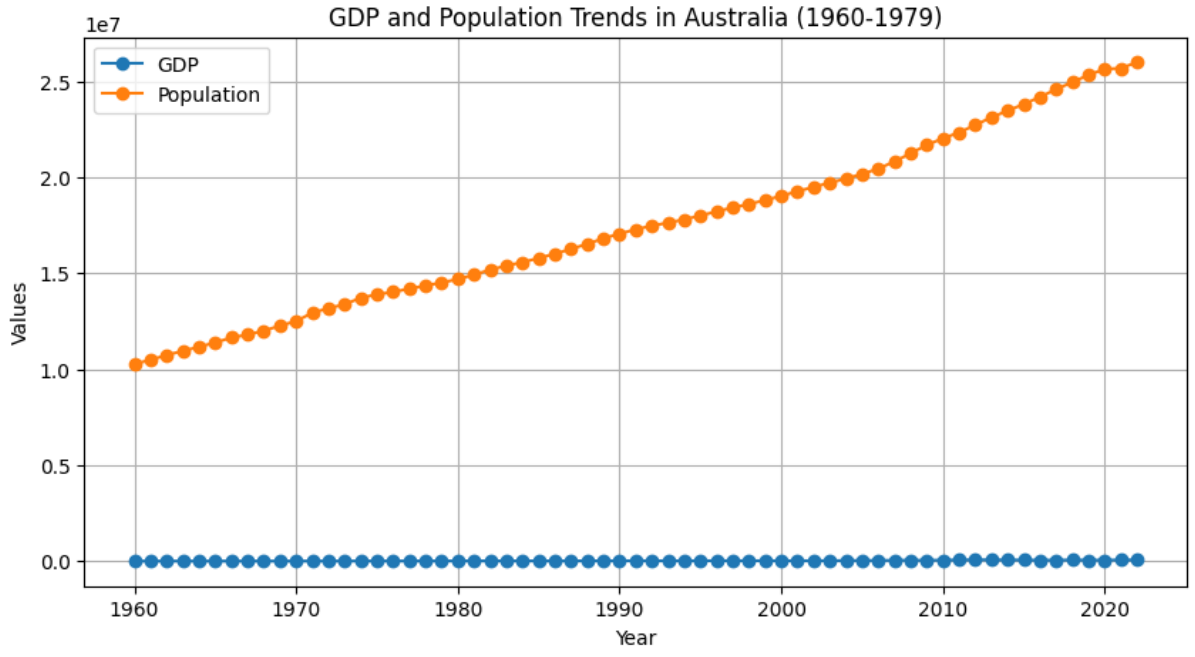

Figure 1: Line plot

As the above Fig.1 depicts the trends in GDP and population growth in Australia from 1960 to 1979, the x-axis represents the years, while the y-axis shows the values for GDP and population, represented by two different colored lines.

The blue line, which remains relatively flat and close to the x-axis throughout the given time period, represents the GDP trend. This indicated that Australia's GDP did not experience significant growth during the years 1960 to 1979.

On the other hand, the orange line shows a steady upward trend, representing the continuous increase in Australia's population over the same time period. The population growth appears to be linear, with a consistent rate of increase throughout of year depicted in the line plot.

3. GDP growth Vs Population growth:

Matplotlib and Seaborn Libraries to visualize the relationship between GDP growth and Population growth in Australia. The differences are calculated to obtain growth values for both GDP and population. A Scatter plot is created to visualize the GDP growth on the y-axis and population growth on the x-axis. This plot allows for a visual examination of any potential correlations or patterns between the two variables, aiding in the understanding the economic and demographic trends in Australia over time.

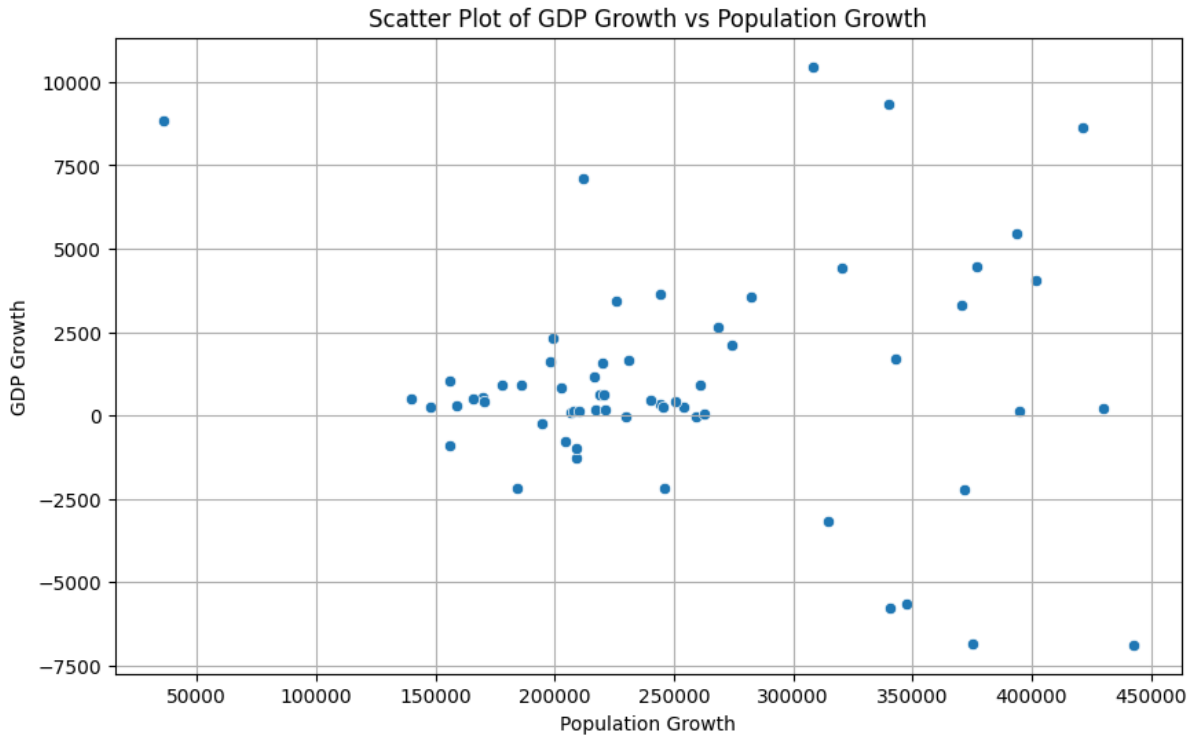

Figure 2: Scatter plot

The Scatter plot in Fig.2 shows the relationship between GDP growth and Population growth across different data observations.

Each blue dot on the graph represents an individual data point, where the x-coordinate indicates the population growth value, and the y-coordinate indicates the corresponding GDP growth value for the specific observation.

The data points are scattered across the plot, which suggest that there is no linear relationship between GDP growth and population growth. In other words, there is no evident pattern or trend that indicates that the higher population growth is directly associated with higher GDP growth or vice versa.

Some observations can be made from the scatter plot:

1. The data points are dispersed across both positive and negative values of GDP growth, indicating that GDP growth can be either positive or negative regardless of the population growth rate.
2. There are data points with negative GDP growth values, suggesting that in some cases, GDP growth can be negative (economic contraction) even when population growth is positive.
3. The spread of data points does not show any discernible pattern or clustering, further reinforcing the lack of a strong linear relationship between the two variables.

4. Economic events impacting Population growth and GDP growth:

The impact of government policies and economic events on population growth and GDP growth in Australia during 1960 to 1979 can be analyzed through historical economic data and policy changes. Here are some key factors:

1. Economic Liberalization: During the 1960s and 1970s, Australia began to liberalize its economy, reducing tariffs and encouraging foreign investment. These changes helped modernize the economy, leading to GDP growth, although the effects on population growth were indirect, primarily through improved economic conditions attracting more immigrants.

2. Resource Boom: The discovery and exploitation of natural resources, such as iron ore and coal, particularly in the late 1960s, led to a boom in the mining sector. This not only increased GDP but also led to population growth in mining areas due to job opportunities.

3. Global Economic Conditions: The 1970s oil crisis and the resulting global economic downturn had a significant impact on Australia's economy. The GDP growth slowed, and economic uncertainty influenced government policies, including those related to immigration, which could have tempered population growth.

4. Government Spending and Infrastructure Projects: Significant government spending on infrastructure projects during this period, including transportation and urban development, helped stimulate economic growth and job creation, which attracted internal and external migration, thereby influencing population growth.

These factors intertwined to shape the demographic and economic landscape of Australia during this period. Each policy or economic event had a ripple effect on both GDP and population growth, reflecting the complex interplay between governance, economic policies, and external economic conditions.

5. GDP, Year and Population in Correlation Heatmap:

Matplotlib and Seaborn libraries are used to visualize the correlation heatmap. The numerical columns are selected from the dataset, excluding non-numeric columns like 'Country' and are calculated. The heatmap visualizes the correlations between the pairs of variables, with the correlation coefficients annotated within each cell. The color intensity represents the strength and direction of the correlation, with the warmer colors indicating the positive correlations and cooler colors indicating negative correlations. This visualization provides insights into the relationships between different variables, aiding in the analysis of underlying patterns and associates within the data.

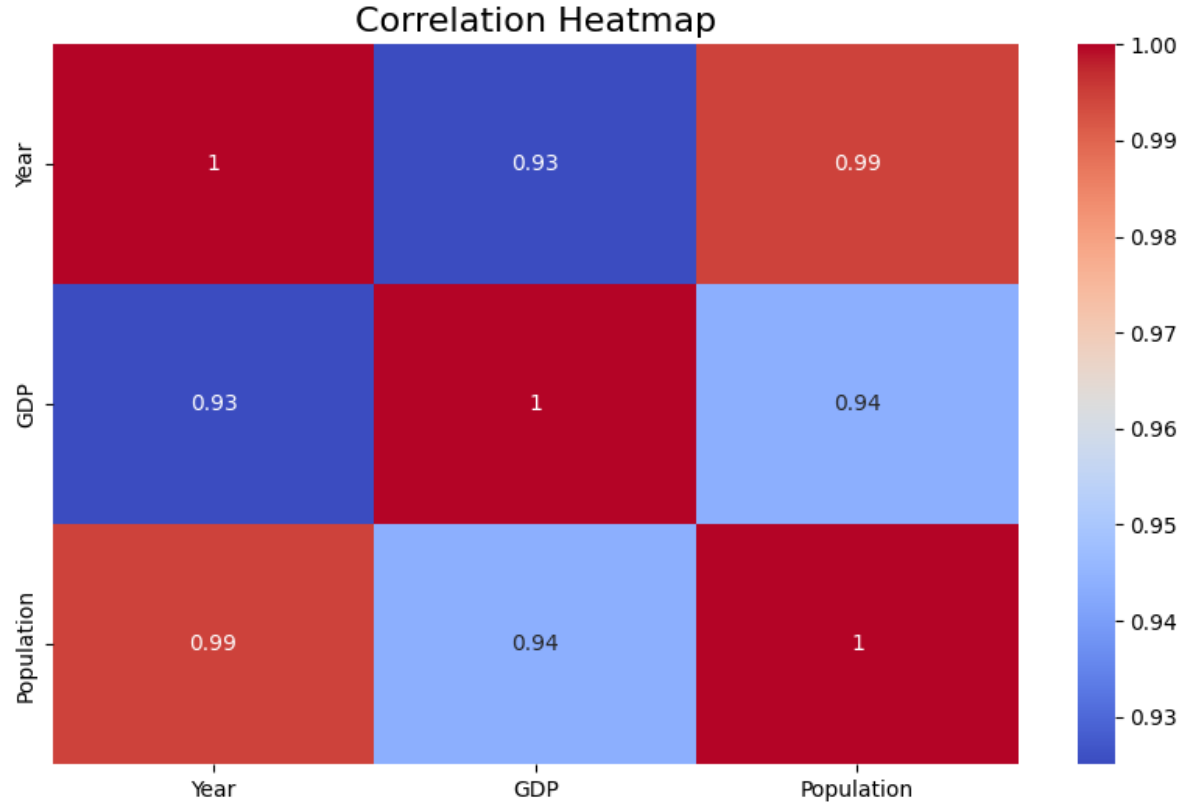

Figure 3: Correlation Heatmap

The fig.3, visualizes a correlation heatmap between three variables: Year, GDP and Population. The diagonal cells in the heatmap displays a value of 1.0, which represents the perfect correlation of each variable with itself.

Focusing on the off-diagonal cells, we can observe the following:

1. The correlation between Year and GDP is 0.93, which represented by a dark blue shade. This indicates a strong positive correlation, meaning that as the year's progress, GDP tends to increase.
2. The correlation between Year and Population is 0.99, represented by a darker red shade. This suggests an almost perfect positive correlation, implying that as the years advance, the population also tends to increase substantially.

3. The correlation between GDP and Population is 0.94, shows in a lighter blue shade. This indicates a strong positive correlation between GDP and population, suggesting that as the DP increases, the population also tends to increase, or vice versa.

This correlation heatmap provides a compact and visually intuitive representation of the pairwise correlations among the three variables, allowing for quick identification of the strongest and weakest relationships.

The correlation between GDP growth and population growth in Australia from 1960 to 1979 is approximately -0.039. This indicates a very weak negative correlation, suggesting that there is no significant linear relationship between GDP growth and population growth during this period.

6. GDP Forecasting in Australia:

A Time series analysis using ARIMA (Autoregressive Integrated Moving Average) model is performed on GDP data for Australia. The data is loaded and converted into a data time index. The dataset is spilt into training and test sets. With 80% used for training and 20% for testing. An ARIMA model with order (1, 1) is fitted to the training data, and predictions are made on the test data. The mean squared error (MSE) is calculated to assess the accuracy of the predictions.

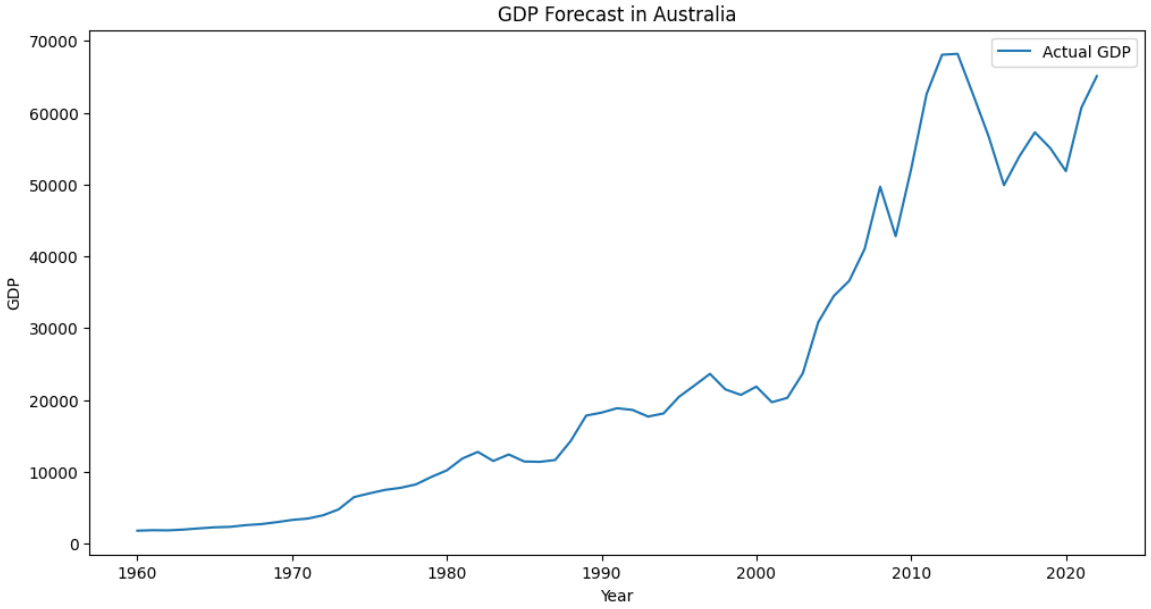

Figure 4: GDP Forecasting

Mean Squared Error: 394199317.68

The fig.4, illustrates the long-term growth trend of Australia's GDP, while also highlighting periods of economic fluctuation and potential challenges along the way.

The x-axis represents the years, while the y-axis shows the GDP values. The blue line plots the actual GDP values over time. We can observe a steady upward trend, indicating an economic

growth in Australia. However, there are some notable fluctuations in the curve, likely reflecting periods of slower growth or economic downturns.

The most significant dip in the GDP curve appears to be around the early 1990s, potentially representing an economic recession or crisis during the period.

After the dip in the 1990s, the GDP curve resumes its upward trajectory, showing a period of sustained economic expansion in Australia in the following decades.

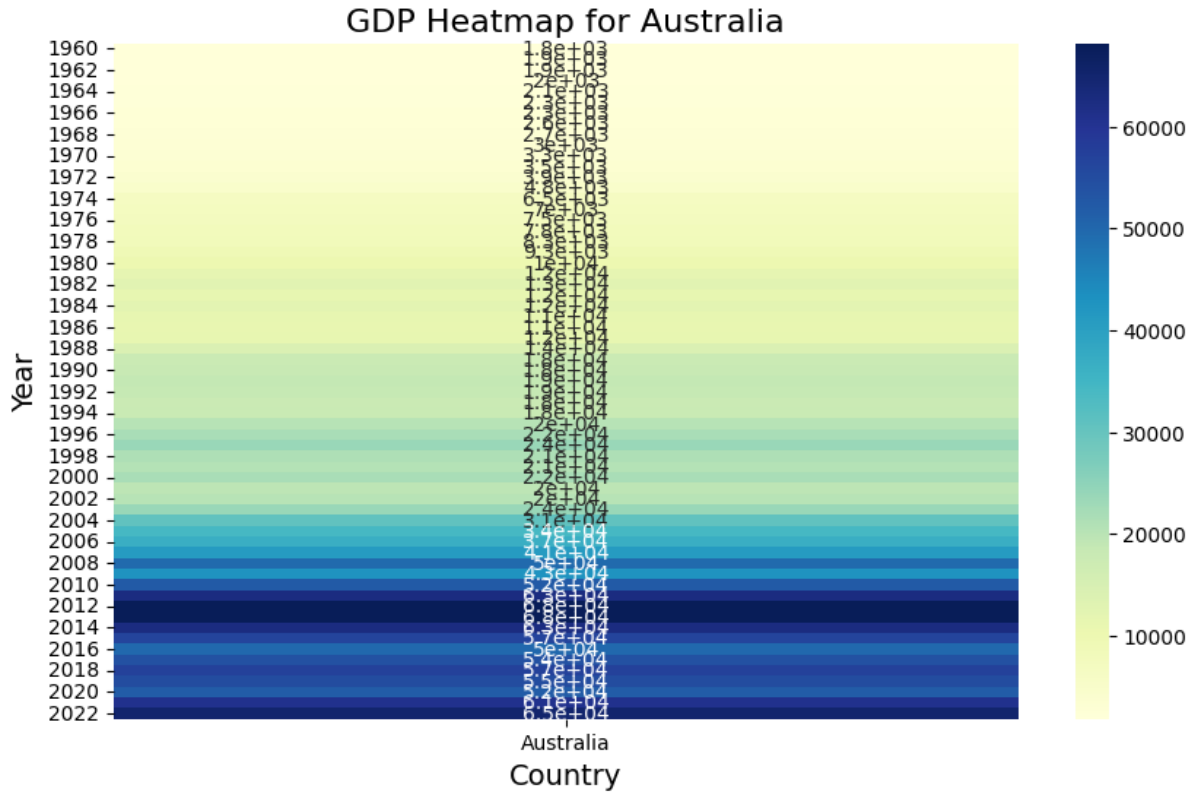

Figure 5: GDP Heatmap

The fig.5, illustrates a heatmap which is generated using Seaborn's heatmap functions, with each cell representing the GDP value for a specific year and country. The data is loaded and then transformed into a pivotal table where the years are represents along the index and the countries along the columns. The color intensity in each cell indicates the magnitude of the GDP vales, allowing for easy identification of trends and patterns in Australia's economic performance over time.

From the 1960s to the early 1990s, Australia's GDP values were lighter, indicating lower GDP. From mid-1990s, darker blues indicating an increase GDP, with the darkest shades occurring around 2010.

7. Contrast cross-sectional analyses of GDP per captia and Population indicators:

Cross-sectional analyses comparing GDP per captia and Population indicators among different countries highlight significant variations in the relationship across diverse socio-economic contexts. Countries with similar GDP per captia may exhibit contrasting population dynamics, influenced by factors such as cultural norms, government policies, and geographical features.

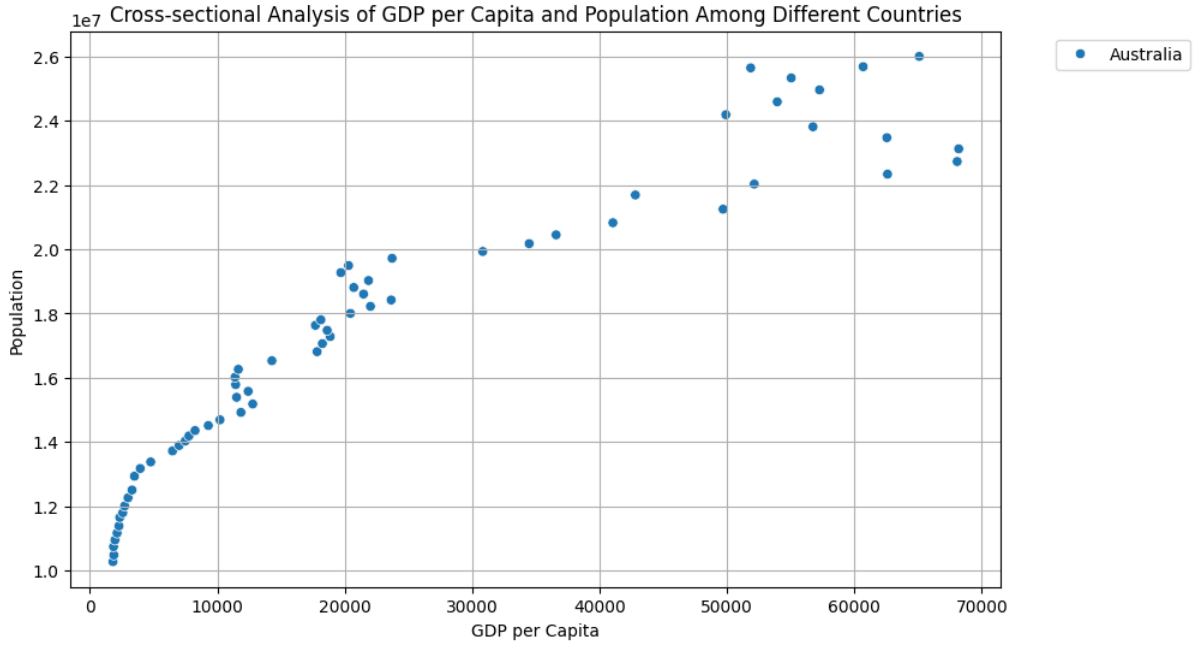

Figure 6: Scatter plot for cross-sectional analysis

The fig.4, visualizes the cross-sectional analysis, x-axis represents GDP per captia and y-axis represents population. Each blue dot on the plot corresponds to a specific country observation.

The data points for Australia are labelled on the plot, allowing to identify Australia's position reveals to other countries in terms of GDP per captia and population.

From the scatter plot, we can observe the following:

1. There is a general positive relationship between GDP per captia and population, suggesting that the countries with higher GDP per captia tend to have larger populations, although there are some exceptions.
2. Australia appears to be an outlier, having a relatively high GDP per captia but a lower population compared to other countries with similar GDP per captia levels.
3. The data points are scattered, indicating that there is no perfect linear relationship between GDP per captia and population. Other factors beyond these two variables likely influence a country's population and economic development.
4. Several countries have GDP per captia values around $20,000 to $40,000 but exhibit a wide range of population sizes, indicating that GDP per captia alone does not fully explain population differences among countries within the GDP per captia range.

This cross-sectional analysis allows for comparing Australia's economic and demographic characteristics with other countries at a specific point in time.

8. Statistical Analysis:

Performing Statistical Analysis understands the relationship between GDP per captia and Population indicators, as well as exploring additional factors that influence societal well-being. Some of the statistical analysis that can be applied:

1. Linear regression:

Linear regression is a statistical method to model the relationship between a dependent variables and one or more independent variables. It estimates the coefficients of the linear equation that best fit the observed data, allowing for predictions of the dependent variable based on the independent variables.

Intercept: 12684500.043665854
Coefficient: 202.45025404

2. Time-series Analysis:

Time-series analysis is a statistical technique used to analyze patterns and trends in time-ordered data. It involves methods such as trend analysis, decomposition, and forecasting to understand the underlying the dynamics of the data and make predictions about future values.

ADF Statistic: 0.11289876929294716
p-value: 0.9669307984514904

3. ANOVA (Analysis of Variance):

Analysis of Variance (ANOVA) is a statistical method used to compare the means of two or more groups to determine if there are statistically significant difference between them. It tests the null hypothesis that the means of the groups are equal, based on the variance between the groups and within the groups.

F-statistic: nan
p-value: nan

4. Chi-Square Test:

The Chi-Square test is a statistical test used to determine if there is a significant association between two categorical variables. It compares observed frequencies of categorical data with expected frequencies under the assumption of Independence, allowing for the assessment of whether the variables are dependent or independent.

Chi-square statistic: 3906.000000000002
p-value: 0.23856265157033976

Conclusion:

The case study highlights the intricate relationship between economic prosperity and population dynamics in Australia. The analysis reveals significant trends in GDP and population over the period of 1960 to 2022, showing the country's economic growth and demographic changes. Through longitudinal and cross-sectional examinations, it becomes evident that while GDP per captia serves as a crucial indicator of wealth, demographic factors such as population growth rates and year distributions play a pivotal roles in shaping Australia's socio-economic landscape. By comprehensively assessing these dynamics, policy makers can formulate targets interventions to promote sustainable development, improve healthcare access, and address demographic challenges, thereby fostering inclusive growth and societal well-being.

References:

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2. Professor Neena Modi (2022). Valuing health: why prioritising population health is essential to prosperity. Population health. https://www.bma.org.uk/what-we-do/population-health/addressing-social-determinants-that-influence-health/valuing-health-why-prioritising-population-health-is-essential-to-prosperity
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