The Economic Implications of COVID-19 for Various Global Superpowers

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Data Description

The World Bank dataset is a massive collection of global socioeconomic data, which spans multiple decades and topics. This data set has a diversity of indicators, for example, ways to measure population growth, literacy rates, and socioeconomic factors as well. Data in the World Bank dataset is time-stamped, meaning certain time periods can be compared to one another. In addition, the data set allows for cross-country comparison, meaning that data from Peru for example, can be compared to data from Japan in terms of the same "indicator" which was mentioned previously. For example, we could compare the socioeconomic outcomes of COVID-19 in terms of how different countries responded to the event. Peru had one of the worst outcomes in regard to covid-19 with one of the highest death tolls, vs. Japan, which had one of the lowest. I'm most specifically curious about analyzing subsets of data during the years when the COVID-19 pandemic had the most detrimental economic effect (from ~2019 to 2021). This is because the COVID-19 pandemic, and therefore its economic consequences occurred in this timeframe. I want to see how different countries responded, and what unintended repercussions of their responses might be in terms of unemployment, child literacy, and the overall robustness of the country's response. I think it would be incredibly interesting to understand the response of the COVID-19 pandemic not in terms of statistics about direct cases but to look at the economic responses and implications for various countries around the world. This helps understand which nations are best equipped to deal with such disasters and helps understand the overall economic and social robustness of a country.

Research questions:

1. How did the US and France compare in terms of unemployment rate in response to the COVID-19 pandemic?
2. Did the general level of immunization in Japan vs. India affect their levels of economic decline when the COVID-19 pandemic occurred? More broadly, did a culture of more vaccination lead to less economic decline during the pandemic?
3. How did China and the United States %GDP spent on healthcare change in response to the COVID-19 pandemic?
4. How did China and the United States' Gross Fixed Capital Formation (GFCF) expressed as a percent of gross domestic product react in response to the Covid-19 pandemic?
5. How did the United States, a country commonly considered to have a "bad" response to the pandemic, compare to Sweden commonly considered to have had a "good" response to COVID-19, in terms of their investments into the educational system during the time of the pandemic?

1. **How did the US and France compare in terms of unemployment rate in response to the COVID-19 pandemic?**

Objective:

I will compare a plot of unemployment data from France versus a plot of unemployment data from the United States to ensure a visible difference in unemployment rates during the COVID-19 pandemic.

I will then conduct an ANOVA test to compare the categorical variables of France and the US to see whether the difference in unemployment rate percentage between 2019 and 2022 is significant.

Figure 1. R Code for Plotting Unemployment between the US and France and conducting an ANOVA test.

```r
us_unemp <- wb(indicator = "SL.UEM.TOTL.ZS", country = "US", startdate = 2015, enddate = 2022)


# Plots to observe unemployment rates visually

ggplot(us_unemp, aes(x = date, y = value, group = 1)) +
  geom_line() +
  labs(title = "Unemployment Rate in the  (2015 - July 2022)",
       x = "Year-Month",
       y = "Unemployment Rate (%)") +
  theme_minimal()

# Gather unemployment data from France
fr_unemp <- wb(indicator = "SL.UEM.TOTL.ZS", country = "FR", startdate = 2015, enddate = 2022)

ggplot(fr_unemp, aes(x = date, y = value, group = 1)) +
  geom_line() +
  labs(title = "Unemployment Rate France (2015 - July 2022)",
       x = "Year-Month",
       y = "Unemployment Rate (%)") +
  theme_minimal()


# Combine the two datasets
combined_data <- bind_rows(
  mutate(us_unemp, country = "United States"),
  mutate(fr_unemp, country = "France")
)

# Plot the combined data
ggplot(combined_data, aes(x = date, y = value, group = country, color = country)) +
  geom_line() +
  labs(title = "Unemployment Rate Comparison (2015 - July 2022)",
       x = "Year-Month",
       y = "Unemployment Rate (%)",
       color = "Country") +
  theme_minimal()

# Anova test to compare the categorical variables of US and France
unemployment_code <- "SL.UEM.TOTL.ZS"

# Gather unemployment data for the US and France
unemployment_data <- wb(country = c("FR", "US"), indicator = unemployment_code, start = 2019, end = 2022)


# Coduct anova anlaysis
anova_result <- aov(value ~ country, data = unemployment_data)

# Summarize results from the ANOVA
summary(anova_result)
```

Figure 2. Plot of Unemployment rates of the United States vs. France between 2015 and 2022

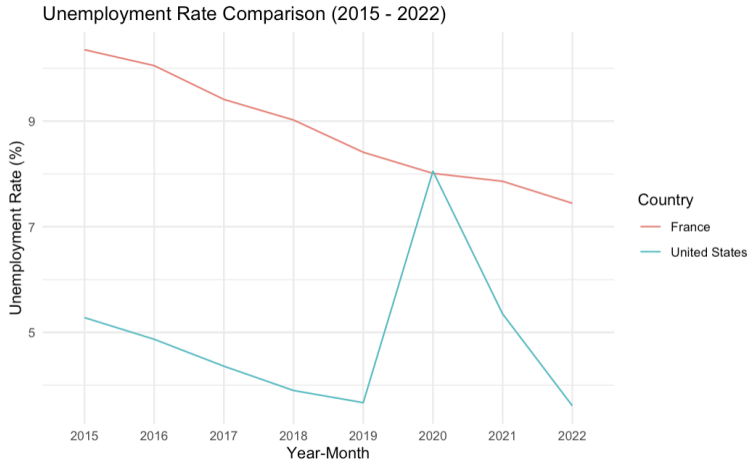

Figure 3. Results of ANOVA analysis of Unemployment in France vs. the United States

```
            Df Sum Sq Mean Sq F value Pr(>F)
country      1  15.25  15.246   6.784 0.0404 *
Residuals    6  13.48   2.247
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

An analysis of variance showed that the effect of the COVID-19 pandemic on unemployment between the United States and France was significant, $F(1, 6) = 6.784$, $p = 0.0404$.

In Figure 3, it’s clear that the consequences of the unemployment rate as an outcome of COVID-19 were much more severe in France than it was in the United States. This is evident by looking at their graphs containing the combined data. What’s interesting, and oftentimes not covered in the news is that France’s unemployment rate was on a downward trend, which slowed down during the pandemic. In contrast, the US employment rate was also on a downward trend but then shot up during the pandemic to levels similar to France. The ANOVA test to compare levels of employment between France and the United States during this time frame reveals that there is a significant difference in unemployment between France and the US during this time. The p-value gathered is 0.0404 which means the results can be deemed statistically significant at an α level of 0.05.

2. **Did the general level of immunization in Japan vs. India affect their levels of economic decline when the COVID-19 pandemic occurred? More broadly, did a culture of more vaccination lead to less economic decline during the pandemic?**

Objective 1: Conduct an ANOVA to compare levels of immunization in Japan vs. India
Objective 2: Conduct an ANOVA to compare changes in the GDP of Japan vs. India

Figure 4. R Code for Conducting ANOVA to Compare Immunization Habits of India vs. Japan

```r
# Searching for proper indicator to look at a country's level of vaccination

immunizations <- wb_search("vaccine")
print(immunizations)

# Filter using the indicator for immunizations for the countries japan and india who have generally different practices for vaccinations

jp_immune <- wb(indicator = "SH.IMM.IDPT", country = "JP", start = 1922, end = 2022)
print(jp_immune)

india_immune <- wb(indicator = "SH.IMM.IDPT", country = "IN", start = 1922, end = 2022)
print(india_immune)

# Combine data using r bind in order to plot

combined_data <- rbind(jp_immune, india_immune)

# Filtering data by the countries Japan and India

combined_data$country <- factor(combined_data$country, labels = c("Japan", "India"))

# ANOVA test
anova_result2 <- aov(value ~ country, data = combined_data)
summary(anova_result2)

# Plot

india_gdp_growth <- wb(indicator = "NY.GDP.MKTP.KD.ZG", country = "IN", start = 2015, end = 2022)

# GDP growth rate for Japan
japan_gdp_growth <- wb(indicator = "NY.GDP.MKTP.KD.ZG", country = "JP", start = 2015, end = 2022)

# Combine gdp data for both countries

combined_gdp_data <- rbind(india_gdp_growth, japan_gdp_growth)
combined_gdp_data$country <- factor(combined_gdp_data$country, labels = c("India", "Japan"))

# Conduct ANOVA analysis

anova_result3 <- aov(value ~ country, data = combined_gdp_data)

# Output results

summary(anova_result3)
```

Figure 5. Results of ANOVA Analysis for Immunization Habits between India and Japan

```
            Df Sum Sq Mean Sq F value   Pr(>F)
country      1  18750   18750   52.22 2.33e-10 ***
Residuals   82  29446     359
```

```
            Df Sum Sq Mean Sq F value Pr(>F)
country      1  102.4  102.37   7.487 0.0161 *
Residuals   14  191.4   13.67
```

An analysis of variance showed that the difference in immunization levels in Japan vs. India was significant, $F(1, 82) = 52.22$, $p < 0.001$. An additional analysis of variance also showed that the difference of GDP in response to the pandemic was significant, $F(1, 14) = 7.487$, $p = 0.016$.

Because higher rates of vaccination inevitably lead to fewer cases of a given virus. We can observe that by looking at vaccination rates, one can also predict the impact of a global

pandemic on an individual country's economy due to how generally resilient the country is to a given virus given their vaccination habits. The p-value 2.33e-10 reflects a great difference in vaccination levels between Japanese and Indian people. Furthermore, the p-value of 0.0161 outputted in the difference in GDP between the two countries could indicate how the robustness of a population in relation to a disease can affect its overall economy, as seen in the COVID-19 pandemic.

3. **How did China and the United States %GDP spent on healthcare change in response to the COVID-19 pandemic?**

Objective 1: Plot %GDP spent on Healthcare in the United States vs China
Objective 2: Conduct ANOVA analysis to compare the %GDP spent on healthcare

Figure 6. R Code for plotting the United States vs. China in terms of % GDP spent on healthcare

```
# Searching for indicators of healthcare

wb_search("healthcare")

# Create a variable for US and China for their %gross domestic product spent on healthcare between the years 2015 and 2022

us_healthcare <- wb(indicator = "SH.XPD.CHEX.GD.ZS", country = "US", startdate = 2015, enddate = 2022)
head(us_healthcare)

china_healthcare <- wb(indicator = "SH.XPD.CHEX.GD.ZS", country = "CN", startdate = 2015, enddate = 2022)
head(china_healthcare)

# Combine the two datasets using the bind_rows() function
combined_data <- bind_rows(
  mutate(us_healthcare, country = "United States"),
  mutate(china_healthcare, country = "China")
)

# Plot the combined data
ggplot(combined_data, aes(x = date, y = value, group = country, color = country)) +
  geom_line() +
  labs(title = "%GDP spending on healthcare comparisson (2015 - 2022)",
       x = "Year",
       y = "%GDP spent on healthcare (%)",
       color = "Country") +
  theme_minimal()
```

Figure 7. R Code for ANOVA Test to Compare the United States and China for %GDP Spent on Healthcare during COVID-19

```
# Part two of investigating this question - Conduct ANOVA test to compare %GDP spent on healthcare of US vs China

anova_result4 <- aov(value ~ country, data = combined_healthcare_data)

# Output results

summary(anova_result4)
```

Figure 8. Plot of %GDP Spent on Healthcare for the United States vs. China during the Pandemic

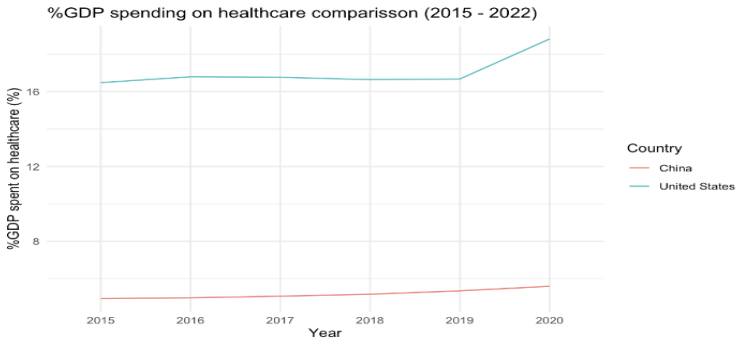

Figure 9. Results of ANOVA test comparing %GDP Spent on Education for the US and China

```
            Df Sum Sq Mean Sq F value   Pr(>F)
country      1  421.0   421.0    1002 2.33e-11 ***
Residuals   10    4.2     0.4
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

An analysis of variance showed that the difference in %GDP spent by the US and China on education during the COVID-19 pandemic was significant, $F(1, 10) = 1002$, $p < 0.001$.

Figure 8 visually illustrates that the United States healthcare spending (expressed as a percentage of GDP) had a stark increase between 2019 and 2020 when the pandemic first struck. This was likely in an effort to combat the rise of COVID-19 in the United States. On the other hand, China's spending on healthcare only increased slightly and still followed the slight positive linear trend as seen in previous years. What's significant about this is that the United States' reaction as a political entity to the pandemic was deemed "bad" and China's deemed "good" in terms of sheer cases, but the data here shows that they had contrasting strategies for managing the situation. Although the United States spent more on healthcare, they also ended up with a more severe number of COVID cases than China. This suggests that whether or not a country "succeeded" in response to COVID-19 isn't directly related to the amount of money it spent on healthcare.

China and the United States had drastically different responses regarding reallocating resources to respond to the effects of the pandemic. In looking at this data, combined with the graph, it appears that the United States's %GDP in response to the pandemic increased

dramatically, as opposed to China whose %GDP spent on healthcare only appeared to increase slightly, but following the same, slightly positive trend it had been since 2015.

4. **How does China and the United States' Gross Fixed Capital Formation (GFCF) expressed as a percent of gross domestic product react in response to the Covid-19 pandemic?**

Objective 1: Plot China vs the United States's Gross Fixed Capital Formation (GFCF)

Objective 2: Conduct an ANOVA analysis to compare China vs the United States' GFCF

Figure 10. R Code for Gathering and Plotting Data on GFCF for China vs. the United States and Conducting ANOVA

```r
# Searching for indicators for investments

wb_search("investments")

# Create a variable for US and China for their Gross Fixed Capital Formation (GFCF) between 2019 and 2021

us_investments <- wb(indicator = "NE.GDI.FTOT.ZS", country = "US", startdate = 2019, enddate = 2021)
head(us_investments)

china_investments <- wb(indicator = "NE.GDI.FTOT.ZS", country = "CN", startdate = 2019, enddate = 2021)
head(china_investments)

# Combine the two datasets using the bind_rows() function
combined_investment_data <- bind_rows(
  mutate(us_investments, country = "United States"),
  mutate(china_investments, country = "China")
)

# Plot the combined data
ggplot(combined_investment_data, aes(x = date, y = value, group = country, color = country)) +
  geom_line() +
  labs(title = "%GDP Gross Fixed Capital Formation as percent of %GDP (GFCF) (2019 - 2021)",
       x = "Year",
       y = "% of Gross Domestic Product: ",
       color = "Country") +
  theme_minimal()

# Part two of investigating this question - Conduct ANOVA test to compare Gross Fixed Capital Formation (GFCF) as expression of %GDP for The United States and China

anova_result5 <- aov(value ~ country, data = combined_investment_data)

# Output results

summary(anova_result5)
```

Figure 11. Plot of %GDP spent on Gross Fixed Capital Formation (Indicator of Economic Stability)

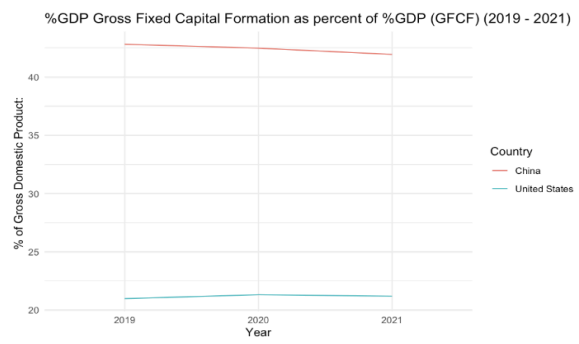

Figure 12. ANOVA Results for Gross Fixed Capital Income for the United States and China

```
             Df Sum Sq Mean Sq F value   Pr(>F)
country       1  678.0   678.0    6107 1.61e-07 ***
Residuals     4    0.4     0.1
```

An analysis of variance showed that the difference in Gross Fixed Capital Income between China and the United States was significant, $F(1, 6) = 6107$, $p < 0.001$.

GFCF can indicate economic stability. These results suggest that there is a significant difference in the percentage of gross domestic product invested in global assets between China and the United States. As seen visually in Figure 11, China's %GDP spent on investing was on a decline between 2019 and 2020 and continued to decline from 2020 to 2021. On the other hand, the United States's %GDP spent on investments increased from 2019 to 2020. This was the year that the pandemic struck which means that a part of the United State's response and consideration regarding the pandemic was the increase in their spending on global investments. The p-value of 1.61e-07 obtained through the ANOVA test, seen in Figure 12, shows that p is significant at $p < 0.05$. This means that there is a 1% chance of inaccurately rejecting the null hypothesis which states that there is no significant between %GDP spent on economic stability between China and the United States during the time of the COVID-19 Pandemic.

5. **How did the United States, a country commonly considered to have a "bad" response to the pandemic, compare to Sweden commonly considered to have had a "good" response to COVID-19, in terms of their investments into the educational system during the time of the pandemic?**

Objective:

Conduct a t-test to compare the economic factor of %GDP spent on education between the United States vs. Sweden during the period of the COVID-19 pandemic.

Figure 13. R Code to Conduct t-test to Compare Government Spending on Education for the US vs. Sweden During the COVID-19 Pandemic

```r
# Conduct a search to find indicators related to levels of education and government spending on education

education <- wb_search("education")
print(education)

# Create variables for US educational spending for the United States vs. Sweden in the years 2015 vs 2021

us_ed_spending <- wb(indicator = "SE.XPD.TOTL.GB.ZS", country = "US", start = 2015, end = 2021)
swede_ed_spending <- wb(indicator = "SE.XPD.TOTL.GB.ZS", country = "SE", start = 2015, end = 2021)

# Print the data to ensure no missing values

print(us_ed_spending)
print(swede_ed_spending)

# Group data by the specific column which holds the data for %GDP spent on education

group1_data <- us_ed_spending$value
group2_data <- swede_ed_spending$value

# Execute an independent samples t test, as the groups are independent

t_test_result <- t.test(group1_data, group2_data, paired = FALSE)

# Print the results of the t test

print(t_test_result)
```

Figure 14. Result of Welch Two Sample t-test for %GDP Spent on Education for US vs. Sweden

```
        Welch Two Sample t-test

data:  group1_data and group2_data
t = 3.1963, df = 5.584, p-value = 0.02064
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.3893768 3.1436360
sample estimates:
mean of x mean of y
 15.31320  13.54669
```

Results indicate a significant difference in the United States' spending on education during the COVID-19 pandemic (M = 15.31) compared to Sweden's educational spending during the COVID-19 pandemic. (M = 13.55), t = 3.2, p = 0.02.

The results of the Welch's two-sample t-test seen in Figure 14, show that the data is significant at $p < 0.05$. We can reject the null hypothesis that states no significant difference in %GDP spent on education during the COVID-19 pandemic. Instead, it can be inferred that the United States and Sweden spent significantly different amounts of money on education. Seen in looking at the raw results of the United States vs. Sweden in terms of educational spending on a year-by-year basis, the United State's spending dropped ~2% between 2019 and 2020 when the pandemic hit, as opposed to Sweden's change of ~0.6%. Sweden has the highest-ranked educational system and the world, and despite this spends less of their money on education than the United States on a percentage basis. The results here shown in Figure 14 reflect that the United States and Sweden spent a significantly different amount of their overall GDP in response to the COVID-19 pandemic.

Conclusion

Each research question addressed in this unstructured report looked at one aspect of the economic implications of the COVID-19 pandemic when comparing similarly influential global superpowers. It was fascinating to understand how although countries have similar resources and capabilities, their individual responses to the pandemic were drastically different. Initially, this was understood by looking at their COVID-19 case count, or percent of the population who had tested positive for COVID-19. Through the data illuminated in this unstructured report, it is evident that certain economic decisions or lack thereof also had a significant impact on these countries' outcomes in terms of whether or not they handled the pandemic in a "good" or "bad" way. A good way is ultimately fewer COVID-19 cases with limited economic decline, vs. a bad way being a high number of COVID-19 cases with severe economic decline.

In each one of my research questions, I addressed a question and compared a country considered to have an overall "good" response to the pandemic vs. a country with a "bad" response in terms of the number of cases and economic consequences. There were five key findings gathered from the five main research questions of this unstructured report. The first is that there was a significant difference in unemployment rates in France vs. the US during the time of the pandemic, and furthermore, the US's rates of unemployment actually increased, while France's remained on a steady decline. Secondly, countries with higher levels of general immunization, such as Japan, did not suffer as much economically as countries with lower levels of general immunization such as India. Thirdly, from creating plots and conducting an ANOVA test, it was clear that the US has spent more of its GDP on healthcare than China. Despite this, the United States suffered more economically and socially in response to the pandemic as they had more cases. Fourthly, the United State's Gross Fixed Capital Formation increased during the COVID-19 Pandemic. At the same time, China's decreased, suggesting that the US was focusing more on investments and generating income during the pandemic, whereas China was more concerned with reallocating its GDP into other areas. Finally, the results between Sweden and the US in terms of education reveal that the countries spent a significantly different amount of their GDP on education during the pandemic. In conclusion, it is possible to understand through economic factors how a country reacted to the COVID-19 pandemic, and whether or not this response was effective in terms of social factors, such as unemployment, or economic factors such as increases or decreases in the entire county's GDP.