The Impact of Population Growth Rate, Inflation Rate, GNI, Exports and Imports on GDP in the South Asian Region Within 1961 To 2021 Period

For
the Bachelor of Science Honours Degree in
Financial Mathematics and Industrial Statistics

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DECLARATION

I, K.L.G.P.Kasundi, declare that the presented project report titled, "The Impact of Population Growth Rate, Inflation Rate, GNI, Exports and Imports on GDP in the South Asian Region Within 1961 To 2021 Period" is uniquely prepared by me based on the group project carried out under the supervision of Dr. Pubudu Thilan, Department of Mathematics, Faculty of Science, University of Ruhuna, as a partial fulfillment of the requirements of the level II , Case Study course unit, MIS 2231 of the Bachelor of Science Honours Degree in Financial Mathematics and Industrial Statistics in Department of Mathematics, Faculty of Science, University of Ruhuna, Sri Lanka.

It has not been submitted to any other institution or study program by me for any other purpose.

Signature: ....
Date: ....

SUPERVISOR'S RECOMMENDATION

I certify that this study was carried out by K.L.G.P.Kasundi under my supervision.

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Abstract

This study investigates the impact of population growth rate, inflation rate, gross national income (GNI), exports and imports on gross domestic product (GDP) in the South Asian Region within 1961 to 2021 period. Here, we are going to analyze this relationship using a regression approach in a multiple linear regression model. The objective of this study is to examine how these determinants contribute to the GDP growth in South Asian region during the past 6 decades. So, this will contribute the valuable insights to the economic growth in South Asia.

Key words: GDP, Population Growth, Inflation, GNI, Exports, Imports, South Asian region, Multiple Linear Regression

Acknowledgment

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1 Introduction

1.1 Background of Study

Economy can be introduced as one of the main factors that measure the development of a country or a region. So, in the South Asian region which includes the countries Sri Lanka, India, Pakistan, Afghanistan, Bhutan, Nepal, Bangladesh and Maldives, the economic growth is measured by the gross domestic product (GDP) which is the key factor of measuring the economic growth. Here, discuss about the variation of GDP related to the population growth, inflation, GNI, exports, imports in South Asia through the data collected by the World Bank website.

1.2 Problem Statement

As the South Asian region is a collection of developing countries, the economy of this area has been steadily improving during the period under review, 1961 to 2021. This is a result of variation of many factors that affect the GDP value. However, the problem addressed in this study is the lack of detailed understanding regarding the impact of population growth rate, inflation rate, GNI, exports and imports on GDP in the South Asian Region. This knowledge gap undermines the process of formulating effective strategies for sustainable economic growth and development in the region. Therefore, there is a need to examine and analyze the relationship between these variables and GDP to gain valuable insights to increase the long term economic stability and propensity in South Asia.

1.3 Significance of Study

This study holds significant importance for several reasons. As this aims to examine the relationship between population growth rate, inflation rate, GNI, exports and imports on GDP, this will help to identify the key factors that contribute to economic development in this region. Also, the findings of this study are important to identify the effective strategies of the economic growth. It will be easy to the policymakers as they can have evidence-based insights to make the decisions. Also, through this study, the existing knowledge and understanding about the economy of the South Asian region can be growing and updating.

1.4 Research Questions

To obtain meaningful research findings, the following research questions have been developed for this study.

- What is the relationship between inflation rate and GDP growth in South Asia?

- What is the impact of population growth rate on the GDP of South Asian countries from 1961 to 2021?

- How the GNI levels effected to the change of GDP during the past 60 years in South Asia?

- What is the impact of exports on the GDP of South Asia?

- How the GDP of South Asia depend on imports during the past 6 decades?

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1.5 Objectives of the Study

The primary objective of this study is to examine the impact of population growth rate, inflation rate, GNI, exports and imports on GDP in the South Asian Region within the last six decades. In addition to that, studying the individual contributions of these variables to GDP, identifying whether they have positive or negative impact on economic growth, providing empirical evidences and insights to formulate effective strategies can also be taken as the objectives of this study.

1.6 Hypotheses

1.6.1 Hypothesis 1

Null hypothesis (H_0):

There is no linear relationship between the dependent variable and independent variables in the South Asian region from 1961 to 2021. ($\beta_i = 0$)

Alternative hypothesis (H_a):

There is a linear relationship between the dependent variable and independent variables in the South Asian region from 1961 to 2021. ($\beta_i \neq 0$)

1.6.2 Hypothesis 2

Null hypothesis (H_0):

The reduced model is suitable for this study.

Alternative hypothesis (H_a):

The full model is suitable for this study.

1.7 Literature Review

1. **GDP (Gross Domestic Product)**

   The value of all products and services generated within any region's borders is measured by GDP, which is identified as a key economic statistic. The dynamics of GDP have been the focus of extensive study and analysis in the South Asian region.

   The South Asia Economic offers insightful information on the GDP trends and economic circumstances in the South Asian countries. This paper discusses the deviation and potential areas for improvement in the GDP growth rates among these countries.(6) And also, the variables like inflation rate and population growth rate frequently have an impact on GDP growth. (3)

2. **Population Growth Rate**

   South Asia region's economic development is significantly influenced by the population growth rate. The research draws attention to the fact that a rapidly expanding population may put pressure on resources and services, thereby slowing economic growth.(3) In a case study of Nigeria, it is also emphasized how crucial it is to understand how population expansion and economic growth are related, especially in the context of South Asia.(4)

3. **Inflation Rate**

   The inflation rate can have a significant impact on economic growth. According to the study done on

Nigeria, high inflation rates might affect the economic stability and impede development. However, the effects of the inflation rate on economic growth may differ among the South Asian countries.(4)

4. **GNI (Gross National Income)**

   The study looks at how trade, GDP, and GNI are related in South Asian nations and emphasizes that a country's economic success can be impacted by GNI levels. For determining how GNI growth in the South Asian region would affect GDP, it is essential to comprehend its dynamics.(5)

5. **Exports**

   According to research, the importance of exports in economic growth is a topic of interest in South Asia. Exports can increase a nation's foreign exchange profits, which can increase GDP. The potential advantages of a booming export sector in South Asian nations are clarified by this study.(5)

6. **Imports**

   According to the economic environment of South Asia, imports are significant. While access to raw materials and technologies made possible by imports can boost domestic output, the balance between imports and exports needs to be carefully monitored to maintain a positive trading climate.(6)

2 Material and Methods

2.1 Research Approach

The overall research approach for this study is quantitative research approach. This approach identifies the relationships between these economic indicators, population growth rate, inflation rate, GNI, exports and imports with the GDP in South Asian region during the past six decades. Quantitative methods such as regression analysis. Correlation analysis will be used to detect these relationship patterns.

2.2 The Conceptual Model
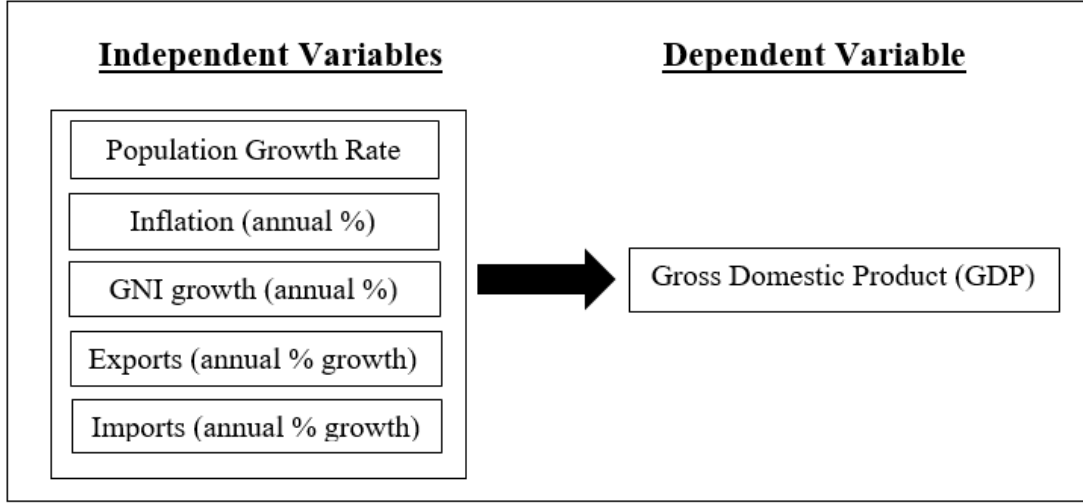
Figure 1: Conceptual Model

2.3 Research Design

The research design for this study under the quantitative approach is multiple linear regression. In multiple linear regression, we model the dependent variable as a linear combination of two or more independent variables. In this study, we get the GDP as a linear combination of population growth rate, inflation rate, GNI growth rate, exports and imports. That means,

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots + \beta_n X^n$$

Where,

$$Y = \text{Dependent variable}$$
$$X_1, X_2, \ldots, X^n = \text{Independent variables}$$

Then, the best regression equation should be selected related to the equation of this linear combination. This selection process aims to reduce the set of predictor variables to find the most important predictor variable or variables while maintaining a good explanation of the data. For this process, there are mainly three methods.

- Forward selection method

  This method starts with an empty equation and step by step add the most significant predictor that means the predictor variable with the lowest p-value until the addition of predictors does not significantly improve the model.

- Backward elimination

  This method starts with the equation that includes the all predictor variables and step by step remove the least significant predictor that means the predictor variable with the highest p-value until the subtraction of predictors does not significantly change the model.

- All possible regression

  This method is also called as stepwise selection method. This is a combination of forward selection method and backward elimination.

Among these methods, this is study is done by using the backward elimination method because it aligns with the objective of studying the individual contributions of variables to GDP while simplifying the model and also this method ensures than all remaining predictor variables in the best regression equation are statistically significant and draw meaningful conclusions on this study.

In addition to these, by selecting forward selection method or all possible regression may increase the risk of over fitting. Therefore, it can affect to occur the errors.

3 Data

3.1 Dataset

This dataset is about the GDP, population growth rate, inflation rate, GNI, exports and imports of the South Asian region from 1961 to 2022.

The R code used to read this dataset is in the appendix.

3.2 Metadata

The source of these data is World Bank national accounts data, and OECD National Accounts data files. (`https://data.worldbank.org/`)

The data collection took place at 2.58 pm on 25th June 2023.

3.3 Data Dictionary

Variable descriptions

1. **Gross Domestic Product:** This is one of the key factors of any region's economic health that measures the overall economic performance for a certain period. This refers to the total value of all final goods and services produced within the region in a specific region. Here, this is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources.

2. **Population growth:** Population means the all individuals regardless of legal status or citizenship. The population growth rate is a percentage which is calculated annually.

3. **Inflation:** Normally, inflation is calculated as an annual percentage rate. It represents the percentage change in the average price of goods and services between two periods.

4. **GNI growth:** This is an economic indicator which measures the total income earned by any region including both domestic income and foreign income. Also, GNI includes all the income generated by individuals, businesses and government entities. Annual GNI growth rate means the annual percentage change in GNI over a specific period.

5. **Exports:** This means the annual percentage change in the value of all goods and other market services provided to the rest of the world. They include the value of insurance, transport, travel, communication, construction, financial, government services and etc.

6. **Imports:** This means the annual percentage change in the value of goods and the services that any region purchased from the rest of the world over a specific period.

Dependent Variable	Independent Variables
Gross Domestic Product	Population growth (annual %)
	Inflation (annual %)
	Gross National Income
	Exports of goods and services
	Imports of goods and services

Table 1: Dependent & independent variables

Here, all the variables are continuous. The dependent variable GDP, is a macroeconomic measure which represents the total value of all production within the region. Therefore, it is typically not based on the categorical variables. In that case, there is no any categorical variables in this data set.

According to the descriptive statistics table obtained by the Minitab software for the exploratory analysis, there are no missing values in this data set. Also, there are no null values in this data set. The R code used, is in the appendix.

Variable	Type	Missing Data Indicators	Scaling & Measurement units
Gross Domestic Product	Numeric	N/A	U.S Dollars
Population growth (annual %)	Numeric	N/A	Percentage
Inflation (annual %)	Numeric	N/A	Percentage
Gross National Income	Numeric	N/A	Percentage
Exports of goods and services	Numeric	N/A	Percentage
Imports of goods and services	Numeric	N/A	Percentage

Table 2: Data Dictionary Table

3.4 Preparation for analysis

3.4.1 Outliers

According to the boxplots obtained from the Minitab, there are outliers in GDP, inflation, GNI and imports. However, these outliers aren't removed as there is no any significant difference in R2 values when the dataset with the outliers and without outliers. The IQR method used to reach these conclusions.

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.299390	91.19%	91.04%	90.29%

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.201540	91.24%	91.05%	90.12%

(a) R squared - without outliers   (b) R squared - without outliers

Figure 2: R squared value analysis

(a) Normal probability plot - without outliers   (b) Normal probability plot - without outliers
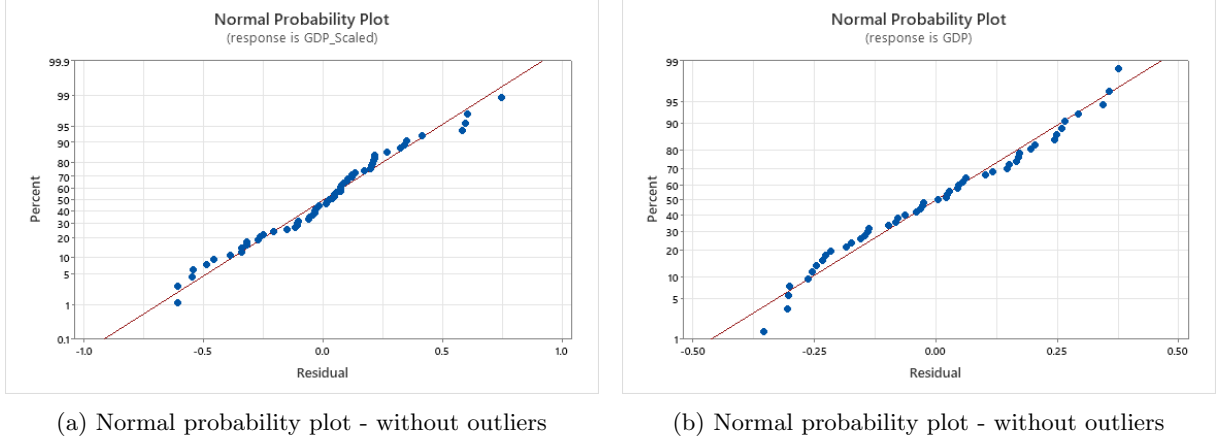
Figure 3: Analysis of Normal probability plots

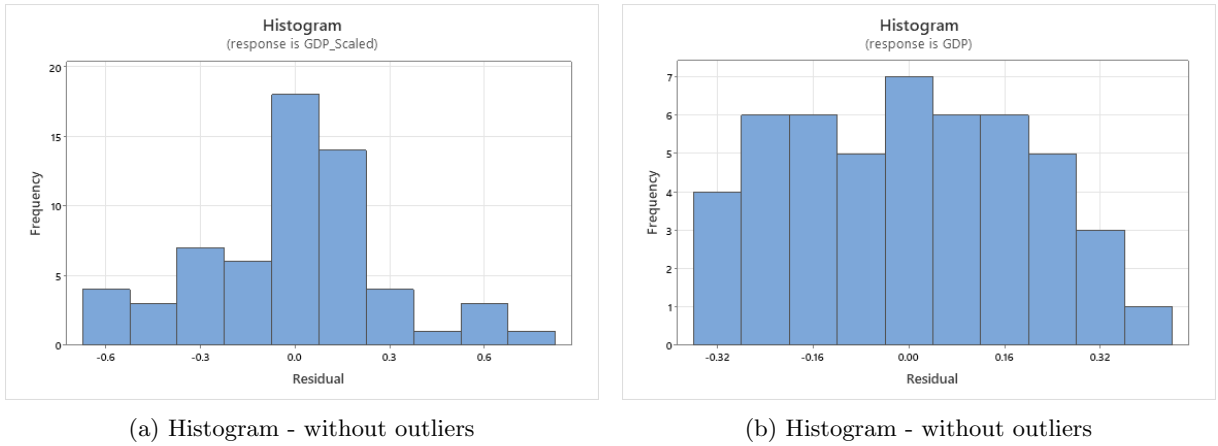(a) Histogram - without outliers   (b) Histogram - without outliers

Figure 4: Analysis of Histograms

According to the figure 2(a) and 2(b), the difference between the R squared values with outliers, 91.19% and without outliers, 91.24% is very small. And also, in the both probability plots, the data points are shown as a straight line roughly. It means the residuals follow a perfectly normal distribution in both scenarios. Here, the figure 4(a) illustrates that the histogram is bell shaped which means the residuals in the regression model are on average and normally distributed.

In addition to these, when removing the outliers, very important information can be removed. Therefore, the model with outliers is chosen for the analysis.

3.4.2   Transformation of variables

Considering the dataset, the GDP values have large magnitudes with more than ten digits. So, we use scaling methods to bring them to a comparable range with other variables. Scaling is a data preprocessing technique that is used to standardize or normalize the variables in the dataset. There are two commonly used methods for this scaling process. They are min-max scaling and z-score scaling. Among these, we hope to go with the Z-score scaling method.

In this method, transform data to have the mean of 0 and standard deviation of 1.

$$\text{Scaled value} = \frac{\text{Value} - \text{Mean}}{\text{Standard deviation}}$$

This method less affected by the presence of outliers will help to bring GDP values to a comparable range with other variables. However, there can be some disadvantages by using this method such as negative scaled values, lack of interpretability that means will not directly interpretable as the original data. So, in the data analysis process, this method can be changed.

4 Results

4.1 Exploratory data Analysis

Statistics

Variable	Total Count	N	N*	Mean	StDev	Minimum
GDP (current US$)	61	61	0	9.13019E+11	1.11926E+12	50316845349
Population growth (annual %)	61	61	0	1.9922	0.4389	1.0295
Inflation (annual %)	61	61	0	7.385	4.043	0.160
GNI growth (annual %)	61	61	0	4.894	2.908	-5.501
Exports (annual % growth)	61	61	0	7.37	8.03	-10.20
Imports (annual % growth)	61	61	0	6.31	10.69	-17.68

Variable	Q1	Median	Q3	Maximum	Kurtosis
GDP (current US$)	1.34238E+11	3.80987E+11	1.35013E+12	4.08877E+12	0.97
Population growth (annual %)	1.5480	2.2112	2.3374	2.4151	-0.78
Inflation (annual %)	4.506	7.279	8.901	24.379	5.90
GNI growth (annual %)	3.635	5.500	7.016	8.351	2.99
Exports (annual % growth)	1.88	7.65	12.46	23.92	-0.58
Imports (annual % growth)	0.16	5.40	12.50	31.67	0.07

Figure 5: Descriptive Statistics Table

The above figure illustrates the summary statistics of each variable. According to this table, the total count of observations is 61 and there are no missing values which is indicated by N*.
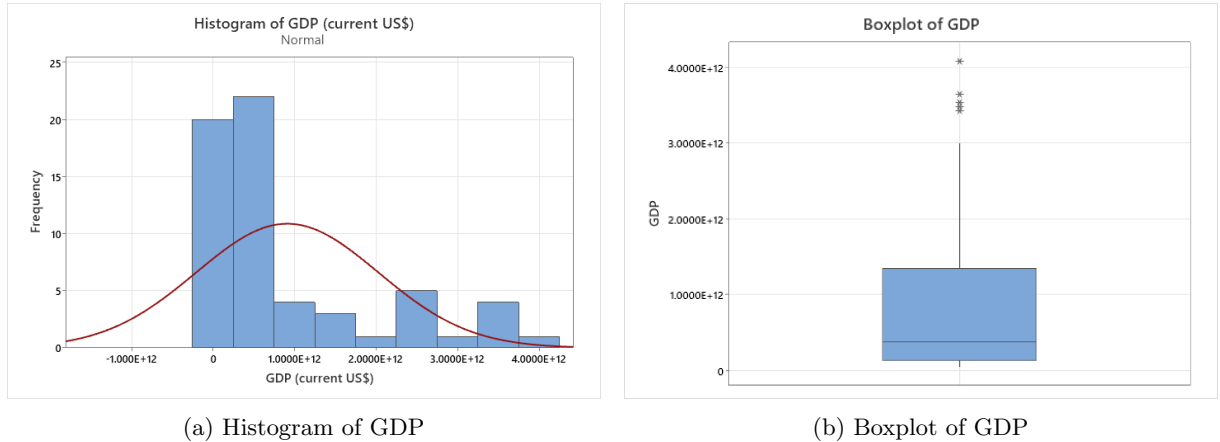

(a) Histogram of GDP

(b) Boxplot of GDP

Figure 6: Analysis of GDP

This histogram illustrates that the GDP values have the symmetric distribution. According to the boxplot, there are some outliers in GDP. However, we can't remove these as this is a time series data set.

(a) Histogram of Inflation
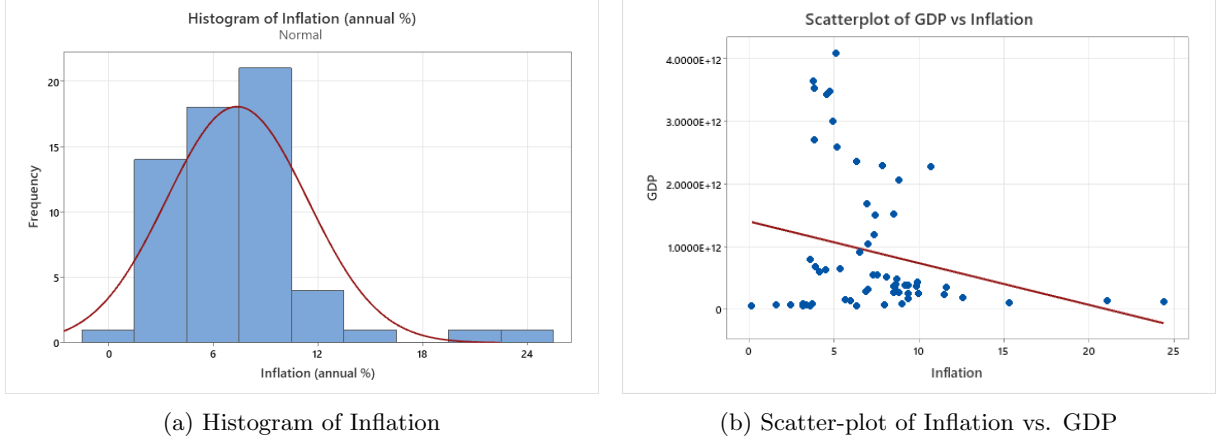
(b) Scatter-plot of Inflation vs. GDP

Figure 7: Analysis of Inflation

According to the figure 7(a) and figure 7(b), this dataset is positively skewed because the majority of data points are in the left if the mean. The scatter plot of GDP vs. inflation shows that they have a negative relationship. It means, if the inflation rate is decreasing then the GDP will go up.

(a) Histogram of Population Growth Rate
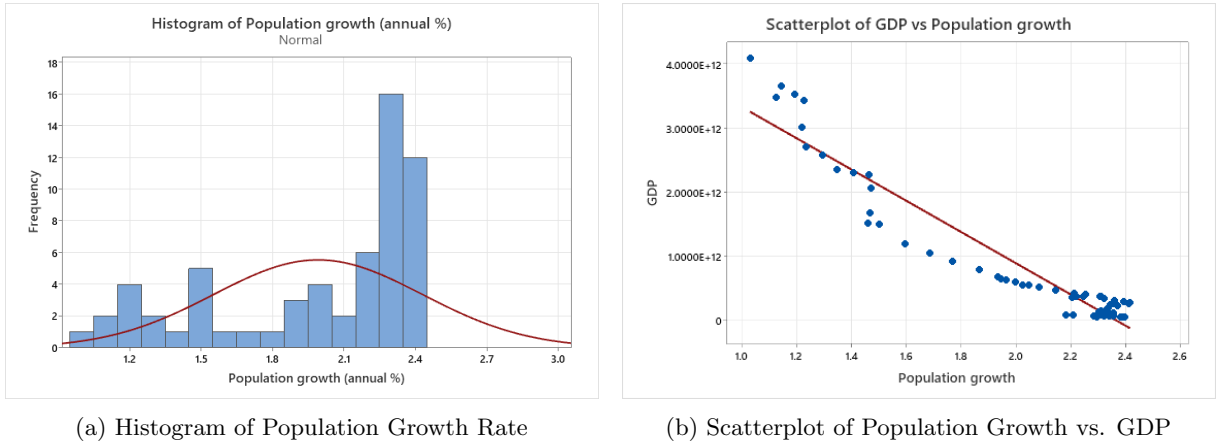
(b) Scatterplot of Population Growth vs. GDP

Figure 8: Analysis of Population Growth Rate

The figure 8(a) illustrates that the population growth rate is symmetrically distributed as the data points spread around the mean. Also according to the figure 8(b), there is a strong negative relationship between the population growth rate and the GDP of South Asia.

(a) Histogram of GNI Growth Rate

(b) Scatterplot of GNI Growth vs. GDP
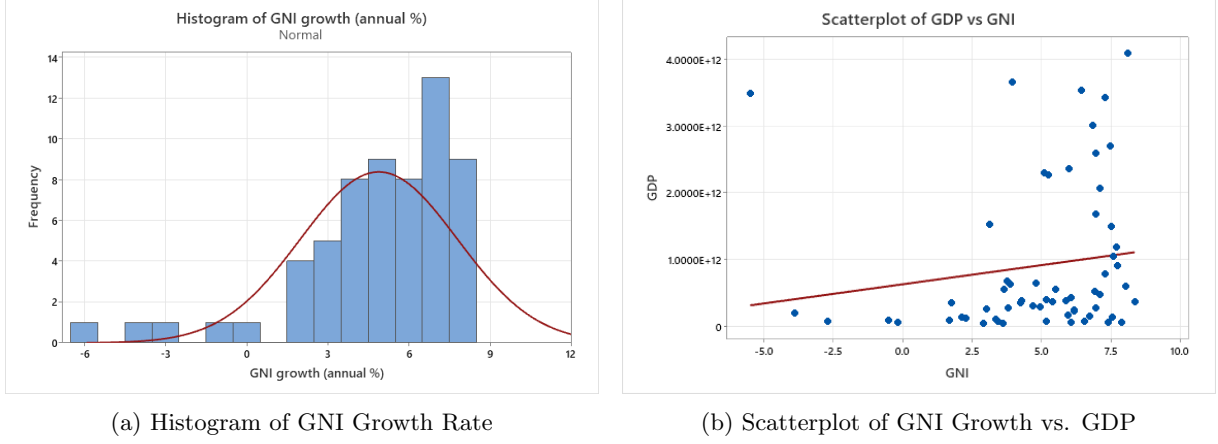
Figure 9: Analysis of GNI Growth Rate

The figure 9(a) shows that the GNI values are negatively skewed because the majority of data points are on the right side of the mean.

The figure 9(b) illustrates the relationship between the GNI and a country's GDP. According to that, the population growth has a positive relationship with GDP.

(a) Histogram of Exports

(b) Scatterplot of Exports vs. GDP

Figure 10: Analysis of Exports

According to the above figure 10(a), exports data set has a symmetric distribution and figure 10(b) shows that there is no relationship between exports and GDP.

(a) Histogram of Imports

(b) Scatterplot of Imports vs. GDP
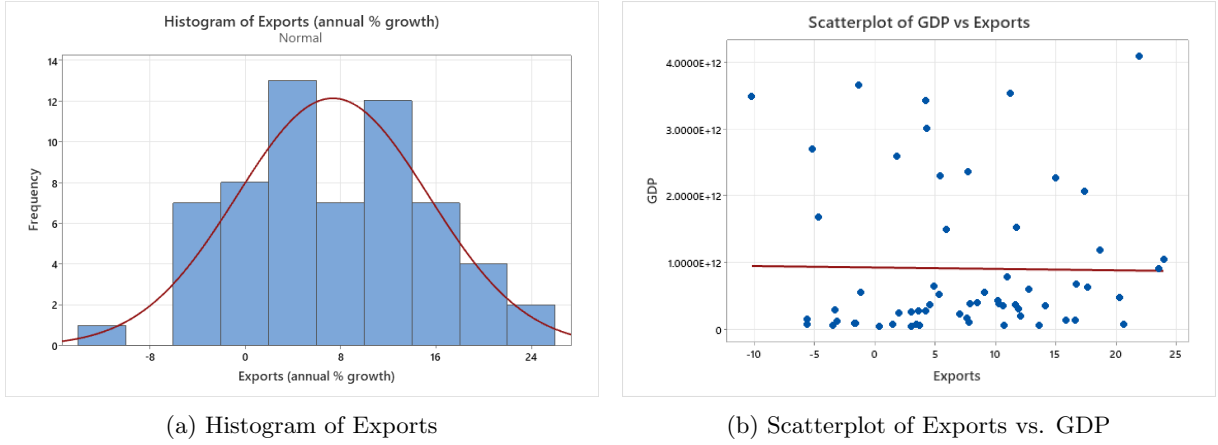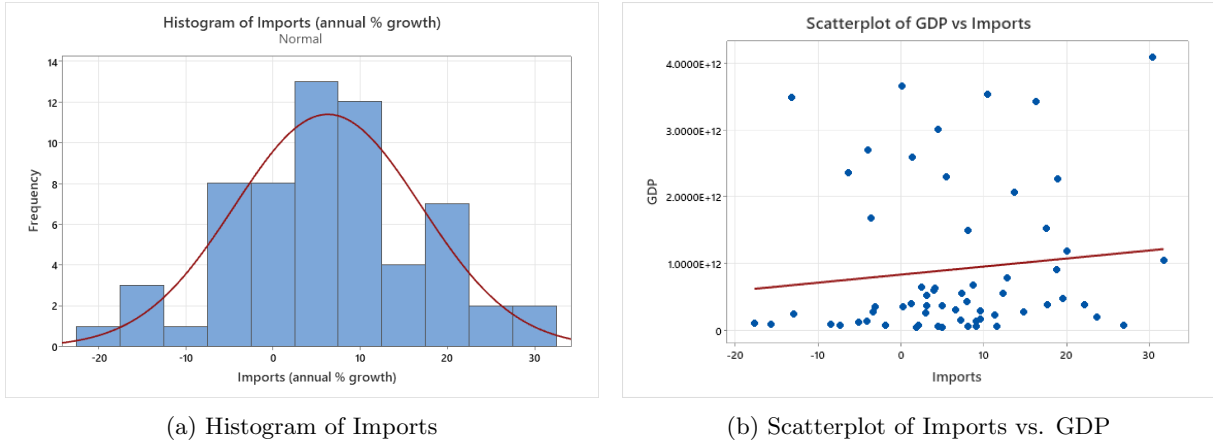
Figure 11: Analysis of Imports

Above figures show that imports data set is symmetrically distributed and has a positive relationship between imports and GDP.

The below figure 11(a) and figure 11(b), show the dispersion of our independent variables of this dataset. According to these, Inflation growth, GNI growth, and Imports have the outliers and population growth and exports have no outliers. Exports, imports, and population growth data sets are normally distributed. Inflation rate and GNI growth have slightly skewed distributions.

Figure 12: Boxplots of Inflation, Imports and Exports

Figure 13: Boxplots of Population Growth and GNI Growth

4.2 Quantitative Analysis

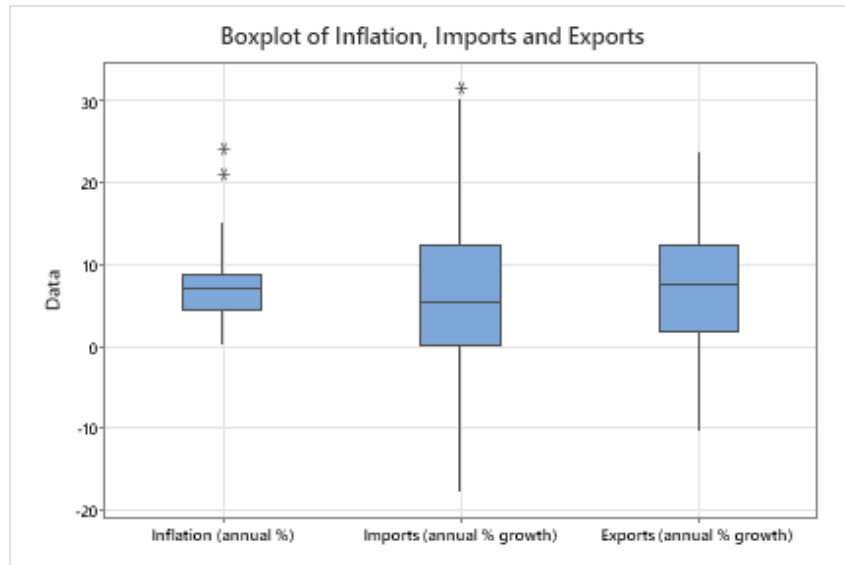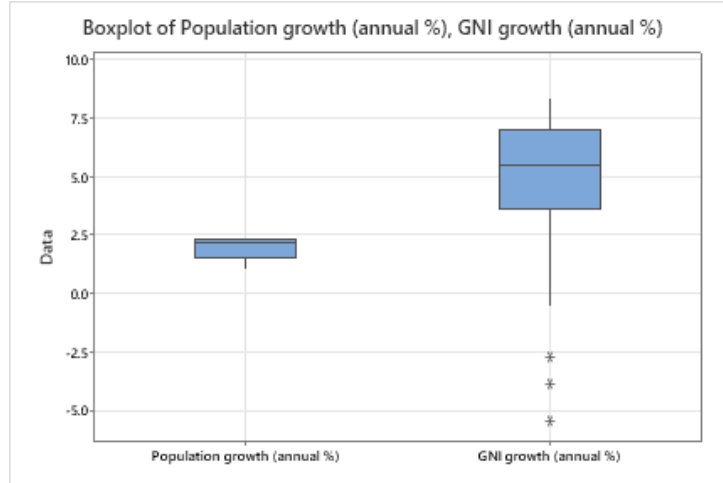As mentioned earlier, there are no missing values and null values in this dataset. Here, the model with the outliers is used for this analysis. However, the Z score scaling method is used to transform GDP values as these values have large magnitudes with more than ten digits.
Please refer the appendix for the associated R code.

4.2.1 Correlation Analysis

Correlations

		GDP_Scaled	Population. growth.. annual	Inflation.. annual	GNI.growth.. annual	Exports.. annual... growth
Population.growth.. annual	Pearson Correlation	-.955**				
	Sig. (2-tailed)	<.001				
	N	61				
Inflation..annual	Pearson Correlation	-.240	.261*			
	Sig. (2-tailed)	.062	.042			
	N	61	61			
GNI.growth..annual	Pearson Correlation	.149	-.183	-.096		
	Sig. (2-tailed)	.253	.158	.460		
	N	61	61	61		
Exports..annual...growth	Pearson Correlation	-.015	-.056	.086	.280*	
	Sig. (2-tailed)	.909	.669	.511	.029	
	N	61	61	61	61	
Imports..annual...growth	Pearson Correlation	.115	-.141	-.129	.314*	.611**
	Sig. (2-tailed)	.376	.278	.321	.014	<.001
	N	61	61	61	61	61

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Figure 14: Correlation Matrix

1. **Research question 1: Relationship between inflation rate and GDP growth**
   The correlation coefficient of -0.24 between inflation rate and GDP growth implies that the relationship between these two variables is weakly negative. This suggests that when the annual inflation rate increasing, the GDP growth trend goes to decrease. Also, this relationship is marginally signif-

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icant at the 0.05 level, indicating that the relationship is less certain compared to highly significant correlations.

2. **Research question 2: Relationship between population growth rate and GDP growth**
   Here, the correlation coefficient is -0.955 which shows the relationship between GDP and population growth is strongly negative. In addition to that, this negative correlation is highly statistically significant as the significance of ($p < 0.01$) suggests that it is unlikely to have occurred by random chance.

3. **Research question 3: Relationship between GNI growth rate and GDP growth**
   According to the correlation of 0.149 between GNI growth and GDP growth, there is weakly positive relationship. But it is not statistically significant at 0.05 level as its significance level is 0.253. This means that there is no strong evidence of a significant linear relationship between these two variables in the dataset.

4. **Research question 4: Relationship between exports and GDP growth**
   The correlation between GDP growth and the annual growth rate of exports is very low and negative because it is -0.015. This means approximately there is almost no relationship between those variables. And also, the significance level is 0.909 ($p > 0.05$)which implies this is not statistically significant at the level 0.05, indicating that there is little evidence of a meaningful linear relationship between these variables.

5. **Research question 5: Relationship between imports and GDP growth**
   The correlation between annual growth rate of imports and GDP growth is 0.115. It implies that the relationship between these variables is weakly positive. But it is not statistically significant at the 0.05 level. This means, there is no a significant linear relationship between these variables in the dataset.

4.3   Estimate model parameters

In this section, backward elimination method is used to find the best regression equation and when selecting the best regression model, the significance level was taken as 95%.

Backward Elimination of Terms

Candidate terms: Population growth rate, Inflation rate, GNI growth rate, Exports growth rate, Imports growth rate

	------Step 1------		------Step 2------		------Step 3------	
	Coef	P	Coef	P	Coef	P
Constant	4.408		4.380		4.396	
Population growth rate	-2.1929	0.000	-2.1889	0.000	-2.1757	0.000
Inflation rate	0.0058	0.570	0.0060	0.555		
GNI growth rate	-0.0045	0.756				
Exports growth rate	-0.01175	0.066	-0.01200	0.057	-0.01125	0.066
Imports growth rate	0.00416	0.386	0.00393	0.404	0.00336	0.462
S		0.299088		0.296668		0.294976
R-sq		91.80%		91.79%		91.73%
R-sq(adj)		91.05%		91.20%		91.30%
Mallows' Cp		6.00		4.10		2.44
AICc		35.65		33.20		31.12
BIC		48.31		44.31		40.58

	------Step 4------		------Step 5-----	
	Coef	P	Coef	P
Constant	4.415		4.334	
Population growth rate	-2.1845	0.000	-2.1757	0.000
Inflation rate				
GNI growth rate				
Exports growth rate	-0.00854	0.076		
Imports growth rate				
S		0.293825		0.299390
R-sq		91.65%		91.19%
R-sq(adj)		91.37%		91.04%
Mallows' Cp		0.98		2.12
AICc		29.33		30.37
BIC		37.06		36.28

α to remove = 0.05

Figure 15: Correlation Matrix

In the stage of step 1, the model includes all the predictor variables which are population growth rate, inflation rate, GNI growth rate, exports growth rate, and imports growth rate. There, the R-squared is 91.8% which indicates a good fit. But, the Mallow' Cp of this stage is 6.0 and it is greater than the number of predictors in this model. This indicates that the model may have some over fitting or model is too complex. This is proven by the predictor variables which has the p value greater than 0.05.

In the stage of step 2, GNI growth rate, the least significant predictor which has the highest p value is step 1 has removed. In this stage R-squared is 91.79%.

Then, in the stage of step 3, inflation rate, the least significant predictor which has the highest p value is step 2 has removed. The R-squared value is 91.73% in this step.

Then, in the stage of step 4, imports growth rate, the least significant predictor which has the highest p value is step 3 has removed. The R-squared value of this step is 91.65%. In this step 4, the model has two predictor variables which are population growth rate and exports growth rate. In this model also there is a predictor variable with p value greater than 0.05. Therefore, in the next step, that variable was removed and in this stage the model is statistically significant as the p value of remaining variable, population growth rate is less than 0.05 which suggests that population growth rate is a strong predictor for explaining GDP.

For this study, the best regression equation is,

$$GDP = 4.334 - 2.1757 \cdot \text{Population growth rate.}$$

In this model, the R-squared value in is 91.19%. This indicates that a significant portion of variability in GDP is explained by this model. The adjusted R-squared value of this model is 91.04%. The difference between the R-squared value and adjusted R-squared value is very small (about 0.15) than the other steps. This means the addition of predictor variables do not improve the model significantly. In other words, it means that this is the best regression model for this dataset.

Here, S is a measure of model fit and selection and it has a value of 0.299390. This implies that the model provides a reasonably good fit to the data as a lower value of S indicates a better fit. The Mallows' Cp is also a measure of model fit. The value of Mallow's Cp in this model is 2.12. This also suggests that the model is providing a good fit to the data.

4.4 Assess model fit

Here are the regression equations of two models.

Full model:

$$GDP = 4.408 - 2.1929 \,\text{Population growth rate} + 0.0058 \,\text{Inflation rate} - 0.0045 \,\text{GNI growth rate}$$
$$- 0.01175 \,\text{Exports growth rate} + 0.00416 \,\text{Imports growth rate}$$

Reduced model:

$$GDP = 4.334 - 2.1757 \cdot \text{Population growth rate.}$$

Figure 16: ANOVA table of reduced model

Figure 17: ANOVA table of full model

1. Hypothesis 1

   The full model (figure 17) is considered for checking this hypothesis.

   - $H_0 : \beta_1 = 0$ against $H_a : \beta_1 \neq 0$

     The p-value of population growth rate is 0.000 and it is less than 0.05. That means the p-value is in the rejection region. So, the null hypothesis is rejected. Therefore, $\beta_1 \neq 0$. This suggests that there is a linear relationship between population growth rate and GDP.

     According to the reduced model, $\beta_1 = -2.1757$.

   - $H_0 : \beta_2 = 0$ against $H_a : \beta_2 \neq 0$

     The p-value of inflation rate is 0.570, which is greater than 0.05. This implies that the p-value is not in the rejection region. So, there is not much evidence to reject the null hypothesis. Consequently, $\beta_2 = 0$. This suggests that there is no linear relationship between inflation rate and GDP.

     According to the reduced model, $\beta_2 = 0$.

   - $H_0 : \beta_3 = 0$ against $H_a : \beta_3 \neq 0$

     The p-value of GNI growth rate is 0.756, which is greater than 0.05. This implies that the

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p-value is not in the rejection region. So, there is not much evidence to reject the null hypothesis. Consequently, $\beta_3 = 0$. This suggests that there is no linear relationship between GNI growth rate and GDP.

According to the reduced model, $\beta_3 = 0$.

- $H_0 : \beta_4 = 0$ against $H_a : \beta_4 \neq 0$

  The p-value of exports growth rate is 0.066, which is greater than 0.05. This implies that the p-value is not in the rejection region. So, there is not much evidence to reject the null hypothesis. Consequently, $\beta_4 = 0$. This suggests that there is no linear relationship between exports growth rate and GDP.

  According to the reduced model, $\beta_4 = 0$.

- $H_0 : \beta_5 = 0$ against $H_a : \beta_5 \neq 0$

  The p-value of imports growth rate is 0.386, which is greater than 0.05. This implies that the p-value is not in the rejection region. So, there is not much evidence to reject the null hypothesis. Consequently, $\beta_5 = 0$. This suggests that there is no linear relationship between imports growth rate and GDP.

  According to the reduced model, $\beta_5 = 0$.

2. Hypothesis 2

   This hypothesis is named as partial F test. In this test, the reduced model is compared with the full model.

   $$\text{Test statistic} = \frac{\text{SS Regression (full)} - \text{SS Regression (reduced)}}{k - p} \div \frac{\text{SS Error (full)}}{n - (k + 1)}$$

   According to this equation,

   $$\text{Test statistic} = \frac{55.08 - 54.712}{5 - 1} \div \frac{4.92}{60 - (5 + 1)} = 1.009756$$

   Now, this value is compared with $F_{0.05}$ with $k - p$ and $n - (k + 1)$ degrees of freedom at the 0.05 significance level.

   $F_{0.05, 4, 54} = 2.5252$

   That means, the test statistic $< F_{0.05}, 4, 54$ which shows that it is not in the rejection region. Therefore, the null hypothesis is not rejected. That means the reduced model is suitable for this study.

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5   Discussion and Conclusions

5.1   Discussion

In this study, the impact of population growth rate, inflation rate, GNI, exports and imports on GDP in the South Asian region within 1961 to 2021 period is observed. So, the dataset includes 61 observations without any missing values and null values.

Here, the distribution of GDP values, population growth, exports and imports appear symmetric while the inflation and GNI growth rates show positive skewness. The scatter plots illustrate the graphical interpretation of the relationships between the independent variables and the GDP values.

The regression analysis is a powerful statistical technique used to examine the relationships between the variables and make predictions. For this study, the regression equation of full model is,

$$GDP = 4.408 - 2.1929 \text{ Population growth rate} + 0.0058 \text{ Inflation rate} - 0.0045 \text{ GNI growth rate}$$
$$- 0.01175 \text{ Exports growth rate} + 0.00416 \text{ Imports growth rate}$$

But, in this model, the contribution from each variable to the dependent variable GDP is very low from the variables inflation rate, GNI growth rate, exports growth rate and imports growth rate. That means these variables are not statistically significant at the level 0.05.

Therefore, to obtain the best regression equation, backward elimination is used and the obtained reduced model equation is,

$$GDP = 4.334 - 2.1757 \cdot \text{Population growth rate}$$

In the backward elimination model, this equation is obtained by removing the least significant predictor variable in each step if there are variables with p value greater than 0.05. That means the variable which has the highest p value greater than 0.05 is removed and continued until the model is significant with the remaining variables. Therefore, according to the reduced model equation, population growth rate makes a big impact on GDP.

In regression analysis, hypothesis testing is used to determine whether independent variables have a significant impact on the dependent variable. According to the results obtained by hypothesis 1,

$$\beta_1 \neq 0, \ \beta_2 = 0, \ \beta_3 = 0, \ \beta_4 = 0, \text{ and } \beta_5 = 0$$

This is further proved by the reduced model equation.

And also, according to the results obtained by the hypothesis 2, called as partial F test, the reduced model is more suitable than the full model of this study

5.2 Conclusions

According to the findings, there is a strong negative relationship between population growth rate and GDP in South Asia from 1961 to 2021. And also, as the relationship is highly significant, the population growth rate plays a significant role in making GDP of this region.

During the past 6 decades, the increasing in inflation rate tends to have a negative impact on GDP. However, this is not highly significant. And also, the variables GNI growth rate, exports and imports may not have a direct linear relationship with economic performance in the South Asian region.

Therefore, these findings imply the importance of managing and controlling population growth to promote economic growth in the South Asian region.

6 Appendix

Here is the R code used for data analysis:

```
# To read  the  data  set
South_Asia <- read.csv('SouthAsia GDP - Group 11.csv')

# Check  null  values
is.null(South_Asia)

# Z score  scaling
GDP_Scaled <- scale(Dataset$GDP..current.US..)
New_Dataset <- cbind(
   Dataset[, -which(names(Dataset) == "GDP..current.US..")],
   GDP_Scaled)
```

References

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