How crisis affect the low-income and high-income economies differently*

An example from the 2020/2021 Covid-19

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This paper examines the impacts of global crises focusing on the 2020 and 2021 COVID-19 pandemic's effects on low and high-income countries. It highlights how globalization links economies, leading to shared challenges during worldwide disturbances. The analysis reveals that low-income countries have suffered more acutely, experiencing higher unemployment, inflation, and slower GDP growth.

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*Code and data are available at: https://github.com/Sluuu/Final-Paper.git

1 Introduction

Globalization improves the connection of different countries of the world. Economically, globalization benefits different countries in multiple ways and being able to trade goods across borders.(Takefman 2023) However, the effects of globalization brings the whole economy on the same boat. Consequently, when various global crises occur, they have multiple and different impacts on the world economy.

In this paper, my focus is on the varying impacts of global crises on low and high income countries. I have selected the 2020 and 2021 COVID-19 pandemic as the primary subject of my study. This crises have led to varying degrees of economic uncertainty and fluctuations in economic performance worldwide.(Strauss-Kahn 2020) The World Bank indicates that the COVID-19 pandemic has widen the inequality between low and high-income countries, with low-income countries experiencing higher unemployment and inflation rates, along with slower GDP growth. These trends align with the expectations set in my study.(Kim Parker 2020)

1.1 Defining Low-income economies and High-income economies

According to The World Bank (Espen Beer Prydz 2019), as of July 2019, using the Gross National Income, GNI, per capita by using the World Bank Atlas method. The Atlas method smooths exchange rate fluctuations using a three-year moving average. The low-income economies are defined as $1,025 or less, lower middle-income economies are those with between $1,026 and $3,995. The upper middle-income economies are those between $3,996 and $12,375. Lastly, the high-income economies are those with a GNI per capita $12,376 or more.

For simplicity, I will group the low-income economies and the lower middle-income economies together as low-income economies. Also, the upper middle-income economies and high-income economies will be grouped as high-income economies. Therefore, a country that has a GNI per capita less than or equal to $3995 will be categorized as low-income country. A country that has a GNI per capita larger than $3995 will be categorized as high-income country. Which I have grouped out in 2020 there are 27 low-income countries in this definition and 85 high-income countries. In 2021, there are

2 Data

The data is obtained from the World Development Indicators and Other World Bank Data, WDI, Arel-Bundock (2022). The raw data set includes, 17024 observations and 11 variables. As the raw data-set recorded some variables have missing values and some repeated values. After combining and deleting the extra and missing values, In the year of 2020, I have 112 observations and in the year of 2021 I have 117 variables which both years with the sharing 10 variables. Which each observations represents a country.

2.1 Variables

- `country`: It records the country's name.
- `year`: It records the year of the data being recorded. In our cleaned data set there will only be year 2020.
- `inflation`: It records the inflation, measured by the consumer price index which reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, such as yearly.
- `gdp_growth`: It records the annual percentage growth rate of GDP at market prices. The calculations are based on constant local currency.
- `population`: It records the total population based on all residents regardless of legal status or citizenship.
- `unem_rate`: It records the unemployment rate, the unemployment refers to the labours that are not working but is available to work or seeking for employment.
- `lf_par_rate`: It records the labor force participation rate, it calculated the proportion of the population who ages 15 and older that are active economically.
- `trade_per`: It records the sum of exports and imports of goods and services measured as a share of GDP.
- `gni_per_cap`: It records the GNI per capita, the unit is converted to U.S. dollars using the World Bank Atlas method. GNI is the sum of value added by all resident producers plus any product taxes. It does not include the value of output plus net receipts of primary income from abroad.
- `low_income`: It is a dummy variable indicating that if a country has a GNI per capita less than or equal to $3995 it will be 1, else, 0.

In Figure 1, I have presented the relationship between GDP growth and Inflation of each countries from my data-set. Which each dot represents one country. From Figure 1, we could see that countries that have higher/positive gdp growth typically also has a higher inflation rate. Also in 2021, the gdp growth for each country are typically higher than in 2020 with having similar inflation rate.

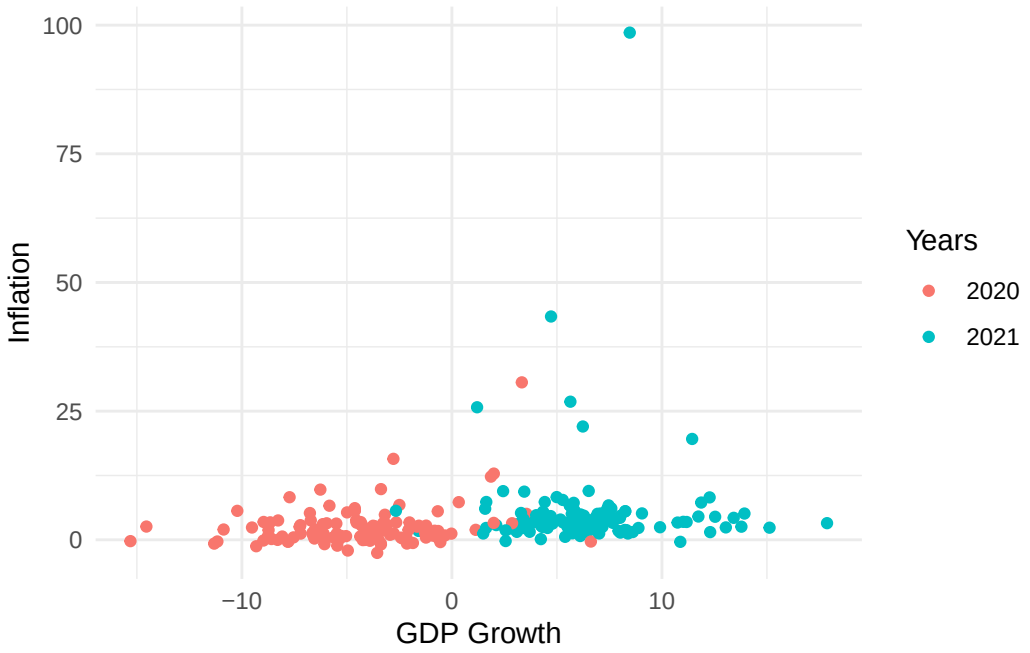

Figure 1: Relationship between GDP growth versus Inflation

In Figure 2, I have shown the inflation rate for the low-income and the high-income countries in 2020 and 2021. On the x-axis, when x is equal to 0, it means that the county is a high-income country and it equals to 1 when the country is a low-income country. From Figure 2, we could also see that high income countries has lower and more stabilized inflation rates in either year 2020 and year 2021. Which in low-income countries the inflation rate varies across each country and there are also more outliers in year 2021 compare with 2020.

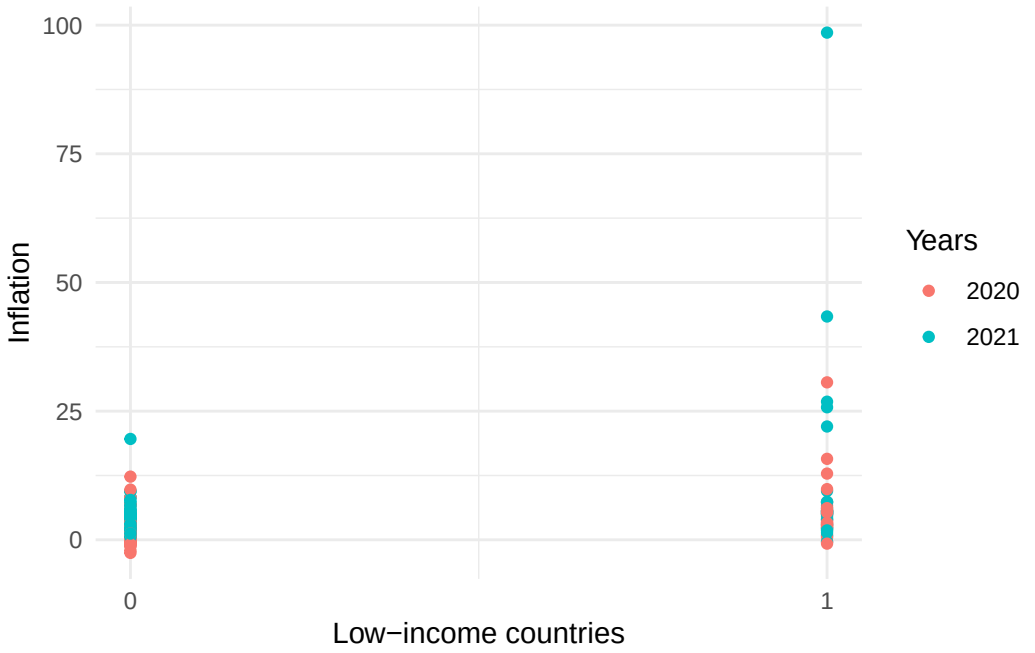

Figure 2: Relationship between differenct level of income countries versus Inflation

In Figure 3, I have shown the gdp growth rate for the low-income and the high-income countries. On the x-axis, when x is equal to 0, it means that the county is a high-income country and it equals to 1 when the country is a low-income country. From Figure 3, we could see that in both 2020 and 2021, each year the high income countries have similar gdp growth rates. Which in low-income countries the gdp growth rates more varies across each country. Lastly in both low and high income situations, the overall gdp growth in 2021 are higher than in 2020.

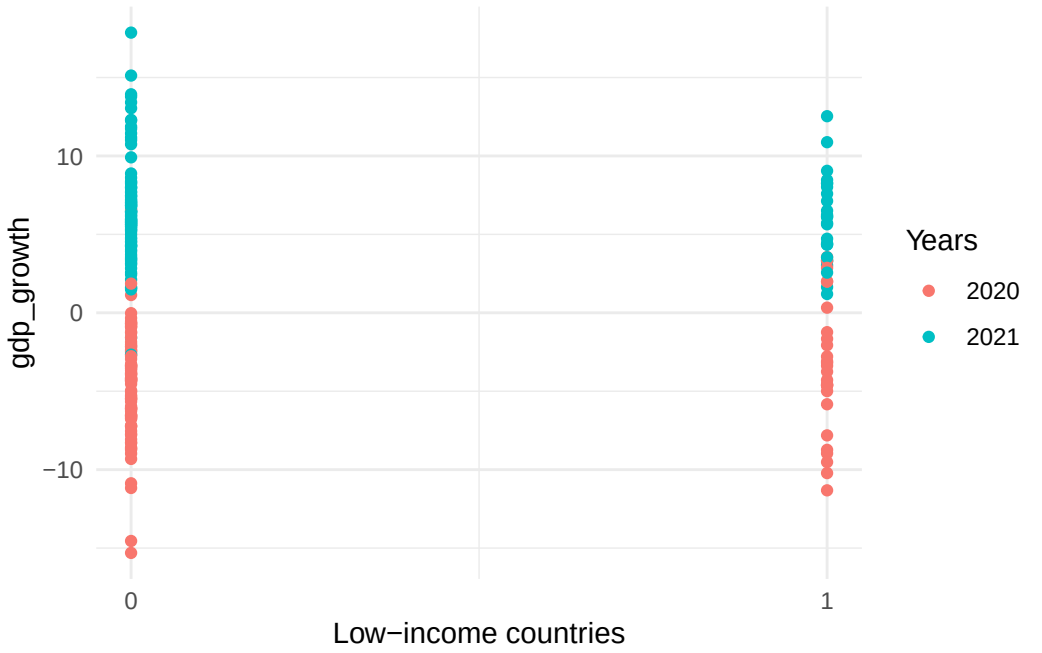

Figure 3: Relationship between differenct level of income countries versus gdp growth

From Figure 4, the low-income countries seems to have lower unemployment rate than in high-income countries. Also, in both 2020 and 2021, the unemployment rates for both low and high income countries have similar results.

Lastly, the data presented in Figure 2, Figure 3, and **?@fig-lf**, I observed that high-income countries shared similar economic performance trends. Despite not necessarily excelling in all economic indicators than the low-income countries, however, these countries generally maintain a more stable economic condition, with only a few exceptions or outliers noted. Also the overall economic performance in 2021 are better than in 2020.

A more detailed relationship between each variable could be found in Figure 5.

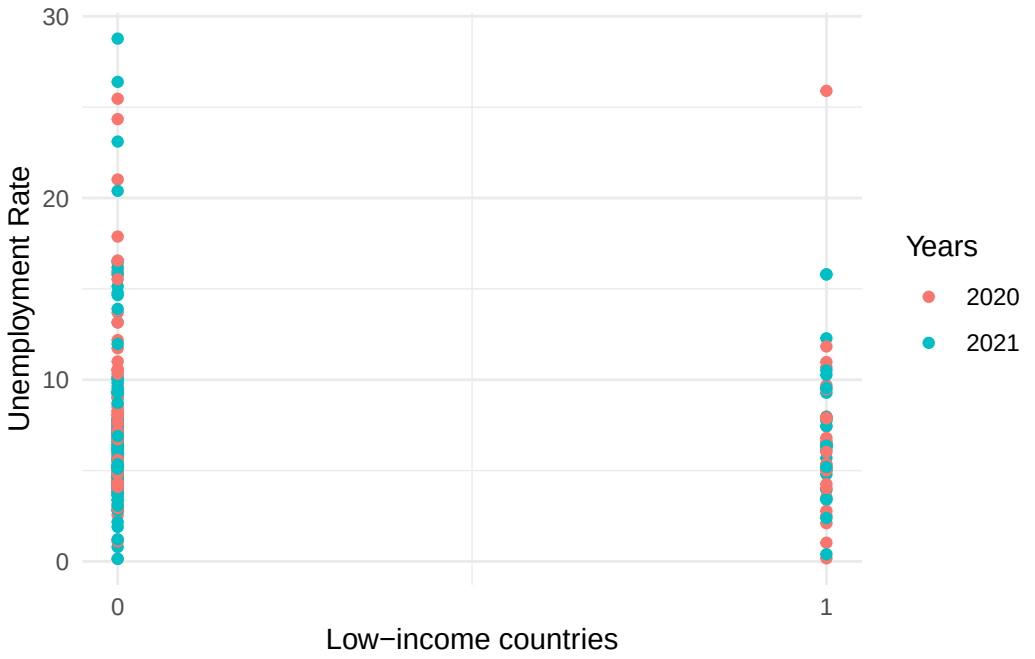

Figure 4: Relationship between differenct level of income countries versus labour force participation rate

3 Model

The model is set up by using R (R Core Team 2023) with the help of the following packages, `tidyverse` package of Wickham et al. (2019), `readr` package of Wickham, Hester, and Bryan (2024), `dplyr` package of Wickham et al. (2023), `dataverse` package of Kuriwaki, Beasley, and Leeper (2023), `stargazer` and package of Hlavac (2022), and `broom` package of Robinson, Hayes, and Couch (2023). Given that countries are classified as low or high income based on their GNI per capita, `gni_per_cap`, I will use this as the dependent variable in a multiple linear regression model to analyze the impact of various factors on `gni_per_cap` across these groups. I will explore how different variables affect `gni_per_cap` in both low and high-income countries. Specifically, I anticipate that low-income countries will experience larger negative effect from unemployment and inflation rates, as well as experience negative GDP growth. This analysis aims to provide insights into the economic challenges faced by these countries and inform potential policy interventions.

```
Summary of Low Income Model
================================================
                        Dependent variable:
                    ----------------------------
                              gni_per_cap
------------------------------------------------
gdp_growth                     -25.093
                               (21.917)

population                     -0.00000
                               (0.00000)

unem_rate                      -23.374
                               (34.236)

lf_par_rate                   -52.818***
                               (13.104)

trade_per                      11.697***
                               (3.992)

inflation                      -7.082
                               (8.800)

Constant                     5,120.936***
                               (926.753)

------------------------------------------------
Observations                      53
Log Likelihood                -432.942
Akaike Inf. Crit.              879.883
================================================
Note:               *p<0.1; **p<0.05; ***p<0.01
```

From the Summary of Low Income Model above, we could see the following situations:

The GDP growth (`gdp_growth`) coefficient is -25.093 with a standard error of 21.917. This suggests there is a negative relationship between GDP growth and GNI per capita, though it is not statistically significant as its high p-value. Then the Unemployment rate (`unem_rate`) coefficient is -23.374 with a standard error of 34.236. This indicates a negative relationship between the unemployment rate and GNI per capita, which is also not statistically significant. Lastly the Inflation (`inflation`) coefficient is -7.082 with a standard error of 8.800, indicating

a negative relationship between inflation and GNI per capita, though this relationship is not statistically significant.

The Labor force participation rate (`lf_par_rate`) coefficient is -52.818 with a standard error of 13.104, and it is significant at the p<0.01 level. This significant negative relationship implies that higher labor force participation is associated with lower GNI per capita among the low-income countries in this analysis, which might suggest underemployment or low-quality jobs prevalent in these economies. The Trade percentage of GDP (`trade_per`) coefficient is 11.697 with a standard error of 3.992, significant at the p<0.01 level. This significant positive relationship suggests that a higher trade percentage of GDP is associated with higher GNI per capita, indicating the beneficial impact of trade on national income in low-income countries.

The Population (`population`) coefficient is different than the other variables. As its coefficient is extremely small and not statistically significant, suggesting that population size, has no impact on GNI per capita in this model.

Summary of High Income Model

	Dependent variable:
	gni_per_cap
gdp_growth	567.121**
	(244.367)
population	0.00000
	(0.00000)
unem_rate	-849.519**
	(350.854)
lf_par_rate	433.735*
	(229.487)
trade_per	59.875***
	(22.554)
inflation	-2,799.239***
	(600.123)
Constant	7,822.731
	(16,169.640)

```
-----------------------------------------------
Observations                      176
Log Likelihood                -1,982.946
Akaike Inf. Crit.              3,979.891
===============================================
Note:                *p<0.1; **p<0.05; ***p<0.01
```

The high income-countries have an overall better performance than the low-income countries: The GDP Growth (`gdp_growth`) coefficient is 567.121 with a standard error of 244.367, significant at the $p<0.05$ level. This suggests a positive and statistically significant relationship between GDP growth and GNI per capita in high-income countries, indicating that economic growth positively impacts income levels. Then the Unemployment Rate (`unem_rate`) coefficient is -849.519 with a standard error of 350.854, significant at the $p<0.05$ level. This indicates a significant negative impact of higher unemployment rates on GNI per capita, suggesting that unemployment is a critical economic issue affecting income in high-income countries. The Labor Force Participation Rate (`lf_par_rate`) coefficient is 433.735 with a standard error of 229.487, significant at the $p<0.1$ level. This shows a positive relationship between labor force participation and GNI per capita, though the relationship is less statistically significant. The Trade Percentage of GDP (`trade_per`) coefficient is 59.875 with a standard error of 22.554, significant at the $p<0.01$ level. This indicates a robust positive relationship, suggesting that trade openness contributes significantly to GNI per capita in high-income countries. Lastly, the Inflation (`inflation`) coefficient is -2,799.239 with a standard error of 600.123, significant at the $p<0.01$ level. This suggests a strong negative impact of inflation on GNI per capita, indicating that higher inflation rates are detrimental to income levels.

Same with the low-income situation, the Population (`population`) coefficient is extremely small and statistically insignificant, implying no clear impact of population size on GNI per capita within this model.

3.1 Model set-up

To consider the effect of the 6 economic indicators on the level on low and high income countries' GNI per capita, I used the multiple linear regression to approach my data. The formula is as follows:

$$\text{gni\_per\_cap} = \alpha + \beta_1 \times \text{population}_i + \beta_2 \times \text{unem\_rate}_i + \beta_3 \times \text{lf\_par\_rate}_i + \beta_4 \times \text{trade\_per}_i + \beta_5 \times \text{inflatio} \tag{1}$$

$$\alpha \sim \text{Normal}(0, 2.5) \tag{2}$$

$$\beta_1 \sim \text{Normal}(0, 2.5) \tag{3}$$

$$\beta_2 \sim \text{Normal}(0, 2.5) \tag{4}$$

$$\beta_3 \sim \text{Normal}(0, 2.5) \tag{5}$$

$$\beta_4 \sim \text{Normal}(0, 2.5) \tag{6}$$

$$\begin{aligned} \text{gni\_per\_cap} = \alpha &+ \beta_1 \times \text{population}_i + \beta_2 \times \text{unem\_rate}_i + \beta_3 \times \text{lf\_par\_rate}_i && (7)\\ &+ \beta_4 \times \text{trade\_per}_i + \beta_5 \times \text{inflation}_i, && (8)\\ \alpha &\sim \text{Normal}(0, 2.5), && (9)\\ \beta_1 &\sim \text{Normal}(0, 2.5), && (10)\\ \beta_2 &\sim \text{Normal}(0, 2.5), && (11)\\ \beta_3 &\sim \text{Normal}(0, 2.5), && (12)\\ \beta_4 &\sim \text{Normal}(0, 2.5), && (13)\\ \beta_5 &\sim \text{Normal}(0, 2.5) && (14) \end{aligned}$$

3.1.1 Model Adjustment

For a better performance and interpretation of the model, I have applied the log transformation to my model. The log transformation is to reduce the skewness in variables that have a skewed distribution, such as `gni_per_cpa`, `gdp_growth`, `population`, etc. By transforming these variables, the distribution is more symmetric, which is closer to the normal distribution. The Log transformations also help stabilize the variance across different levels of input variables, reduces homoscedasticity. The log transformation variables are the follows: Log of `gni_per_cap` The dependent variable's log transformation can help in normalizing the distribution and making relationships more linear. The log of `gdp_growth` and `population` shared similar reasons. As Economic growth rates and population can vary widely, and the impact on GNI per capita might scale logarithmically rather than linearly.

```
Summary of Low Income Model
================================================
                        Dependent variable:
                    ---------------------------
```

	log(gni_per_cap)
log(gdp_growth + 1)	0.170
	(0.181)
log(population + 1)	0.003
	(0.053)
unem_rate	-0.001
	(0.029)
lf_par_rate	-0.030***
	(0.009)
trade_per	0.009***
	(0.002)
inflation	-0.001
	(0.005)
Constant	8.532***
	(1.392)
Observations	32
Log Likelihood	-18.684
Akaike Inf. Crit.	51.368

Note: *p<0.1; **p<0.05; ***p<0.01

Summary of High Income Model

	Dependent variable:
	log(gni_per_cap)
log(gdp_growth + 1)	0.044
	(0.082)
log(population + 1)	0.047
	(0.046)

```
unem_rate                      -0.043**
                                (0.021)

lf_par_rate                     0.011
                                (0.014)

trade_per                      0.004***
                                (0.001)

inflation                      -0.110***
                                (0.031)

Constant                       8.647***
                                (1.468)

-----------------------------------------------
Observations                      101
Log Likelihood                 -118.903
Akaike Inf. Crit.               251.806
===============================================
Note:               *p<0.1; **p<0.05; ***p<0.01
```

4 Results

Labor Force Participation (lf_par_rate): Low-Income: Significant negative relationship. High-Income: Significant positive relationship. Insight: This contrast may indicate that in low-income countries, increases in labor force participation may include low-quality, low-income jobs, whereas in high-income countries, higher participation could be linked to high-skill, high-income roles. Trade as Percentage of GDP (trade_per): Both: Positive impact and significant in both models. Insight: Trade openness appears beneficial across both income groups, enhancing GNI per capita. Other Significant Predictors GDP Growth (gdp_growth): Low-Income: Insignificant. High-Income: Significant and positive. Insight: Economic growth plays a more critical role in high-income countries, possibly reflecting more developed financial systems and infrastructure which better translate growth into GNI per capita. Unemployment Rate (unem_rate): Low-Income: Insignificant. High-Income: Significant and negative. Insight: Unemployment negatively impacts GNI per capita in high-income countries, where unemployment may lead to significant economic losses. Inflation (inflation): Low-Income: Insignificant. High-Income: Significant and negative. Insight: Inflation is a critical factor in high-income countries, perhaps due to more developed financial markets and economies where inflation can erode real income levels more noticeably. Model Performance

Metrics Log Likelihood and AIC: The log likelihood is notably lower (more negative) in the high-income model, reflecting the larger scale and complexity of the dataset. The AIC is also significantly higher, suggesting a less efficient model relative to the number of parameters and the sample size compared to the low-income model. Overall Conclusion The comparison reveals distinct economic dynamics between low- and high-income countries. Factors like labor force participation and trade are important in both, but their impacts differ by income level. Economic growth, unemployment, and inflation are more influential in high-income contexts, suggesting different policy priorities for each group. This analysis underscores the importance of tailored economic policies that consider specific national circumstances and economic structures.

5 Discussion

5.1 First discussion point

If my paper were 10 pages, then should be be at least 2.5 pages. The discussion is a chance to show off what you know and what you learnt from all this.

5.2 Second discussion point

5.3 Third discussion point

5.4 Weaknesses and next steps

If two different time events occurs does low-income countries being impacted differently before, after they become high-income countries?

A Additional data details

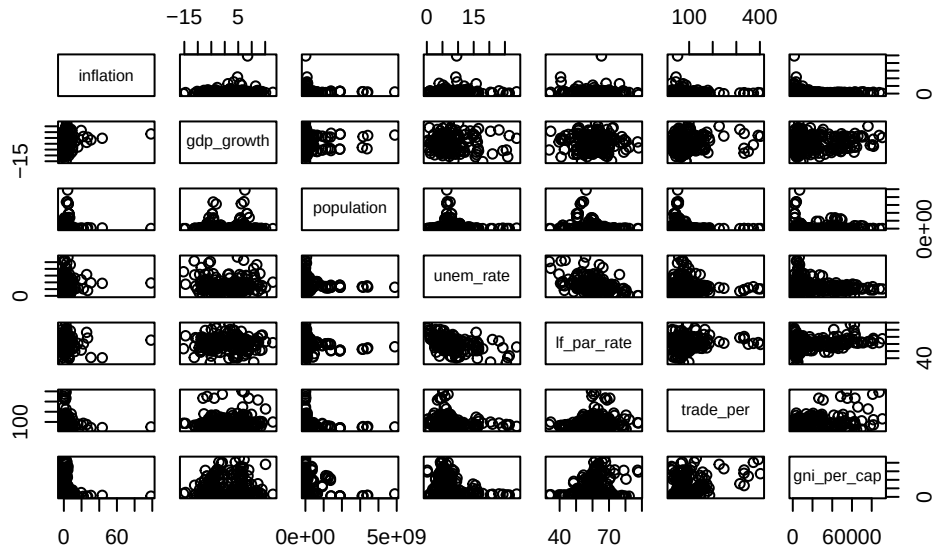

Figure 5: Scatterplot matrix of each variables

B Model details

B.1 Posterior predictive check

B.2 Diagnostics

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