Covid-19 Policies to the Economy Analysis

For the course of CS-GY 6513 Big Data

Team Member:

Han Xu   hx2163

Jindong Du   jd4573

Bojian Wang bw2197

Kaibo Zhang kz2111

Objective

Coronavirus disease 2019 (Covid-19) is a contagious disease caused by a virus and has a high mortality rate. The world has been affected for about three years. Vaccines are crucial to fighting the epidemic, but government response policies are more meaningful and important before the appearance of vaccines. We will analyze how these policies affect our daily life and economy. We aim to analyze the government's responsiveness to the pandemic and how the people cooperate with the government from the two perspectives: corresponding policies enforcement and mobility control.

Application

According to our analysis, we can make recommendations for the government on which corresponding policies are most effective and how to combat the covid-19 epidemic. Before COVID-19, most countries' pandemic responses were based on building urban structures designed to reduce people's risk of infection, but now we rely more on digital information sources, such as through smartphone apps(Google map) which means that the development of public health policy increasingly relies on big data. With the help of the Google mobility data set, we can analyze the degree to which people follow the government's policies or not.
To prevent future epidemic disasters, provide a reference for governments on how to respond to such disasters by adjusting policies. The government can also gain experience by dealing with future epidemics by studying how to fight this epidemic effectively.

Technologies

Mainly use Dask, plotly and Matplotlib

Key results

GDP is positively affected by the face-covering policy and the covid vaccination policy. The former has a 0.250567 impact and the latter has a 0.13877 impact. The 'stay at home' policy has a 0.646110 impact in Turkey and 0.100117 impact in Japan on the residential mobility change. The residential mobility change has a -0.685645 impact in Turkey and -0.720047 impact in Japan on quarterly GDP growth rate.

Data Description

World_GDP contains 48 countries' and 6 groups' quarterly GDP growth rate from 2018 to 2021[1].

In all the policy responses about covid[2], we selected several policies that are significantly related to the economy, including Covid-vaccination-policy, Face-covering-policies-covid, Income-support-covid, Public-Transport-covid, School-Closures-covid, Stay-at-Home-covid, and Stringency-Index. Data include 'Entity' showing countries names, 'Code' showing countries' three letter symbols, 'Day' showing corresponding days, and response policy showing severity of policy from 0 as none to 4 as the most severe. However, Covid's vaccination policy is 0-5 instead.

In the mobility datasets, the data includes 7 aspects[3]:
'country_region_code' shows countries' two letter symbols.
'retail_and_recreation_percent_change_from_baseline' shows the mobility trends for places like restaurants, cafes, shopping centers, theme parks, museums, libraries, and movie theaters.
'grocery_and_pharmacy_percent_change_from_baseline' shows the mobility trends for places like grocery markets, food warehouses, farmers markets, specialty food shops, drug stores, and pharmacies.
'parks_percent_change_from_baseline' shows the mobility trends for places like national parks, public beaches, marinas, dog parks, plazas, and public gardens.
'transit_stations_percent_change_from_baseline' shows the mobility trends for places like public transport hubs such as subway, bus, and train stations.
'workplaces_percent_change_from_baseline' shows the mobility trends for places of work.
'residential_percent_change_from_baseline' shows the mobility trends for places of residence.

Data Cleaning

For the World_GDP dataset, LOCATION, TIME, and VALUE were the three columns selected. Following that, we removed the unnecessary years from our analysis, leaving only the years 2020 to 2021, and filtered out the 6 groups' data.
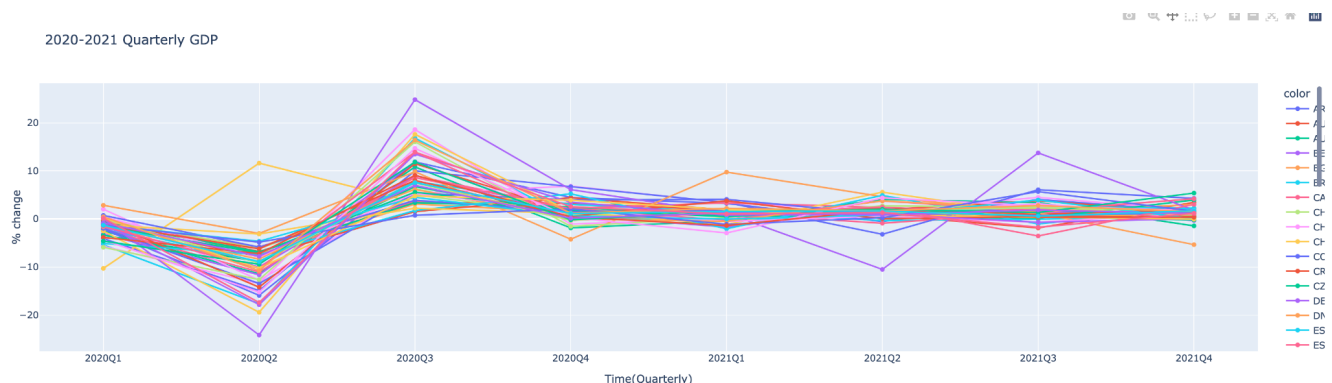
The above graph shows that most of the countries have a similar pattern, except that China has an increase from 2020Q1 to 2020Q2. Due to the first case being identified in Wuhan, China in December 2019, China adopted Covid pandemic early on.

For the policy responses data, we first convert it to a quarterly range by taking the mean of the quarterly data. Then selecting the corresponding columns from each corresponding policy and combining them with GDP quarterly growth rate. After combining the data, we filtered out the country that either contains null information or it does not have full two year quarterly data. For some countries, we cannot find their GDP quarterly data. The only country that does not have quarterly GDP figures for two years is Russia. It may have been affected by the Ukraine war since it missed the 2021-Q4 data. For consistency and integrity of the data, we decided not to include Russian in the combination dataset.

For the mobility datasets, we first load the data in mobility changes by year for five typical countries, then concatenate the data for each country in chronological order. For the column 'Date', we convert its type from String to Datetime. Then we filter out the data where 'sub_region_1' is NaN, that represents the mobility data for the whole country and drop some unuseful columns. Lastly, we fill all NaN values in the datasets as 0.

Data Exploration

In order to analyze the data, we first rank each country according to the average GDP quarterly growth rate between 2020 Q1 and 2021 Q4.
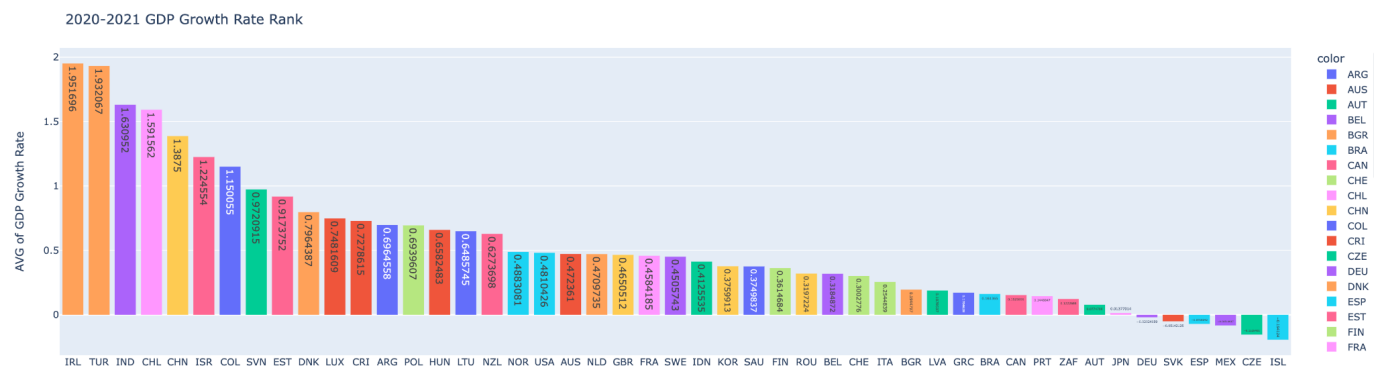

In this dataset, most of the countries' average quarterly growth rate during these two years has a positive growth rate, except for several countries.

Each policy was ranked based on a two-year average to see which country implemented it the most effectively.
As can be seen from the below figure, Mexico, India, Italy, and Turkey all have strong mask policies, with an average of more than 3. On the contrary, some countries such as Sweden, Japan, and Finland have very low mask policies, all below 1. They also have a low GDP growth rate.

2020-2021 Facial Coverings Policy Rank
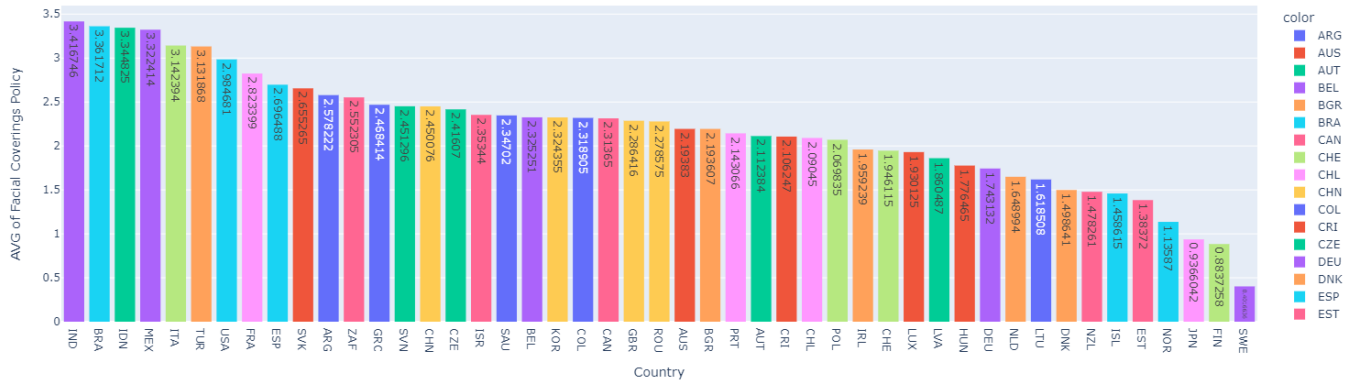
In terms of income support, the top five are all European countries. In some Asian countries, income support is relatively poor.

2020-2021 Income Support Policy Rank
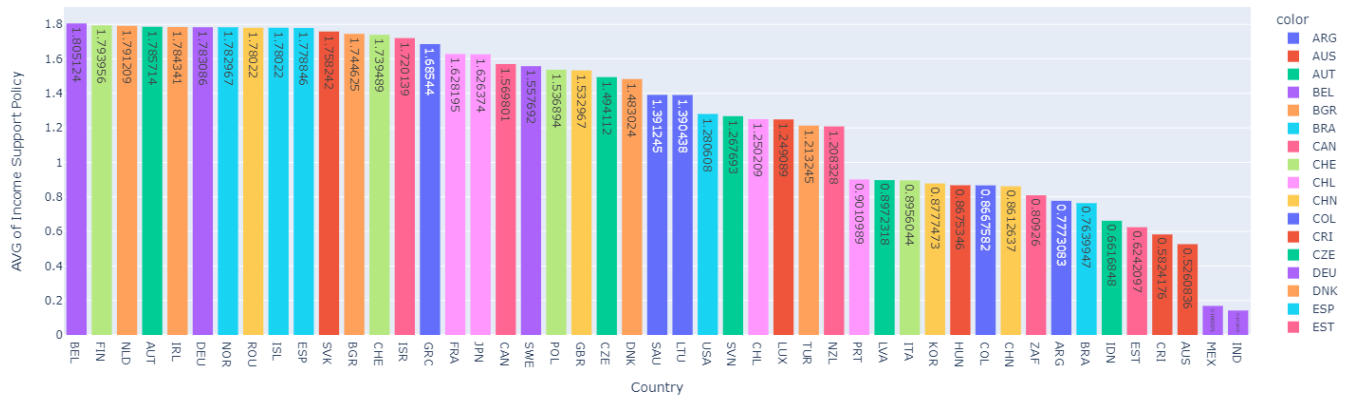
Regarding school closure policies, many countries pay more attention to young people, such as Saudi Arabia, China, and Canada


2020-2021 School Closures Policy Rank

We can see that most countries have a strong enforcement on the vaccination policy, the average is about 2. Even for some negative GDP growth rate countries like Israel, they also promote vaccination strongly.


2020-2021 Vaccination Policy Rank

As shown in the graphs below, most developed countries have a low enforcement rate for the public transport restriction. This may be due to the fact that private cars are the main mode of transportation. The control of public transportation is very strict in developing countries like Argentina, Brazil, China, and Greece, all ranked low on the human development index.

2020-2021 Close Public Transport Policy Rank


human_development_index Rank
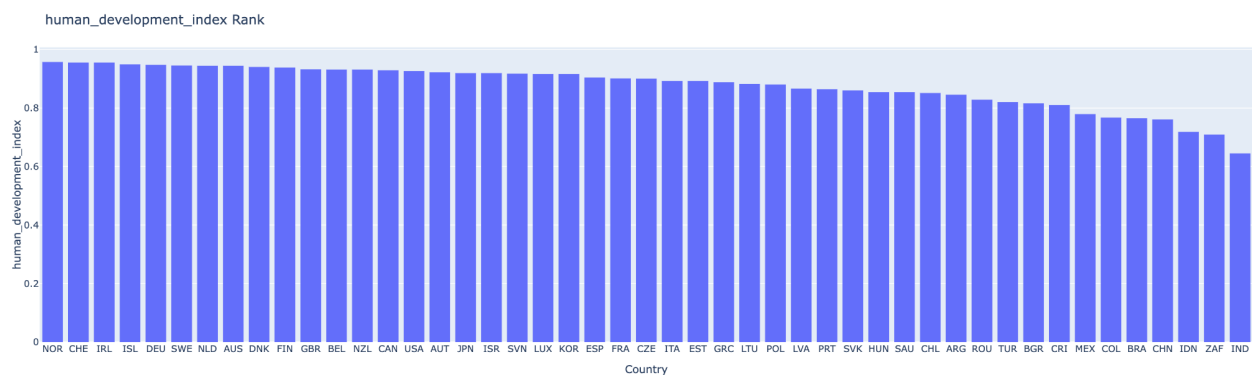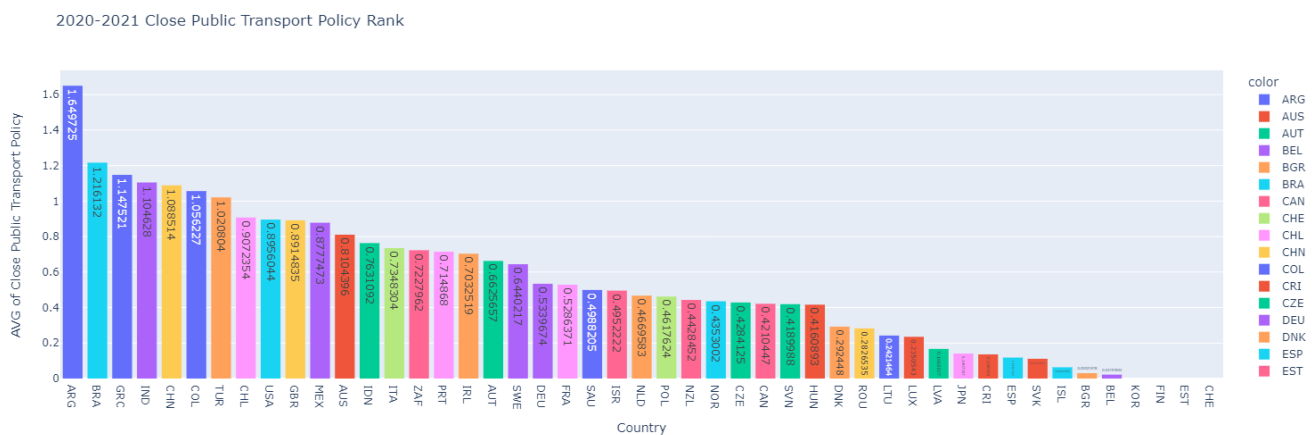
We can see that no country has the strictest implementation of every policy, but for the country which has ranked the top in the GDP growth rate, their implementation of each policy is strong, such as China, Turkey, USA and so on. There are some outliers like Ireland, it has the top GDP growth rate, but their enforcement of each policy is weak. This may because Ireland has been less affected by the Covid.

To observe the effect of mobility, we choose four aspects in the datasets, which are park mobility changes, residential mobility changes, workplace mobility changes, and grocery mobility changes. From the figure of park mobility changes, we can see that the park mobility varies seasonally. The park mobility increases significantly in the warmer months. In the cold season, park mobility is the same as previous.

figure: parks mobility change in US, GB, JP, CA, and TR
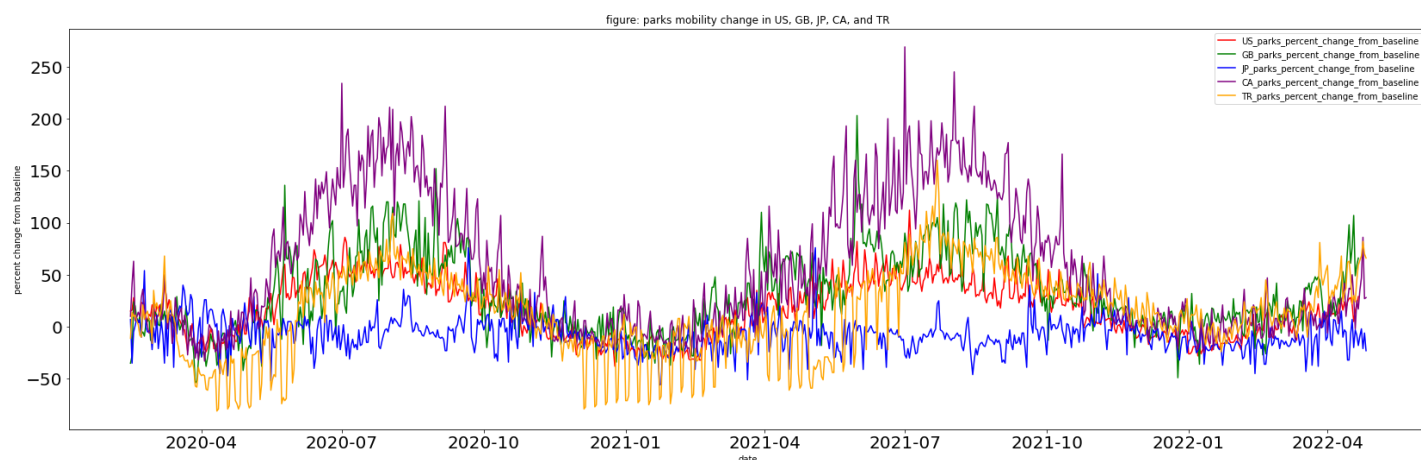
From the figure of residential mobility changes, we can see that the residential mobility in the United States, Great Britain and Canada consistently trending greater than zero due to the stay at home policy, especially in July 2020 and July 2021, the two outbreaks of Covid-19. The changes of Japan and Turkey float above and below the baseline.

figure: residential mobility change in US, GB, JP, CA, and TR
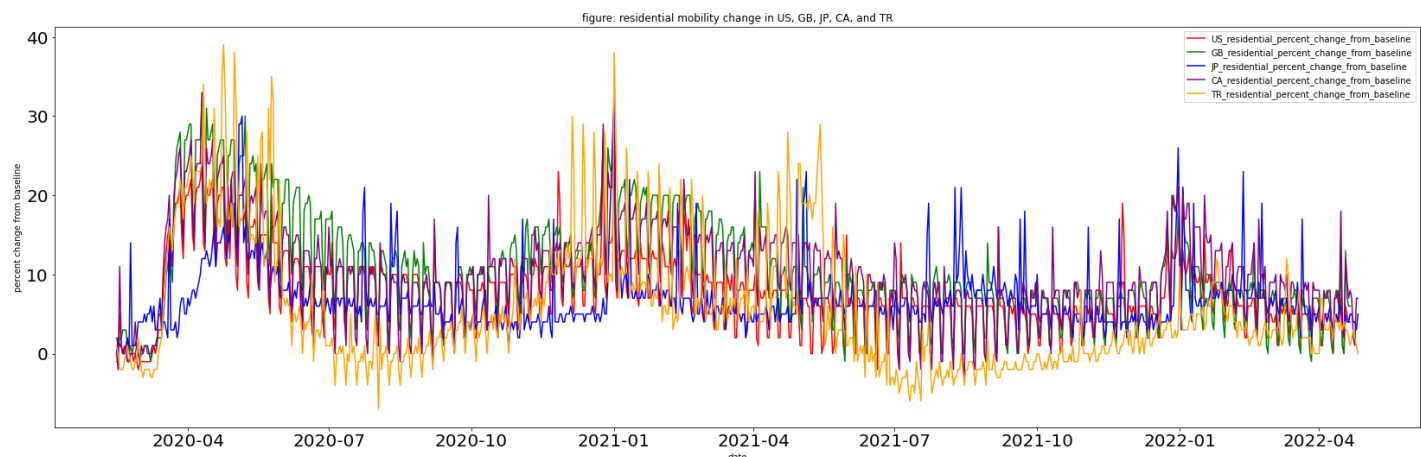
From the figure below, we can see that the mobility of the workplace has declined significantly in all five countries. Some countries even dropped by 80% in April 2020. The main reason is that at the start of the Covid-19 epidemic, to avoid people gathering, many countries advocated working from home, which has led to a significant decrease of the population of the workplace.

figure: workplaces mobility change in US, GB, JP, CA, and TR
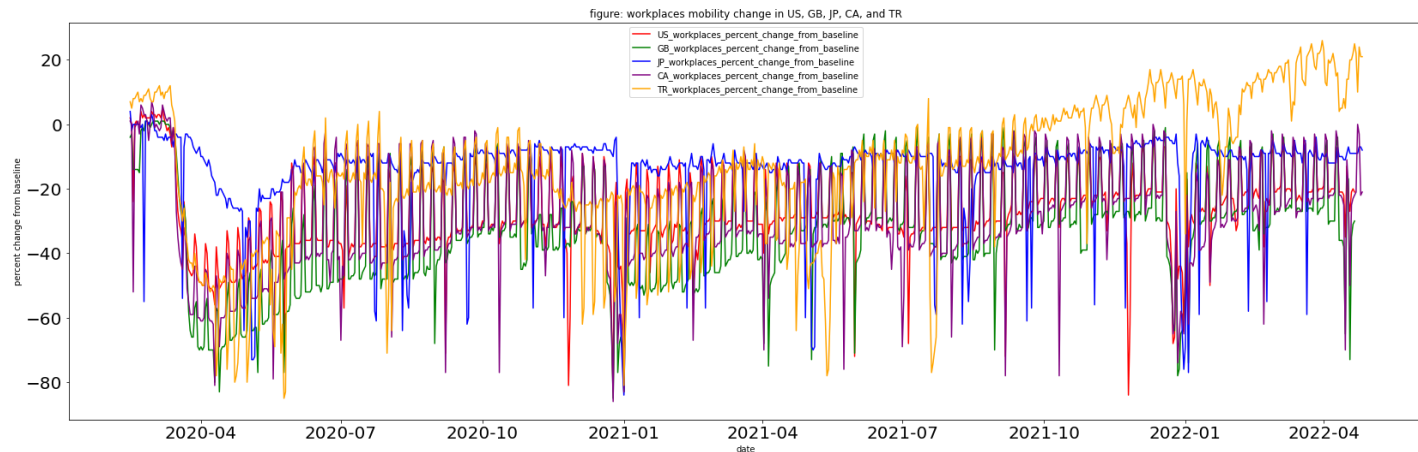
From the figure of grocery mobility changes, we can see that the grocery mobility showed a slight decrease at the beginning of the outbreak. Then the data in Turkey has a growth of fifty percent than baseline. The changes of other four countries float above and below the baseline because grocery is the basic need in people's daily life.

figure: grocery mobility change in US, GB, JP, CA, and TR
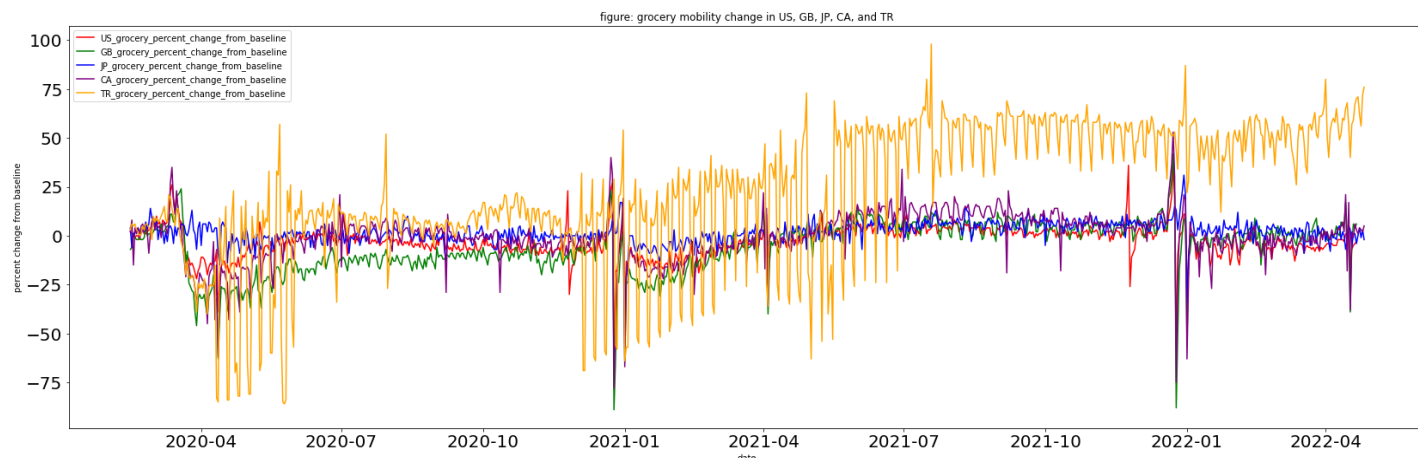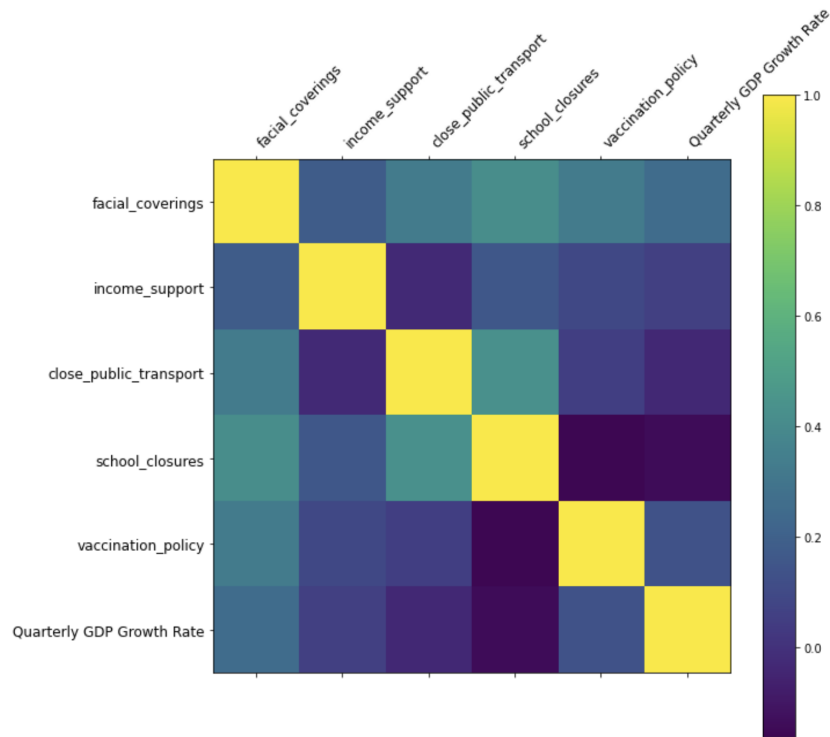
Correlation Study

The correlation matrix was composed on the dataset that combines GDP quarterly growth rate with selected policies. From the above correlation study, the top 2 important policies for supporting a positive quarterly GDP growth rate are: 'facial_coverings' and 'vaccination_policy'. One interesting finding is that, with significant 'income_support' should have a positive correlation with GDP growth rate, because this may stimulate consumptions. There is no significant correlation between the two, perhaps due to the severity of the economic impact of Covid-19, and the levels of income support are too low in some countries to have a positive impact on the economy.
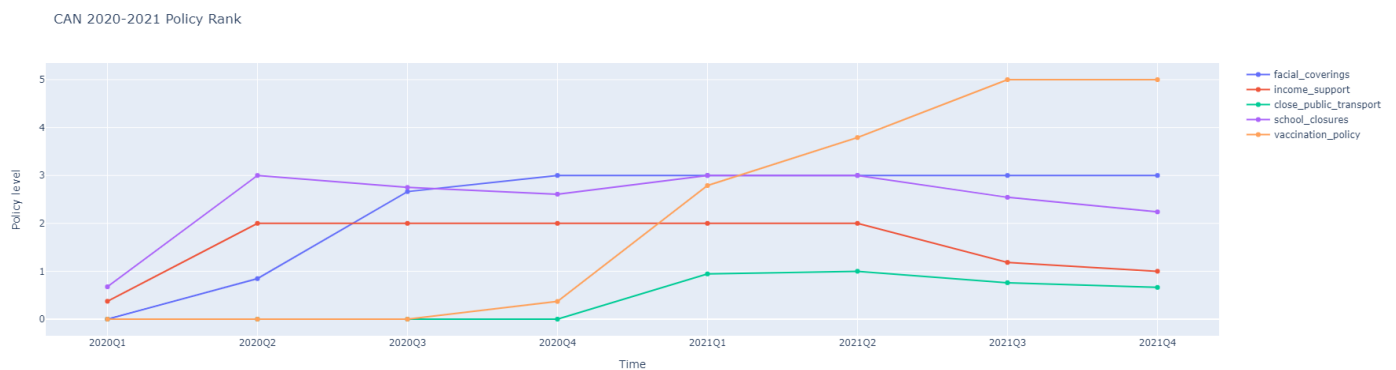
Policy Analysis:

Turkey has the second highest GDP growth rate during the Covid pandemic. They have the highest facial covering policy at all times. Despite the easing of the epidemic around the globe in 2021, masks are still strictly enforced. This shows that their government attaches great importance to epidemic prevention.

TUR 2020-2021 Policy Rank
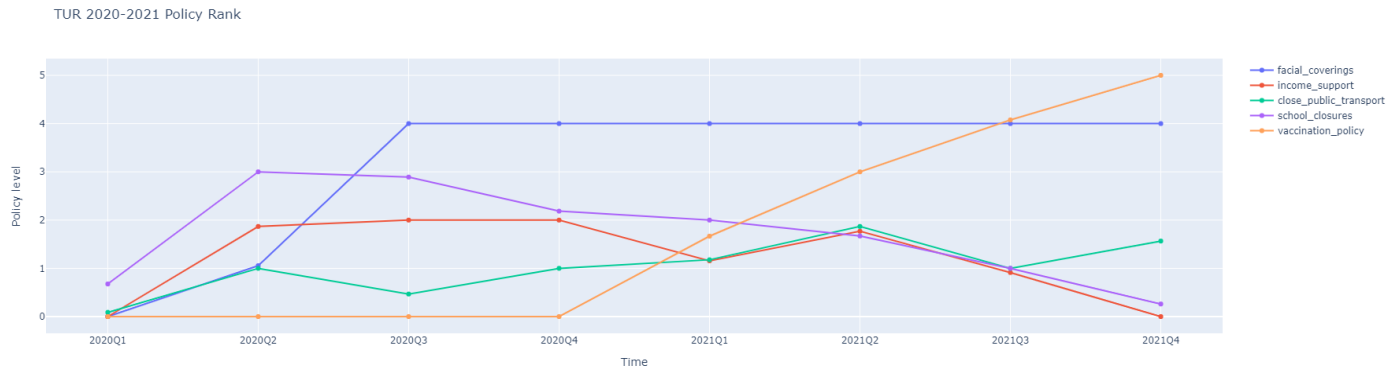
For the USA, it has an approximate 0.5% two year average GDP growth rate in the mid-tier. The enforcement of all the policies are strong. The severity of the mask policy has been maintained at above 3, school closure police was also strictly enforced for a long time. This shows that the U.S. government also attaches great importance to the control and prevention of the epidemic.

USA 2020-2021 Policy Rank
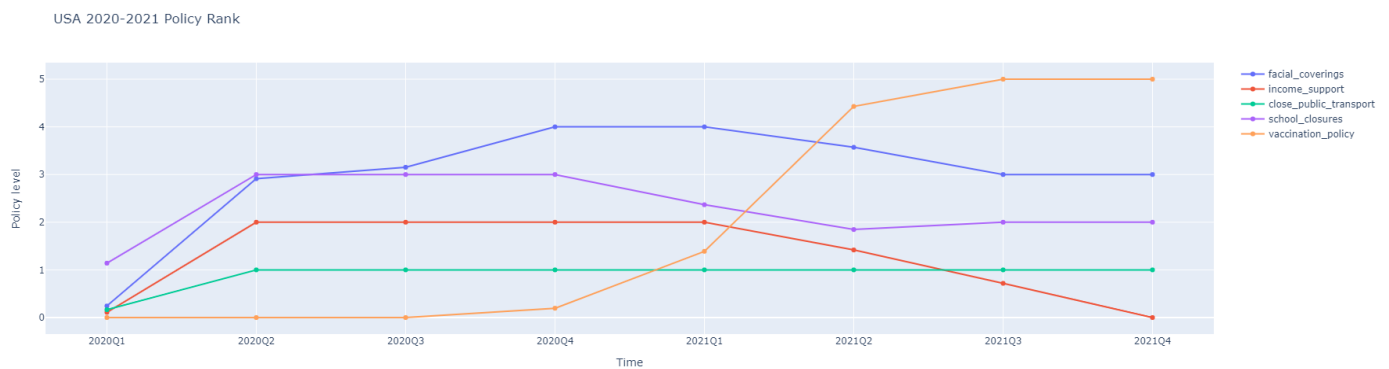
Canada is an example of a lower mid-tier GDP growth rate country. Their government pays more attention to the mask and school closure policies, but the severity of the other policies was lower.

CAN 2020-2021 Policy Rank

Japan, as a country with a relatively low GDP growth ranking during the epidemic,we try to understand what causes their economy through their policy analysis. Compared with the severity of policies in other countries, we can see that the Japanese government doesn't pay much attention to control of each policy, most severity are below 2. The Japanese government's negative response to the epidemic plus they also hosted the Tokyo 2020 Olympic Games during the epidemic. Due to the covid epidemic, people were restricted from traveling, and without enough travelers, the Olympic Games may negatively impact Japan's GDP. However, low GDP could be caused by other factors, we will discuss more in the mobility section.


JPN 2020-2021 Policy Rank
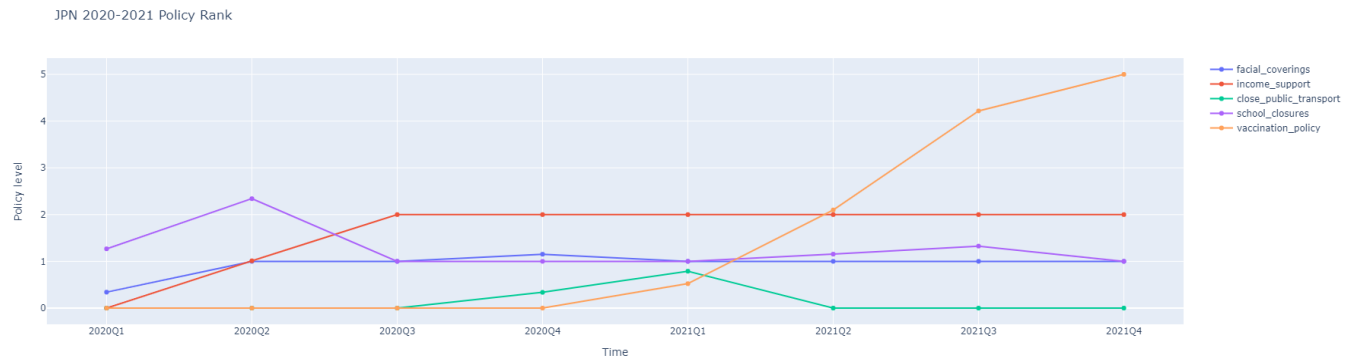
Mobility Analysis:

To research how policies influence mobility, we select two typical countries, Turkey and Japan. From the above research, we can see Turkey had the second highest GDP growth rate during the Covid pandemic and Japan's GDP growth has been negative which is the worst performance in the developed countries. By studying these two countries, we expect to find the pattern of how the policies influence the mobility, and subsequently affect the GDP growth rate.

Turkey:

The figure below shows the mobility changes of transit station, parks, residential, and workplace in Turkey from 2020 to 2022. From the figure, we can see that there is a significant drop in residential and workplace mobility at the beginning due to the policies issued to prevent the spread of COVID-19. People in Turkey are highly cooperative with the government. With the strengthening of vaccine policy and weakening of the closure policy since 2021, the transit station and workplace mobility gradually rebound to pre-pandemic levels.

Turkey 2020-2022 Mobility change
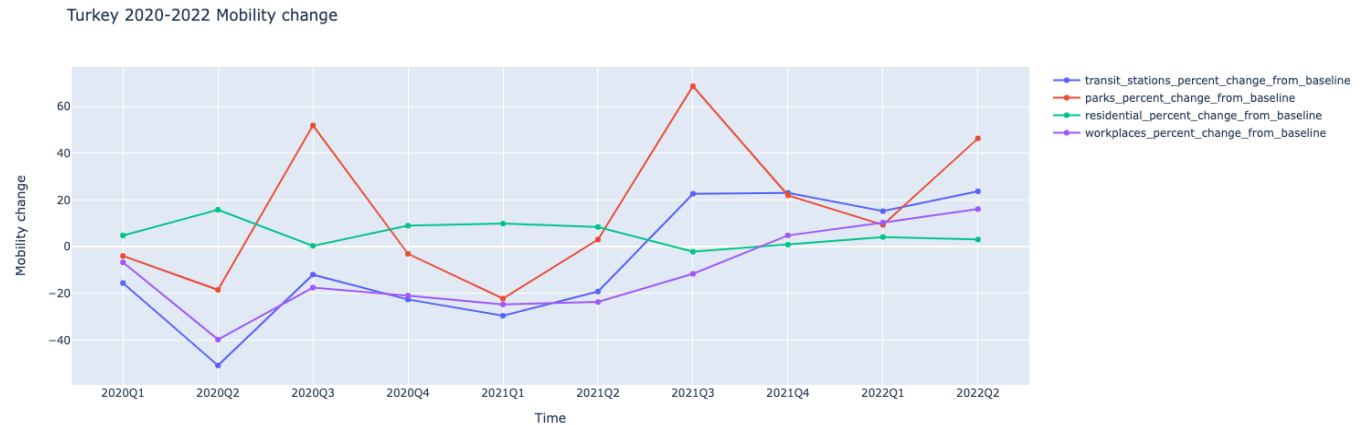
The correlation matrix was composed on the dataset that combines policies index with mobility changes in Turkey. From the correlation study, we can see that 'stay_home_requirement' has a very strong positive correlation with residential and strong negative correlation with transit and parks. People prefer to follow the policy and choose to stay at home rather than go out. The 'school_closures' policy is also positively related to the mobility of residents. From the above research, we can find that the government of Turkey has set strict policies and people actively comply with these policies at the same time.


How policies influence mobility (Turkey)
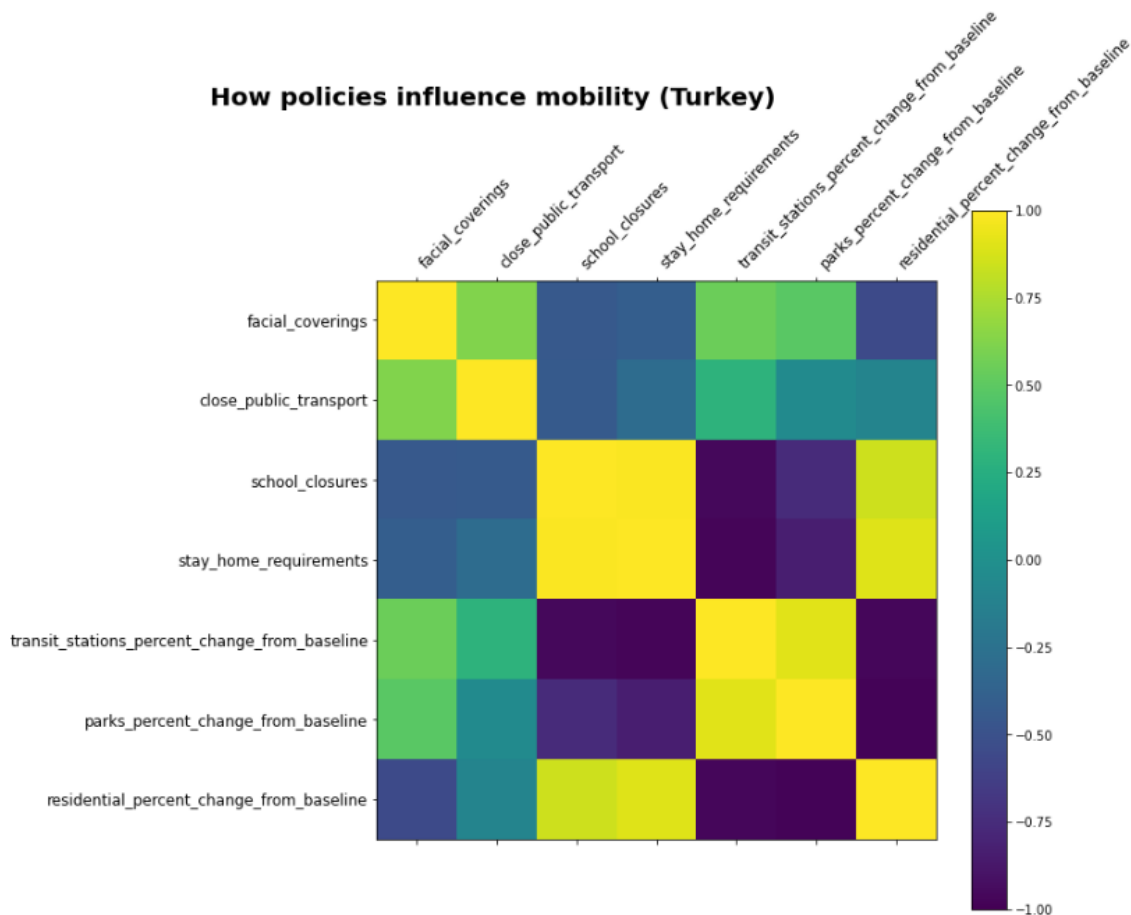
Japan:

The figure below shows the mobility changes of four different types of areas in Japan from 2020 to 2022. From this line chart, we can find that since the beginning of the Covid-19 epidemic, there has been a significant reduction in mobility in places other than residential areas. The mobility of residential areas has slightly increased. These mobility changes accord with the policy expectation, but they are more stable than those in Turkey. Combining this with the policy rank chart, we can find that no matter how the epidemic trend changed, the attitude of Japanese residents towards the epidemic is relatively more conservative.

Japan 2020-2022 Mobility change
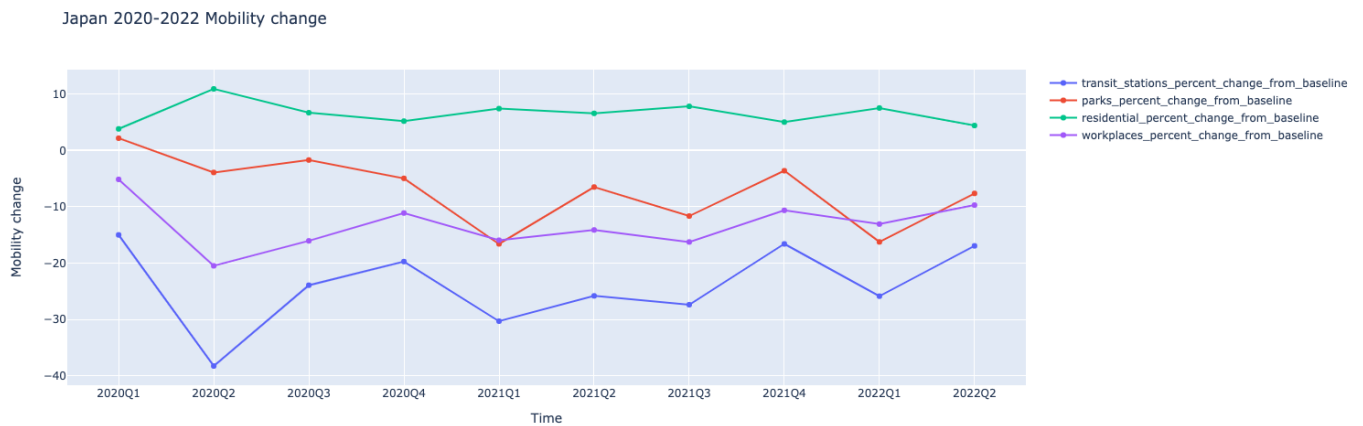
The correlation matrix was composed on the dataset that mobility changes in different places with selected policies. From the correlation study below, we find the 'close_public_transport' policy is positively related to the mobility of transit stations. 'stay_home_requirements' and 'school_closures' policies are also positively related to the mobility of residential areas, which restricts residents' daily lives. This result indicates that these policies are also well implemented in Japan even though its policy rank is lower than Turkey, and have a great impact on the Japanese residents' daily lives. Therefore, we can conclude that a good implementation of policies for Covid-19 affects Japanese residents' daily life a lot.

How policies influence mobility (Japan)
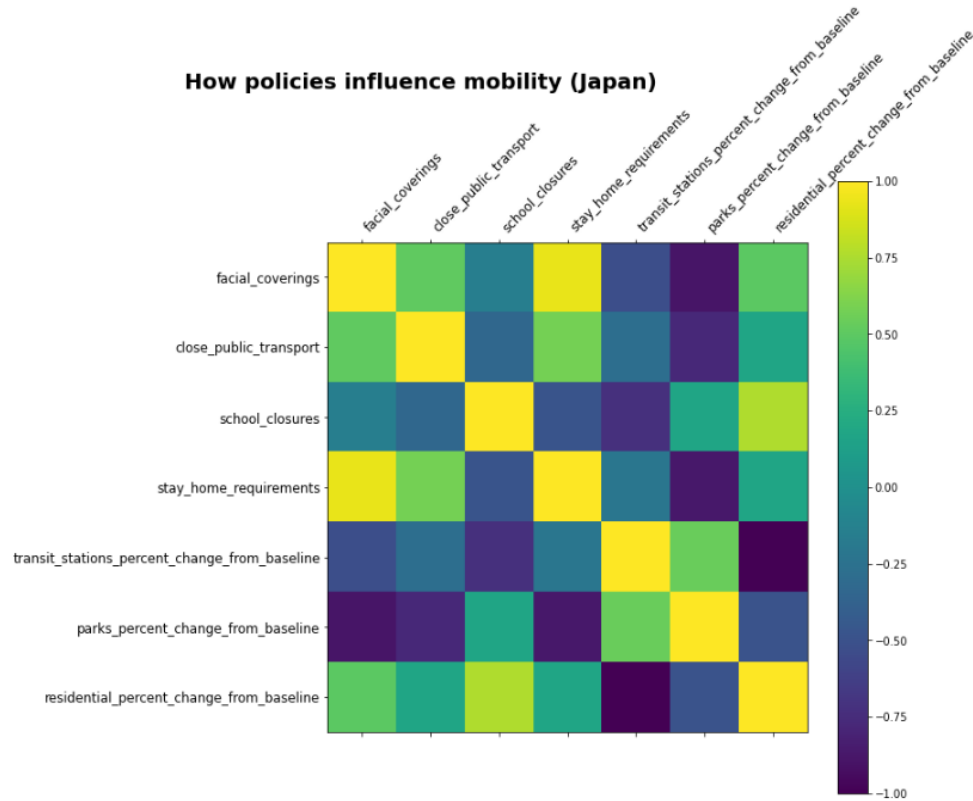
Mobility Impacts:

From the above study about the impacts of these two countries' policies on mobility changes, we can see that although the policy ranks are different in these two countries, their policies are well implemented and restrict the daily lives of residents for both countries. Now, we focus on the relation of mobility changes and GDP growth rate to explore how mobility change affects GDP growth rate.

Turkey:

The correlation matrix was composed on the dataset that combines mobility changes in different areas with GDP growth in Turkey. From the matrix figure, we can see that the mobility changes of transit stations, parks, workplaces, and grocery stores have a very strong positive correlation to GDP growth. The mobility change of residential data has a very strong negative correlation to GDP growth. From the research above, we find that the strong implementation of each policy mitigates the impact of the pandemic and makes economic positive correlation mobility data recover quickly after the impact. The transit station and workplace mobility in Turkey gradually rebound to pre-pandemic levels or even better. Thus, Turkey has better GDP growth data in the world.

Mobility to GDP in Turkey
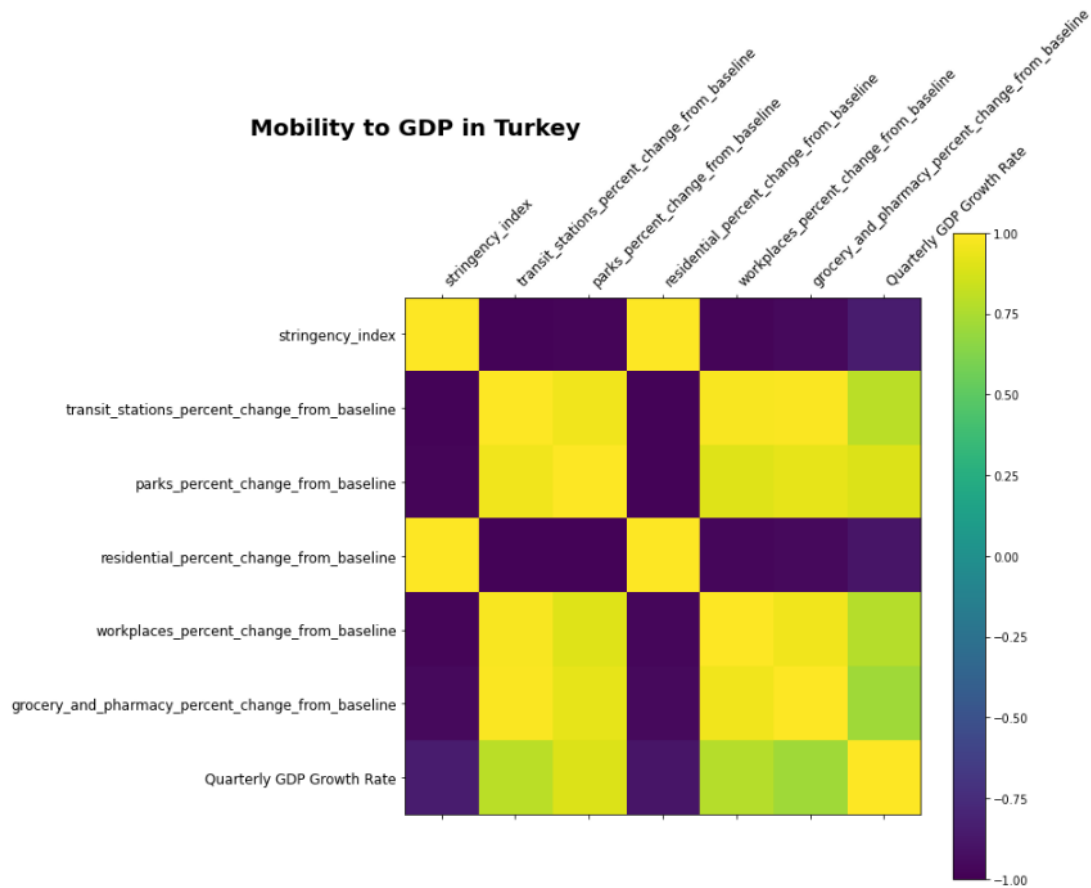
Japan:

The correlation matrix below was composed of the dataset that combines mobility changes in different areas with quarterly GDP growth rate in Japan. In this correlation matrix, we find the mobility changes of transit stations, parks, workplaces, and grocery stores are positively related to the GDP growth rate. Among these areas, transit stations have the highest correlation with GDP growth rate. However, the mobility change of residential areas has a strong negative correlation with GDP growth rate. Thus, from the study of this correlation matrix, we can obtain a pattern that the growth of mobility in outdoor areas will stimulate the growth rate of GDP, but the growth of mobility in residential areas will inhibit the growth rate of GDP. Combining its epidemic prevention policy and the Japanese residents' conservative attitude towards the epidemic, we can find that an important reason for the relatively low ranking of its GDP growth rate is that the mobility of the entire society has declined, resulting in a reduction in economic activities.

Mobility to GDP in Japan

Conclusion:

There is a world of difference between the Turkish government and the Japanese government in their attitudes towards the Covid-19. According to our analysis of the above two aspects, the level of seriousness demonstrated by the government's enforcement of its response policies to COVID-19 and the level of cooperation shown by the residence mobility. The enforcement of relevant policies will have a positive effect, but this also needs people to cooperate. Our example shows that the Turkish government attaches significant importance to the epidemic and has enforced relevant policies, and that the population is highly cooperative with the government, resulting in a high GDP growth rate. In contrast, the Japanese government did not treat the Covid-19 pandemic seriously enough, but the Japanese people spontaneously reacted positively, which did not positively affect GDP enough. Also, the Japanese government's insistence on hosting the Olympics during the epidemic can also reflect they don't take viruses seriously.

The government's understanding is more comprehensive and capable of making more scientific judgments, which can be more adaptive. Individuals may work hard, but they lack enough data and scientific knowledge. Therefore, when it comes to dealing with the epidemic, the government's decisions play a key role, but without the cooperation of the masses it cannot succeed.

Dataset:

1. **World GDP** :

   https://data.oecd.org/gdp/quarterly-gdp.htm#indicator-chart ("GDP and spending - Quarterly GDP")

2. **Covid-vaccination-policy, Face-covering-policies-covid, income-support-covid, public-transport-covid, school-closures-covid, stay-at-home-covid and owid-covid-data:**

   https://ourworldindata.org/policy-responses-covid

3. **Google Mobility Trends(corresponding countries):**

   https://www.google.com/covid19/mobility/

4. **United States COVID-19 Cases and Deaths by State over Time:**

   https://data.cdc.gov/Case-Surveillance/United-States-COVID-19-Cases-and-Deaths-by-State-o/9mfq-cb36

5. **COVID-19 Vaccinations in the United States:**

   https://data.cdc.gov/Vaccinations/COVID-19-Vaccinations-in-the-United-States-Jurisdi/unsk-b7fc