Section 4. World economy

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COVID IMPACT ON GLOBAL ECONOMY

Abstract. Millions of people lost their jobs and small businesses, hospitals and medical care professionals experienced unprecedented hardships, children all over the world face the loss of family members and the psychological consequences of the isolation from remote learning… just to name a few aftermath caused by the pandemic. This paper aims to draw insights from analyzing the pandemic data. The data used in this study includes 210 countries concerning the impact of covid-19 on the global economy. 6 feature indicators including 4 economic indicators and COVID-19 Total Cases (TC) and Total Deaths (TD). The economic indicators are Human Development Index (HDI), Stringency Index (STI), Population (POP), and Gross Domestic Product per capita (GDPCAP). The Organization for Economic Co-operation and Development (OECD) unemployment data is also included in the analysis, which includes 38 member countries' unemployment values from January 2020 to October 2020. From these key dimensions of global development, lessons can be learned to aid government officials in response to future pandemics.

Keywords: Covid19, economic indicator, impact, employment, global economy.

1. Introduction

The COVID-19 pandemic disrupted almost every corner of the world in countless ways for the past two and half years. Millions of people lost their jobs and small businesses, hospitals and medical care professionals experienced unprecedented hardships, many children all over the world face the loss of family members and the psychological consequences of the isolation from remote learning… just to name a few. While we can't solve or alleviate any of these problems by looking back at the pandemic data, insights and lessons for the future can be drawn by harvesting the power of data.

The data used in this study includes 210 countries concerning the impact of covid-19 on the global economy. 50418 data entries and 6 feature indicators including 4 economic indicators and COVID-19 Total Cases (TC) and Total Deaths (TD). The economic indicators are Human Development Index (HDI), Stringency Index (STI), Population (POP), and Gross Domestic Product per capita (GDPCAP). The HDI is the composite statistic of life expectancy, education, literacy, and income indices used to rank countries into four stages of human development.

The stringency Index represents the systematically collected information on several different common policy responses governments have taken, measured, and aggregated. STI is a composite measure of nine of the response metrics calculated by The Oxford Coronavirus Government Response Tracker (OxCGRT) project. The metrics include school closures; workplace closures; cancellation

of public events; restrictions on public gatherings; closures of public transport; stay-at-home requirements; public information campaigns; restrictions on internal movements; and international travel controls.

The Organization for Economic Co-operation and Development (OECD) unemployment data is also included in the analysis, which includes 38 member countries' unemployment values from January 2020 to October 2020. The OECD is a group of developed countries with high HDI that commit to democracy and market economy intending to stimulate economic progress and world trade.

Although we can't paint a complete picture of the world with only these economic indicators, financial hardship is an integral part of people's suffering and an important metric for governments' performances.

2. Data analysis and Results

The data (.csv file) is imported as a DataFrame using Python programming language. Figure 1 shows the result from the.info() function from the Pandas library. The HDI column has 6202 null values according to figure 1. No obvious missing values in other columns and three columns have object data types while the rest are all numeric. Figure 2 visualizes the dispersed missing values in the HDI column.

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 50418 entries, 0 to 50417
Data columns (total 9 columns):
 #   Column   Non-Null Count   Dtype
---  ------   --------------   -----
 0   CODE     50418 non-null   object
 1   COUNTRY  50418 non-null   object
 2   DATE     50418 non-null   object
 3   HDI      44216 non-null   float64
 4   TC       50418 non-null   float64
 5   TD       50418 non-null   float64
 6   STI      50418 non-null   float64
 7   POP      50418 non-null   float64
 8   GDPCAP   50418 non-null   float64
dtypes: float64(6), object(3)
memory usage: 3.5+ MB
```

Figure 1. Information of the dataset

To aid the further investigation, the DATE column was transferred to the Date Time type using the to_datetime function from the Pandas library. The time frame of the dataset is from 2019–12–31 to 2020–10–19. The month information is extracted and formed a new column called "MONTH".
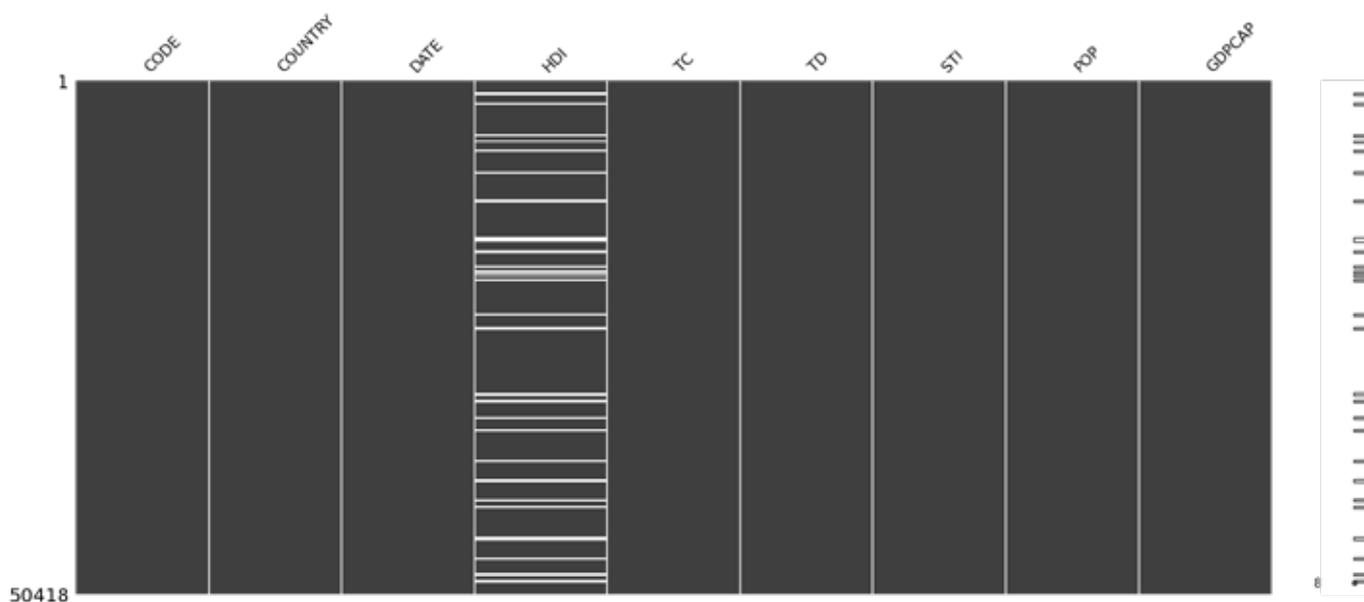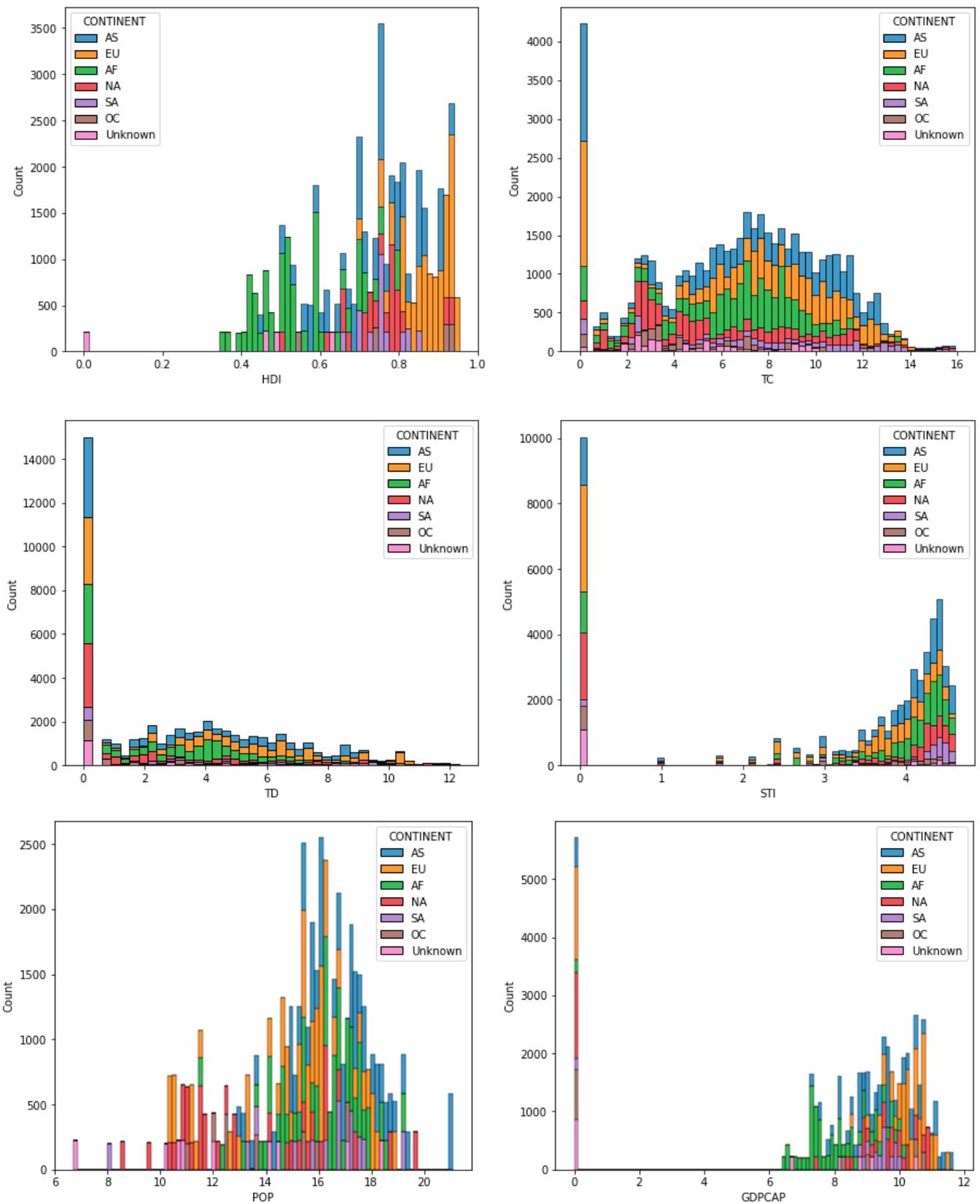

Figure 2. Missing values in the dataset

Figure 3. Histograms of each feature, color-coded by continent

With the pycountry_convert library, continent information was created from each country name. The following countries resulted in an "Unknown" continent: 'Bonaire Sint Eustatius and Saba', «Cote d'Ivoire», 'Curacao', 'Democratic Republic of Congo', 'Faeroe Islands', 'Kosovo', 'Sint Maarten (Dutch part)', 'Timor', 'Vatican'.

Figure 3 shows the histograms for every feature column in "stacked" mode color-coded by the Continent. Histograms visualize the distribution of data

with the x-axis being the "bins" and the y-axis is the count of observance for the data that fall inside each range (bin). Missing values are omitted in the histograms. In the HDI histogram, a small amount of "Unknown" Continent data is close to zero which means potential missing data as well. The same conclusion can be drawn for the STI and GDPCAP columns according to the COVID-19 stringency index data from Our World in Data and the GDP per capita data from the World Bank.
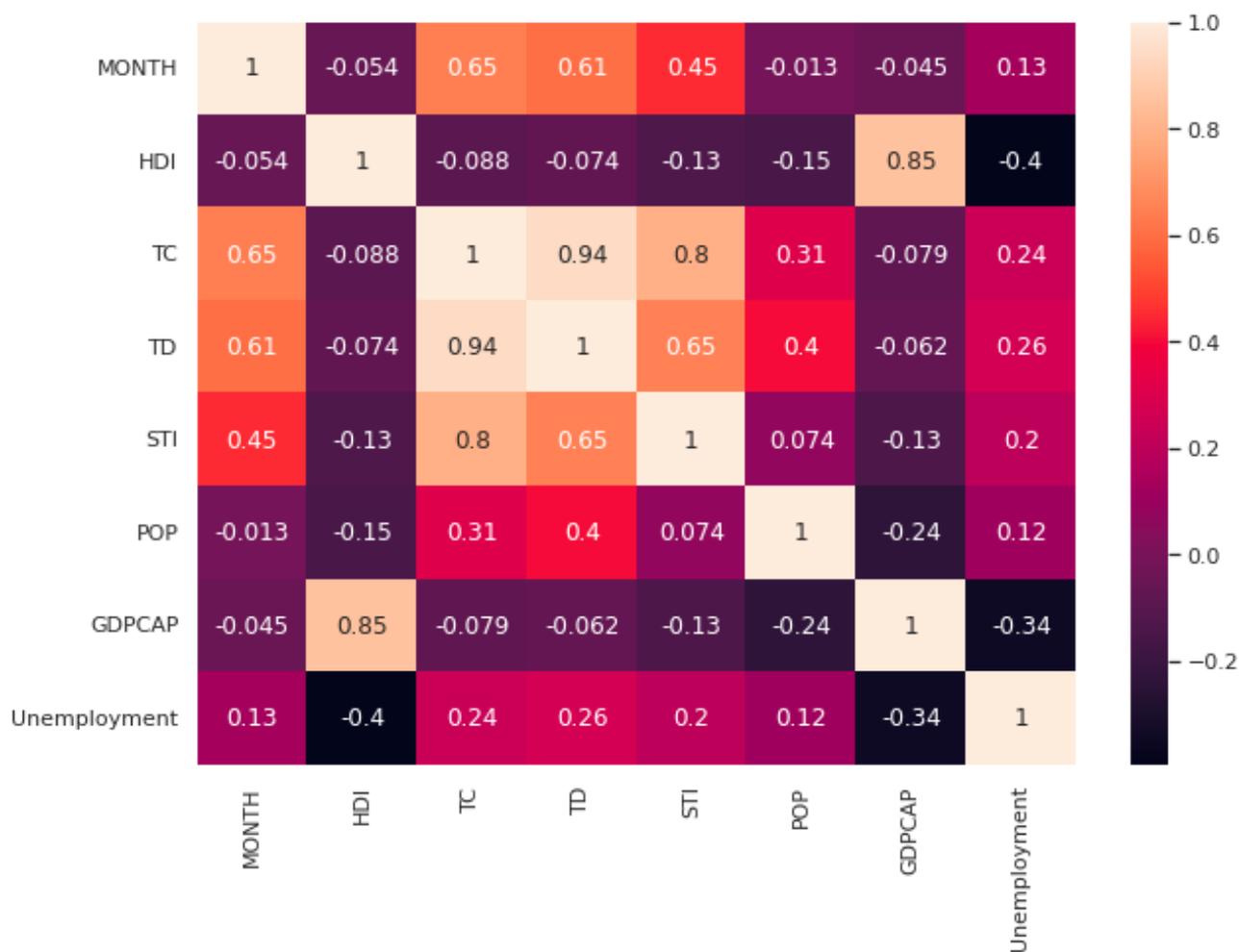

Figure 4. Heatmap of the correlation matrix of the features

After merging the unemployment data with the previous DataFrame, the correlation matrix can be calculated and shown as a heat map in figure 4. A heat map is a visualization tool that uses color intensity to represent the magnitude of numbers. From figure 4, HDI and GDP per capita are highly correlated with

a correlation coefficient of 0.85. Total cases and total deaths, total cases, and STI are highly correlated as well. TD and STI, POP and TC, POP and TD, POP and STI, POP and GDPCAP, GDP and TD are all moderately correlated. HDI and unemployment, GDPCAP, and unemployment are negatively correlated.
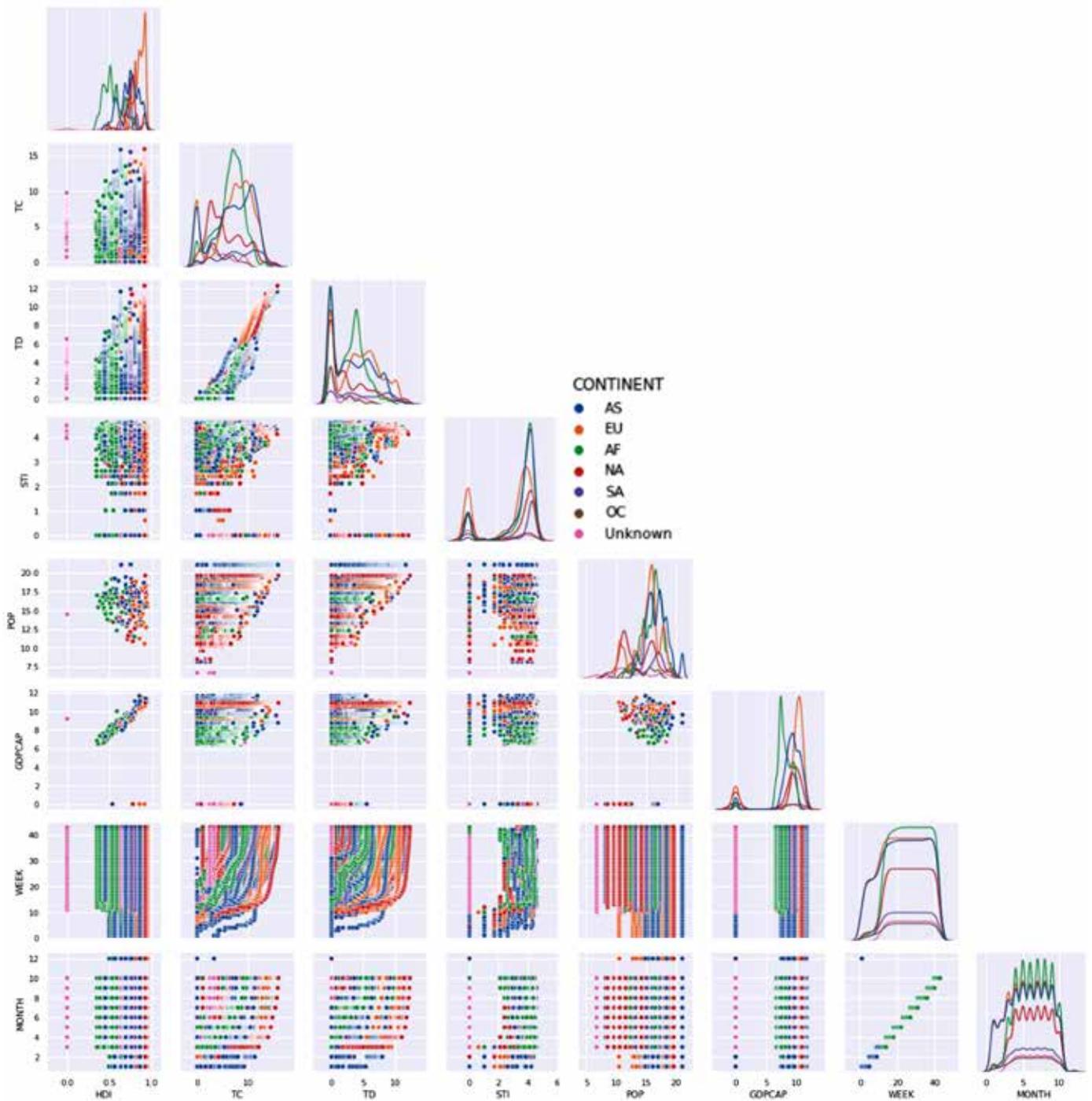
Figure 5. Pair plot of features to show pair-wise relations

HDI (human development index)

Figure 5 shows the pairwise relationships between each feature column. It is color-coded by the continent column as well. TC and TD, GDPCAP and HDI both have a linear relationship with each other.

After dropping missing values in the HDI column, 182 countries remained. The index also stayed constant during the time frame in the dataset. From figure 6, the top 5 countries with the highest HDI are Germany, Ireland, Australia, Switzerland, Nor-

way; the bottom 5 countries with the lowest HDI are Kosovo, Niger, Central African Republic, South Sudan, Chad.

Figures 7, 8, 9, 10, 12, 14, 15, 16, 17 are generated by the lineplot() function from the Seaborn library which automatically calculates the average value of the y-axis at any given point on the x-axis and generates a colored range for the y values.

Figure 7 shows that European countries have the highest average HDI, the second-highest continent is Australia. The lowest HDI continent is the "Unknown" category.

	CODE	COUNTRY	CONTINENT	HDI
25104	OWID_KOS	Kosovo	Unknown	0.000
33784	NER	Niger	AF	0.354
9180	CAF	Central African Republic	AF	0.367
42568	SSD	South Sudan	AF	0.388
9398	TCD	Chad	AF	0.404
...	...	...	...	...
17652	DEU	Germany	EU	0.936
22604	IRL	Ireland	EU	0.938
2434	AUS	Australia	OC	0.939
44296	CHE	Switzerland	EU	0.944
34494	NOR	Norway	EU	0.953

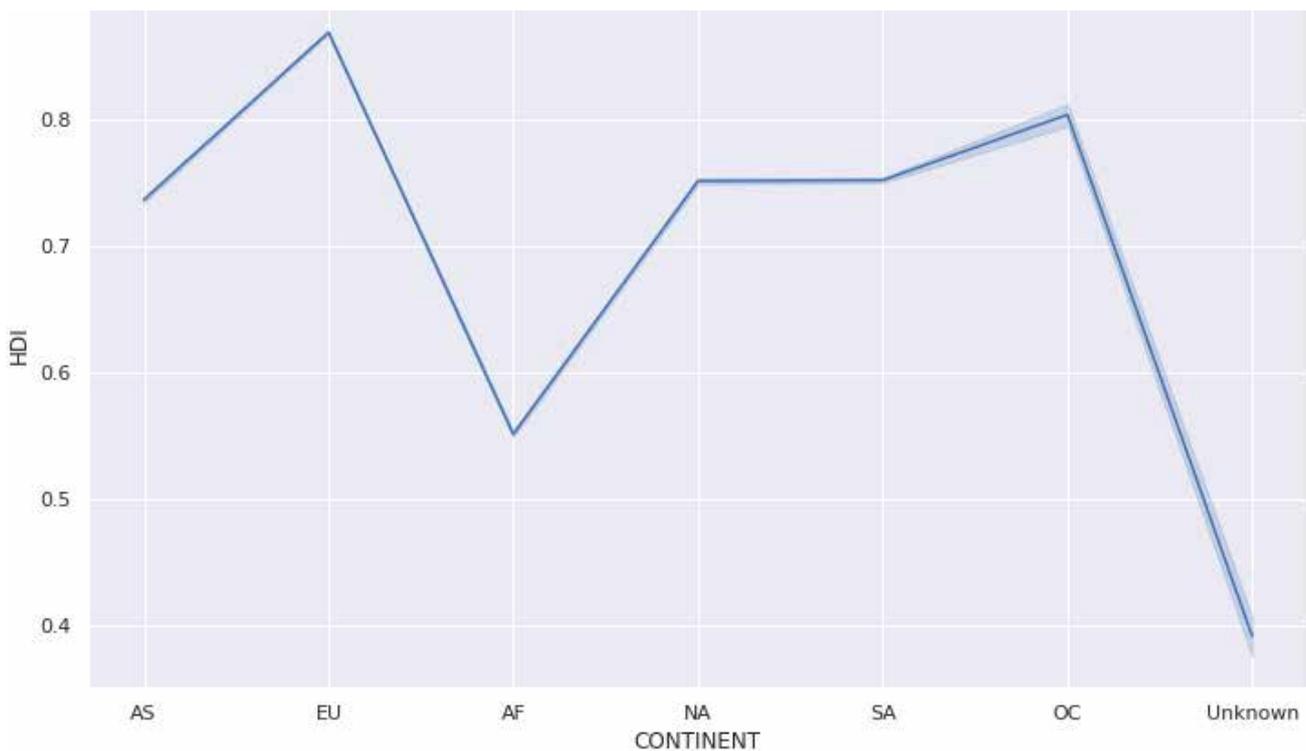Figure 6. Top 5 and bottom 5 countries ranked by HDI

Figure 7. Line plot of HDI in each continent

Total Cases (TC) and Total Deaths (TD)

The COVID-19 total cases and total deaths data recorded 210 countries for most of 2020. Figure 8 shows the time-series data of total cases color-coded by continent. There is a sharp increase worldwide in March 2020 and South America has the biggest increase since then. Figure 9 confirms that South America has the most total cases with Europe being the second. Figure 10 shows the time-series data of total deaths color-coded by continent. South America has the most total deaths again. Oceania has the lowest case and death count.
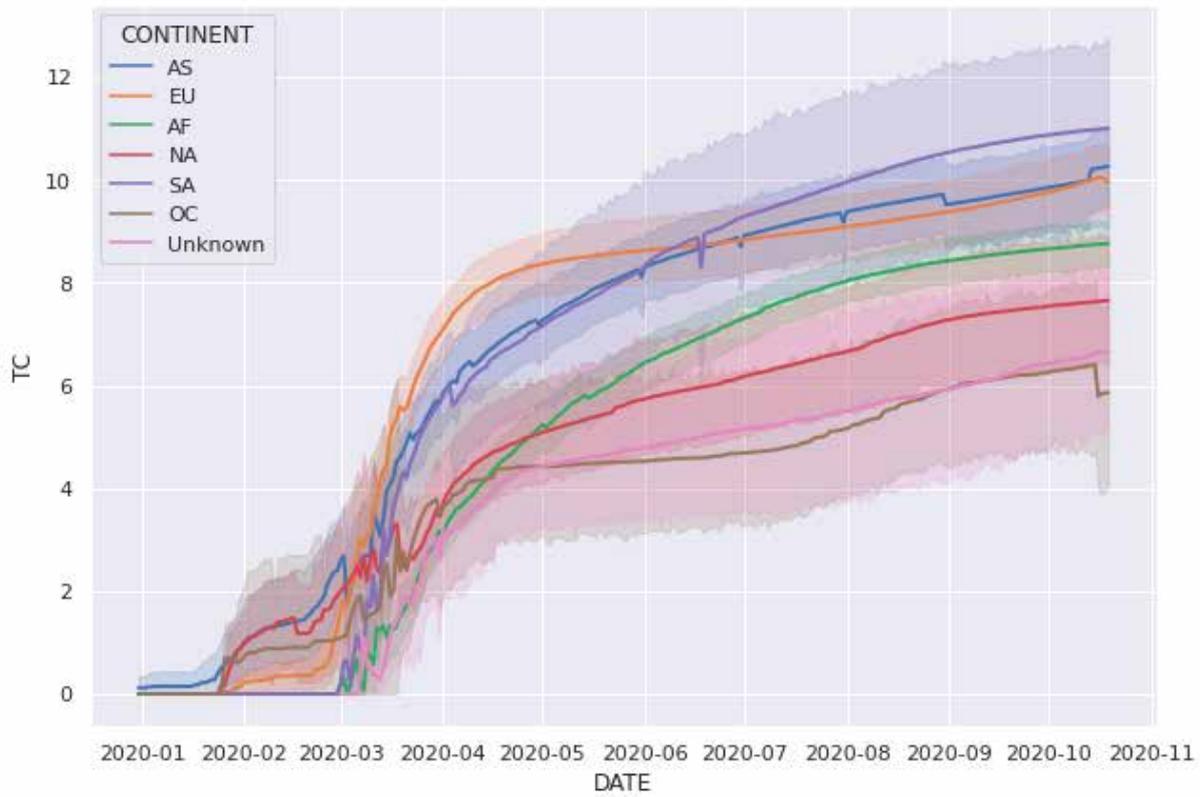
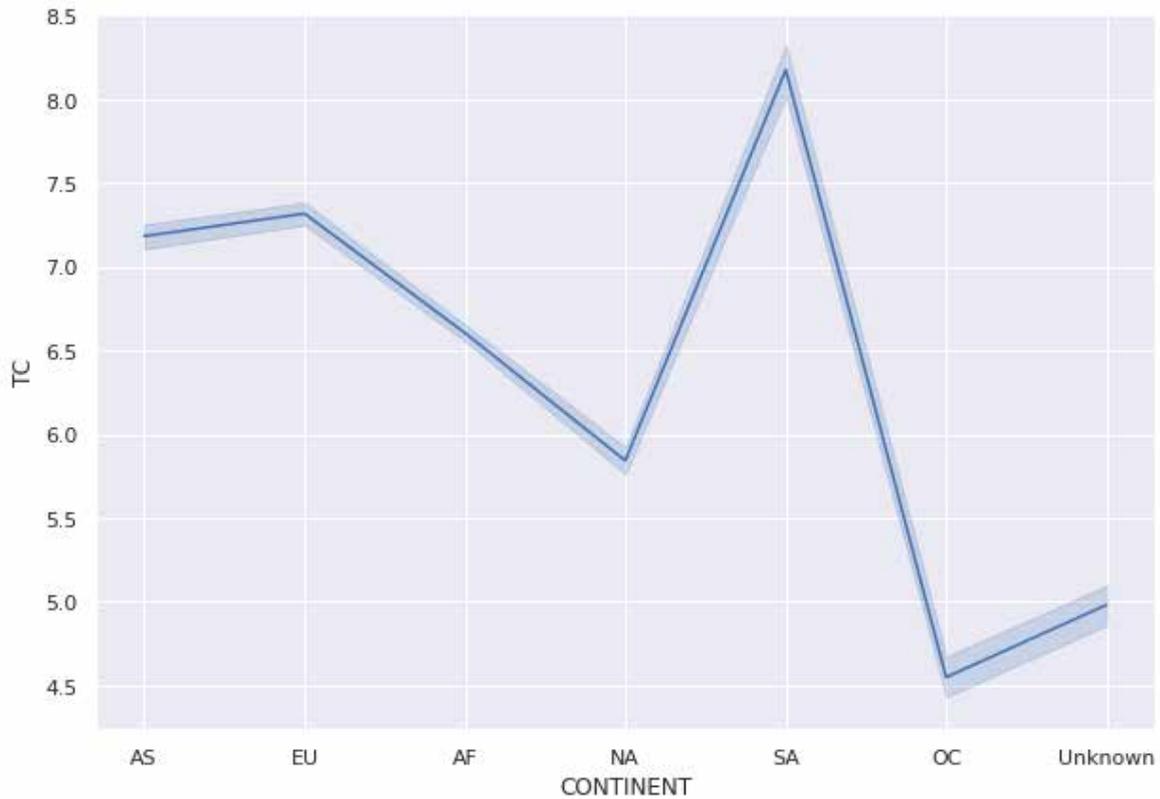Figure 8. Line plot of total cases over time, color-coded by continent

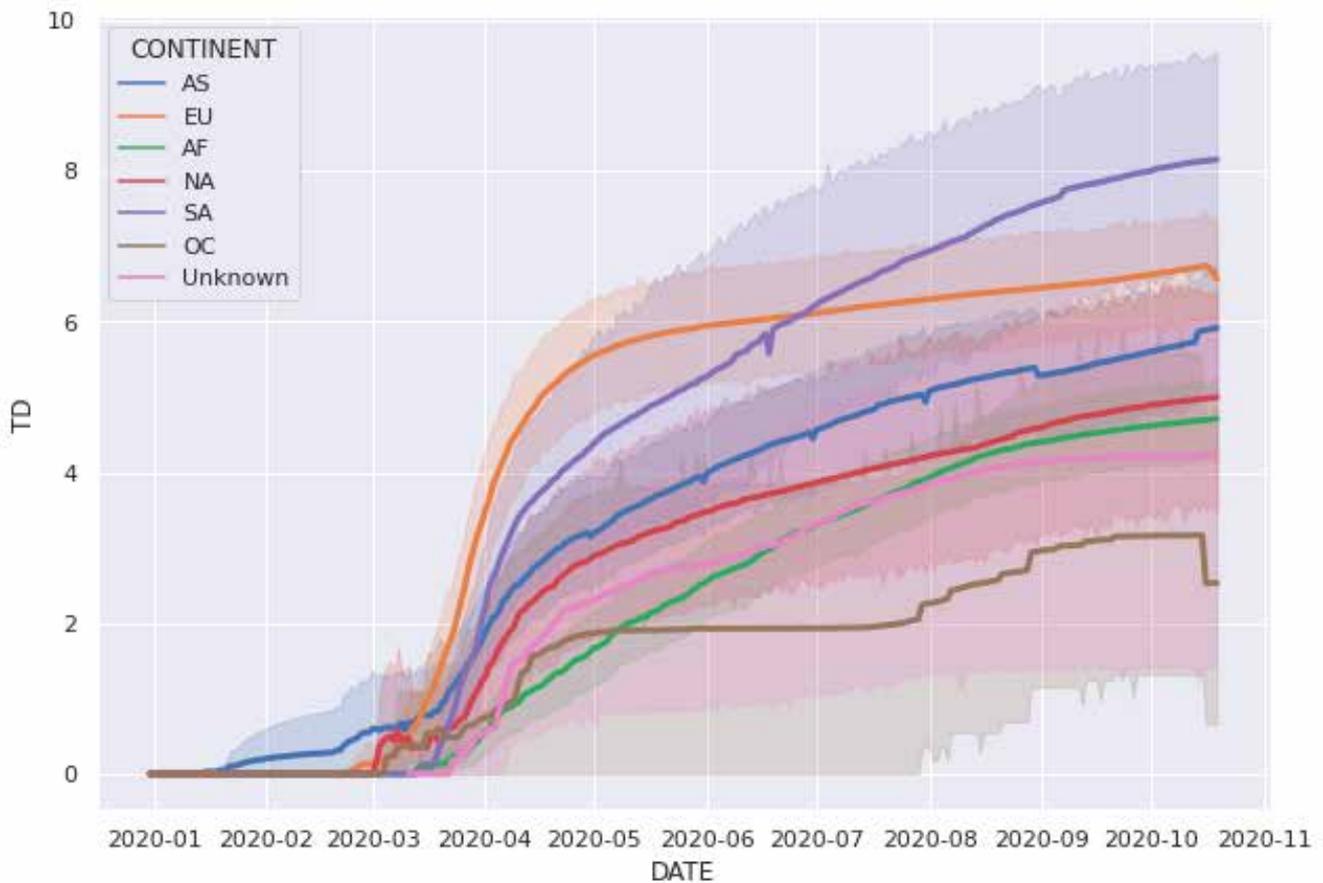Figure 9. Total cases in each continent

Figure 10. Line plot of total deaths over time, color-coded by continent

	COUNTRY	TC
87	Hong Kong	0.000000
173	Solomon Islands	3.988984
5	Anguilla	224.574488
65	Falkland Islands	493.373289
24	Bonaire Sint Eustatius and Saba	497.356421
...	...	...
178	Spain	2843.820343
97	Italy	2873.314489
27	Brazil	2913.256895
41	China	3128.587021
200	United States	3343.050755

Figure 11. Top 5 and bottom 5
countries in total cases

Figure 11 lists the top and bottom 5 countries ranked by total cases. Hong Kong, Solomon Islands, Anguilla, Falkland Islands, and Bonaire Sint Eustatius and Saba have the least amount of total cases. Spain, Italy, Brazil, China, and United States have the highest count of total cases. Figure 12 shows the time series plot of total cases in 10 countries with the most COVID-19 cases. China had the earliest increase but contained the situation rapidly and steadily, while the United States had the fastest increase and the highest count from April to November 2020.
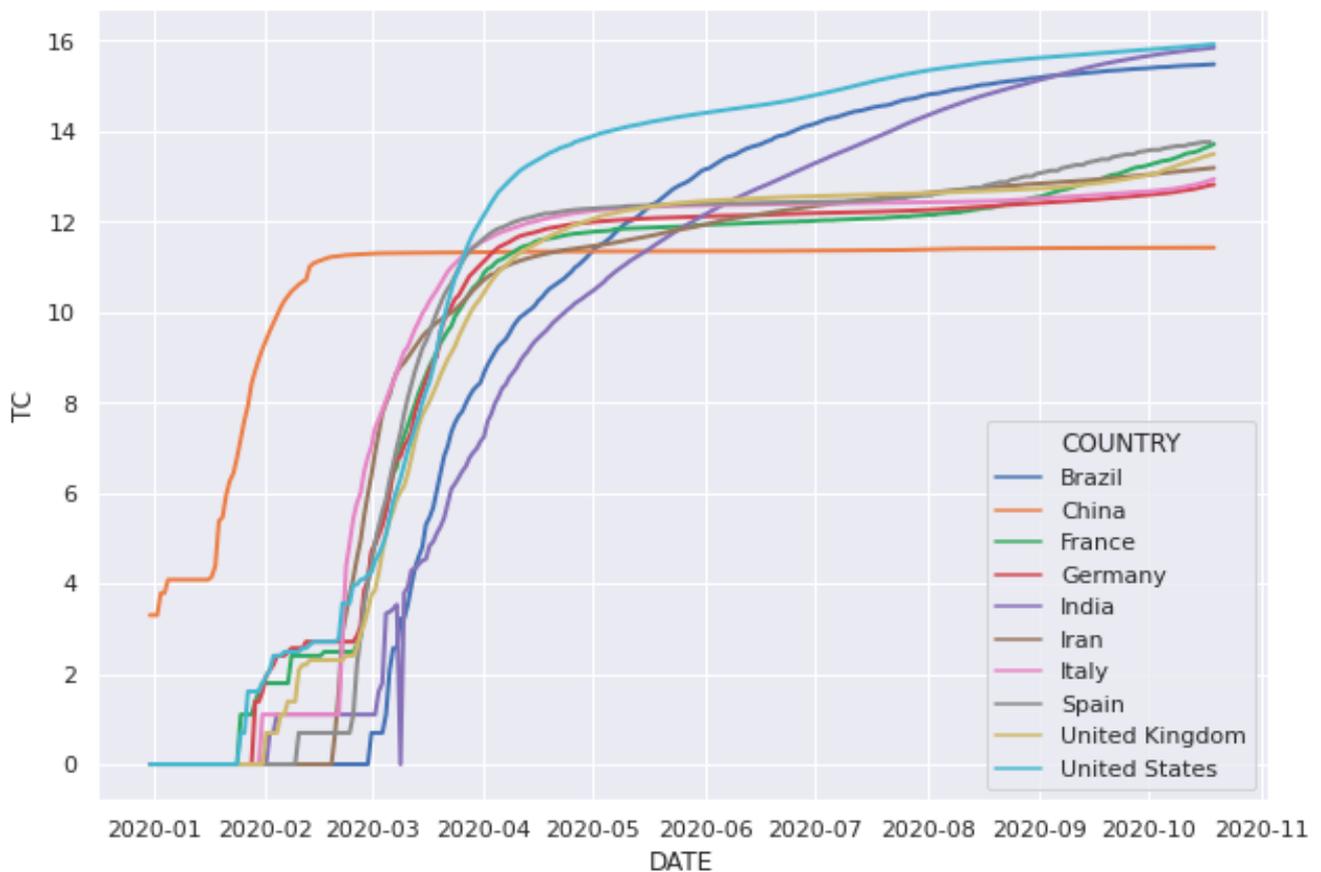
Figure 12. 10 countries with the most COVID cases

28 countries had zero total deaths during the time in the data. Some examples are Monaco, Timor, Liechtenstein, British Virgin Islands, and Gibraltar as shown in figure 13. The five countries that had the most deaths due to the pandemic are France, China, the United Kingdom, Italy, and United States. Figure 14 shows the time series plot of total deaths in 10 countries with the most deaths from the pandemic. Similar conclusions can be drawn as the total cases in figure 12.

STI (stringency index)

The OxCGRT's STI is a composite measure of nine of the response metrics rescaled to a value from 0 to 100 (100 = strictest). It represents the different common policy responses governments have taken. There are 210 unique countries in the dataset, 30 of those have STI of zero which are missing values. Figure 15 shows the time series plot of STI color-coded by continents. Australia, Africa, and South America have the strictest pandemic responses.

	COUNTRY	TD
127	Monaco	0.000000
190	Timor	0.000000
113	Liechtenstein	0.000000
28	British Virgin Islands	0.000000
75	Gibraltar	0.000000
...	...	...
68	France	2203.766710
41	China	2205.740166
199	United Kingdom	2209.519314
97	Italy	2327.710204
200	United States	2480.576064

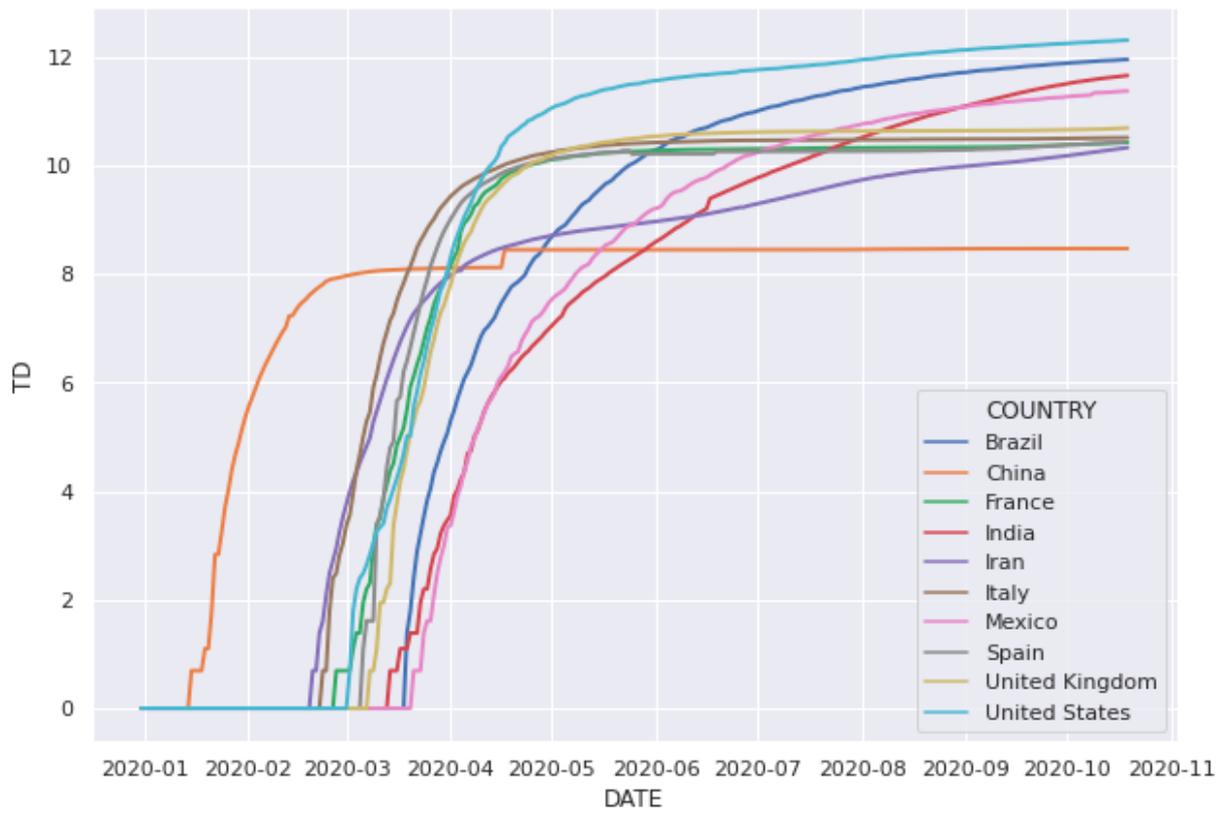Figure 13. Top 5 and bottom 5 countries in total deaths

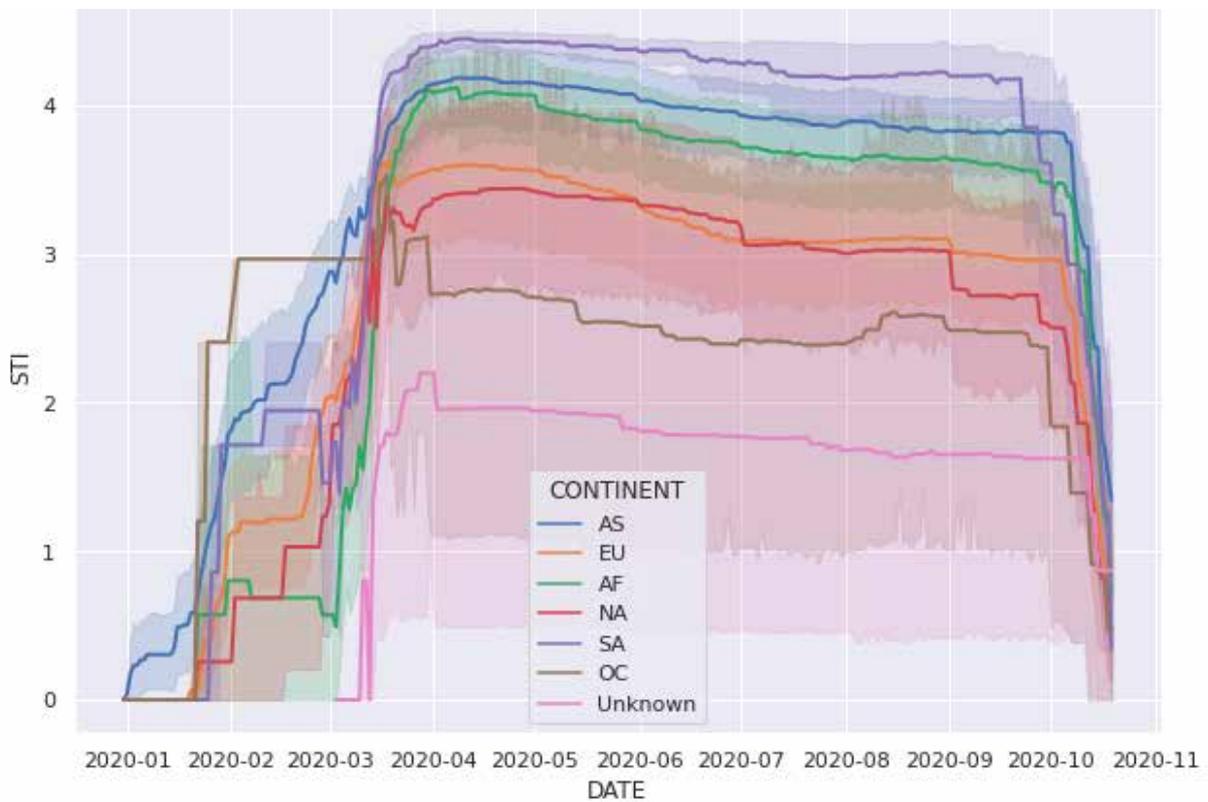Figure 14. 10 countries with the most deaths caused by the pandemic

Figure 15. Line plot of stringency index over time, color-coded by continent

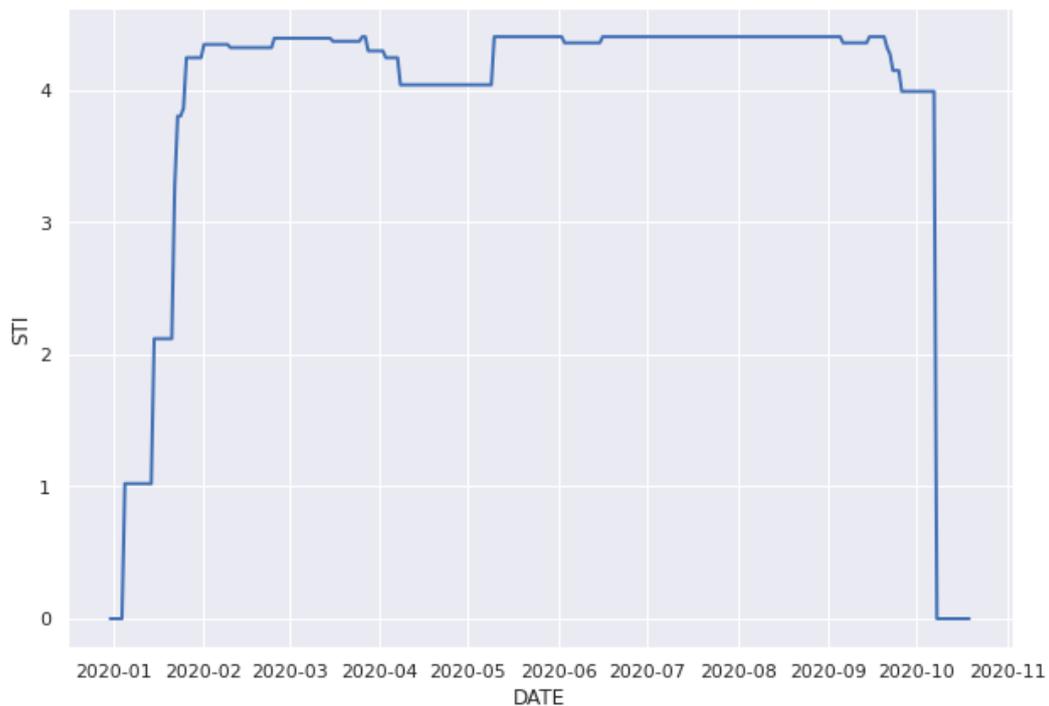Figure 16. United States STI over time

Figure 17. China STI over time

Figures 16 and 17 illustrate the STI of the US and China over time. US's response to covid is slower and more gradual than China's. However, after April 2020, they had similar STIs despite the common impression. Figure 18 shows the five strictest countries towards the pandemic are Panama, Uganda, El Salvador, Honduras, Eritrea.

	CONTINENT	COUNTRY	STI
209	Unknown	Vatican	0.000000
127	EU	Malta	0.000000
129	EU	Monaco	0.000000
130	EU	Montenegro	0.000000
123	EU	Liechtenstein	0.000000
...	...	...	...
170	NA	Panama	4.374658
49	AF	Uganda	4.406101
160	NA	El Salvador	4.414523
165	NA	Honduras	4.424304
15	AF	Eritrea	4.507309

Figure 18. Countries ranked by their average STI value over the time in the data

	COUNTRY	POP
49062	Vatican	6.695799
15656	Falkland Islands	8.155649
31363	Montserrat	8.516993
1251	Anguilla	9.615939
5945	Bonaire Sint Eustatius and Saba	10.174316
...	...	...
35082	Pakistan	19.213186
21722	Indonesia	19.426899
48121	United States	19.617637
21428	India	21.045353
9841	China	21.087439

Figure 19. Top 5 and bottom 5 of the countries ranked by population

Population (POP)

Population in the 210 countries stayed constant within the time frame in the dataset. The top five countries are India, China, the United States, Indonesia, and Pakistan. And the five countries with the smallest population are the Vatican, Falkland Islands, Montserrat, Anguilla, and Bonaire Sint Eustatius and Saba. And Anguilla, Falkland Islands, and Bonaire Sint Eustatius and Saba are among the five countries with the least amount of total cases.

The Gross Domestic Product per capita (GDP-CAP)

As justified earlier, the countries with the GDP-CAP of zero are missing data. Out of the 210 countries in the dataset, 27 countries have GDPCAP=0. From figure 20, the richest countries are San Marino, Switzerland, Norway, Kuwait, United Arab Emirates, Ireland, Brunei, Singapore, Luxembourg, and Qatar.

	CONTINENT	COUNTRY	GDPCAP
39208	EU	San Marino	10.948373
44296	EU	Switzerland	10.957977
34494	EU	Norway	11.079062
25324	AS	Kuwait	11.090272
47533	AS	United Arab Emirates	11.116819
22604	EU	Ireland	11.117440
7072	AS	Brunei	11.181769
40821	AS	Singapore	11.356685
27693	EU	Luxembourg	11.454003
37464	AS	Qatar	11.669379

Figure 20. Top countries in GDP per capita

Unemployment in OECD countries

Even before the pandemic hit, global economic growth had slowed. COVID-19 put a big dent in the world economy. Millions of jobs were lost and the worst recession since the Great Depression happened in 2020.

Among OECD members, the Czech Republic and Japan have the lowest unemployment rate

around 2 and 2.5. Spain, Greece, and Colombia have the highest unemployment rate at around 16 and 20. Figure 21 shows the color-coded stacked histogram of the unemployment data. European countries and Australia on average have lower unemployment rates. North America is more spread out while South American countries typically have higher unemployment rates.

Figure 21. Distribution plot of unemployment rate in OECD countries color-coded by continent
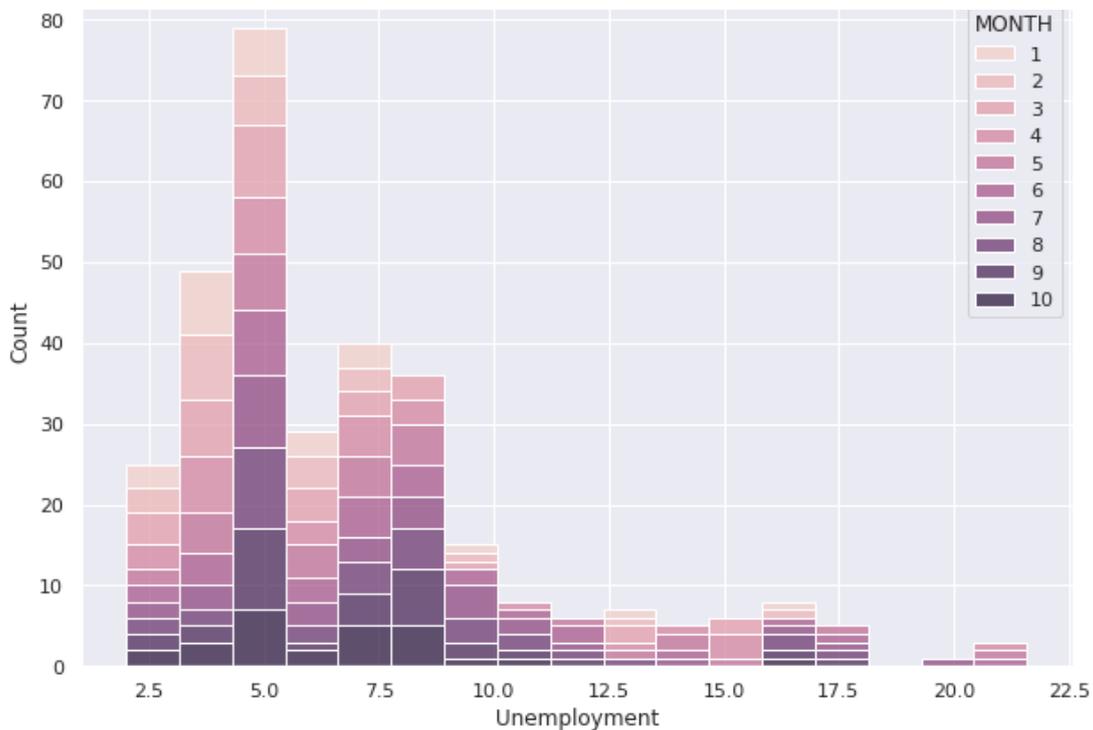

Figure 22. Distribution plot of unemployment rate in OECD countries color-coded by month

Figure 22 shows the stacked histogram of unemployment data color-coded by month. While some countries don't seem to be affected by the pandemic, more countries have higher unemployment rates during the height of the pandemic.

Figure 23 shows the line plot of the unemployment time series data color-coded by continent. The "Unknown" category experienced the most dramatic change in February and June compared to other continents. Most countries had a sharp increase in March and a gradual fall around June except African and European countries which had a slow increase in most of 2020.
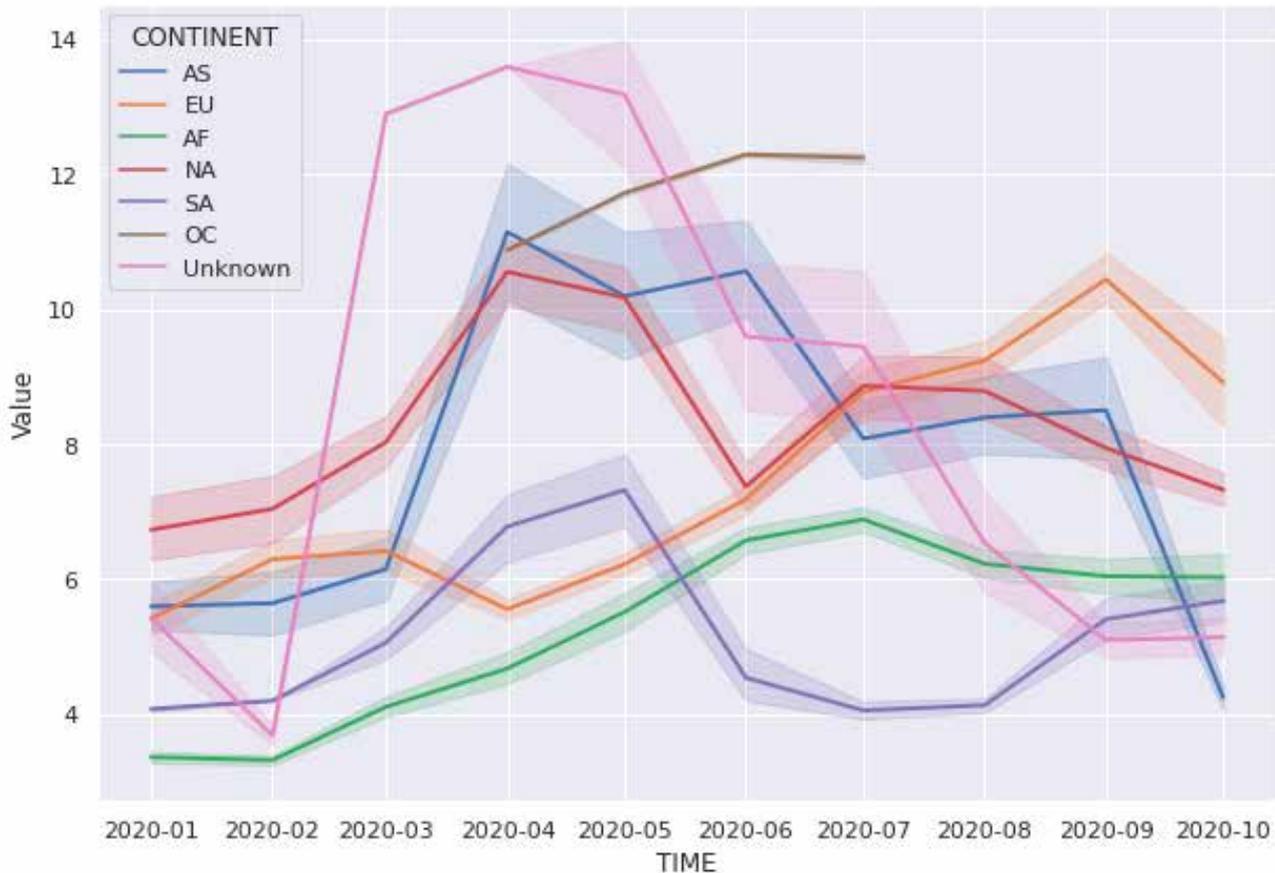

Figure 23. Line plot of unemployment rate in OECD countries color-coded by continent

3. Conclusion

Unsurprisingly, HDI and GDP per capita are highly correlated with a correlation coefficient of 0.85. Total Covid cases and deaths are closely related. And STI is highly correlated with total cases meaning most countries impose more stringent policies in response to higher case counts. The unemployment rates in OECD countries are negatively correlated with HDI and GDP per Capita.

COVID-19 brought the worst recession since the Great Depression in 2020. Most countries have higher unemployment rates during the height of the pandemic. European countries and Australia have the highest average HDI and lower unemployment rate on average in comparison with other countries. Most countries had a sharp increase in the unemployment rate in March and a gradual fall around June except African and European countries which had a slow increase in most of 2020. Among OECD members, Spain, Greece, and Colombia have the highest unemployment rate at around 16 and 20.

A sharp increase in total Covid cases also happened worldwide in March 2020 and South America has the biggest increase since then. Spain, Italy, Brazil,

China, and United States have the highest count of total cases. China had the earliest increase but contained the situation rapidly and steadily, while the United States had the fastest increase and the highest count from April to November 2020. The five countries that had the most deaths due to the pandemic are France, China, the United Kingdom, Italy, and United States.

Australia, Africa, and South America have the strictest pandemic responses. US's response to covid is slower and more gradual than China's. However, after April 2020, they had similar STIs despite the common impression. It can be concluded that the initial response is crucial in fighting the pandemic.

The limitations of this study can come from the explicit and inexplicit missing data in almost all the variable columns. Also, during the data analysis stage, some countries were classified as the "Unknown" continent which has the lowest HDI and experienced the most dramatic change in the unemployment rate in February and June of 2020. The countries in this category may need further investigation.

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