EXPLORATORY DATA ANALYSIS

Project: Analysis of different measures taken by different countries to control the spread of Covid-19 virus

Team Members
Nisha Ramrakhyani (Student Id: 801208678)
Punit Mashruwala (Student Id: 801208416)
Zalak Panchal (Student Id: 801196881)

Exploratory Data Analysis is a process having a set of techniques for analyzing datasets, performing initial investigations on data to discover patterns, spot errors using graphical representations.
The steps involved in Exploratory Data Analysis are-
a) Importing and cleaning data and checking for errors and other special conditions.
b) Exploring Variables one at a time, visualizing distributions
c) Exploring relationships between variables two at a time, using scatter plots and other visualizations
d) Exploring multivariate reltionships using multiple regression and logistic regression.
We perform Exploratory Data Analysis to use data to answer questions and guide in decision making.
We perform Exploratory Data Analysis especially in the early stages of a project, or while working with a new dataset.

In [1]:

```
#Importing libraries
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt

from sklearn.preprocessing import LabelEncoder
from sklearn.model_selection import train_test_split
from bokeh.io import output_notebook, curdoc
from bokeh.plotting import figure, show
from bokeh.models import ColumnDataSource, HoverTool, CategoricalColorMapper,
output_notebook()
```

```
(https://bokeh.org)BokehJS 2.1.1 successfully loaded.
```

In [3]:

```
#Importing datatset
dataset = pd.read_excel('covid_19_data_2.xlsx')
print(dataset.head())
```

```
   ID  ISO    COUNTRY   REGION                              LOG_TYPE  \
0  98  AUS  Australia  Pacific  Introduction / extension of measures   
1  96  AUS  Australia  Pacific  Introduction / extension of measures   
2  93  AUS  Australia  Pacific  Introduction / extension of measures   
3  94  AUS  Australia  Pacific  Introduction / extension of measures   
4  97  AUS  Australia  Pacific  Introduction / extension of measures   

                                 CATEGORY  \
0  Governance and socio-economic measures   
1  Governance and socio-economic measures   
2                   Movement restrictions   
3                  Public health measures   
4                  Public health measures   

                                             MEASURE TARGETED_POP_GROUP  
\
0  Emergency administrative structures activated ...                NaN   
1                                  Economic measures                NaN   
2                                  Visa restrictions            checked   
3                  Isolation and quarantine policies            checked   
4             Strengthening the public health system                NaN   

                                            COMMENTS  \
0  Australian Health Sector Emergency Plan Activated   
1  Implementation of an economic response to the ...   
2  Citizens from China, Italy, South Korea, Iran,...   
3  14 days self-quarantine, for nationals arrivin...   
4                       Additional masks and funding   

                 NON_COMPLIANCE DATE_IMPLEMENTED                SOURCE  \
0                Not applicable       2020-02-17  Department of Health   
1                Not applicable       2020-03-01  Department of Health   
2  Refusal to Enter the Country       2020-03-01                  IATA   
3                 Not available       2020-03-01                  IATA   
4                Not applicable       2020-03-12  Department of Health   

           SOURCE_TYPE                                               LINK  
\
0           Government  https://www.health.gov.au/news/health-alerts/n... 
(https://www.health.gov.au/news/health-alerts/n...)
1           Government  https://www.health.gov.au/news/health-alerts/n... 
(https://www.health.gov.au/news/health-alerts/n...)
2  Other organisations  https://www.iatatravelcentre.com/international... 
(https://www.iatatravelcentre.com/international...)
3  Other organisations  https://www.iatatravelcentre.com/international... 
(https://www.iatatravelcentre.com/international...)
4           Government  https://www.health.gov.au/news/health-alerts/n... 
(https://www.health.gov.au/news/health-alerts/n...)

  ENTRY_DATE  covid_case_per_date  population  
0 2020-03-14                 15.0    25499884  
1 2020-03-14                 14.0    25499884  
```

```
2 2020-03-14                 14.0    25499884
3 2020-03-14                 14.0    25499884
4 2020-03-14                 28.0    25499884
```

Data Pre-processing

In [4]:

```
#Selecting features that are important in our analysis
df = dataset[['COUNTRY','CATEGORY', 'MEASURE', 'COMMENTS', 'DATE_IMPLEMENTED'
print(df.head())
```

```
     COUNTRY                                CATEGORY  \
0  Australia  Governance and socio-economic measures   
1  Australia  Governance and socio-economic measures   
2  Australia                   Movement restrictions   
3  Australia                  Public health measures   
4  Australia                  Public health measures   

                                             MEASURE  \
0  Emergency administrative structures activated ...   
1                                  Economic measures   
2                                  Visa restrictions   
3                   Isolation and quarantine policies   
4            Strengthening the public health system   

                                           COMMENTS DATE_IMPLEMENTED  \
0  Australian Health Sector Emergency Plan Activated       2020-02-17   
1  Implementation of an economic response to the ...       2020-03-01   
2  Citizens from China, Italy, South Korea, Iran,...       2020-03-01   
3  14 days self-quarantine, for nationals arrivin...       2020-03-01   
4                         Additional masks and funding       2020-03-12   

   covid_case_per_date  population  
0                 15.0    25499884  
1                 14.0    25499884  
2                 14.0    25499884  
3                 14.0    25499884  
4                 28.0    25499884  
```

In [12]:

```
#Converting datatype of column 'DATE_IMPLEMENTED' to datetime
df['DATE_IMPLEMENTED'] =  pd.to_datetime(df['DATE_IMPLEMENTED'])
print(df['DATE_IMPLEMENTED'])
```

```
0      2020-02-17
1      2020-03-01
2      2020-03-01
3      2020-03-01
4      2020-03-12
          ...    
4138   2020-11-02
4139   2020-11-02
4140   2020-11-02
4141   2020-11-02
4142   2020-11-02
Name: DATE_IMPLEMENTED, Length: 4107, dtype: datetime64[ns]
```

In [5]:

```
print(df.isnull().sum())
```

```
COUNTRY                 0
CATEGORY                0
MEASURE                 0
COMMENTS                6
DATE_IMPLEMENTED       26
covid_case_per_date    31
population              0
dtype: int64
```

In [6]:

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 4143 entries, 0 to 4142
Data columns (total 7 columns):
 #   Column               Non-Null Count  Dtype         
---  ------               --------------  -----         
 0   COUNTRY              4143 non-null   object        
 1   CATEGORY             4143 non-null   object        
 2   MEASURE              4143 non-null   object        
 3   COMMENTS             4137 non-null   object        
 4   DATE_IMPLEMENTED     4117 non-null   datetime64[ns]
 5   covid_case_per_date  4112 non-null   float64       
 6   population           4143 non-null   int64         
dtypes: datetime64[ns](1), float64(1), int64(1), object(4)
memory usage: 226.7+ KB
```

In [7]:

```
df.describe()
```

Out[7]:

	covid_case_per_date	population
count	4112.000000	4.143000e+03
mean	6756.807636	1.223711e+08
std	14039.385920	2.703601e+08
min	0.000000	4.822233e+06
25%	42.000000	2.141325e+07
50%	556.000000	3.774215e+07
75%	4649.000000	6.788601e+07
max	132854.000000	1.380004e+09

In [8]:

```
sum = df['covid_case_per_date'].sum()
print(sum)
```

```
27783993.0
```

In [9]:

```
df.isnull().sum()
```

Out[9]:

```
COUNTRY                0
CATEGORY               0
MEASURE                0
COMMENTS               6
DATE_IMPLEMENTED      26
covid_case_per_date   31
population             0
dtype: int64
```

In [10]:

```
#Dealing with missing values
df = df[df['DATE_IMPLEMENTED'].notna()]
df.isnull().sum()
```

Out[10]:

```
COUNTRY                0
CATEGORY               0
MEASURE                0
COMMENTS               5
DATE_IMPLEMENTED       0
covid_case_per_date   10
population             0
dtype: int64
```

In [11]:

```
#Dealing with missing values
df = df[df['covid_case_per_date'].notna()]
df.isnull().sum()
```

Out[11]:

```
COUNTRY               0
CATEGORY              0
MEASURE               0
COMMENTS              5
DATE_IMPLEMENTED      0
covid_case_per_date   0
population            0
dtype: int64
```

In [13]:

```
#Performing log normalization
df['log_value'] = np.log(df['covid_case_per_date'])
print(df)
```

```
        COUNTRY                                CATEGORY  \
0     Australia  Governance and socio-economic measures   
1     Australia  Governance and socio-economic measures   
2     Australia                   Movement restrictions   
3     Australia                  Public health measures   
4     Australia                  Public health measures   
...         ...                                     ...   
4138    Belgium                                Lockdown   
4139    Belgium                       Social distancing   
4140    Belgium                       Social distancing   
4141    Belgium                  Public health measures   
4142    Belgium                  Public health measures   

                                                MEASURE  \
0     Emergency administrative structures activated ...   
1                                     Economic measures   
2                                     Visa restrictions   
3                     Isolation and quarantine policies   
4                Strengthening the public health system   
...                                                 ...   
4138                                      Full lockdown   
4139          Closure of businesses and public services   
4140                            Limit public gatherings   
4141       Amendments to funeral and burial regulations   
4142                            General recommendations   

                                               COMMENTS DATE_IMPLEMENTED  
\
0     Australian Health Sector Emergency Plan Activated       2020-02-17   
1     Implementation of an economic response to the ...       2020-03-01   
2     Citizens from China, Italy, South Korea, Iran,...       2020-03-01   
3     14 days self-quarantine, for nationals arrivin...       2020-03-01   
4                          Additional masks and funding       2020-03-12   
...                                                 ...              ...   
4138                         Second nationwide lockdown       2020-11-02   
4139                Closure of non-essential businesses       2020-11-02   
4140   Mixing between households should be limited, ...       2020-11-02   
4141                   15 people permitted for funerals       2020-11-02   
4142  Supermarkets are to remove all non-essential p...       2020-11-02   

      covid_case_per_date  population  log_value  
0                    15.0    25499884   2.708050  
1                    14.0    25499884   2.639057  
2                    14.0    25499884   2.639057  
3                    14.0    25499884   2.639057  
4                    28.0    25499884   3.332205  
...                   ...         ...        ...  
4138              11789.0    11589623   9.374922  
4139              11789.0    11589623   9.374922  
4140              11789.0    11589623   9.374922  
4141              11789.0    11589623   9.374922  
4142              11789.0    11589623   9.374922  
```

```
[4107 rows x 8 columns]

C:\Users\nisha\anaconda3\lib\site-packages\pandas\core\series.py:679: Runti
meWarning: divide by zero encountered in log
  result = getattr(ufunc, method)(*inputs, **kwargs)
```

In [14]:

```
country_array = df.COUNTRY.unique()
country_array
```

Out[14]:

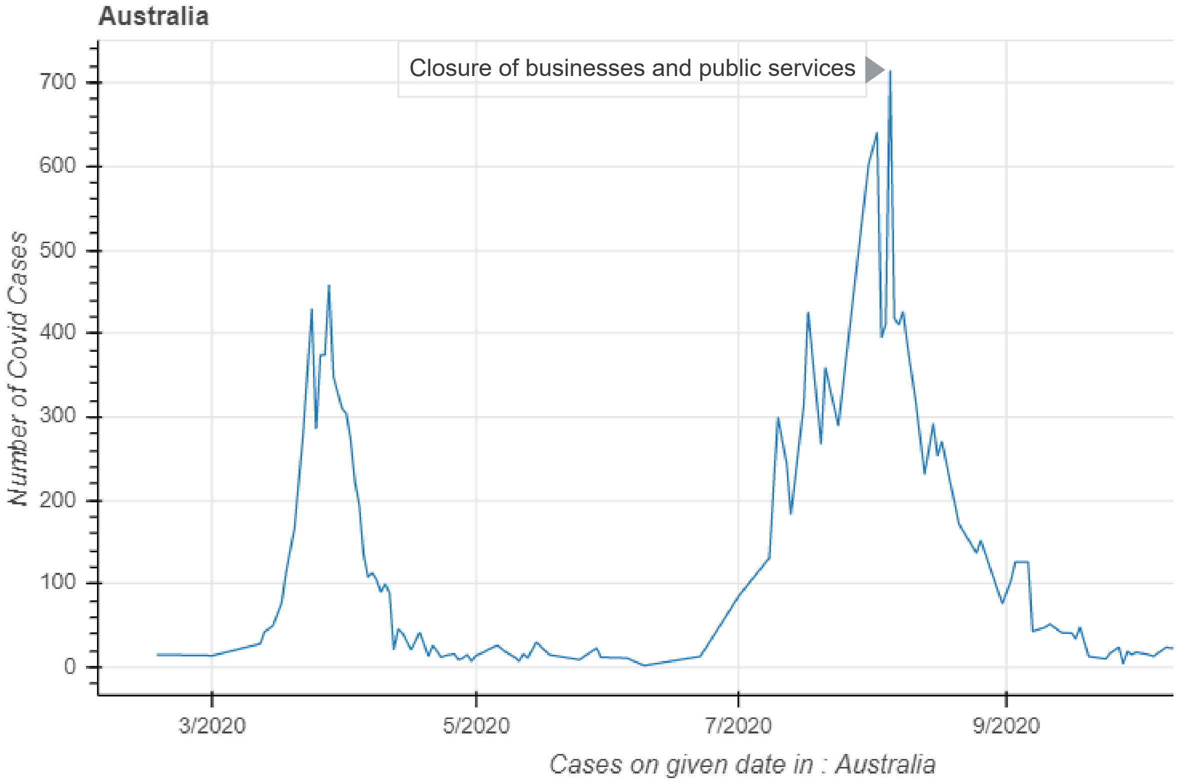
```
array(['Australia', 'France', 'Germany', 'India', 'Italy',
       'United States', 'New Zealand', 'Canada', 'Norway', 'Sweden',
       'United Kingdom', 'Mexico', 'Singapore', 'Spain', 'Sri Lanka',
       'Belgium'], dtype=object)
```

Performing EDA

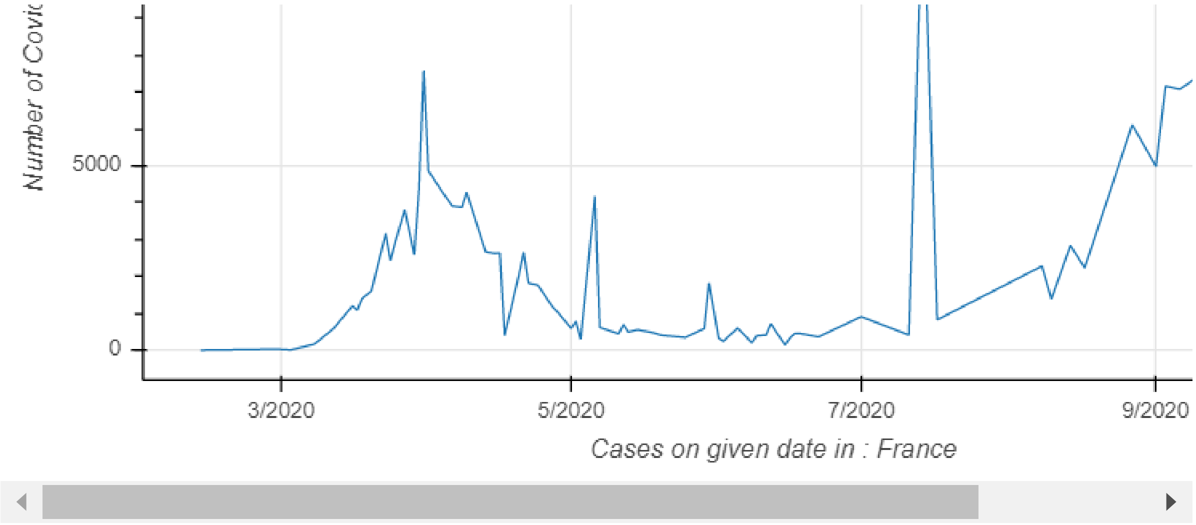
1) What was the number of cases after taking the different measures for each country?

In [15]:

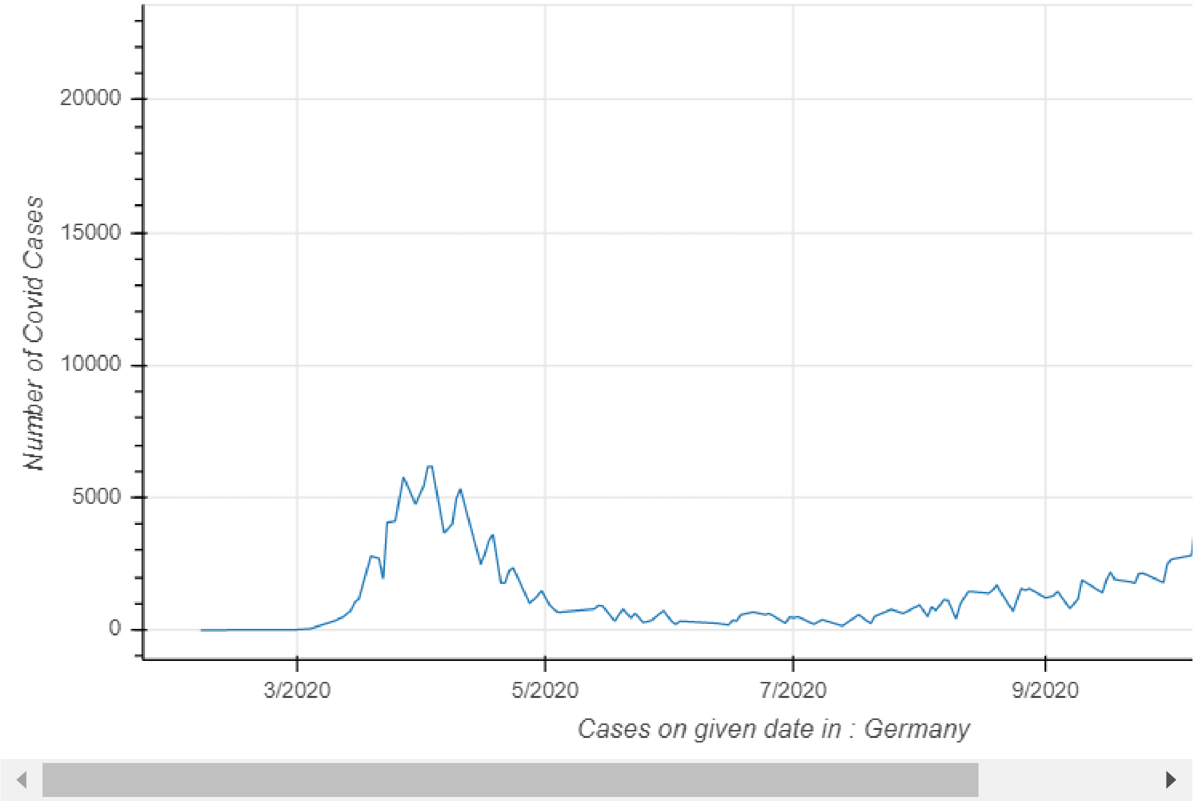
```
# Below graphs show the number of covid cases for each country after each mea
# On Hovering over the graph, we can see the different measures taken in the
for i in range(len(country_array)):
    plt.figure(figsize=(10,5))
    new_df = df[df["COUNTRY"] == country_array[i]]
    new_df = new_df.drop_duplicates(subset=['DATE_IMPLEMENTED'])
    new_df = new_df.sort_values(by="DATE_IMPLEMENTED")
    source = ColumnDataSource(new_df)
    plot = figure(plot_width=300, plot_height=300)
    source = ColumnDataSource(data=dict(
        x=new_df['DATE_IMPLEMENTED'],
        y=new_df['covid_case_per_date'],
        desc=new_df['MEASURE'],
    ))
    p = figure(title=country_array[i],x_axis_type='datetime', x_axis_label="C
           plot_height=400, plot_width=700,
           tools=[HoverTool(tooltips='@desc')],toolbar_location=None)
    p.line('x', 'y', source=source)
    show(p)
```



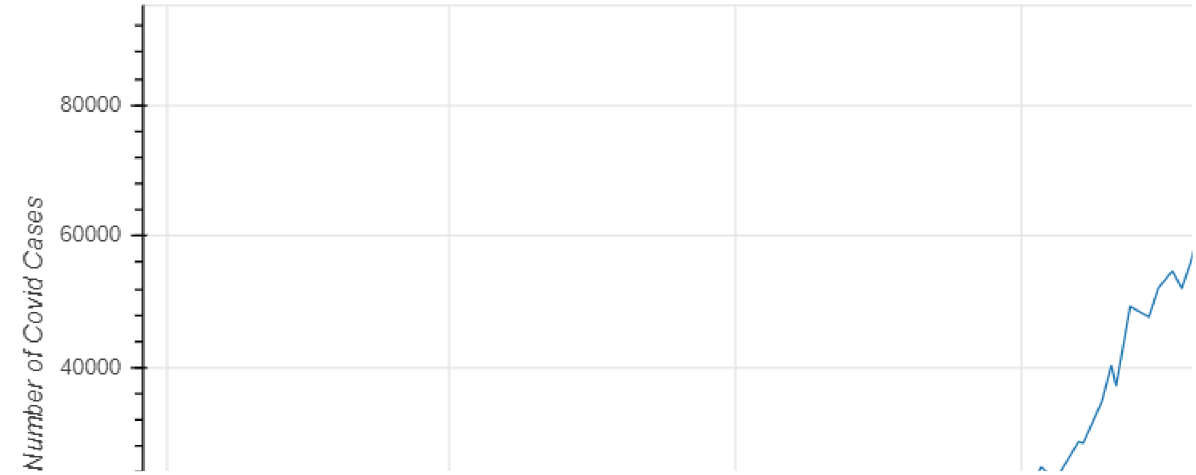
France
15000
10000
d Cases

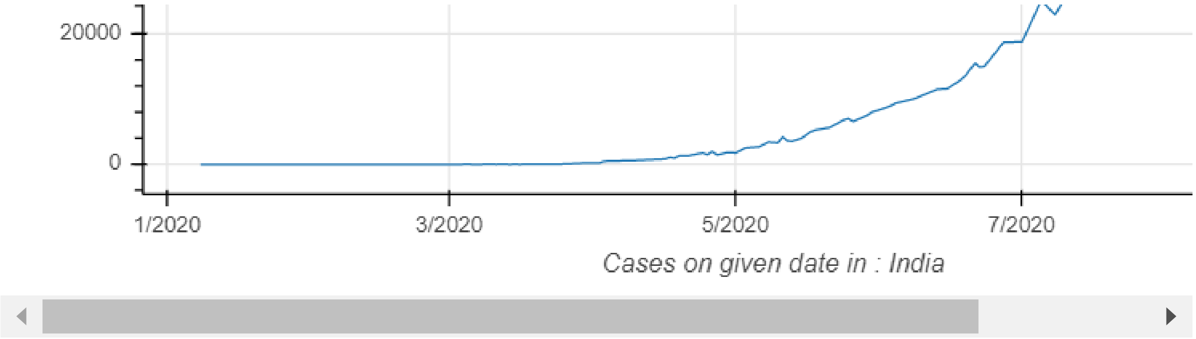


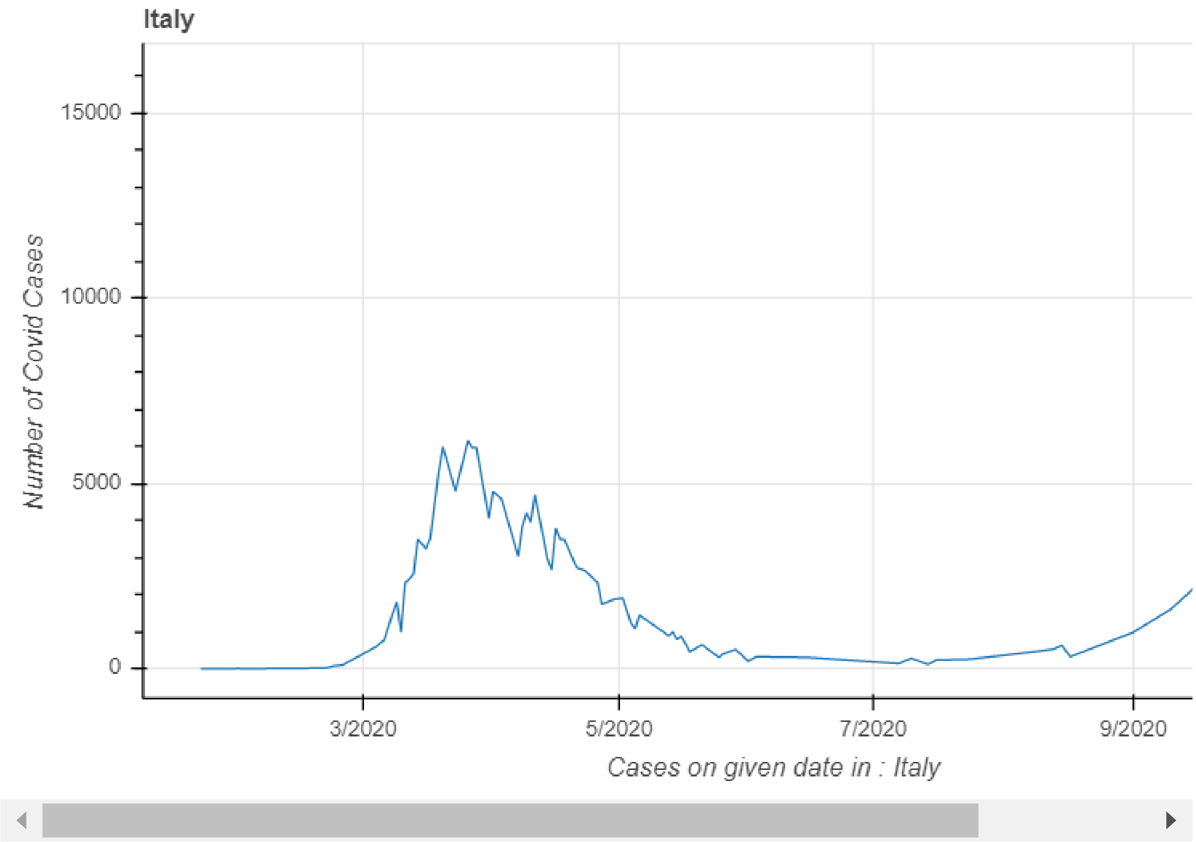
Germany

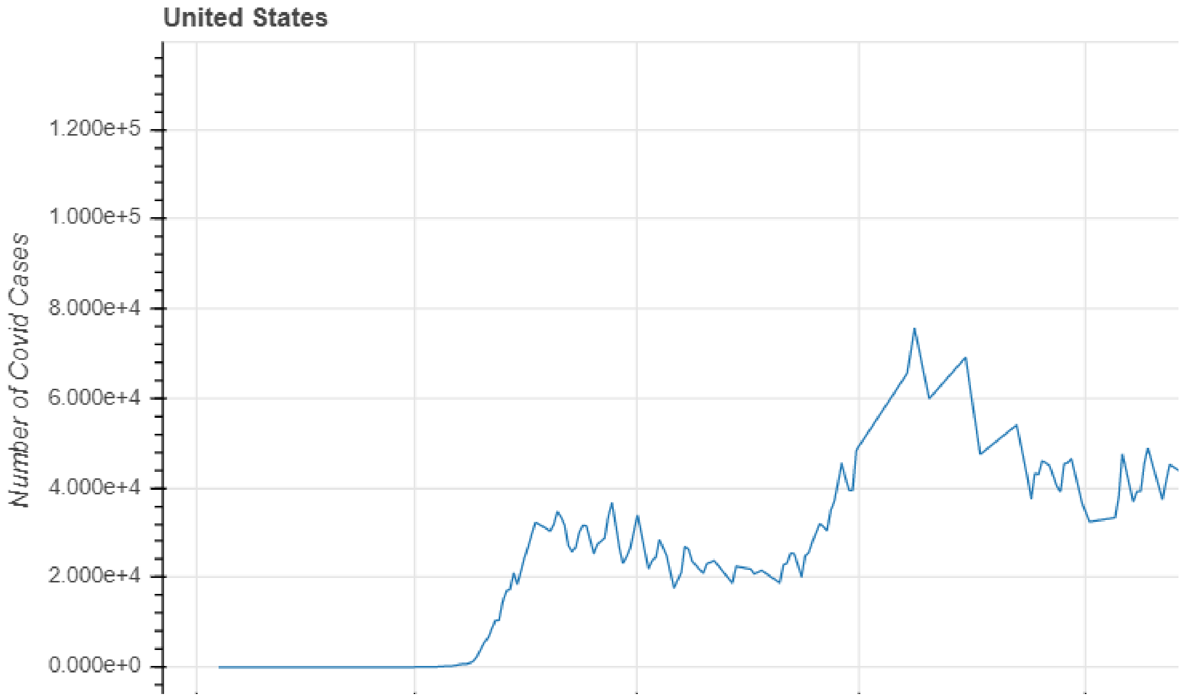


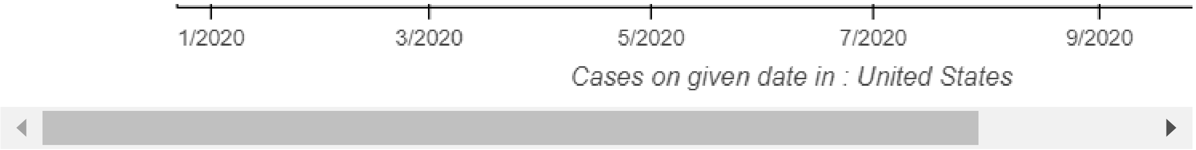
India

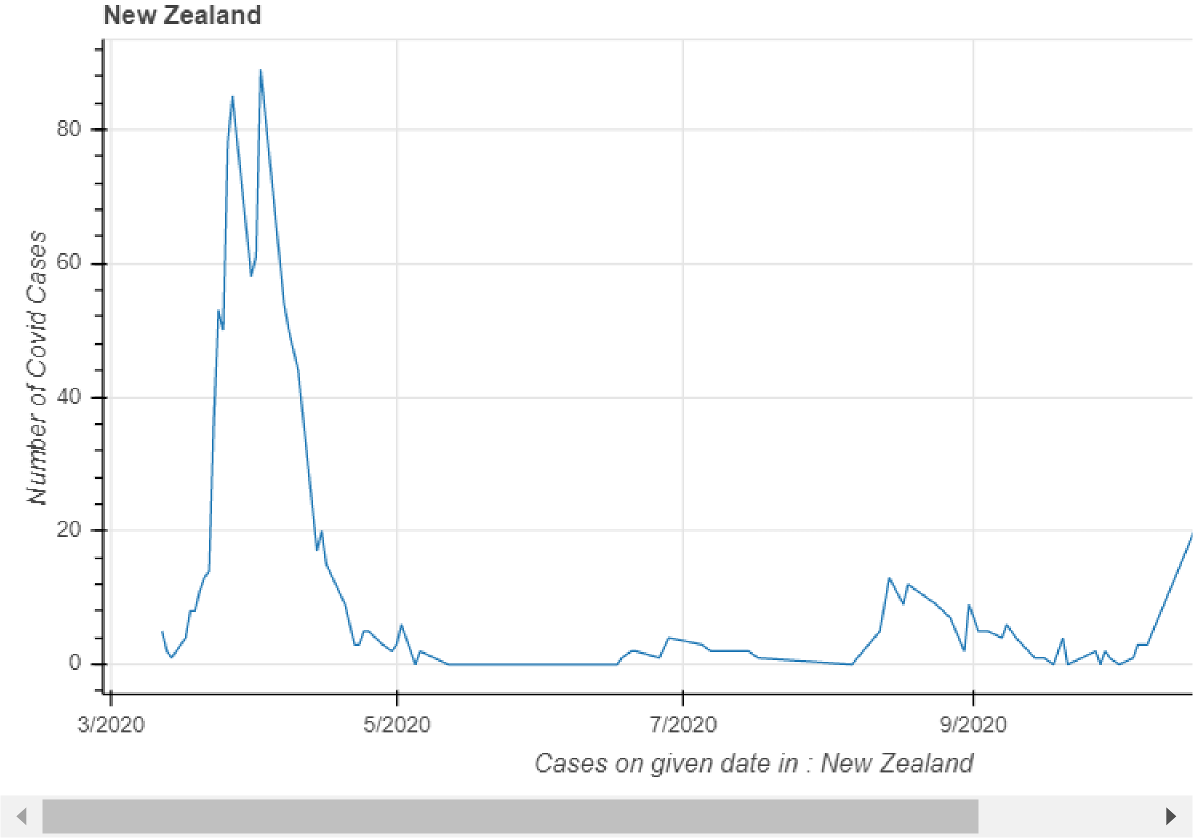


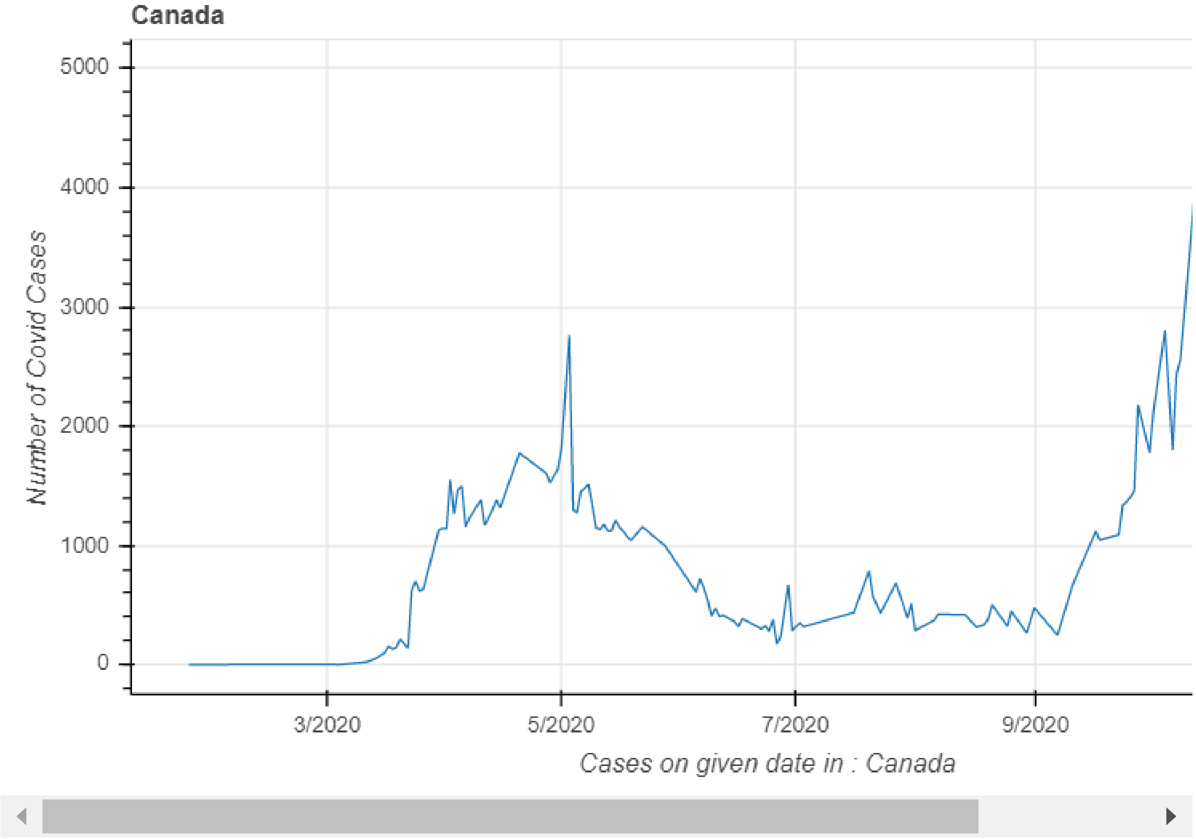

20000
0
1/2020
3/2020
5/2020
7/2020
Cases on given date in : India

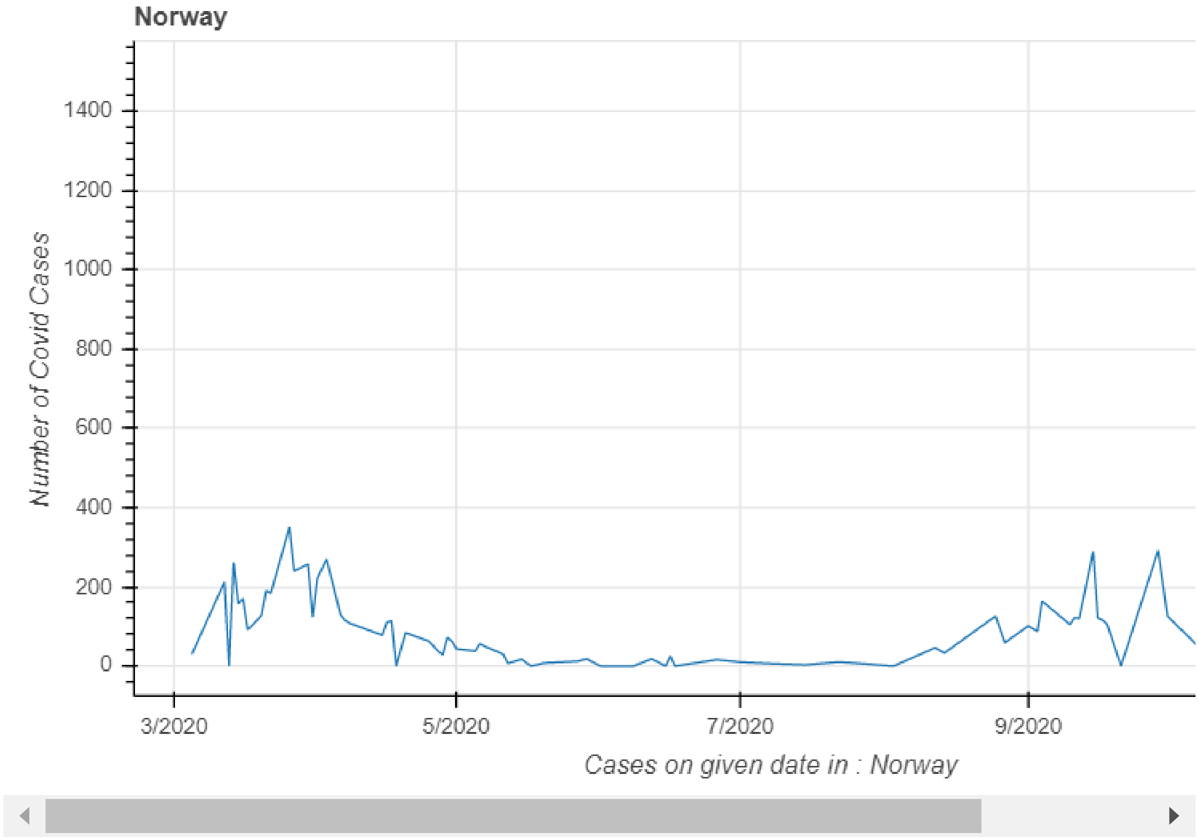

Italy
Number of Covid Cases
15000
10000
5000
0
3/2020
5/2020
7/2020
9/2020
Cases on given date in : Italy


United States
Number of Covid Cases
1.200e+5
1.000e+5
8.000e+4
6.000e+4
4.000e+4
2.000e+4
0.000e+0

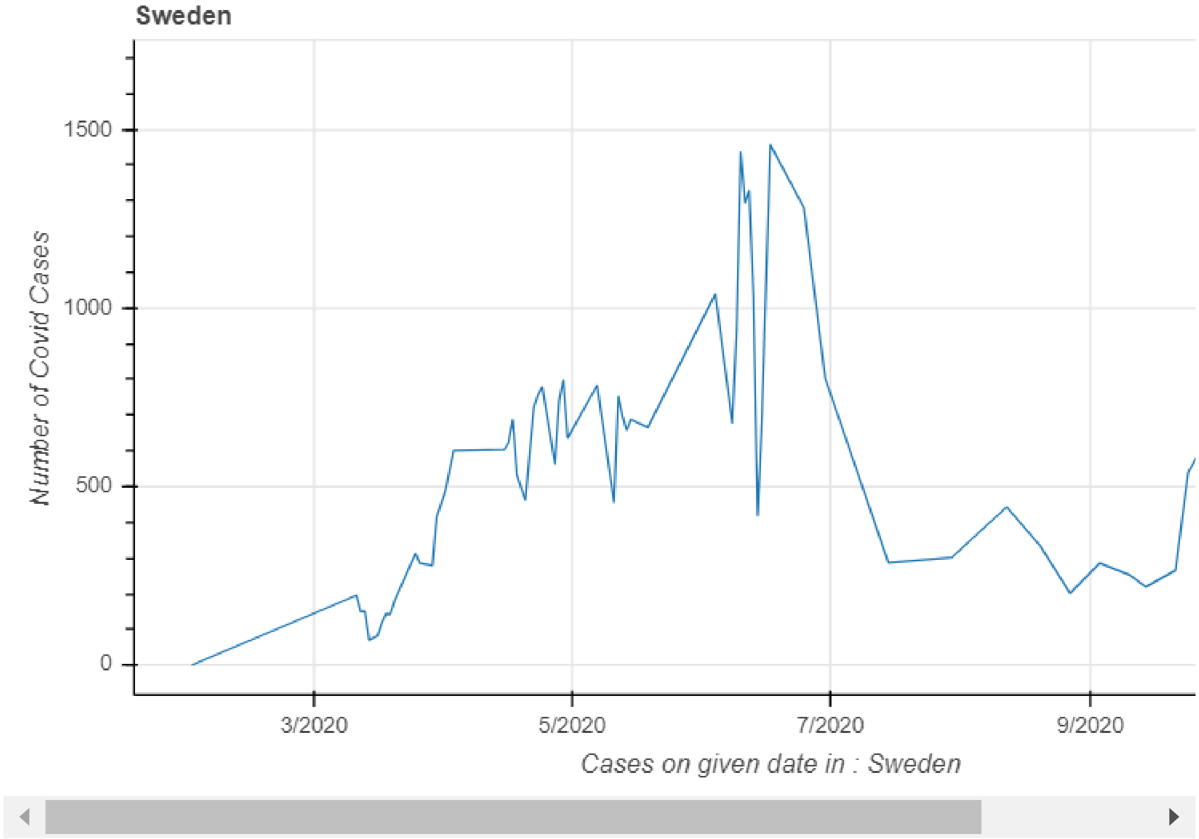

1/2020
3/2020
5/2020
7/2020
9/2020
Cases on given date in : United States


New Zealand
Number of Covid Cases
0
20
40
60
80
3/2020
5/2020
7/2020
9/2020
Cases on given date in : New Zealand


Canada
Number of Covid Cases
0
1000
2000
3000
4000
5000
3/2020
5/2020
7/2020
9/2020
Cases on given date in : Canada

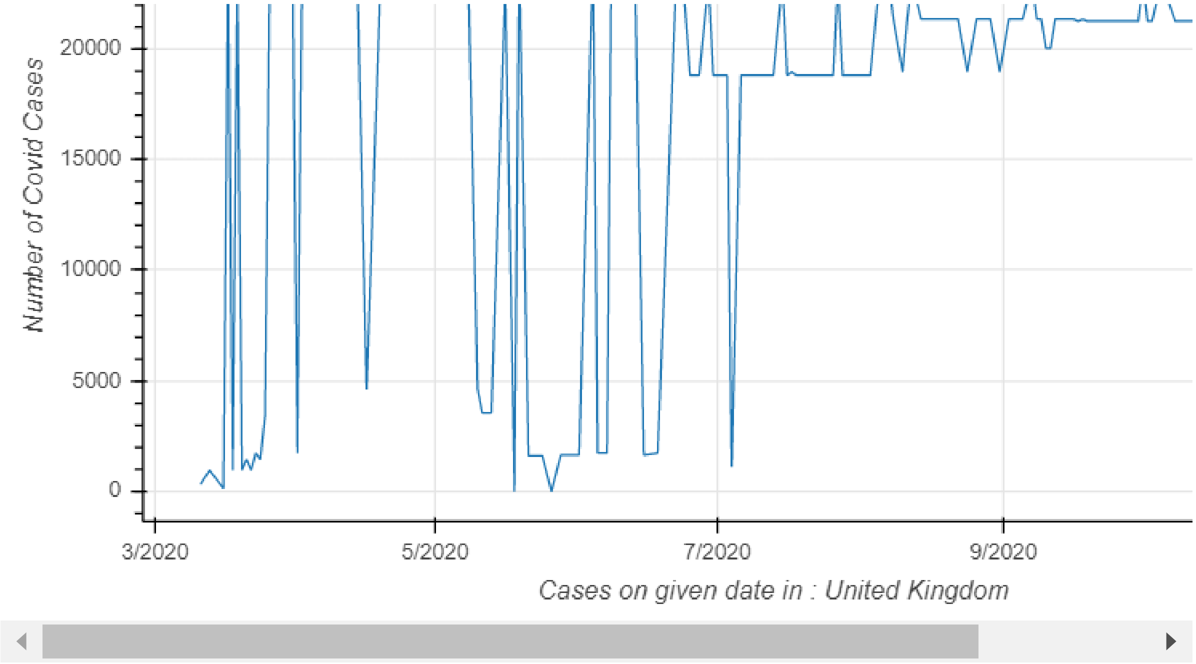


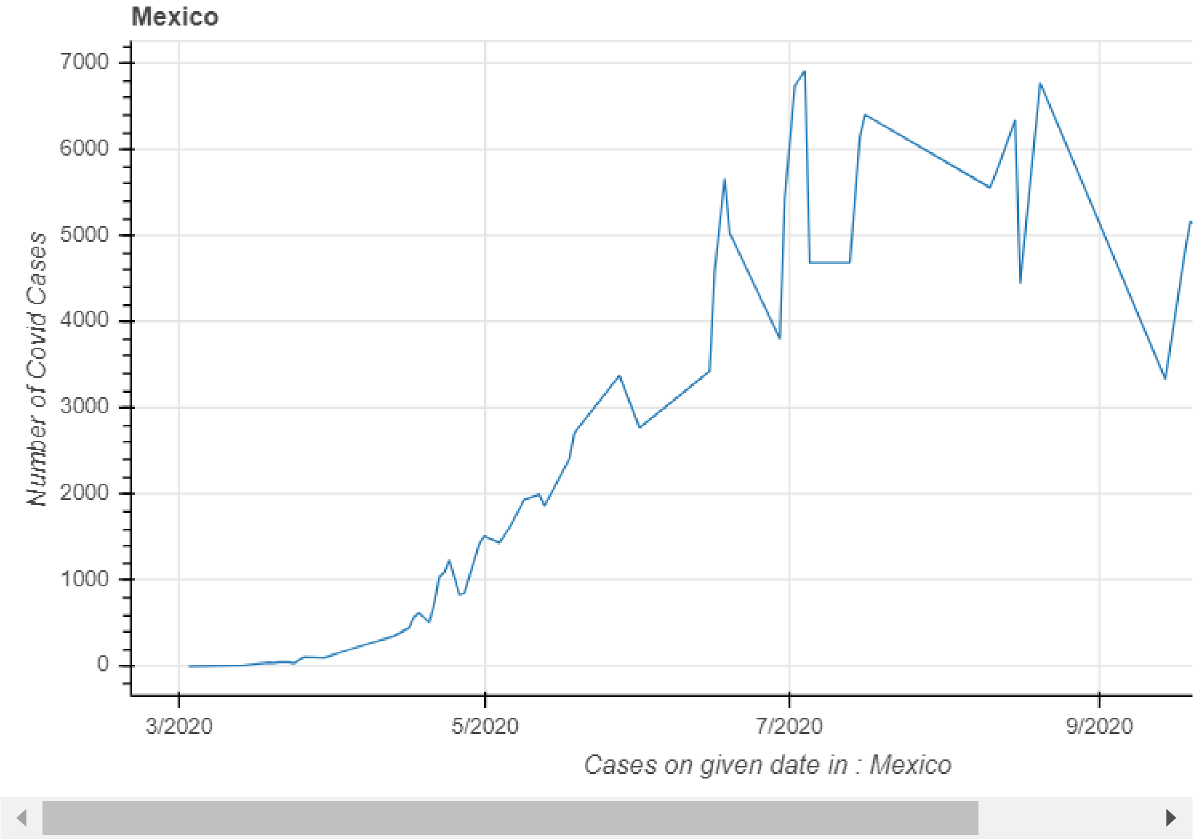
Norway

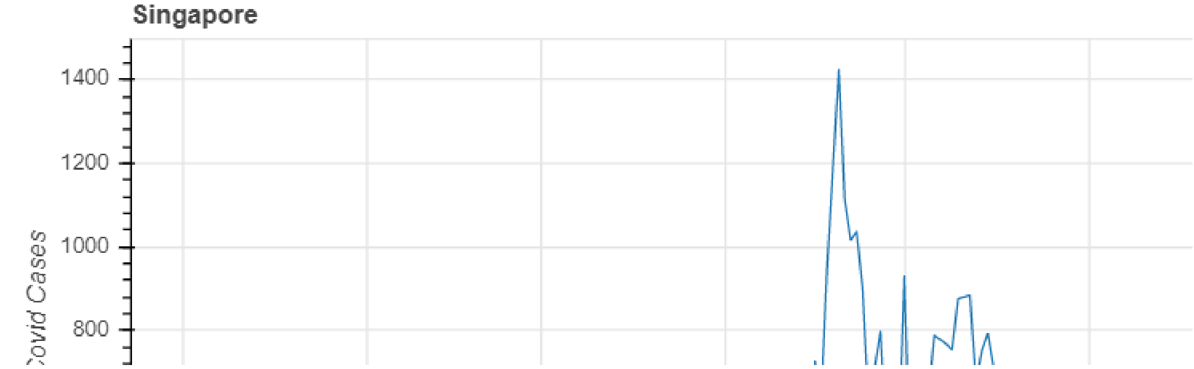


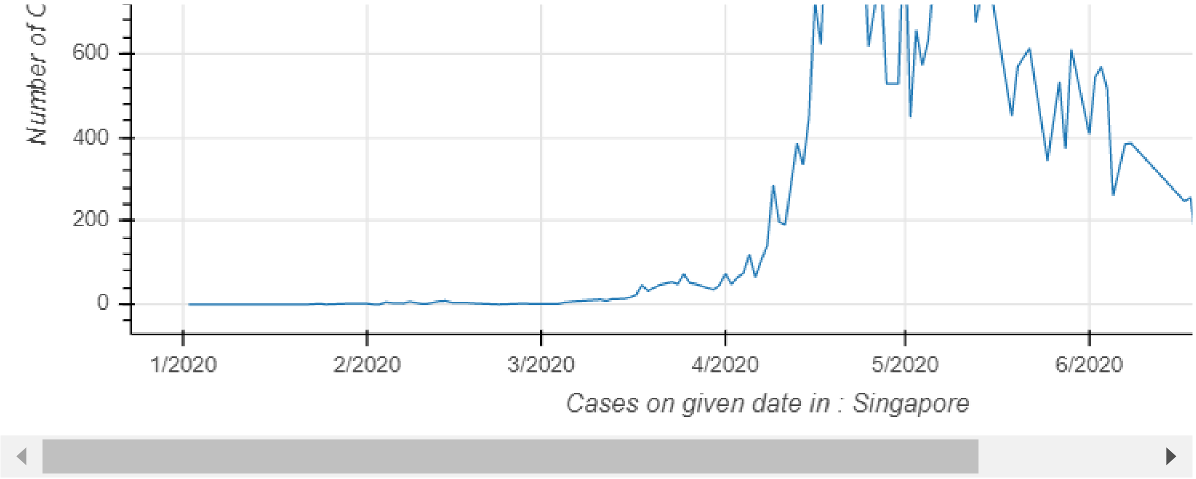
Sweden

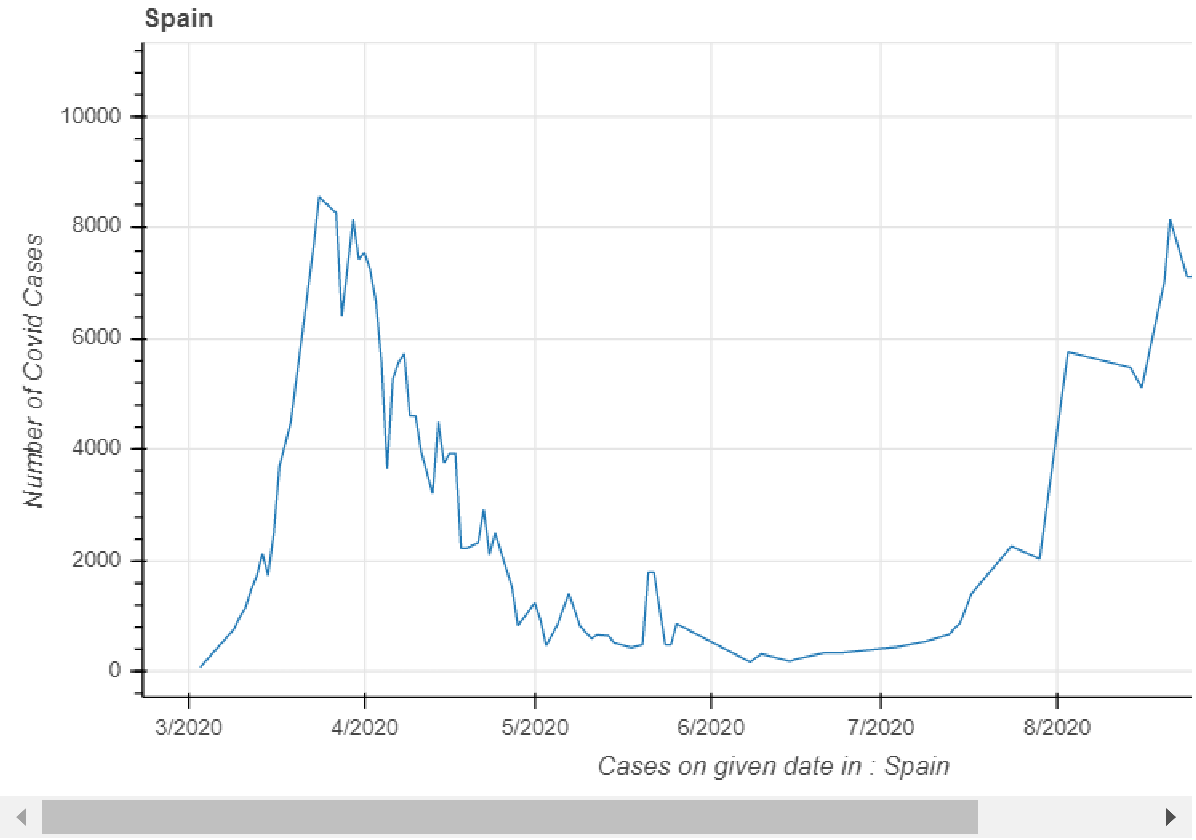
United Kingdom

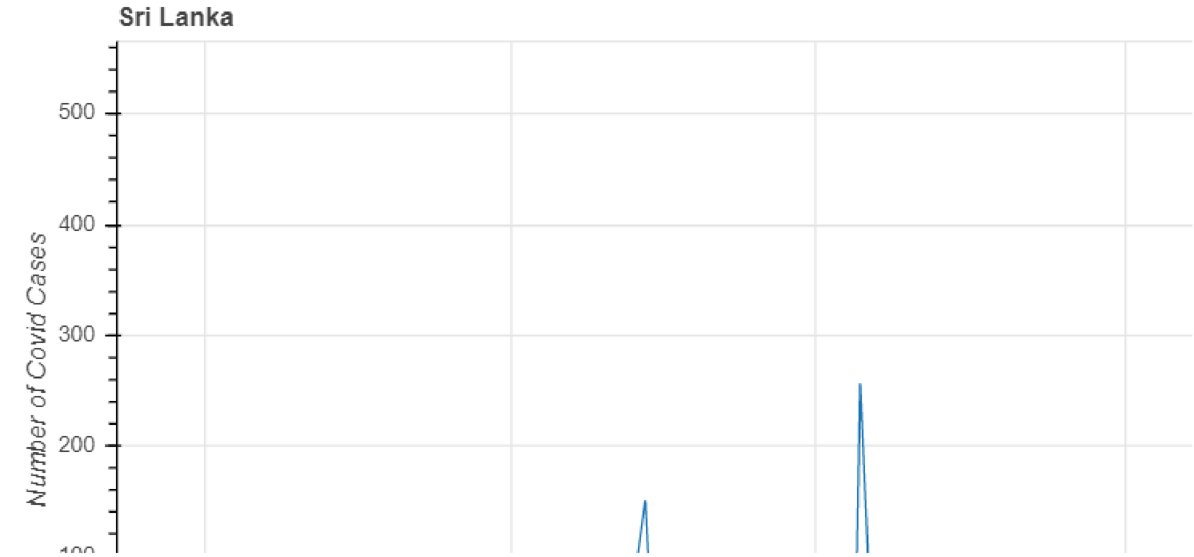

Number of Covid Cases
20000
15000
10000
5000
0
3/2020
5/2020
7/2020
9/2020
Cases on given date in : United Kingdom

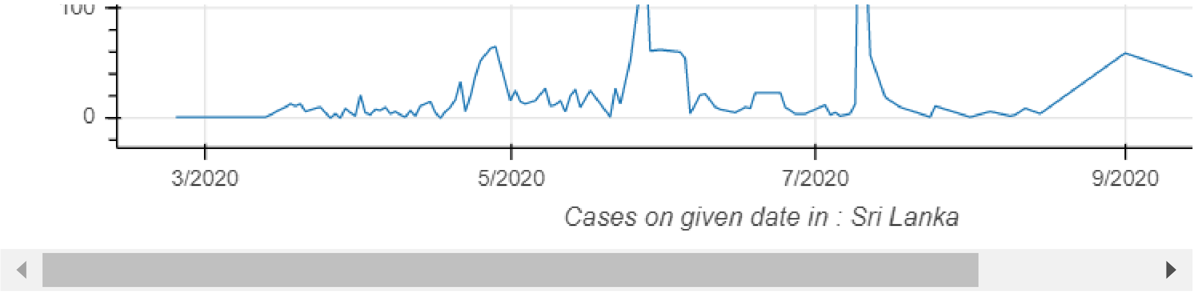

Mexico
Number of Covid Cases
7000
6000
5000
4000
3000
2000
1000
0
3/2020
5/2020
7/2020
9/2020
Cases on given date in : Mexico

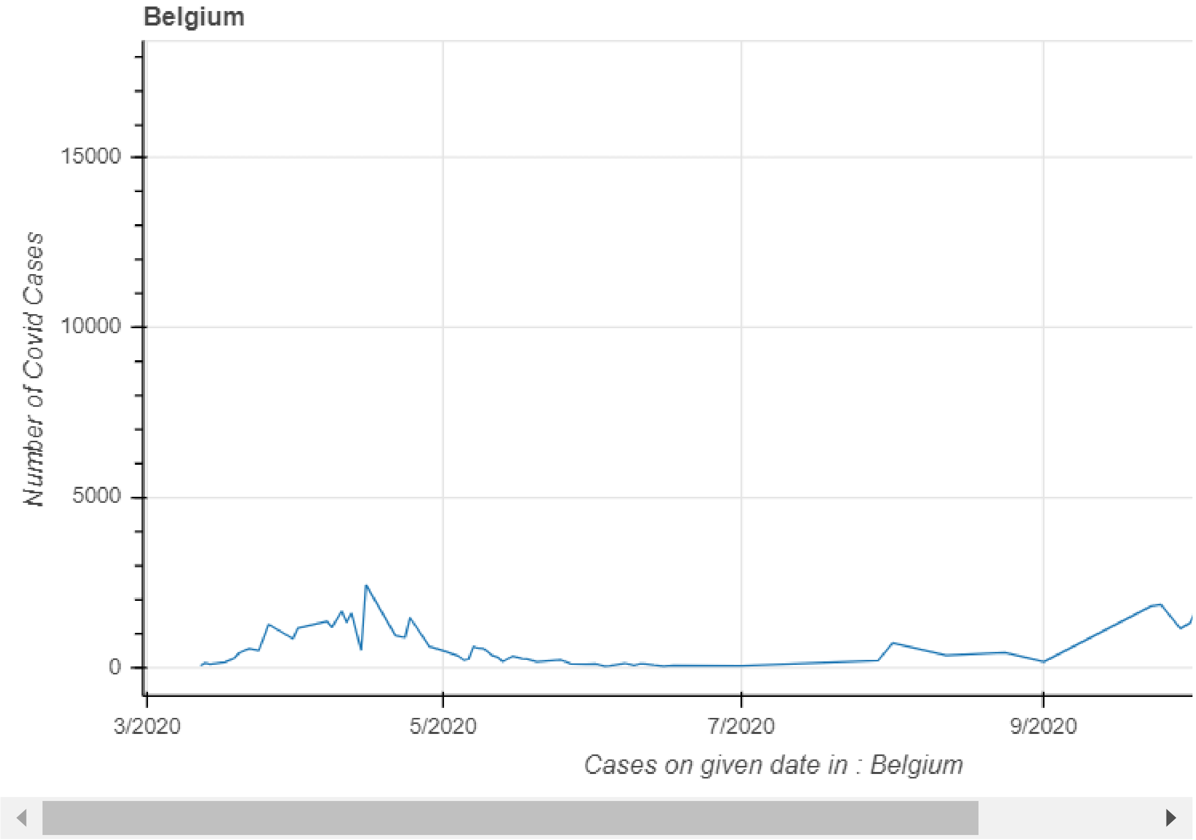

Singapore
Covid Cases
1400
1200
1000
800


Number of C
600
400
200
0
1/2020
2/2020
3/2020
4/2020
5/2020
6/2020
Cases on given date in : Singapore


Spain
Number of Covid Cases
10000
8000
6000
4000
2000
0
3/2020
4/2020
5/2020
6/2020
7/2020
8/2020
Cases on given date in : Spain


Sri Lanka
Number of Covid Cases
500
400
300
200


100
0
3/2020
5/2020
7/2020
9/2020
Cases on given date in : Sri Lanka


Belgium
Number of Covid Cases
15000
10000
5000
0
3/2020
5/2020
7/2020
9/2020
Cases on given date in : Belgium

```
<Figure size 720x360 with 0 Axes>

<Figure size 720x360 with 0 Axes>

<Figure size 720x360 with 0 Axes>

<Figure size 720x360 with 0 Axes>

<Figure size 720x360 with 0 Axes>

<Figure size 720x360 with 0 Axes>

<Figure size 720x360 with 0 Axes>

<Figure size 720x360 with 0 Axes>

<Figure size 720x360 with 0 Axes>

<Figure size 720x360 with 0 Axes>

<Figure size 720x360 with 0 Axes>

<Figure size 720x360 with 0 Axes>
```

```
<Figure size 720x360 with 0 Axes>

<Figure size 720x360 with 0 Axes>

<Figure size 720x360 with 0 Axes>

<Figure size 720x360 with 0 Axes>
```

In [16]:

```
for i in range(len(country_array)):
    new_df = df[df["COUNTRY"] == country_array[i]]
    new_df = new_df.drop_duplicates(subset=['DATE_IMPLEMENTED'])
    new_df = new_df.sort_values(by="DATE_IMPLEMENTED")
    if i == 0:
        df0 = new_df
    else:
        df0 = df0.append(new_df)
```

In [17]:

```
sum = df0['covid_case_per_date'].sum()
print(sum)
```

```
11102926.0
```

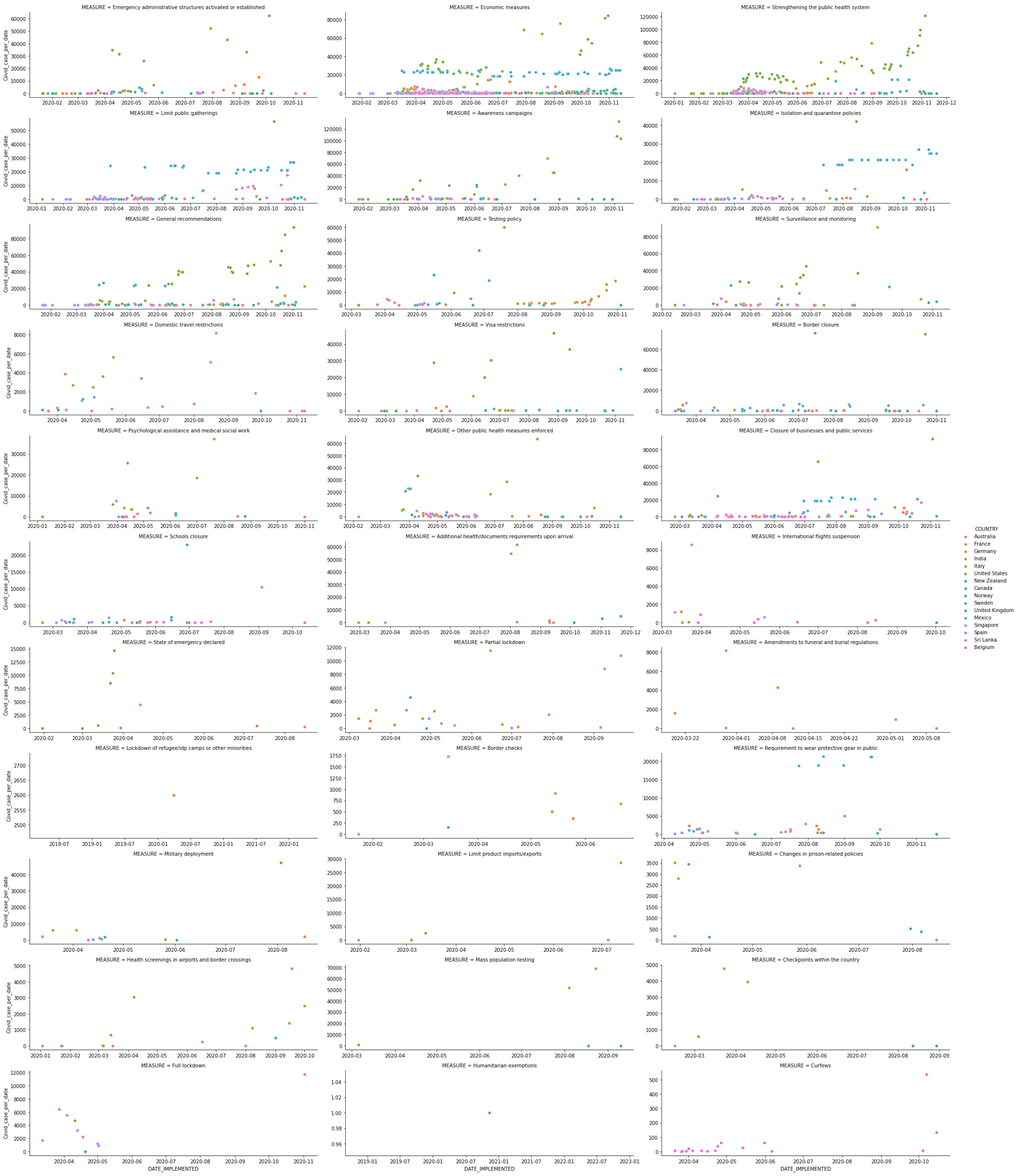
2) What was the impact of each measure on the number of Covid-19 cases in the different countries?

In [23]:

```
#Below are the scatterplots that show the impact of each measure on the numbe
import seaborn as sns
plt.tight_layout()
g = sns.FacetGrid(df0, col="MEASURE", hue="COUNTRY", height=3, aspect=3, col_
g.map_dataframe(sns.scatterplot, x="DATE_IMPLEMENTED", y="covid_case_per_date
g.set_axis_labels("DATE_IMPLEMENTED", "Covid_case_per_date")
g.add_legend()
```

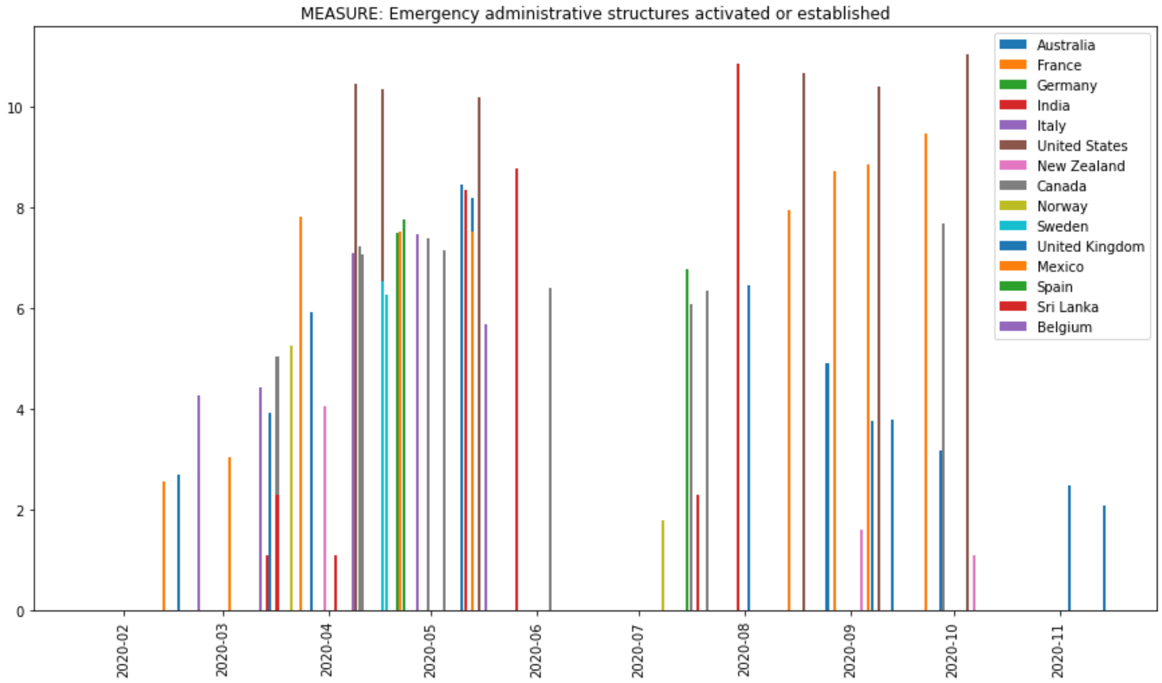
Out[23]:

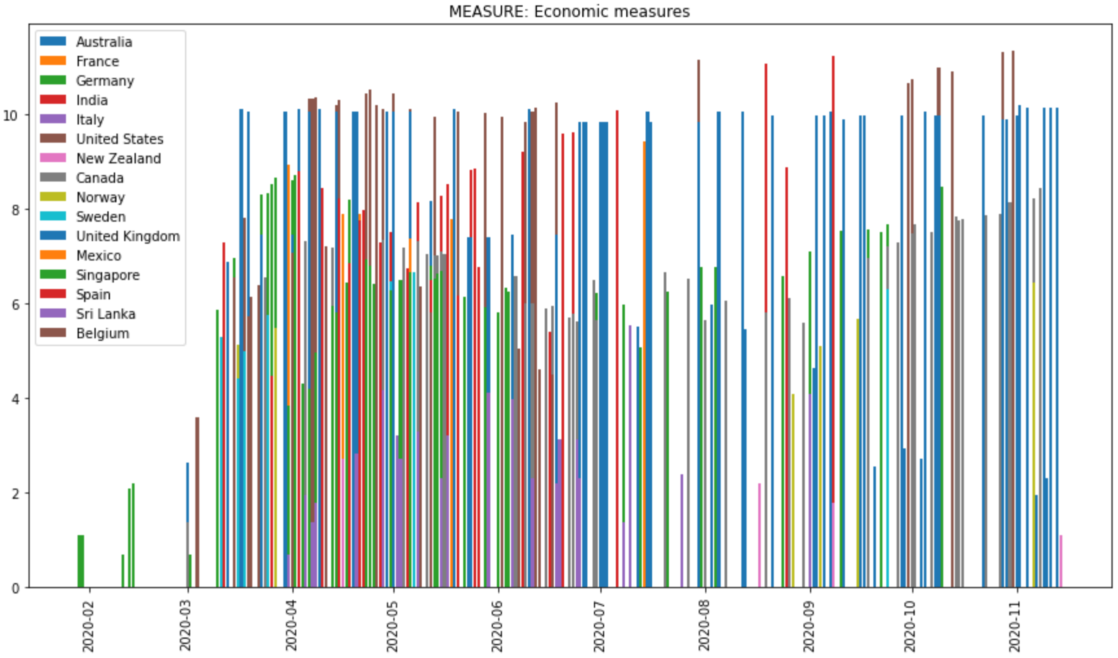
```
<seaborn.axisgrid.FacetGrid at 0x7f03a72c3748>

<Figure size 432x288 with 0 Axes>
```

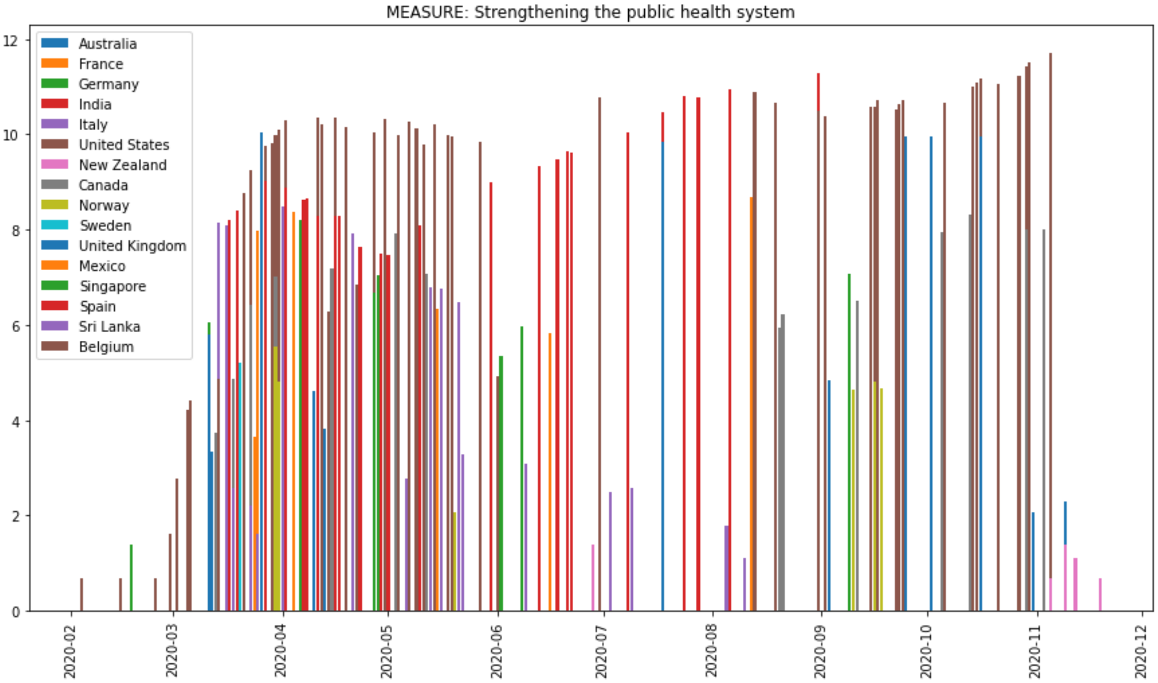


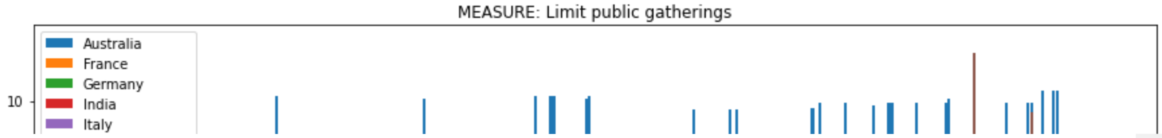
In [24]:

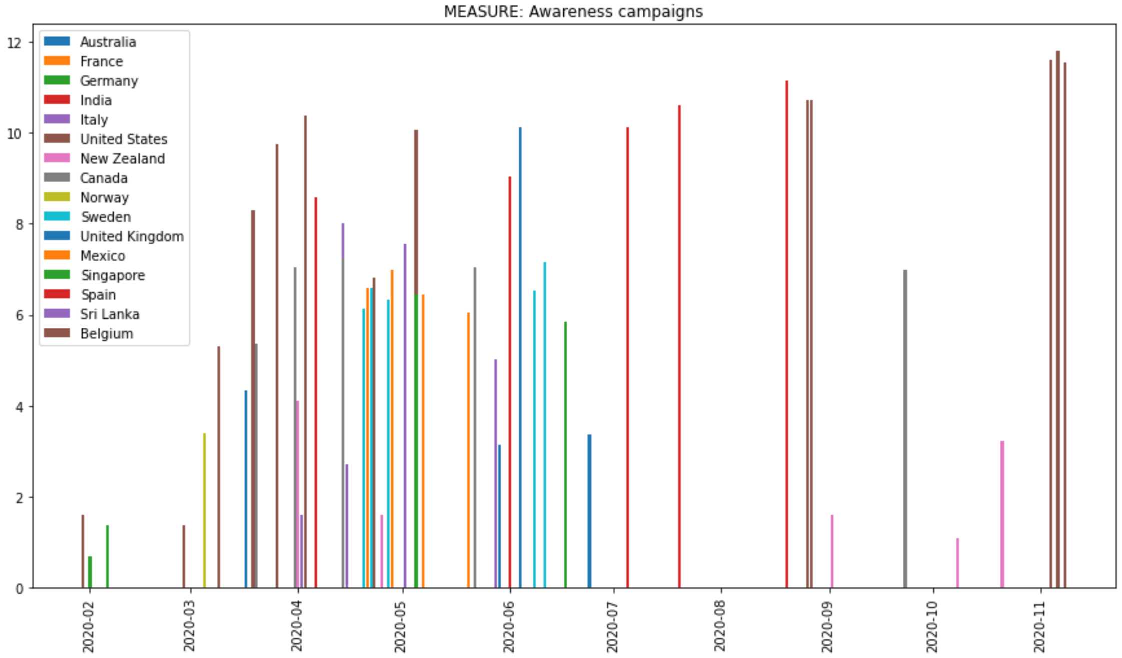
```
# These bar-graphs show the impact of each measure on the number of Covid-19
# We have plotted the log-value of covid cases on the y-axis to normalize the
Measure_array=df0["MEASURE"].unique()
for i in range(len(Measure_array)):
    new_df = df0[df0['MEASURE'] == Measure_array[i]]
    Country_array=new_df["COUNTRY"].unique()
    if len(Country_array) > 1:
        plt.figure(figsize=(15,8))
        for j in range(len(Country_array)):
            df1 = df0[df0["MEASURE"]== Measure_array[i]]
            df1 = df1[df1["COUNTRY"] == Country_array[j]]
            if len(df1) > 0:
                plt.bar(df1['DATE_IMPLEMENTED'],df1['log_value'],label=Countr
                plt.xticks(rotation=90)
        plt.legend()
        title="MEASURE: "+Measure_array[i]
        plt.title(title)
        plt.show()
```

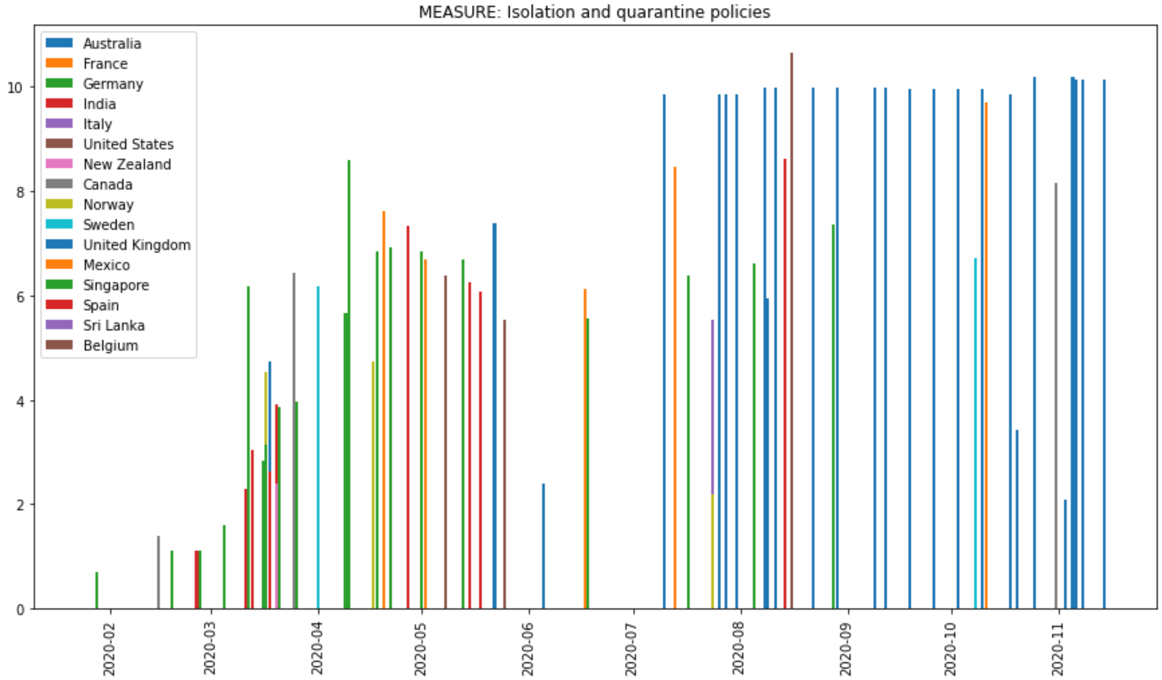


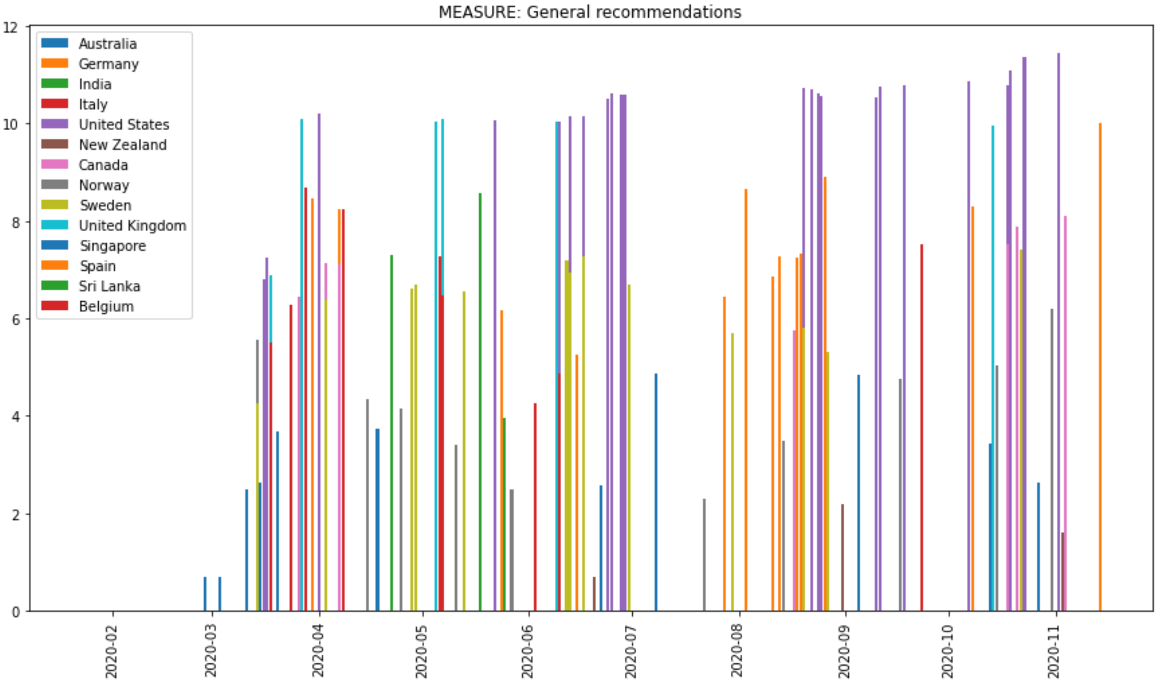

MEASURE: Economic measures
Australia
France
Germany
India
Italy
United States
New Zealand
Canada
Norway
Sweden
United Kingdom
Mexico
Singapore
Spain
Sri Lanka
Belgium
0
2
4
6
8
10
2020-02
2020-03
2020-04
2020-05
2020-06
2020-07
2020-08
2020-09
2020-10
2020-11

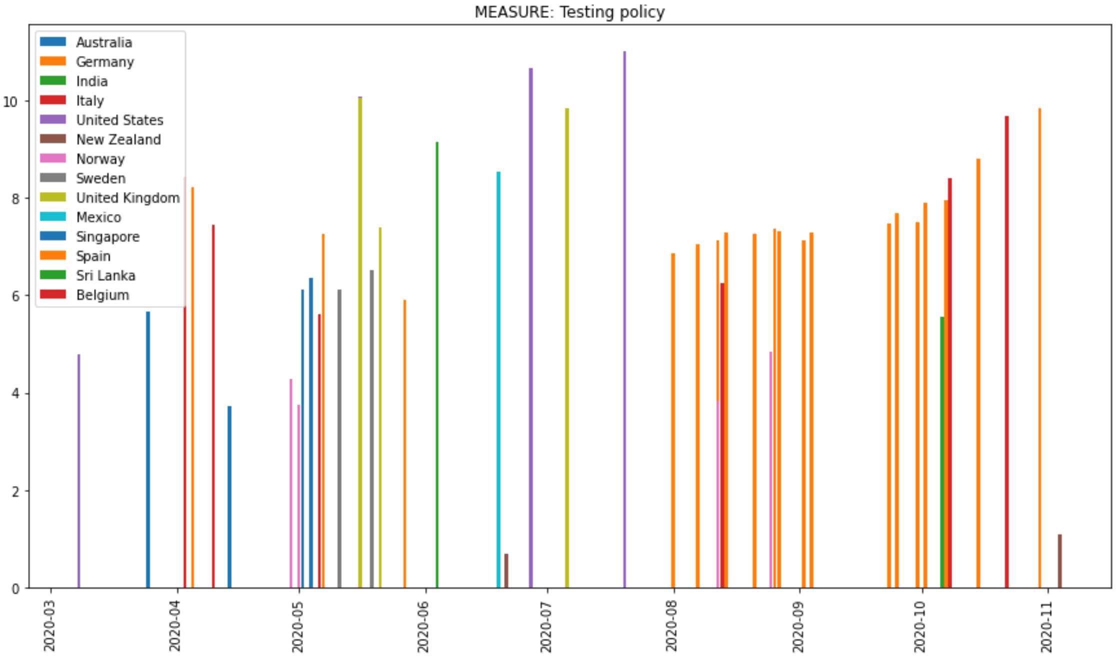

MEASURE: Strengthening the public health system
Australia
France
Germany
India
Italy
United States
New Zealand
Canada
Norway
Sweden
United Kingdom
Mexico
Singapore
Spain
Sri Lanka
Belgium
0
2
4
6
8
10
12
2020-02
2020-03
2020-04
2020-05
2020-06
2020-07
2020-08
2020-09
2020-10
2020-11
2020-12

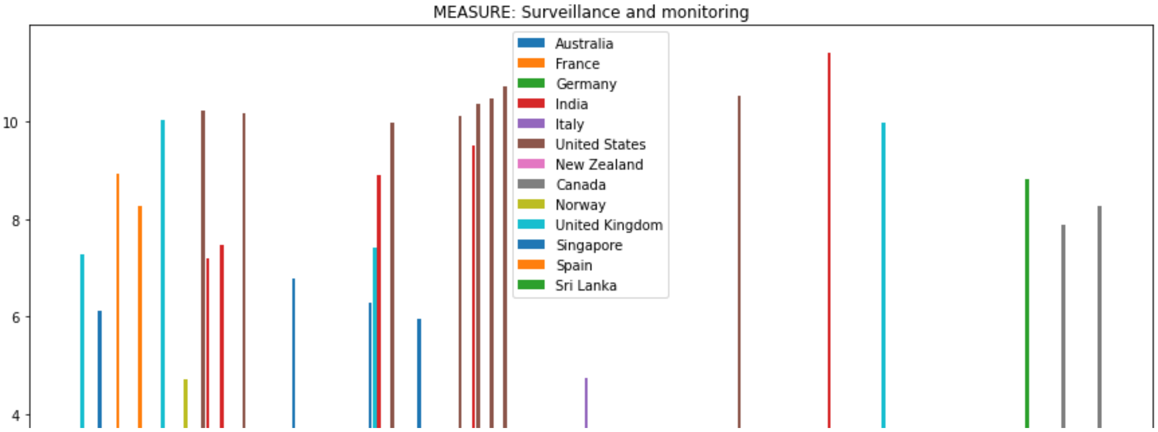

MEASURE: Limit public gatherings
Australia
France
Germany
India
Italy
10

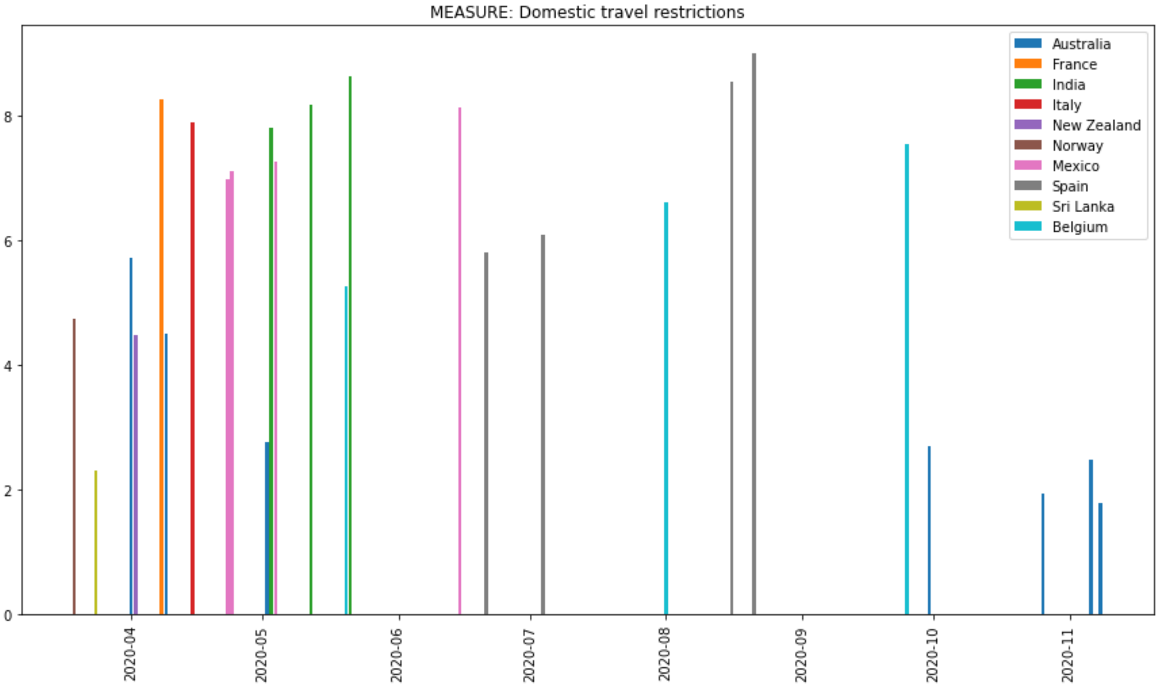

MEASURE: Awareness campaigns
Australia
France
Germany
India
Italy
United States
New Zealand
Canada
Norway
Sweden
United Kingdom
Mexico
Singapore
Spain
Sri Lanka
Belgium
0
2
4
6
8
10
12
2020-02
2020-03
2020-04
2020-05
2020-06
2020-07
2020-08
2020-09
2020-10
2020-11

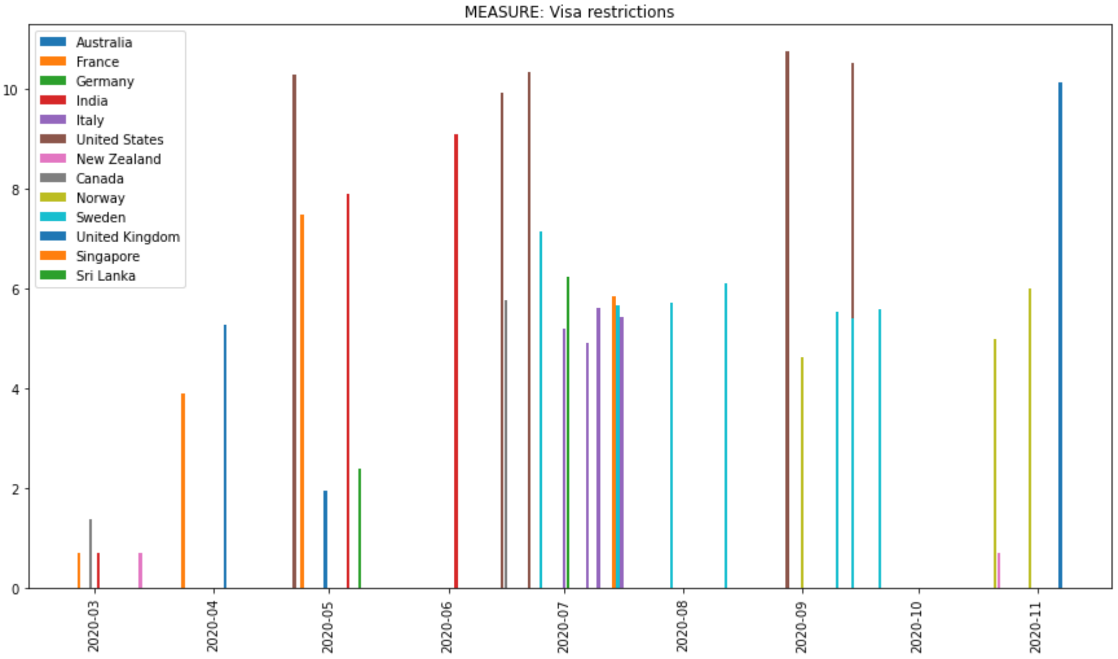

MEASURE: Isolation and quarantine policies
Australia
France
Germany
India
Italy
United States
New Zealand
Canada
Norway
Sweden
United Kingdom
Mexico
Singapore
Spain
Sri Lanka
Belgium
0
2
4
6
8
10
2020-02
2020-03
2020-04
2020-05
2020-06
2020-07
2020-08
2020-09
2020-10
2020-11

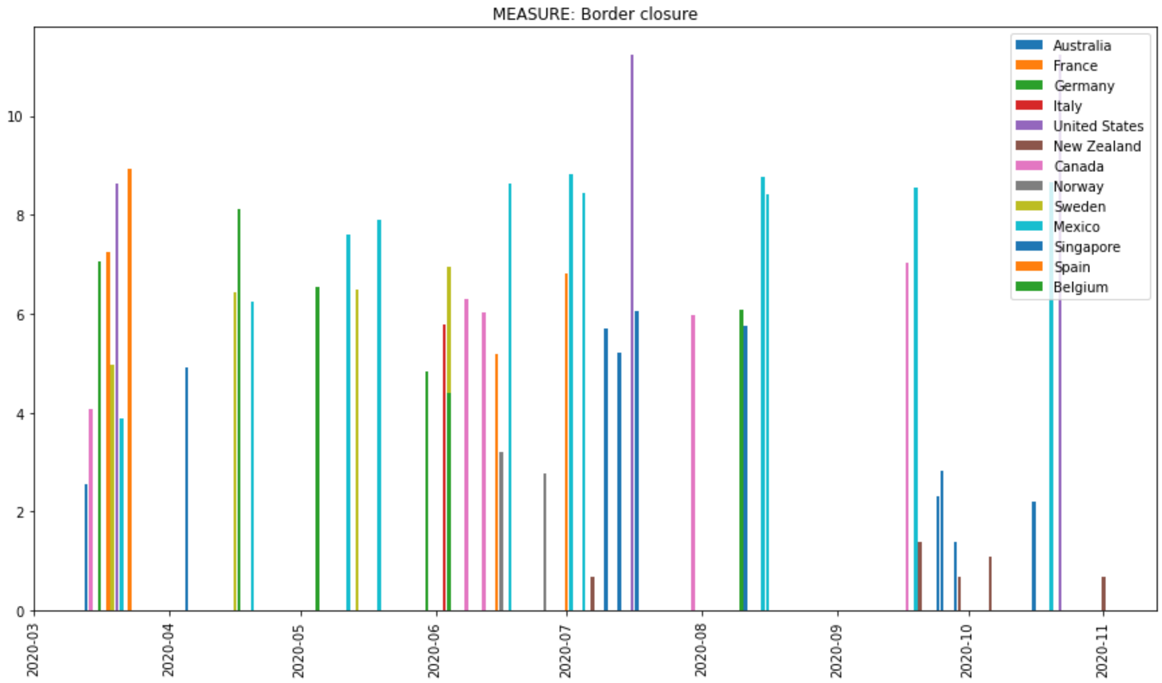

MEASURE: General recommendations
Australia
Germany
India
Italy
United States
New Zealand
Canada
Norway
Sweden
United Kingdom
Singapore
Spain
Sri Lanka
Belgium
12
10
8
6
4
2
0
2020-02
2020-03
2020-04
2020-05
2020-06
2020-07
2020-08
2020-09
2020-10
2020-11

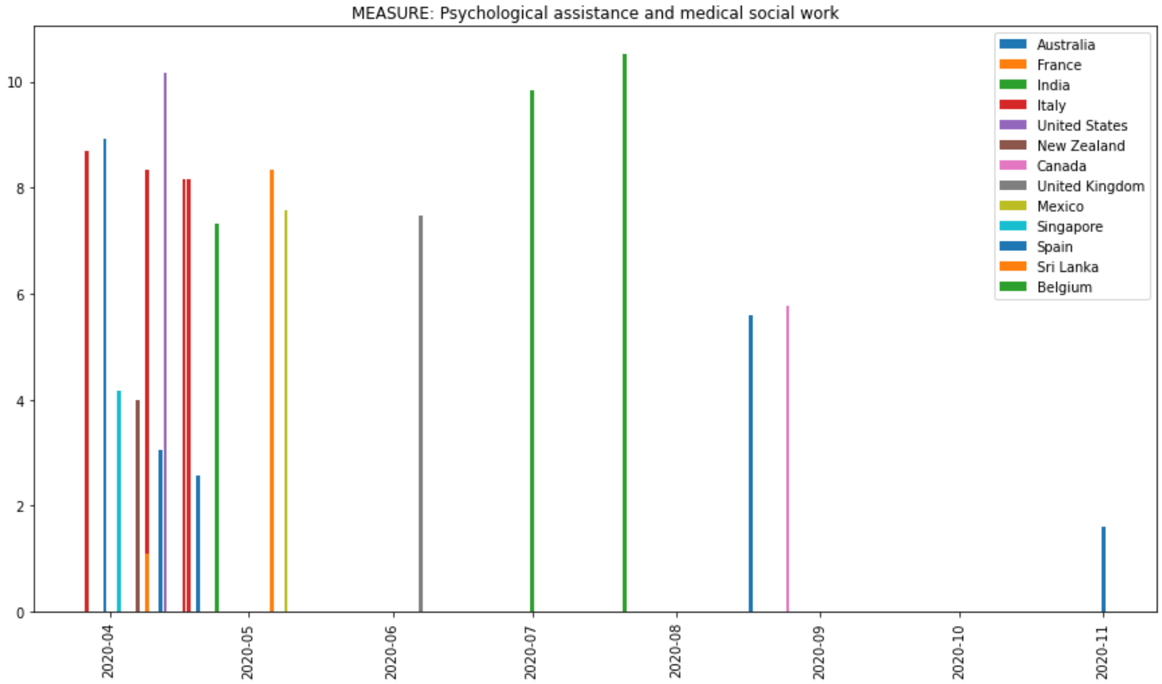

MEASURE: Testing policy
Australia
Germany
India
Italy
United States
New Zealand
Norway
Sweden
United Kingdom
Mexico
Singapore
Spain
Sri Lanka
Belgium
10
8
6
4
2
0
2020-03
2020-04
2020-05
2020-06
2020-07
2020-08
2020-09
2020-10
2020-11

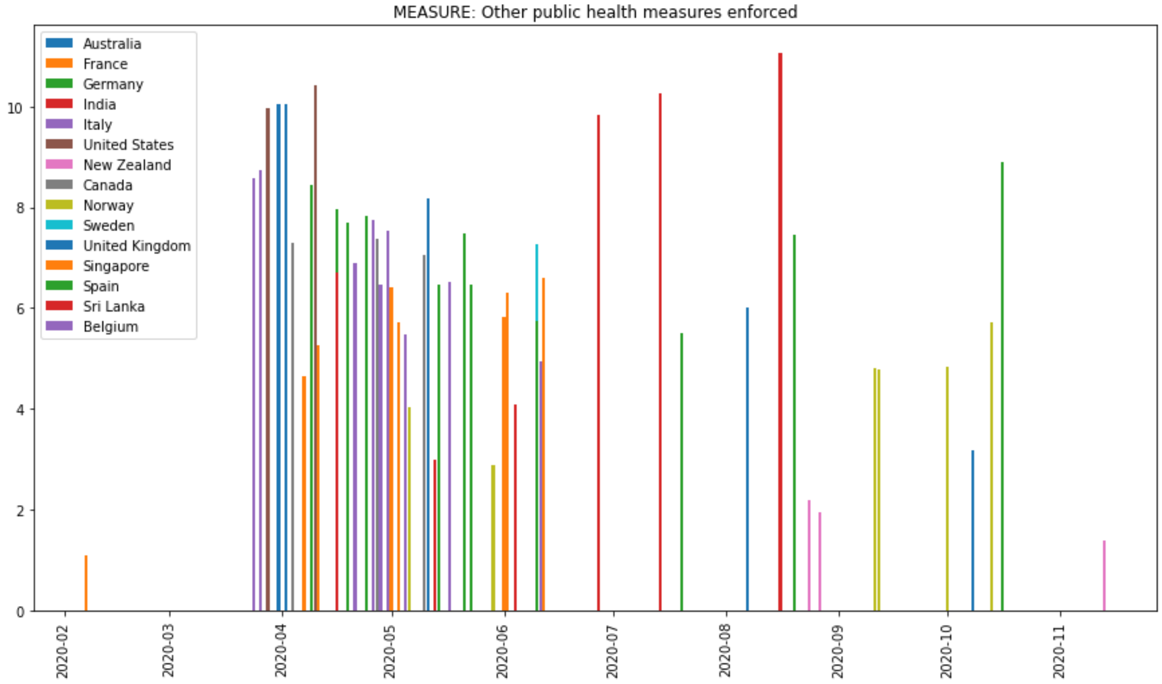

MEASURE: Surveillance and monitoring
Australia
France
Germany
India
Italy
United States
New Zealand
Canada
Norway
United Kingdom
Singapore
Spain
Sri Lanka
10
8
6
4

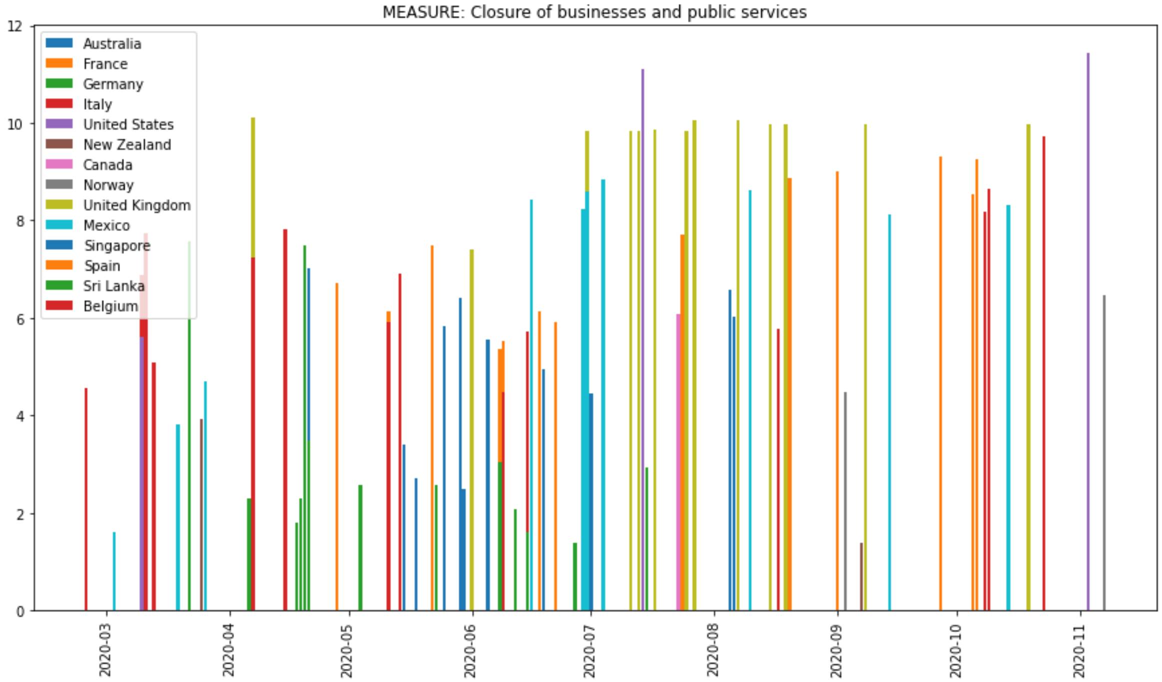

MEASURE: Domestic travel restrictions
Australia
France
India
Italy
New Zealand
Norway
Mexico
Spain
Sri Lanka
Belgium
8
6
4
2
0
2020-04
2020-05
2020-06
2020-07
2020-08
2020-09
2020-10
2020-11

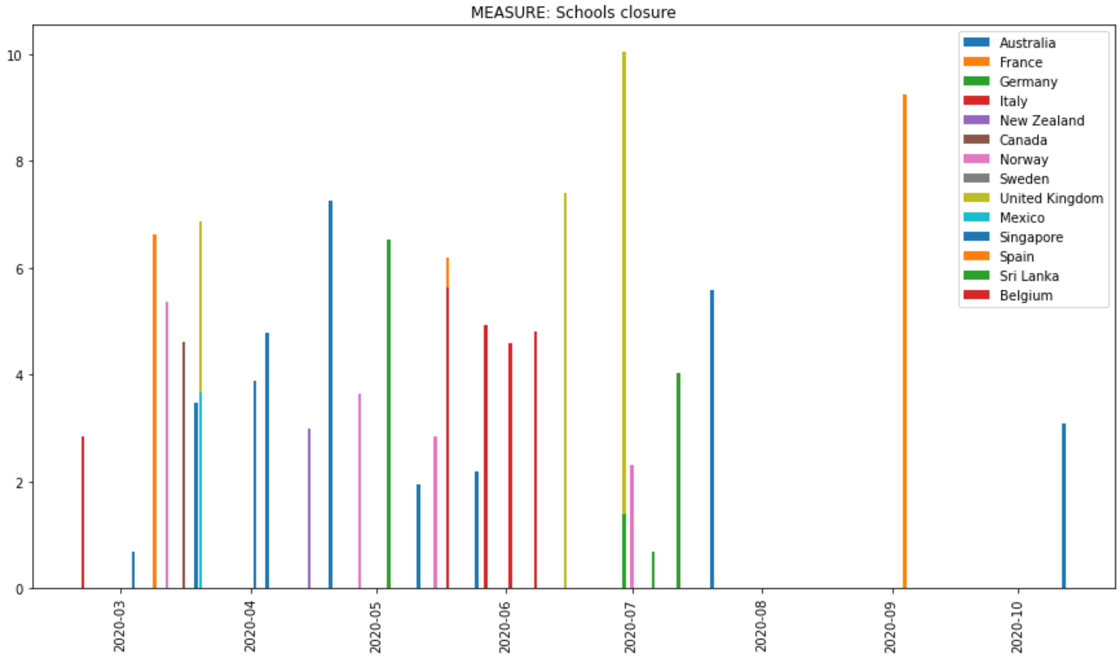

MEASURE: Visa restrictions
Australia
France
Germany
India
Italy
United States
New Zealand
Canada
Norway
Sweden
United Kingdom
Singapore
Sri Lanka
10
8
6
4
2
0
2020-03
2020-04
2020-05
2020-06
2020-07
2020-08
2020-09
2020-10
2020-11

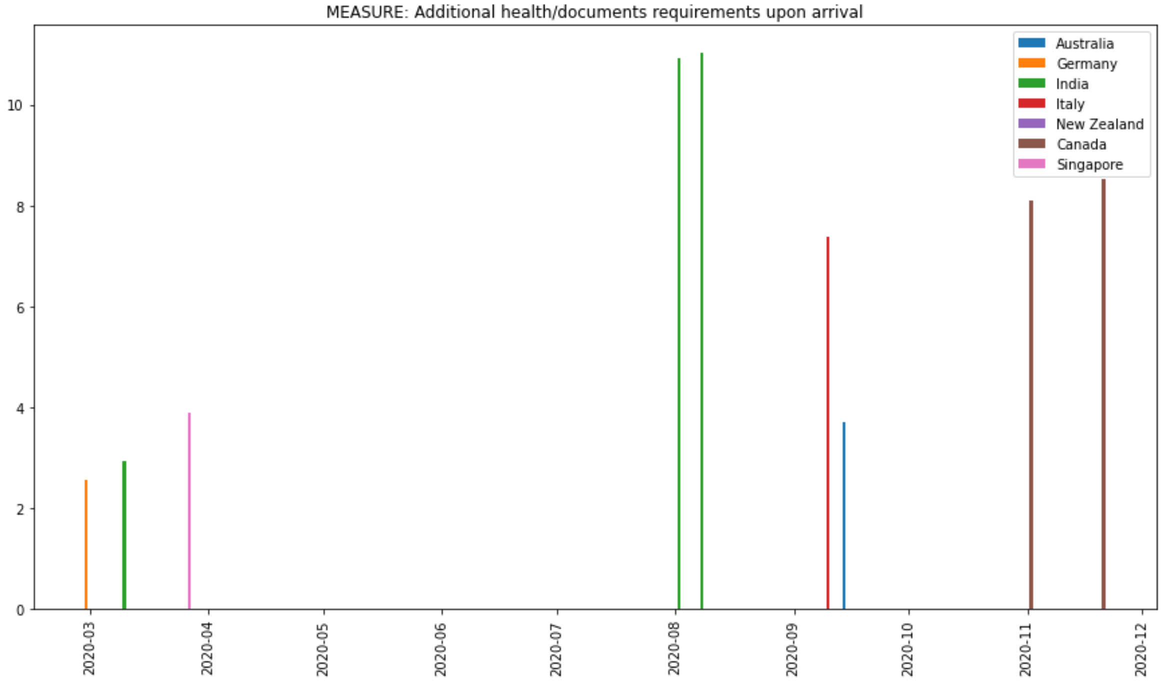

MEASURE: Border closure
0
2
4
6
8
10
2020-03
2020-04
2020-05
2020-06
2020-07
2020-08
2020-09
2020-10
2020-11
Australia
France
Germany
Italy
United States
New Zealand
Canada
Norway
Sweden
Mexico
Singapore
Spain
Belgium

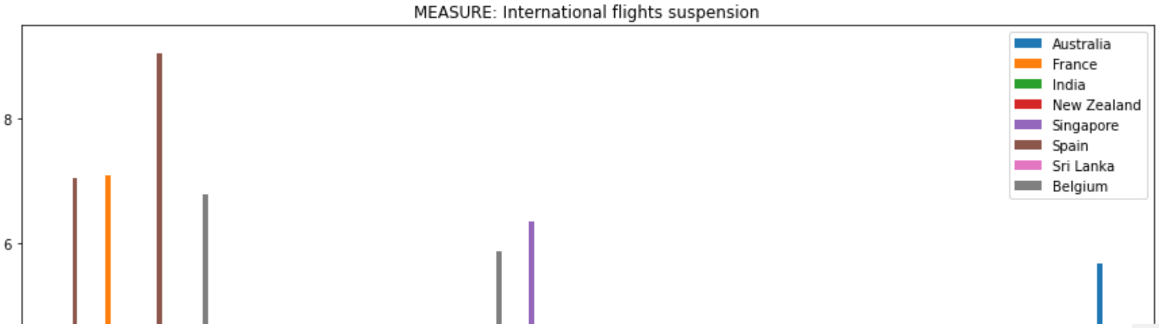

MEASURE: Psychological assistance and medical social work
0
2
4
6
8
10
2020-04
2020-05
2020-06
2020-07
2020-08
2020-09
2020-10
2020-11
Australia
France
India
Italy
United States
New Zealand
Canada
United Kingdom
Mexico
Singapore
Spain
Sri Lanka
Belgium

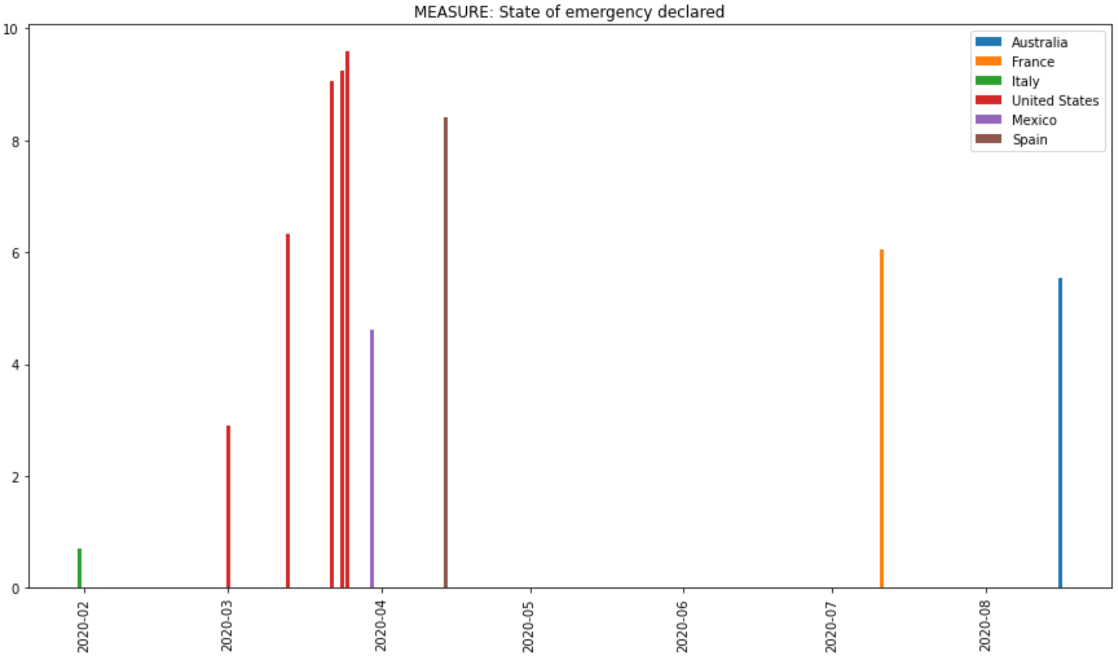

MEASURE: Other public health measures enforced
Australia
France
Germany
India
Italy
United States
New Zealand
Canada
Norway
Sweden
United Kingdom
Singapore
Spain
Sri Lanka
Belgium
0
2
4
6
8
10
2020-02
2020-03
2020-04
2020-05
2020-06
2020-07
2020-08
2020-09
2020-10
2020-11

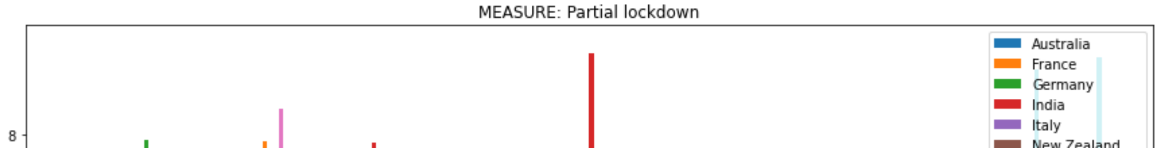

MEASURE: Closure of businesses and public services
Australia
France
Germany
Italy
United States
New Zealand
Canada
Norway
United Kingdom
Mexico
Singapore
Spain
Sri Lanka
Belgium
0
2
4
6
8
10
12
2020-03
2020-04
2020-05
2020-06
2020-07
2020-08
2020-09
2020-10
2020-11


MEASURE: Schools closure
Australia
France
Germany
Italy
New Zealand
Canada
Norway
Sweden
United Kingdom
Mexico
Singapore
Spain
Sri Lanka
Belgium
0
2
4
6
8
10
2020-03
2020-04
2020-05
2020-06
2020-07
2020-08
2020-09
2020-10

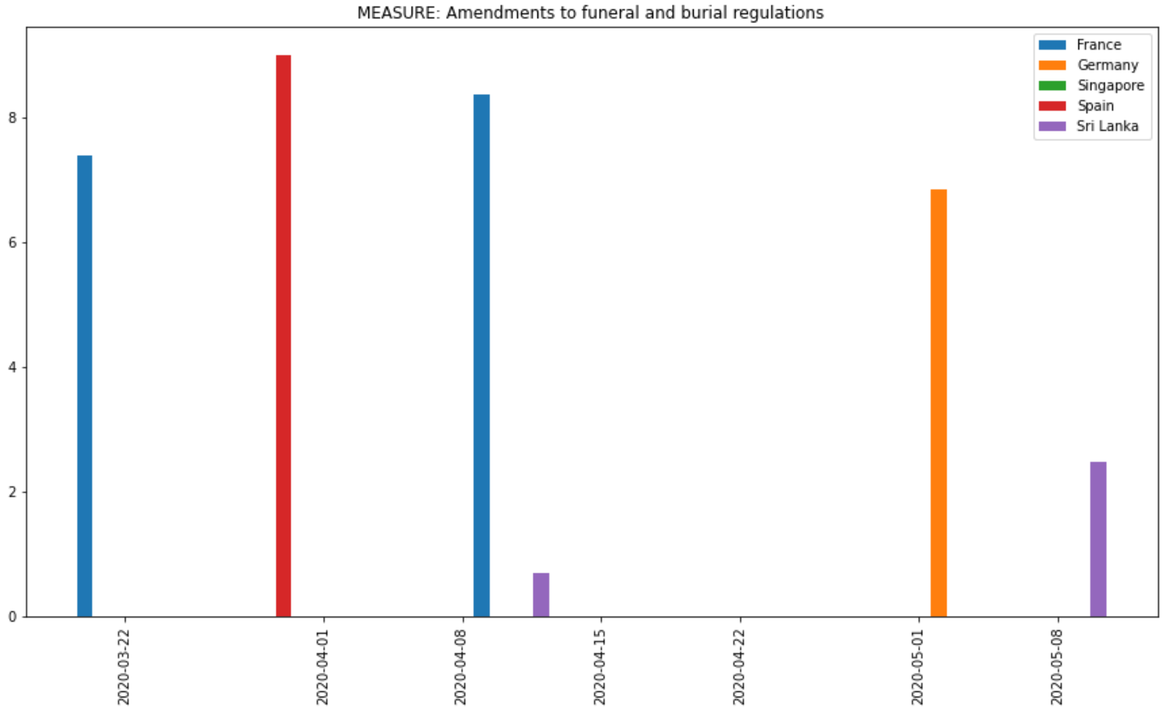

MEASURE: Additional health/documents requirements upon arrival
Australia
Germany
India
Italy
New Zealand
Canada
Singapore
0
2
4
6
8
10
2020-03
2020-04
2020-05
2020-06
2020-07
2020-08
2020-09
2020-10
2020-11
2020-12


MEASURE: International flights suspension
8
6
Australia
France
India
New Zealand
Singapore
Spain
Sri Lanka
Belgium

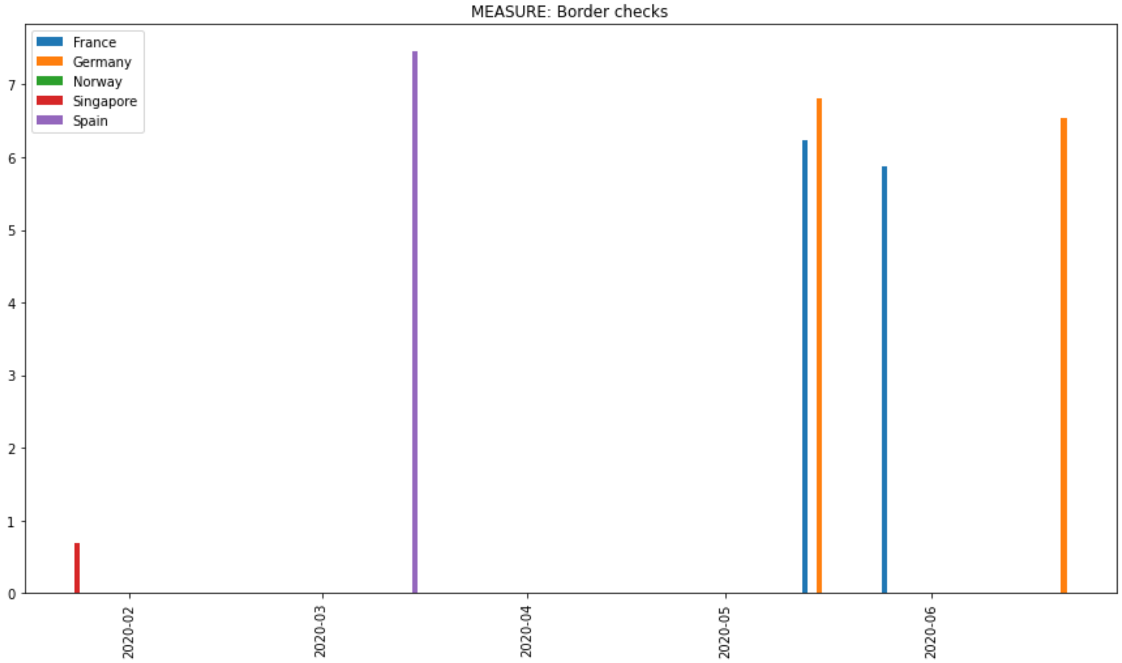

MEASURE: State of emergency declared
10
8
6
4
2
0
Australia
France
Italy
United States
Mexico
Spain
2020-02
2020-03
2020-04
2020-05
2020-06
2020-07
2020-08



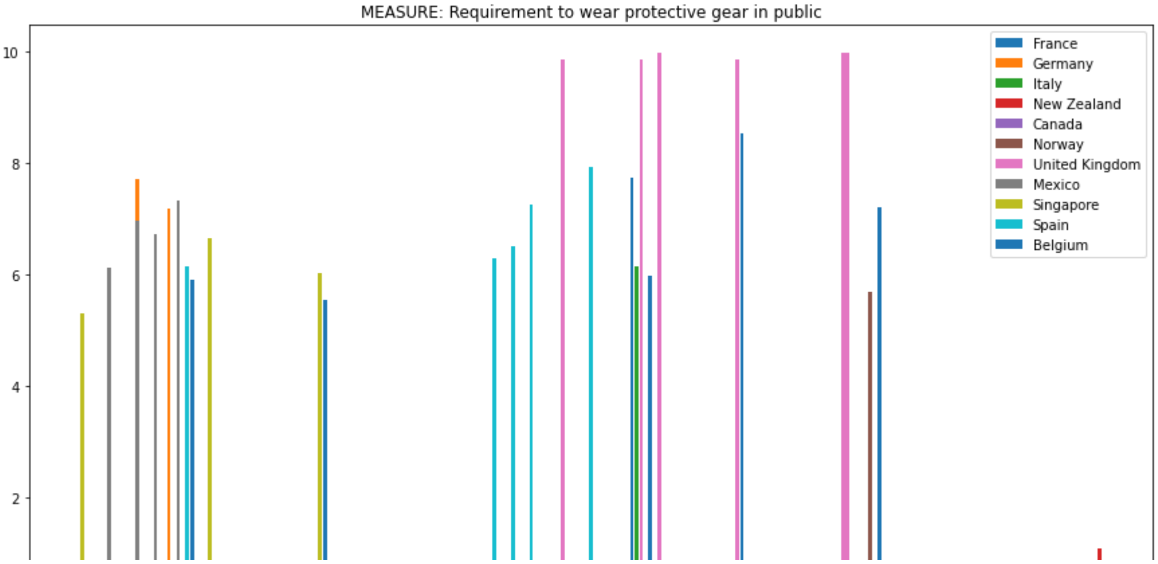
MEASURE: Partial lockdown

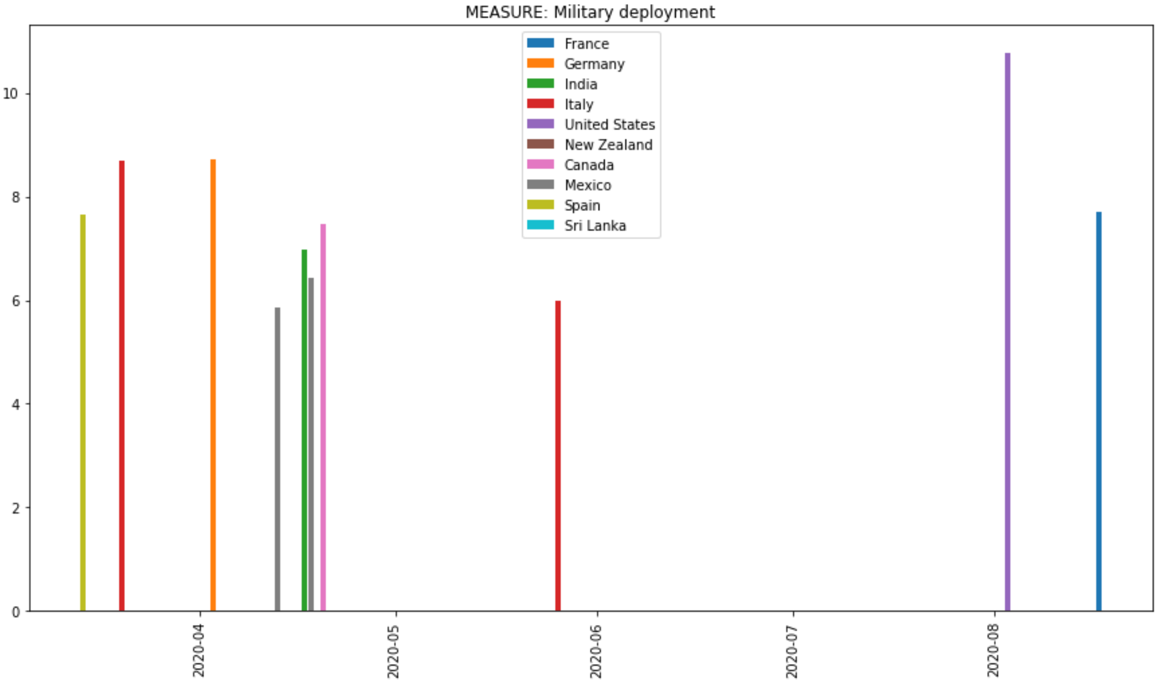


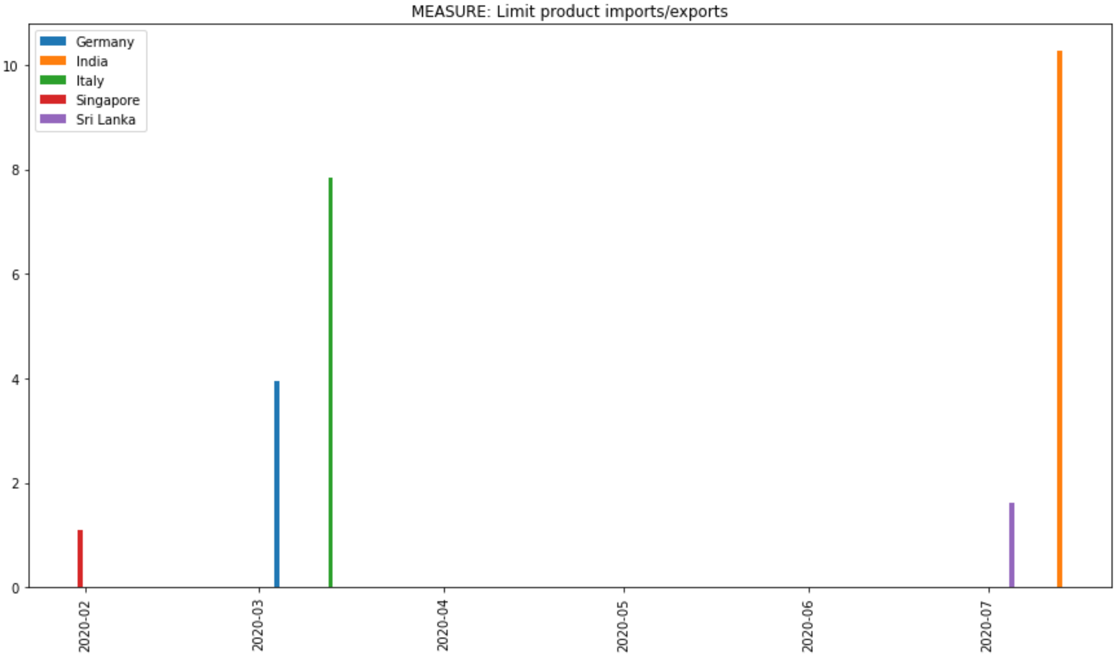
MEASURE: Amendments to funeral and burial regulations

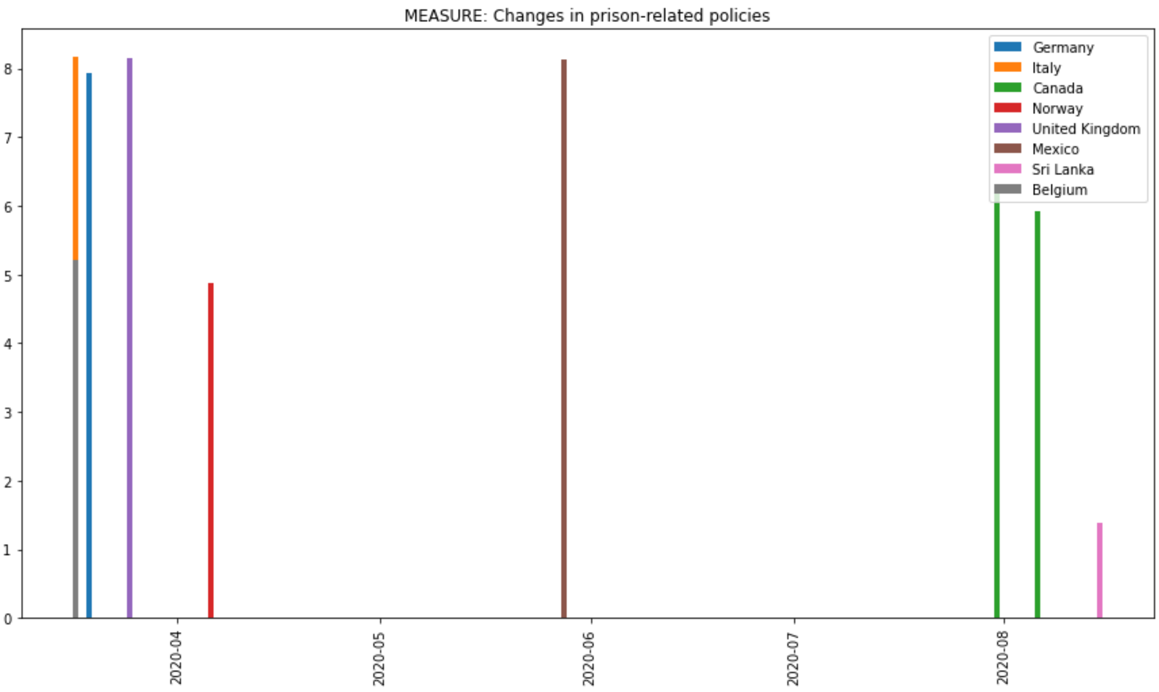


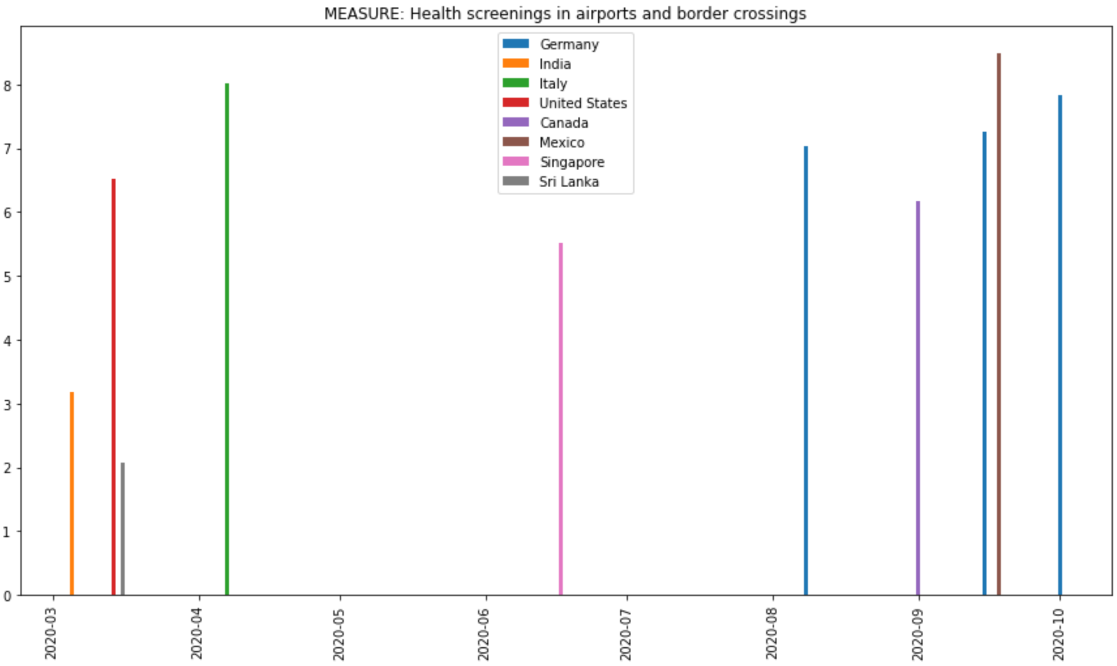
MEASURE: Border checks

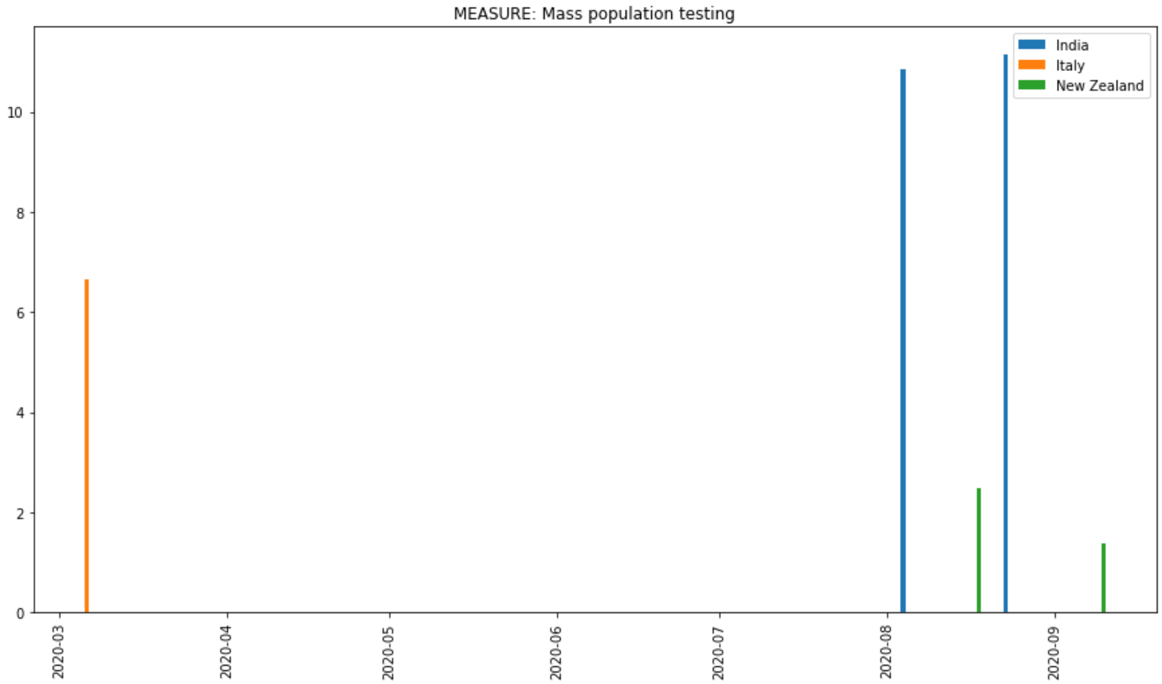

MEASURE: Requirement to wear protective gear in public
10
8
6
4
2
France
Germany
Italy
New Zealand
Canada
Norway
United Kingdom
Mexico
Singapore
Spain
Belgium

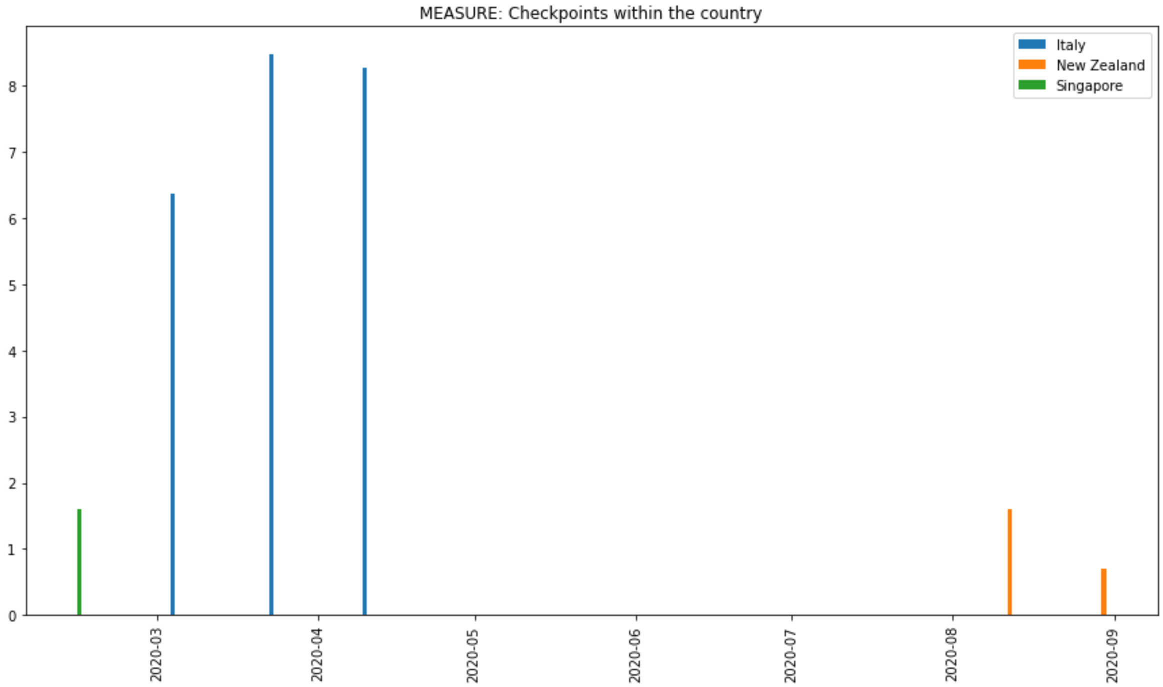

MEASURE: Military deployment
0
2
4
6
8
10
France
Germany
India
Italy
United States
New Zealand
Canada
Mexico
Spain
Sri Lanka
2020-04
2020-05
2020-06
2020-07
2020-08

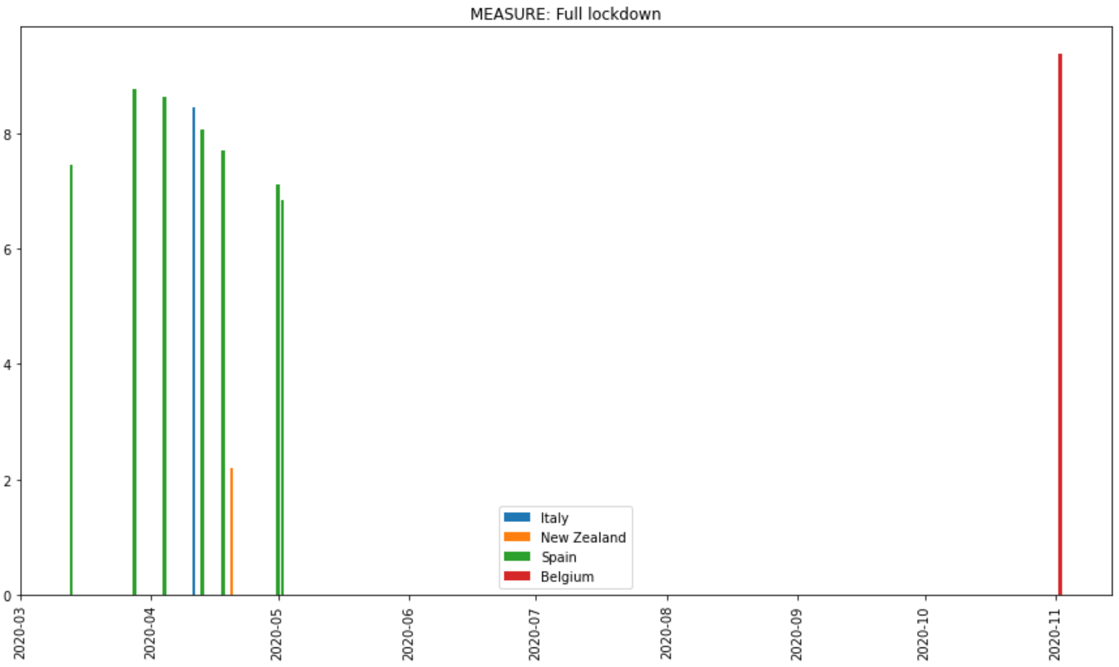

MEASURE: Limit product imports/exports
0
2
4
6
8
10
Germany
India
Italy
Singapore
Sri Lanka
2020-02
2020-03
2020-04
2020-05
2020-06
2020-07


MEASURE: Changes in prison-related policies
Germany
Italy
Canada
Norway
United Kingdom
Mexico
Sri Lanka
Belgium
0
1
2
3
4
5
6
7
8
2020-04
2020-05
2020-06
2020-07
2020-08


MEASURE: Health screenings in airports and border crossings
Germany
India
Italy
United States
Canada
Mexico
Singapore
Sri Lanka
0
1
2
3
4
5
6
7
8
2020-03
2020-04
2020-05
2020-06
2020-07
2020-08
2020-09
2020-10


MEASURE: Mass population testing
India
Italy
New Zealand
0
2
4
6
8
10
2020-03
2020-04
2020-05
2020-06
2020-07
2020-08
2020-09


MEASURE: Checkpoints within the country
Italy
New Zealand
Singapore
0
1
2
3
4
5
6
7
8
2020-03
2020-04
2020-05
2020-06
2020-07
2020-08
2020-09



Determining the Countries with more than 15000 new Covid-19 cases in a day and the measures taken by them

In [18]:

```
df0['max_covid_cases'] = np.where(df0['covid_case_per_date']>= 15000, True, F
max_covid_cases_countries = df0[df0['max_covid_cases'] == True]
max_covid_cases_countries['MEASURE'].unique()
```

Out[18]:

```
array(['Isolation and quarantine policies', 'Testing policy',
       'General recommendations',
       'Strengthening the public health system',
       'Other public health measures enforced',
       'Psychological assistance and medical social work',
       'Awareness campaigns', 'Economic measures',
       'Limit product imports/exports',
       'Emergency administrative structures activated or established',
       'Additional health/documents requirements upon arrival',
       'Mass population testing', 'Surveillance and monitoring',
       'Visa restrictions', 'Closure of businesses and public services',
       'Border closure', 'Military deployment', 'Limit public gatherings',
       'Schools closure', 'Requirement to wear protective gear in public'],
      dtype=object)
```

In [19]:

```
Measure_array = max_covid_cases_countries["MEASURE"].unique()
Measure_array
```

Out[19]:

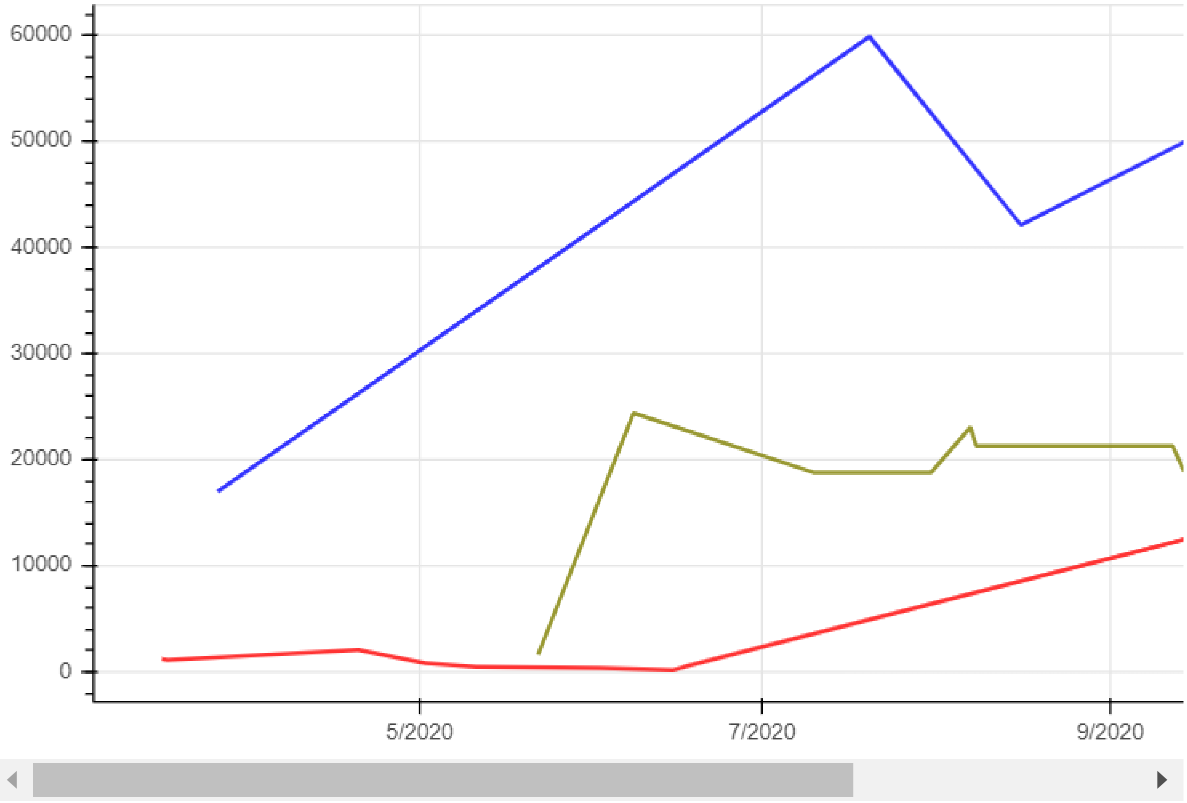
```
array(['Isolation and quarantine policies', 'Testing policy',
       'General recommendations',
       'Strengthening the public health system',
       'Other public health measures enforced',
       'Psychological assistance and medical social work',
       'Awareness campaigns', 'Economic measures',
       'Limit product imports/exports',
       'Emergency administrative structures activated or established',
       'Additional health/documents requirements upon arrival',
       'Mass population testing', 'Surveillance and monitoring',
       'Visa restrictions', 'Closure of businesses and public services',
       'Border closure', 'Military deployment', 'Limit public gatherings',
       'Schools closure', 'Requirement to wear protective gear in public'],
      dtype=object)
```

3) Countries with maximum Covid-19 cases, the measures taken by them and the impact of those measures

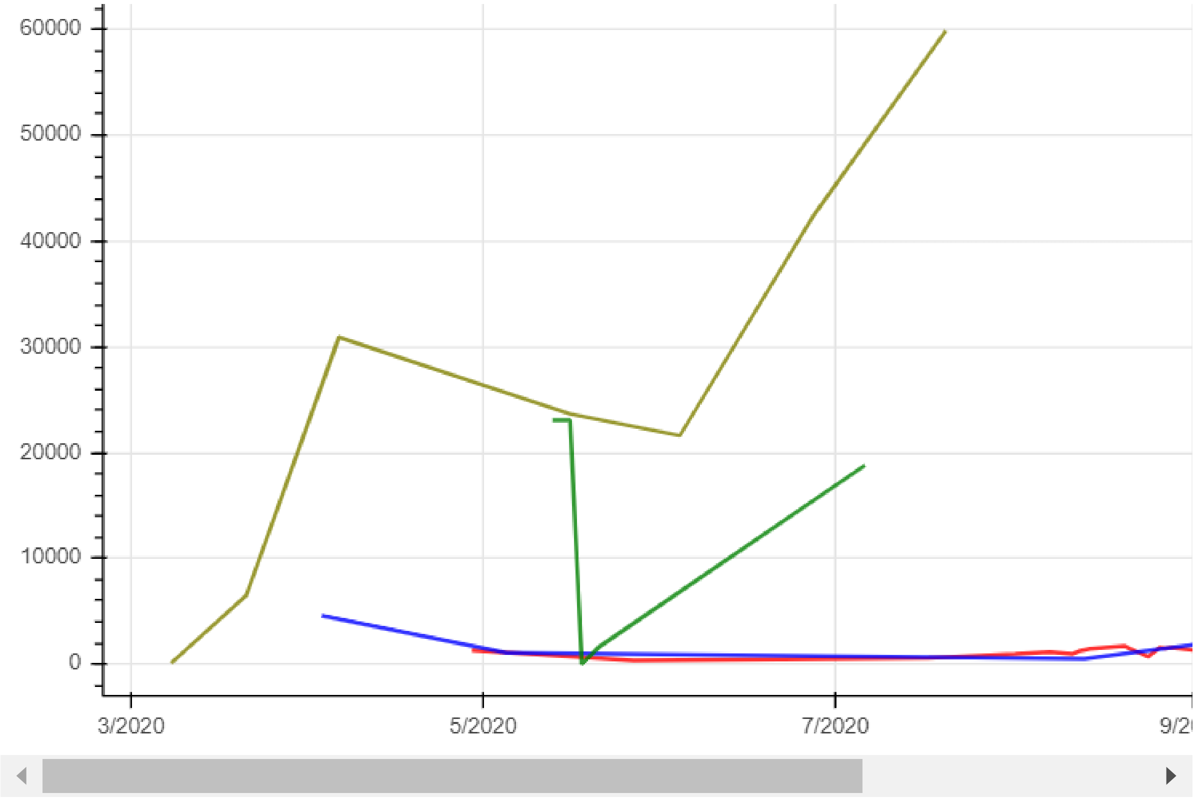
In [20]:

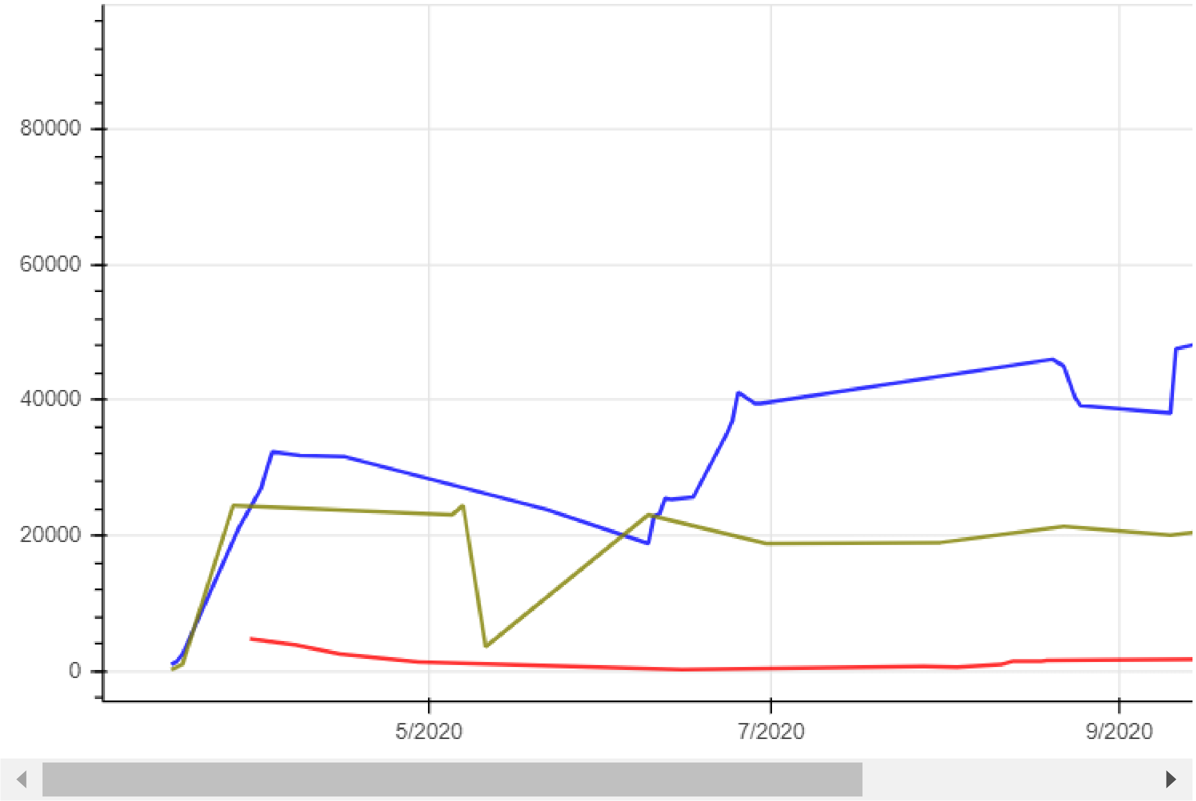
```
# Below graphs show the countries with maximum Covid-19 cases, the measures t
# On hovering over the graph, we can see the number of new covid cases on a p
Measure_array = max_covid_cases_countries["MEASURE"].unique()
mapper_color=['red','blue','olive','green','black','purple','maroon']


for i in range(len(Measure_array)):
    p = figure(plot_width=800, plot_height=400, x_axis_type="datetime",toolba
    p.title.text = "MEASURE "+Measure_array[i]
    new_df = max_covid_cases_countries[max_covid_cases_countries['MEASURE'] =
    Country_array = new_df["COUNTRY"].unique()
    if len(Country_array) > 1:
        for j in range(len(Country_array)):
            df1 = df[df["MEASURE"]== Measure_array[i]]
            df1 = df1[df1["COUNTRY"] == Country_array[j]]
            df1 = df1.drop_duplicates(subset=['DATE_IMPLEMENTED'])
            df1 = df1.sort_values(by="DATE_IMPLEMENTED")
            source = ColumnDataSource(data=dict(
                x=df1['DATE_IMPLEMENTED'],
                y=df1['covid_case_per_date'],
                desc=df1['covid_case_per_date']
                ))
            p.line('x','y', line_width=2, alpha=0.8,
                   legend_label=Country_array[j],source=source,color=mapper_c
            p.add_tools(HoverTool(tooltips='@desc'))
        show(p)
        p.legend.location = "top_left"
        p.legend.click_policy="hide"
```

MEASURE Isolation and quarantine policies

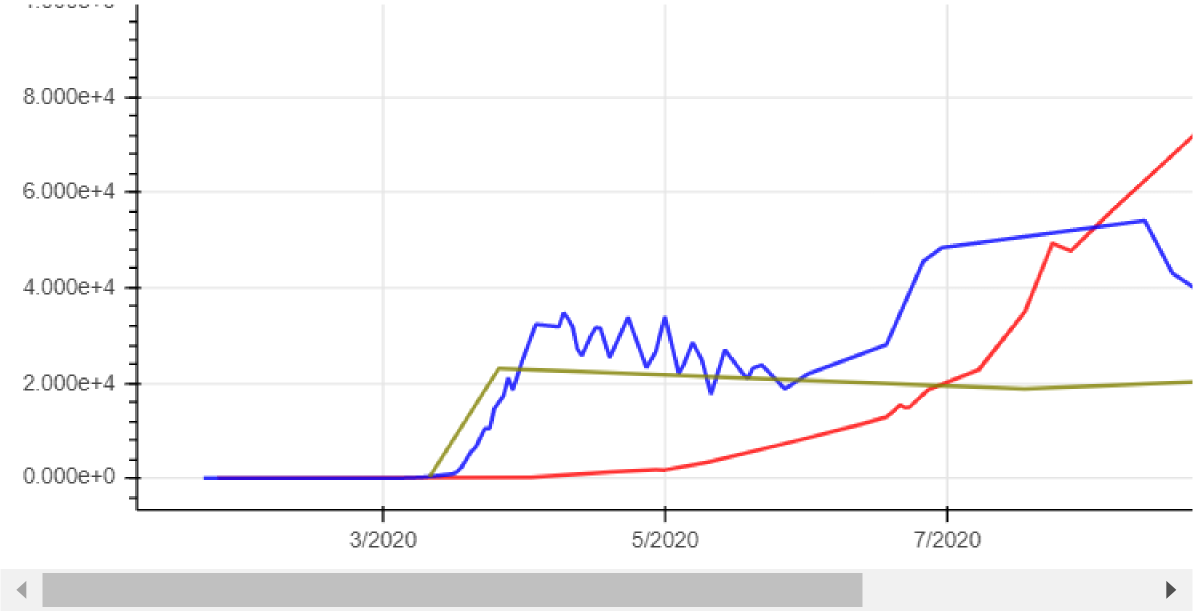


MEASURE Testing policy

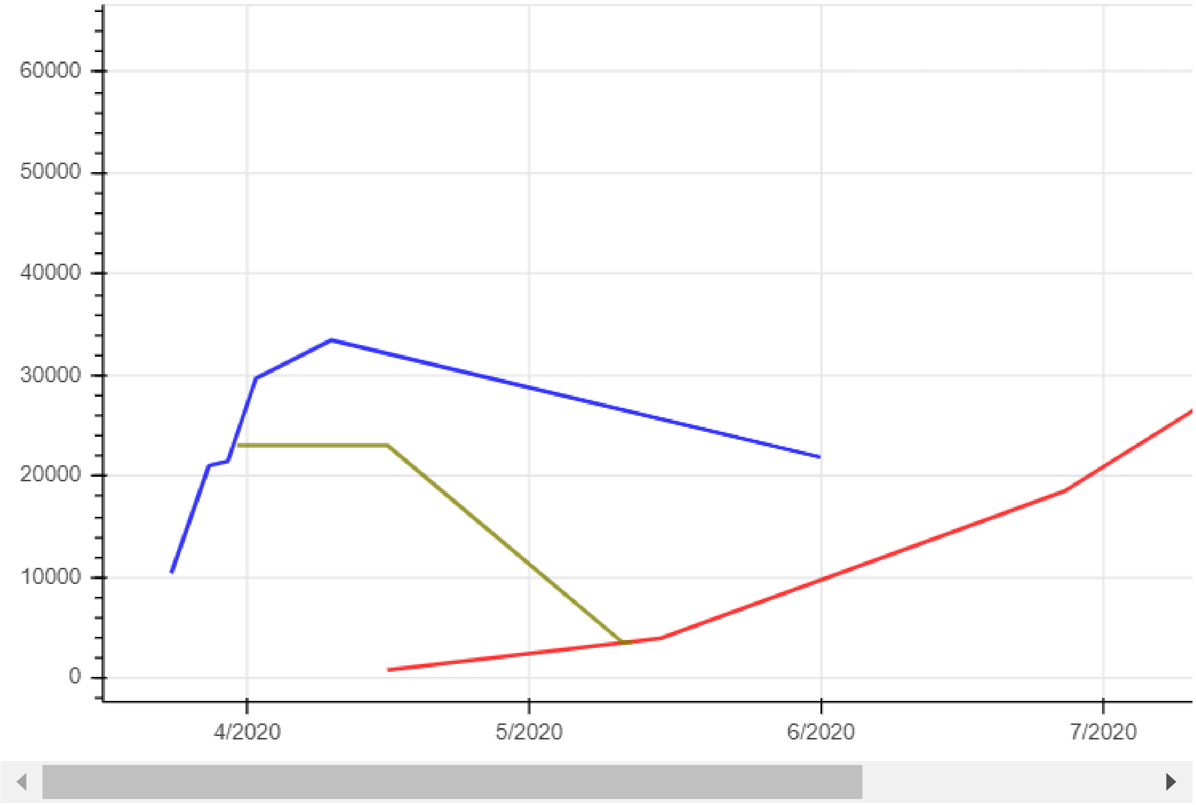



MEASURE General recommendations

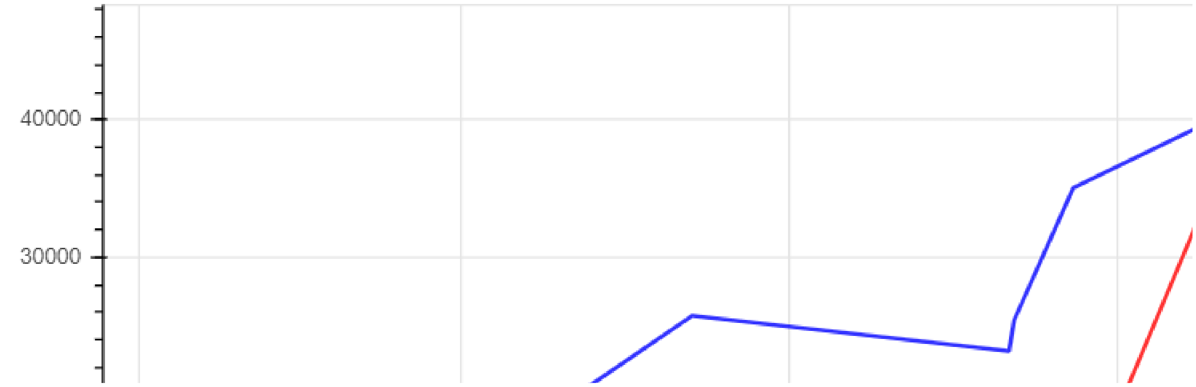
MEASURE Strengthening the public health system

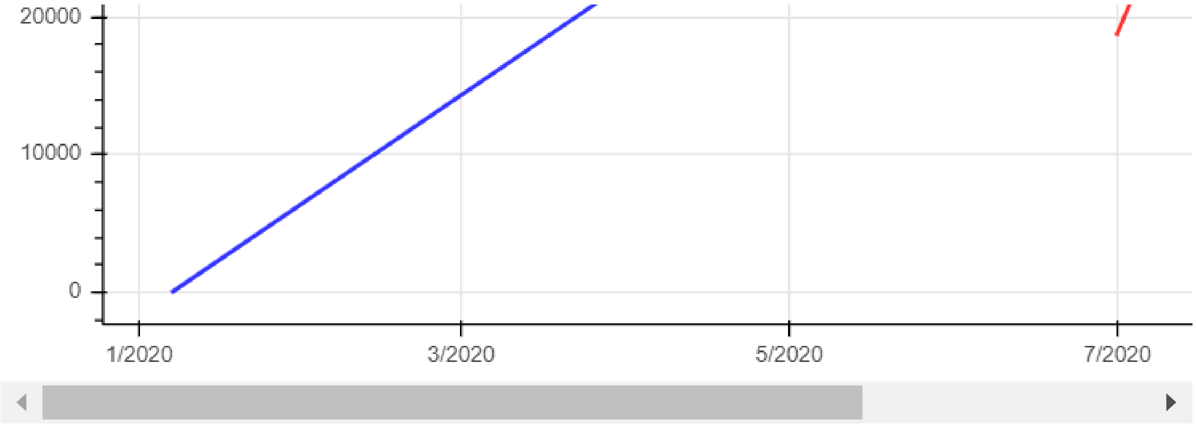


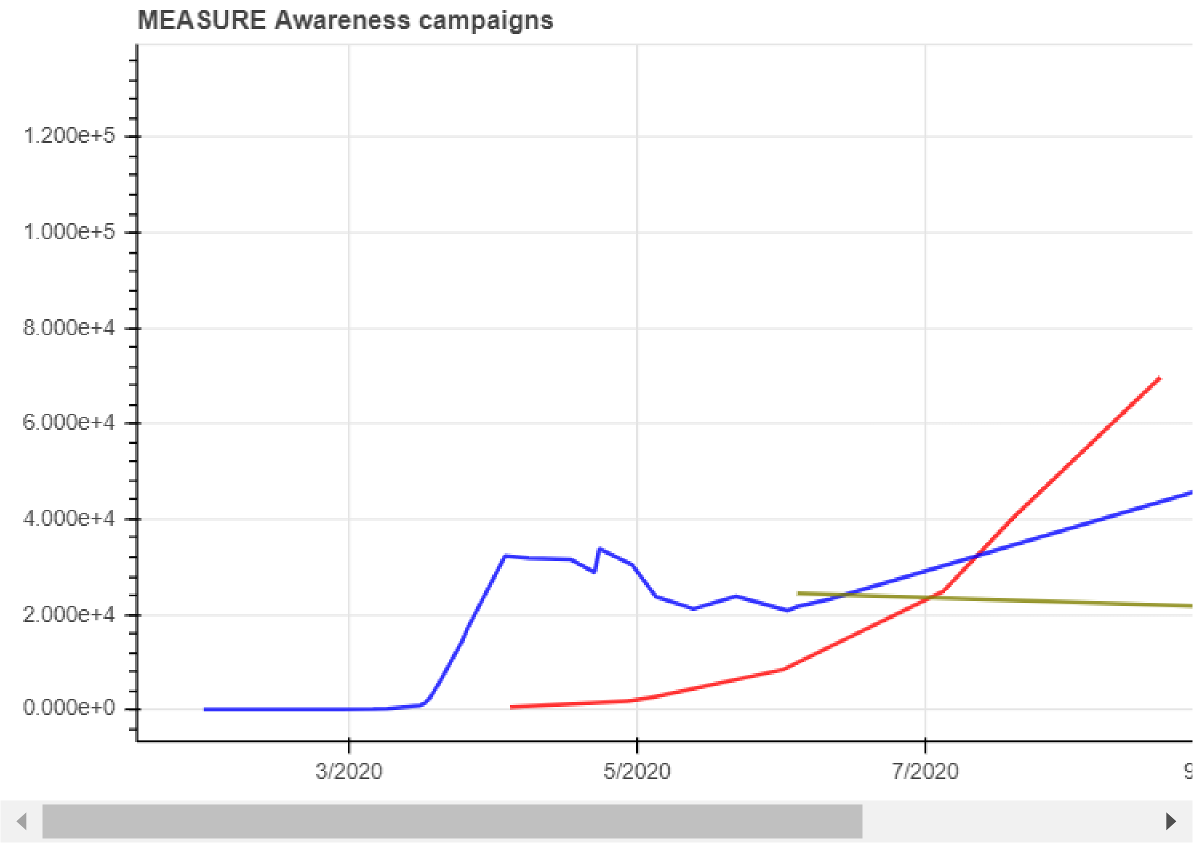
MEASURE Other public health measures enforced

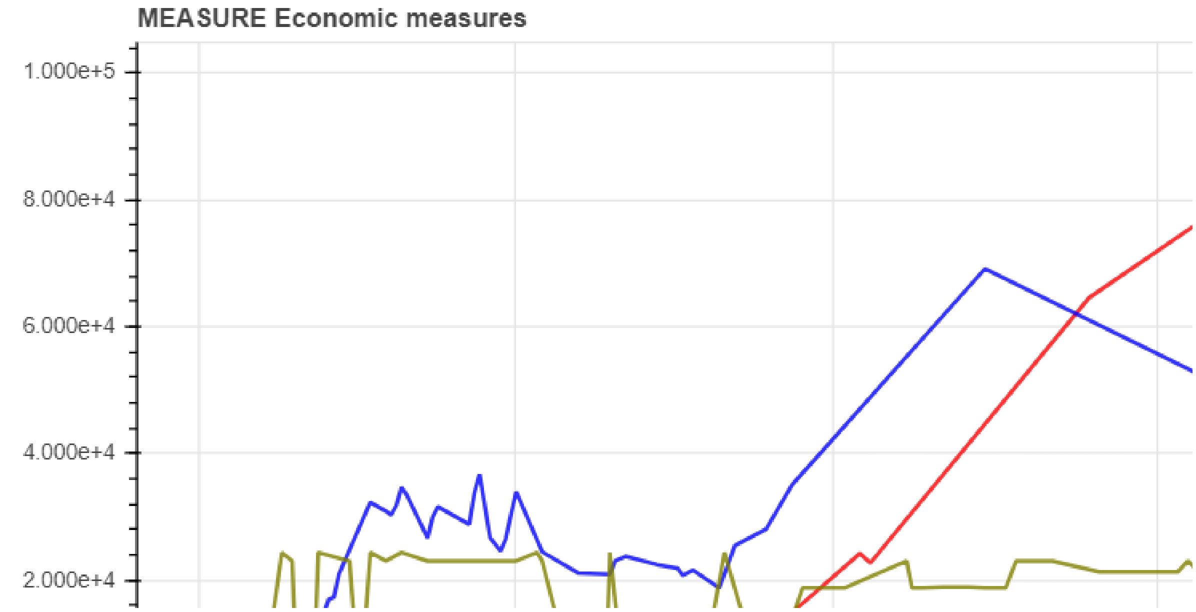


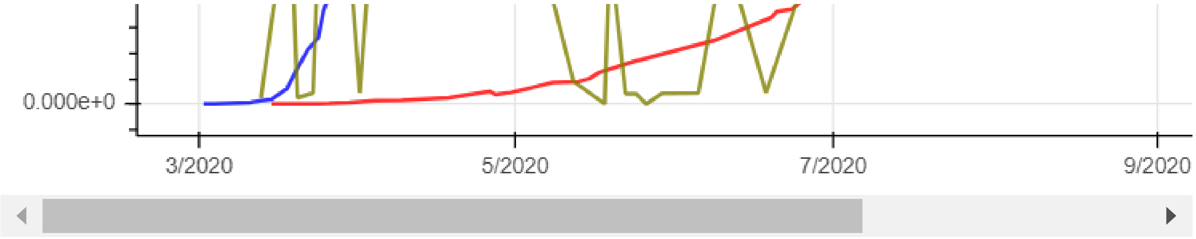
MEASURE Psychological assistance and medical social work

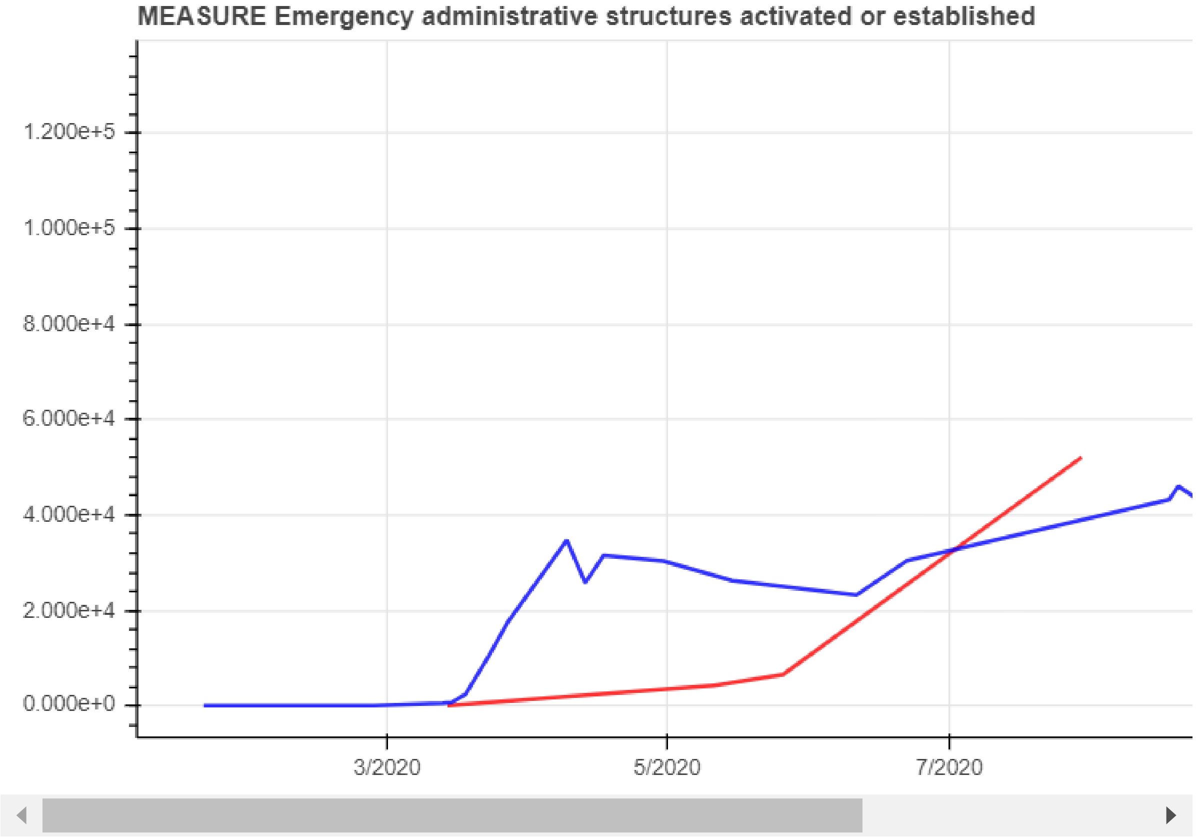


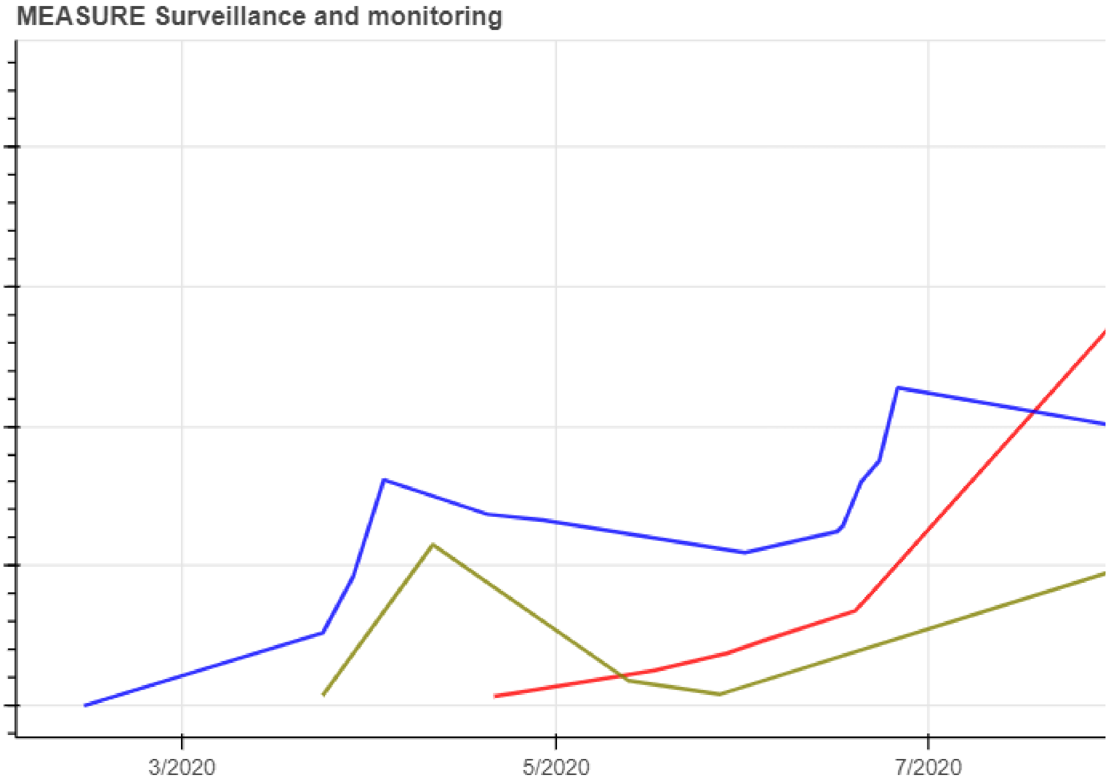


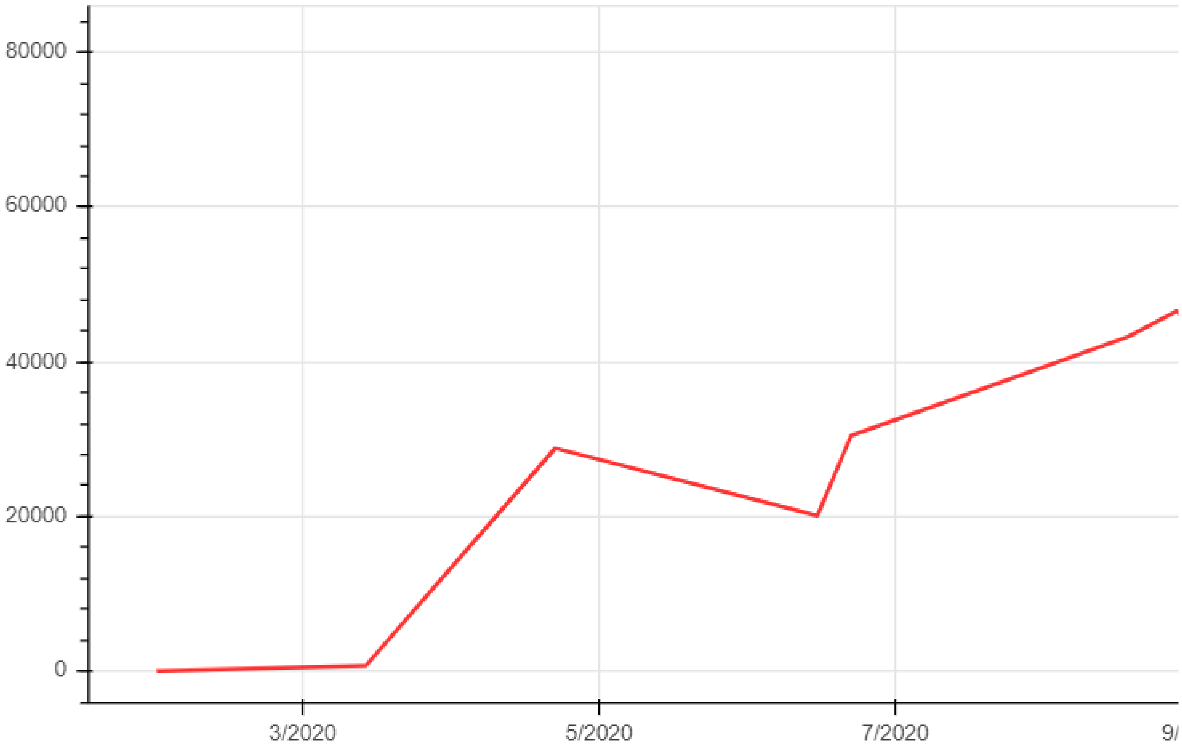

MEASURE Awareness campaigns


MEASURE Economic measures

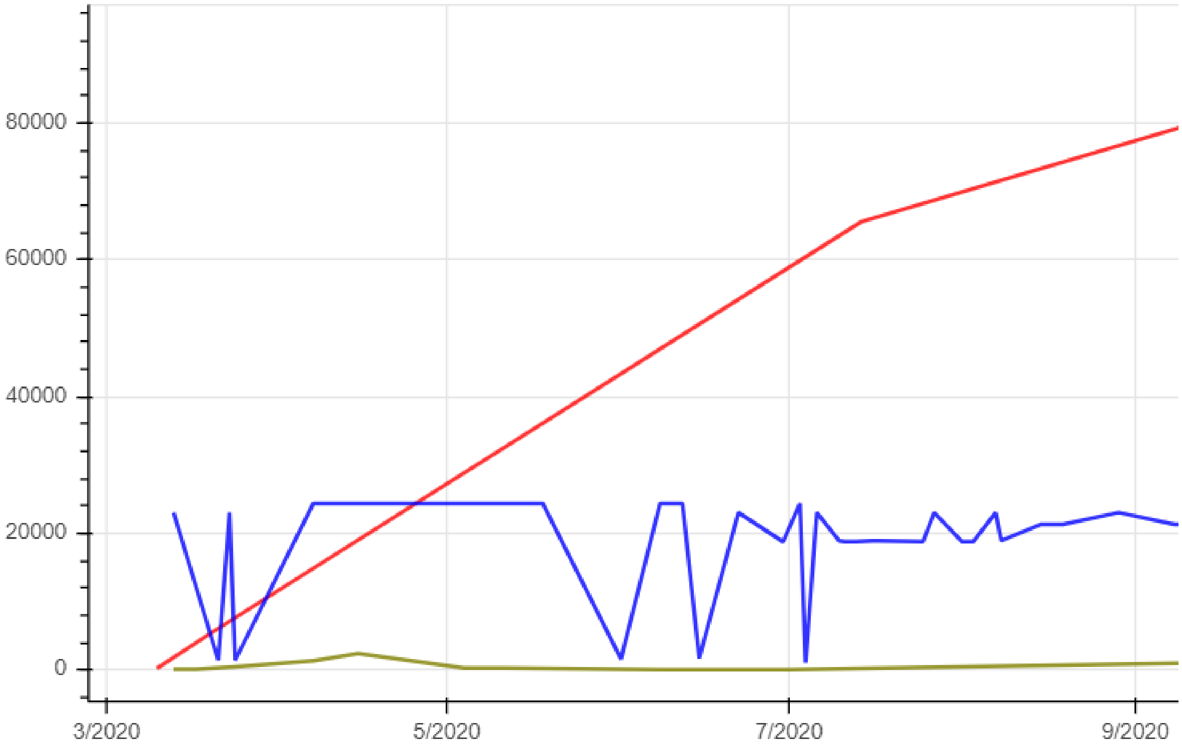



MEASURE Emergency administrative structures activated or established

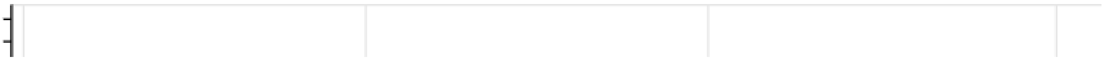

MEASURE Surveillance and monitoring



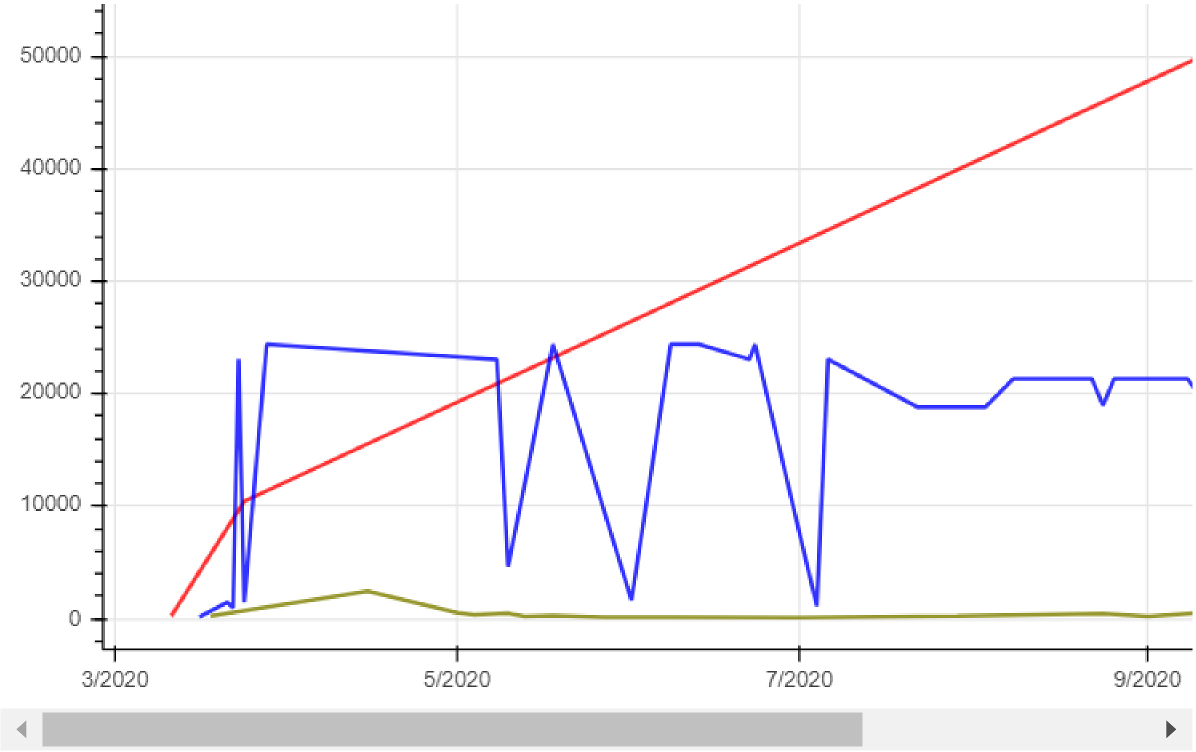
MEASURE Visa restrictions



MEASURE Closure of businesses and public services



MEASURE Limit public gatherings



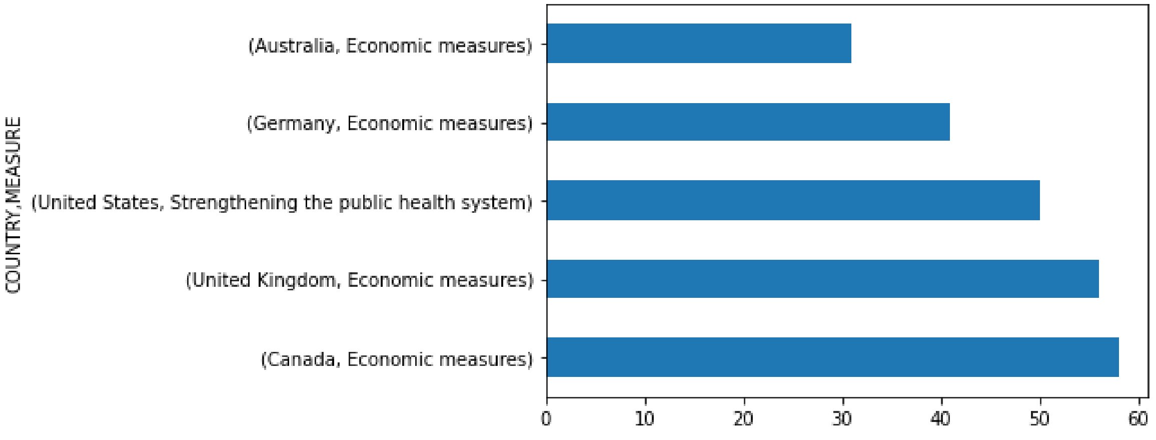
4) Which countries took the maximum amount of measures?

In [28]:

```
#Countries that took maximum amount of measures
sorting=df0.groupby(['COUNTRY','MEASURE']).size()
sorting.sort_values(inplace=True, ascending=False)
countries_max_measures = sorting.head()
countries_max_measures
countries_max_measures.plot.barh(stacked=True)
```

Out[28]:

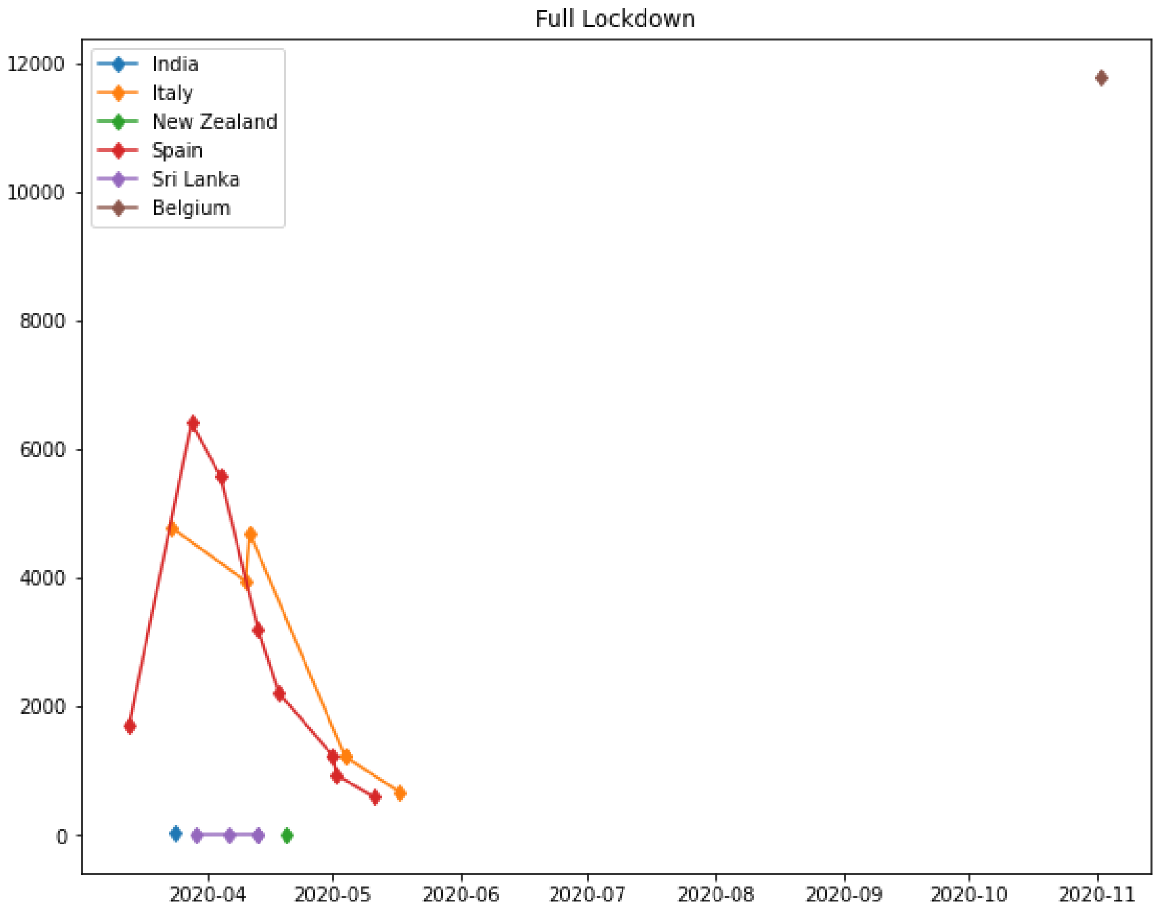
```
<matplotlib.axes._subplots.AxesSubplot at 0x7f039ff8d9e8>
```



5) Which countries opted for a complete lockdown?

In [29]:

```
#Countries that opted for a complete lockdown
comp_lockdown=df.loc[df['MEASURE'] == 'Full lockdown']
full_country_array = comp_lockdown.COUNTRY.unique()
plt.figure(figsize=(10,8))
for i in range(len(full_country_array)):
    country_df = comp_lockdown[comp_lockdown["COUNTRY"] == full_country_array
    plt.plot(country_df['DATE_IMPLEMENTED'],country_df['covid_case_per_date']
    plt.legend()
    title="Full Lockdown"
    plt.title(title)
plt.show()
```



6) What is the distribution of covid cases across the different measures taken by different countries?

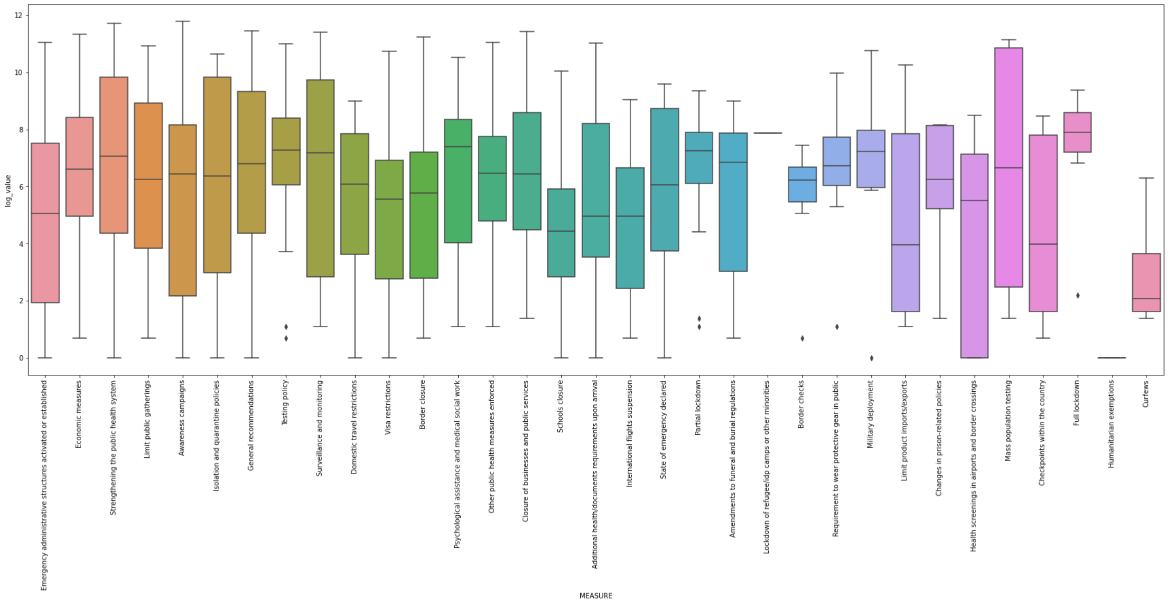
In [31]:

```
#This is the boxplot of measures vs the log-value of number of Covid-cases
plt.figure(figsize=(30,10))
plt.xticks(rotation=90)
sns.set_theme(style="whitegrid")
sns.boxplot(df0['MEASURE'],df0['log_value'])
```

```
/usr/local/lib/python3.6/dist-packages/seaborn/_decorators.py:43: FutureWar
ning: Pass the following variables as keyword args: x, y. From version 0.1
2, the only valid positional argument will be `data`, and passing other arg
uments without an explicit keyword will result in an error or misinterpreta
tion.
  FutureWarning
```

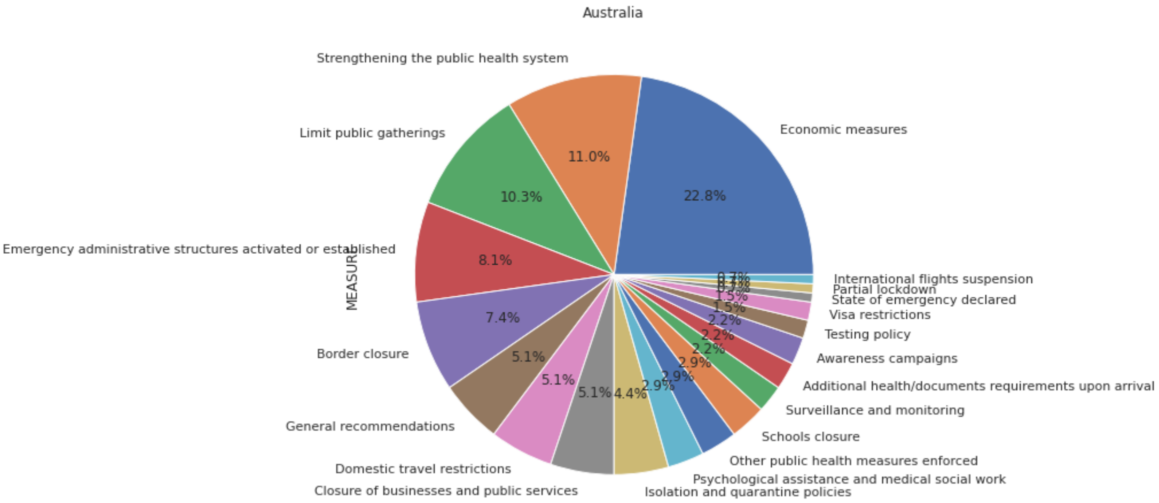
Out[31]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f03a0309550>
```

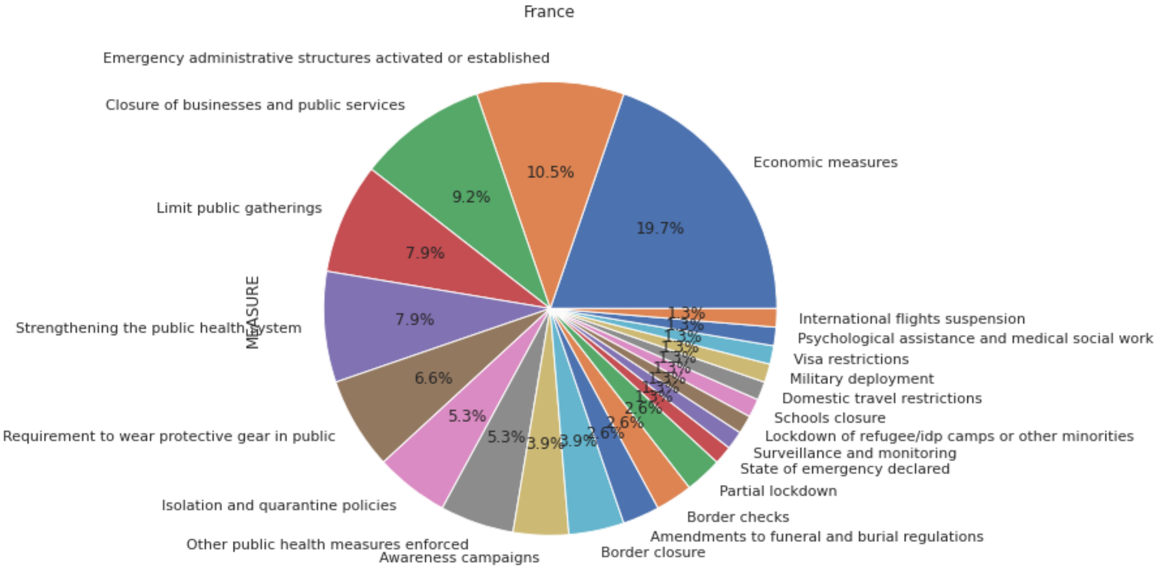


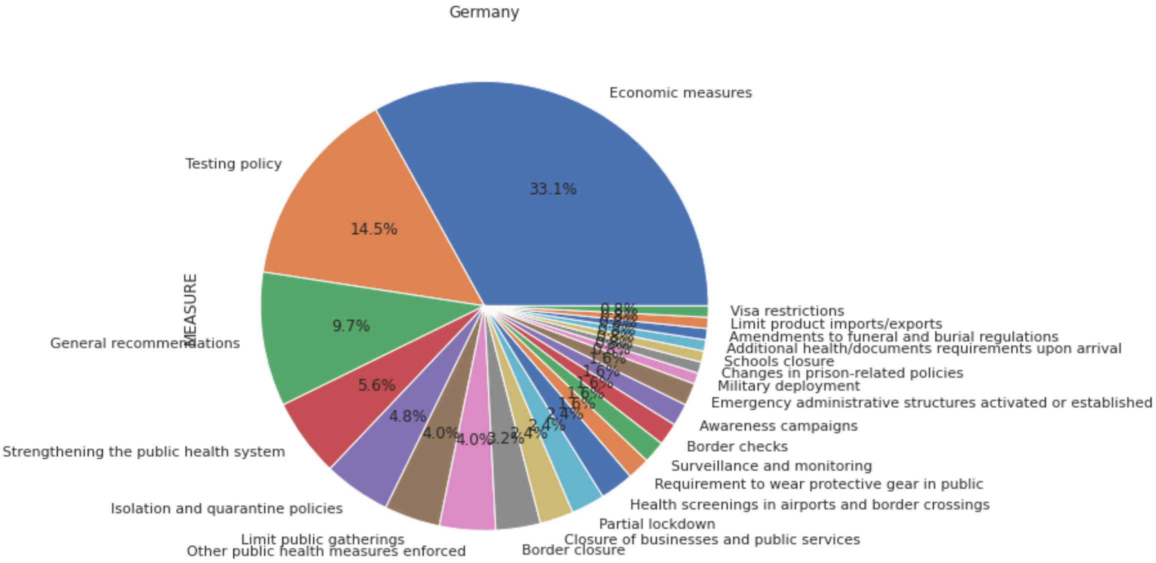
7) What is the distribution of measures taken by different countries?

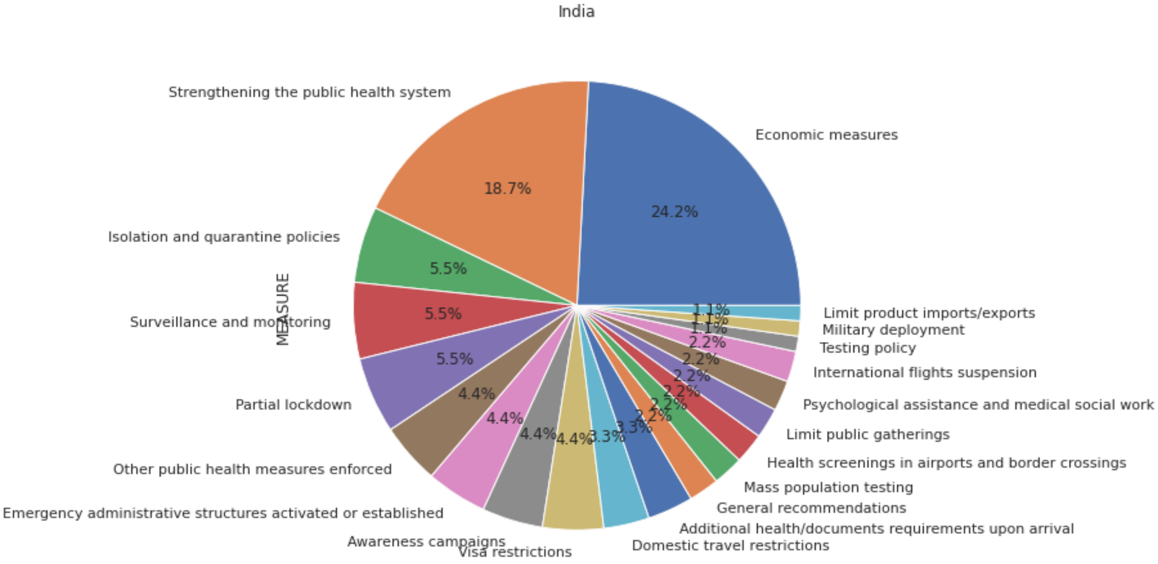
In [32]:
```
# These pie-charts show amount of different measures taken by different count
country_array = df0['COUNTRY'].unique()
for i in range(len(country_array)):
    countries = df0[df0['COUNTRY'] == country_array[i]]
    plt.figure(figsize=(8,8))
    countries['MEASURE'].value_counts().plot.pie(autopct="%1.1f%%")
    plt.title(country_array[i])
    plt.show()
    print("-----------------------------------------------------------------
```



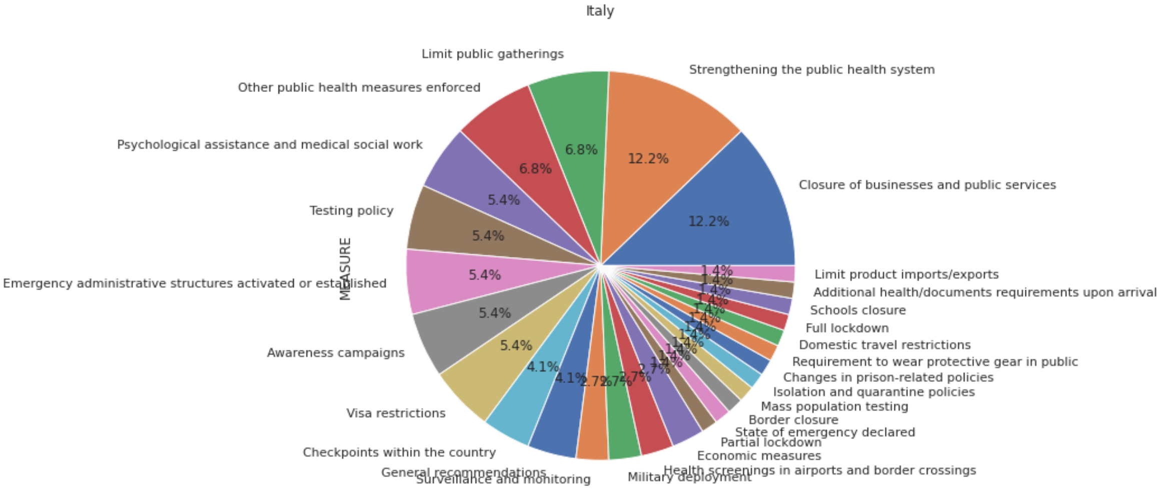
```
--------------------------------------------------------------------------
----------------------------------
```


France
Emergency administrative structures activated or established
Closure of businesses and public services
Economic measures
Limit public gatherings
10.5%
9.2%
19.7%
7.9%
MEASURE
Strengthening the public health system
7.9%
6.6%
Requirement to wear protective gear in public
5.3%
5.3%
3.9%
3.9%
2.6%
2.6%
2.6%
1.3%
International flights suspension
Psychological assistance and medical social work
Visa restrictions
Military deployment
Domestic travel restrictions
Schools closure
Lockdown of refugee/idp camps or other minorities
Surveillance and monitoring
State of emergency declared
Partial lockdown
Border checks
Amendments to funeral and burial regulations
Border closure
Isolation and quarantine policies
Other public health measures enforced
Awareness campaigns

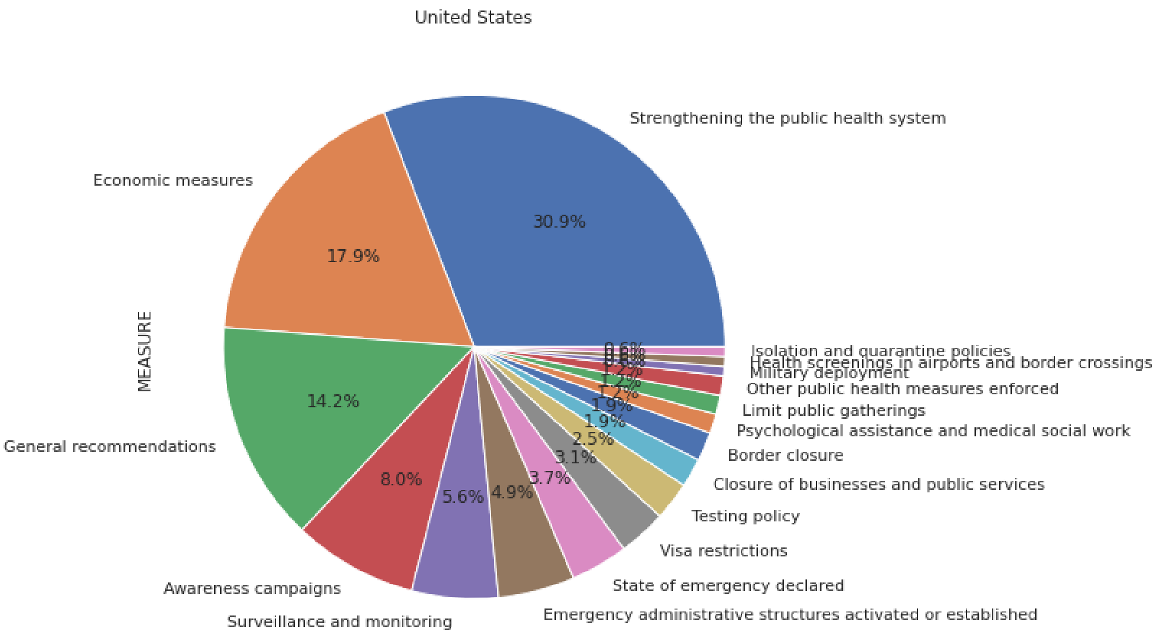

Germany
Economic measures
Testing policy
33.1%
14.5%
MEASURE
General recommendations
9.7%
5.6%
4.8%
4.0%
4.0%
3.2%
2.4%
2.4%
1.6%
1.6%
0.8%
Strengthening the public health system
Isolation and quarantine policies
Limit public gatherings
Other public health measures enforced
Visa restrictions
Limit product imports/exports
Amendments to funeral and burial regulations
Additional health/documents requirements upon arrival
Schools closure
Changes in prison-related policies
Military deployment
Emergency administrative structures activated or established
Awareness campaigns
Border checks
Surveillance and monitoring
Requirement to wear protective gear in public
Health screenings in airports and border crossings
Partial lockdown
Closure of businesses and public services
Border closure


India
MEASURE
Economic measures
Strengthening the public health system
Isolation and quarantine policies
Surveillance and monitoring
Partial lockdown
Other public health measures enforced
Emergency administrative structures activated or established
Awareness campaigns
Visa restrictions
Domestic travel restrictions
Additional health/documents requirements upon arrival
General recommendations
Mass population testing
Health screenings in airports and border crossings
Limit public gatherings
Psychological assistance and medical social work
International flights suspension
Testing policy
Military deployment
Limit product imports/exports
24.2%
18.7%
5.5%
5.5%
5.5%
4.4%
4.4%
4.4%
4.4%
3.3%
3.3%
2.2%
2.2%
2.2%
2.2%
2.2%
2.2%
1.1%
1.1%
1.1%

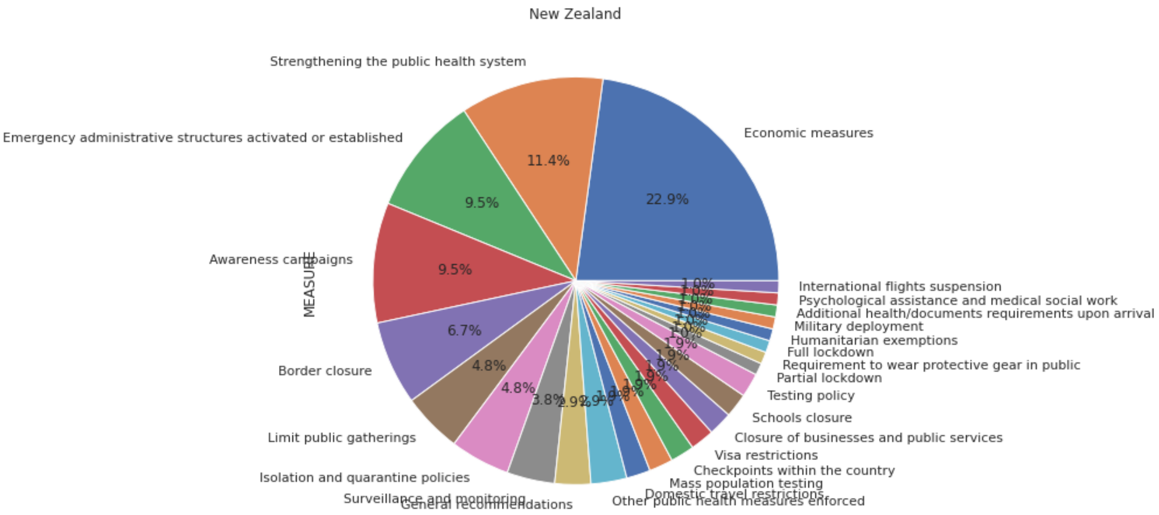
```
------------------------------------------------------------------------------------------------------
```


Italy
MEASURE
Closure of businesses and public services
Strengthening the public health system
Limit public gatherings
Other public health measures enforced
Psychological assistance and medical social work
Testing policy
Emergency administrative structures activated or established
Awareness campaigns
Visa restrictions
Checkpoints within the country
General recommendations
Surveillance and monitoring
Military deployment
Health screenings in airports and border crossings
Economic measures
Partial lockdown
State of emergency declared
Border closure
Mass population testing
Isolation and quarantine policies
Changes in prison-related policies
Requirement to wear protective gear in public
Domestic travel restrictions
Full lockdown
Schools closure
Additional health/documents requirements upon arrival
Limit product imports/exports
12.2%
12.2%
6.8%
6.8%
5.4%
5.4%
5.4%
5.4%
5.4%
4.1%
4.1%
2.7%
2.7%
2.7%
2.7%
1.4%
1.4%
1.4%
1.4%
1.4%
1.4%
1.4%
1.4%
1.4%
1.4%
1.4%
1.4%

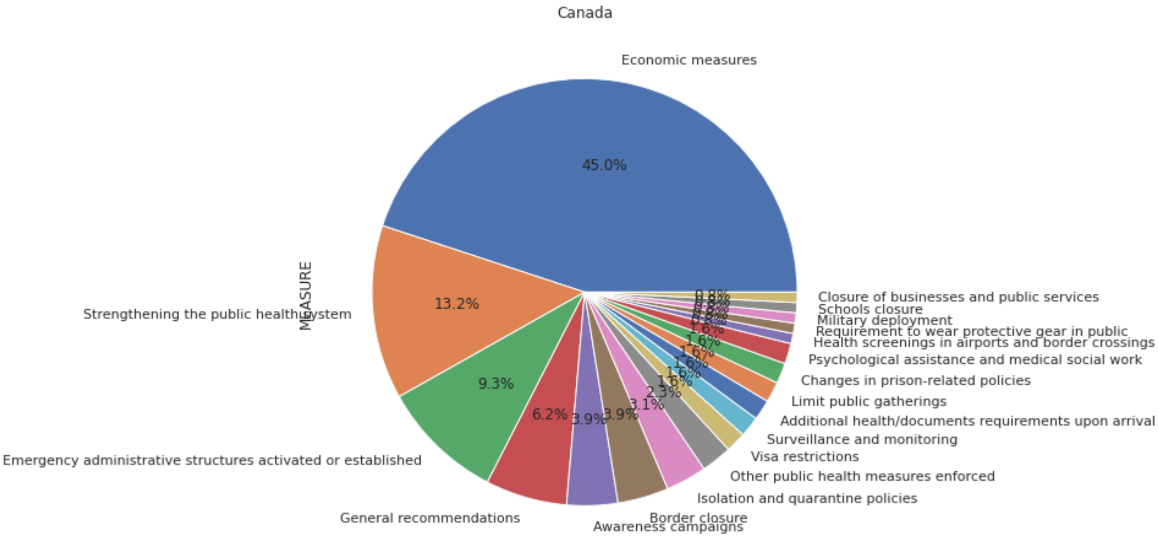
```
--------------------------------------------------------------------
--------------------------------
```


United States
MEASURE
Strengthening the public health system
30.9%
Economic measures
17.9%
General recommendations
14.2%
Awareness campaigns
8.0%
Surveillance and monitoring
5.6%
Emergency administrative structures activated or established
4.9%
State of emergency declared
3.7%
Visa restrictions
3.1%
Testing policy
2.5%
Closure of businesses and public services
1.9%
Border closure
1.9%
Psychological assistance and medical social work
1.2%
Limit public gatherings
1.2%
Other public health measures enforced
1.2%
Military deployment
Health screenings in airports and border crossings
Isolation and quarantine policies
0.6%

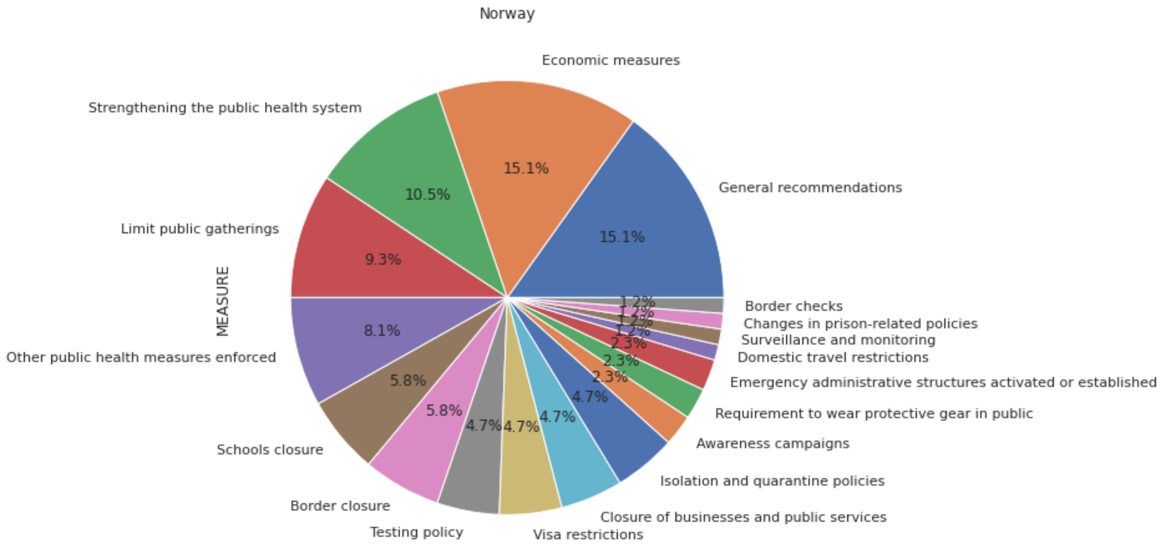
```
--------------------------------------------------------------------
--------------------------------
```


New Zealand
MEASURE
Economic measures
22.9%
Strengthening the public health system
11.4%
Emergency administrative structures activated or established
9.5%
Awareness campaigns
9.5%
Border closure
6.7%
Limit public gatherings
4.8%
Isolation and quarantine policies
4.8%
Surveillance and monitoring
3.8%
General recommendations
2.9%
2.9%
Other public health measures enforced
Domestic travel restrictions
Mass population testing
Checkpoints within the country
Visa restrictions
Closure of businesses and public services
Schools closure
Testing policy
Partial lockdown
Requirement to wear protective gear in public
Full lockdown
Humanitarian exemptions
Military deployment
Additional health/documents requirements upon arrival
Psychological assistance and medical social work
International flights suspension
1.9%
1.9%
1.9%
1.9%
1.9%
1.0%
1.0%

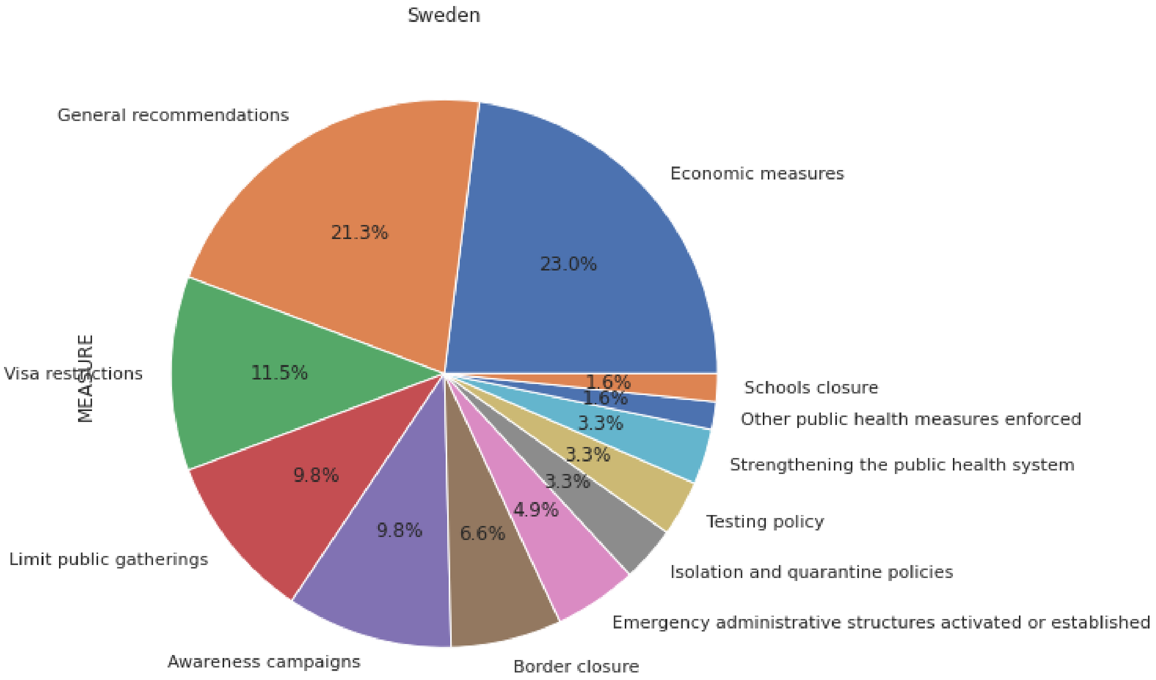
```
--------------------------------------------------------------------------
-----------------------------------
```


Canada
MEASURE
Economic measures
45.0%
Strengthening the public health system
13.2%
Emergency administrative structures activated or established
9.3%
General recommendations
6.2%
Awareness campaigns
3.9%
Border closure
3.9%
Isolation and quarantine policies
3.1%
Other public health measures enforced
2.3%
Visa restrictions
1.6%
Surveillance and monitoring
1.6%
Additional health/documents requirements upon arrival
1.6%
Limit public gatherings
1.6%
Changes in prison-related policies
1.6%
Psychological assistance and medical social work
1.6%
Health screenings in airports and border crossings
Requirement to wear protective gear in public
Military deployment
Schools closure
Closure of businesses and public services
0.8%

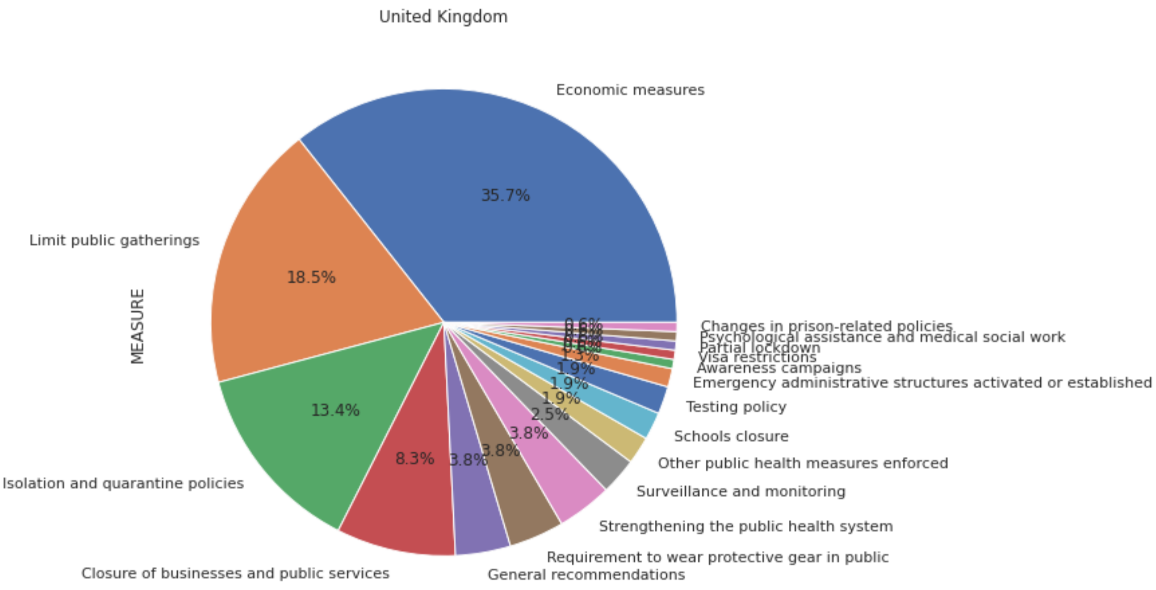
```
--------------------------------------------------------------------------
-----------------------------------
```


Norway
Economic measures
15.1%
Strengthening the public health system
10.5%
General recommendations
15.1%
Limit public gatherings
9.3%
MEASURE
Other public health measures enforced
8.1%
Schools closure
5.8%
Border closure
5.8%
Testing policy
4.7%
Visa restrictions
4.7%
Closure of businesses and public services
4.7%
Isolation and quarantine policies
4.7%
Awareness campaigns
2.3%
Requirement to wear protective gear in public
2.3%
Emergency administrative structures activated or established
2.3%
Domestic travel restrictions
1.2%
Surveillance and monitoring
1.2%
Changes in prison-related policies
1.2%
Border checks
1.2%

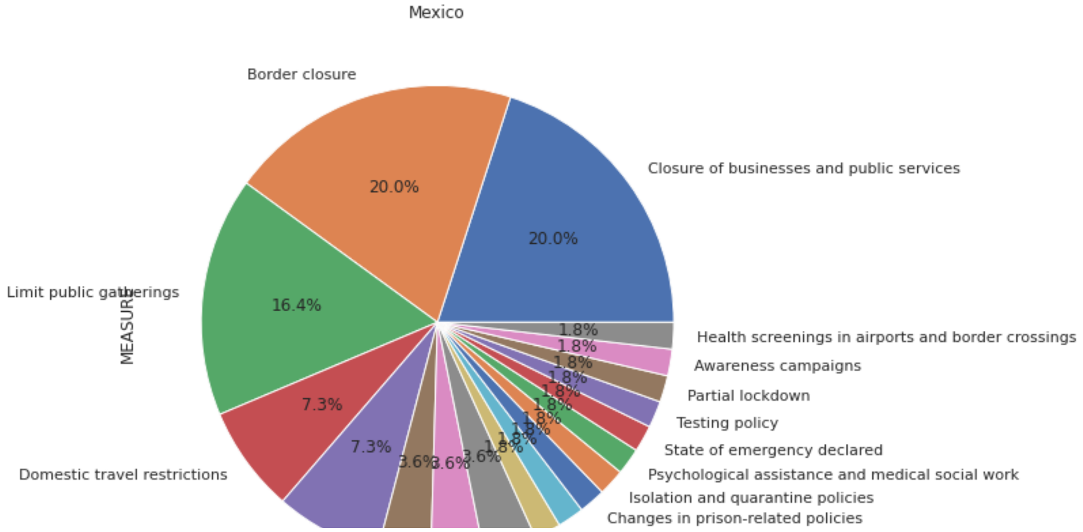
```
-------------------------------------------------------------
-----------------------------
```


Sweden
General recommendations
21.3%
Economic measures
23.0%
Visa restrictions
11.5%
MEASURE
Limit public gatherings
9.8%
Awareness campaigns
9.8%
Border closure
6.6%
Emergency administrative structures activated or established
4.9%
Isolation and quarantine policies
3.3%
Testing policy
3.3%
Strengthening the public health system
3.3%
Other public health measures enforced
1.6%
Schools closure
1.6%

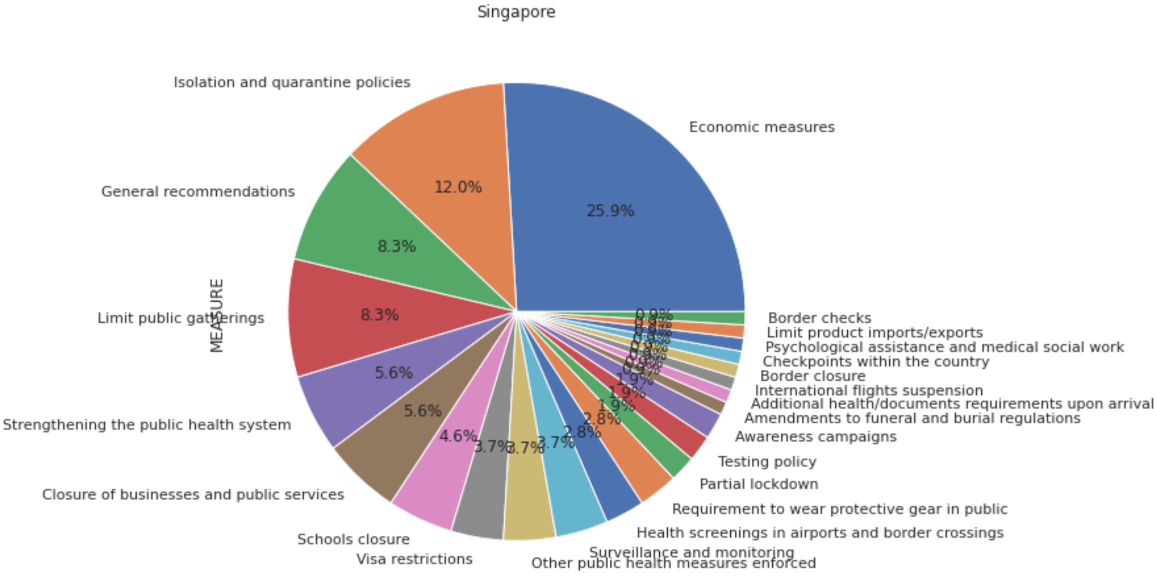
```
---------------------------------------------------------------------------
-----------------------------------
```


United Kingdom
MEASURE
Economic measures
35.7%
Limit public gatherings
18.5%
Isolation and quarantine policies
13.4%
Closure of businesses and public services
8.3%
General recommendations
3.8%
Requirement to wear protective gear in public
3.8%
Strengthening the public health system
3.8%
Surveillance and monitoring
2.5%
Other public health measures enforced
1.9%
Schools closure
1.9%
Testing policy
1.9%
Emergency administrative structures activated or established
1.3%
Awareness campaigns
0.6%
Visa restrictions
0.6%
Partial lockdown
0.6%
Psychological assistance and medical social work
0.6%
Changes in prison-related policies
0.6%

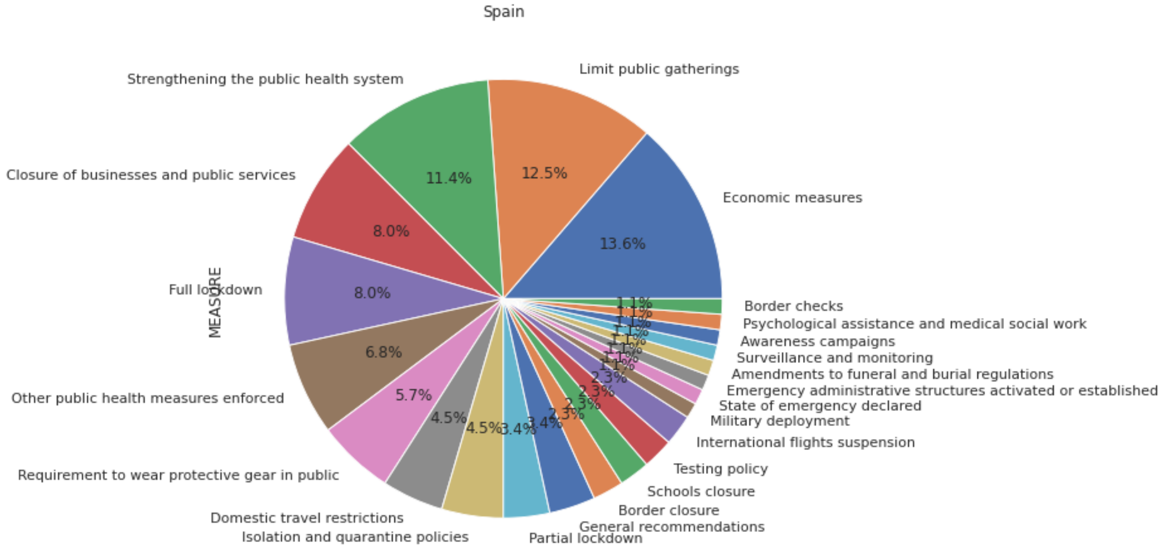
```
---------------------------------------------------------------------------
-----------------------------------
```


Mexico
Border closure
Closure of businesses and public services
Limit public gatherings
Domestic travel restrictions
MEASURE
20.0%
20.0%
16.4%
7.3%
7.3%
3.6%
3.6%
3.6%
1.8%
Health screenings in airports and border crossings
Awareness campaigns
Partial lockdown
Testing policy
State of emergency declared
Psychological assistance and medical social work
Isolation and quarantine policies
Changes in prison-related policies

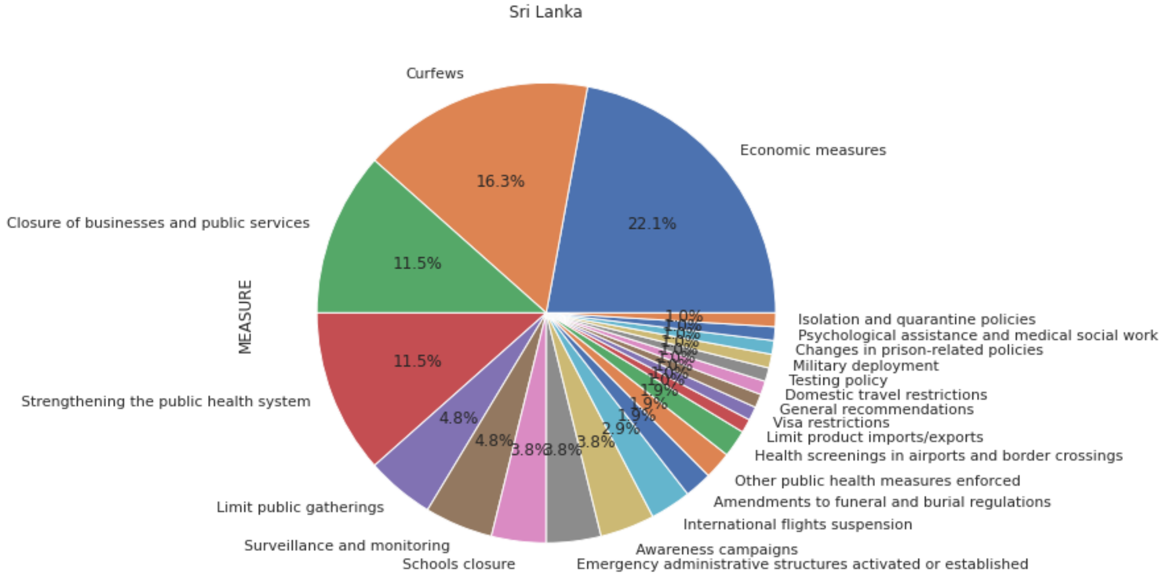
```
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
```


Singapore
Isolation and quarantine policies
Economic measures
General recommendations
Limit public gatherings
MEASURE
Strengthening the public health system
Closure of businesses and public services
Schools closure
Visa restrictions
25.9%
12.0%
8.3%
8.3%
5.6%
5.6%
4.6%
3.7%
3.7%
3.7%
2.8%
2.8%
1.9%
1.9%
1.9%
0.9%
Border checks
Limit product imports/exports
Psychological assistance and medical social work
Checkpoints within the country
Border closure
International flights suspension
Additional health/documents requirements upon arrival
Amendments to funeral and burial regulations
Awareness campaigns
Testing policy
Partial lockdown
Requirement to wear protective gear in public
Health screenings in airports and border crossings
Surveillance and monitoring
Other public health measures enforced

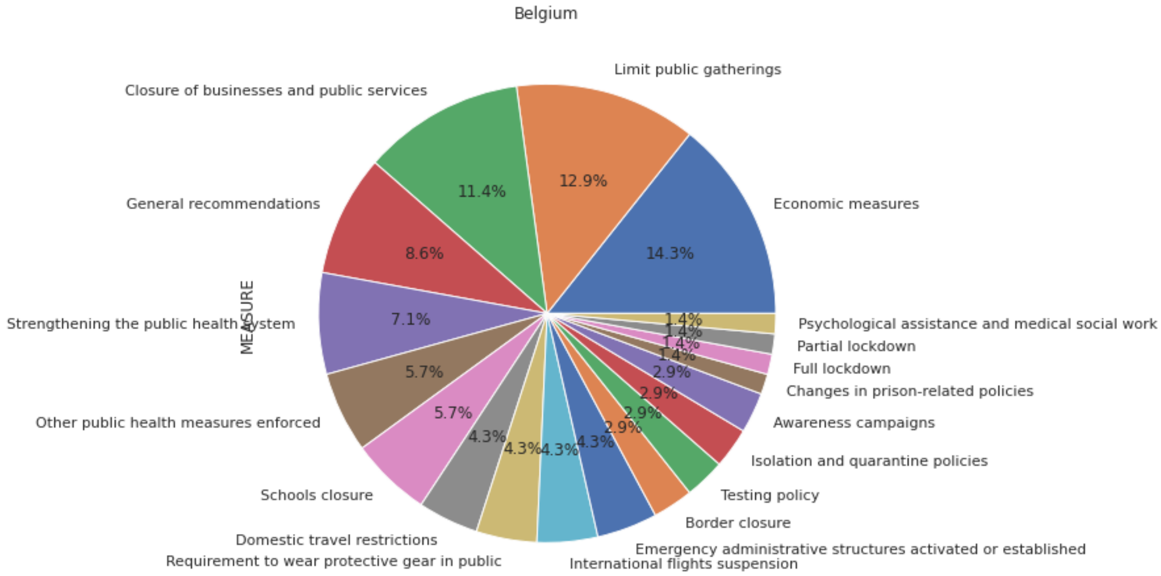
```
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
```


Spain
MEASURE
Economic measures
13.6%
Limit public gatherings
12.5%
Strengthening the public health system
11.4%
Closure of businesses and public services
8.0%
Full lockdown
8.0%
Other public health measures enforced
6.8%
Requirement to wear protective gear in public
5.7%
Domestic travel restrictions
4.5%
Isolation and quarantine policies
4.5%
Partial lockdown
3.4%
General recommendations
3.4%
Border closure
2.3%
Schools closure
2.3%
Testing policy
2.3%
International flights suspension
2.3%
Military deployment
1.1%
State of emergency declared
1.1%
Emergency administrative structures activated or established
1.1%
Amendments to funeral and burial regulations
1.1%
Surveillance and monitoring
1.1%
Awareness campaigns
1.1%
Psychological assistance and medical social work
1.1%
Border checks
1.1%

```
------------------------------------------------------------------
-------------------------------
```


Sri Lanka
MEASURE
Economic measures
22.1%
Curfews
16.3%
Closure of businesses and public services
11.5%
Strengthening the public health system
11.5%
Limit public gatherings
4.8%
Surveillance and monitoring
4.8%
Schools closure
3.8%
Emergency administrative structures activated or established
3.8%
Awareness campaigns
3.8%
International flights suspension
2.9%
Amendments to funeral and burial regulations
1.9%
Other public health measures enforced
1.9%
Health screenings in airports and border crossings
1.9%
Limit product imports/exports
1.0%
Visa restrictions
1.0%
General recommendations
1.0%
Domestic travel restrictions
1.0%
Testing policy
1.0%
Military deployment
1.0%
Changes in prison-related policies
1.0%
Psychological assistance and medical social work
1.0%
Isolation and quarantine policies
1.0%

```
------------------------------------------------------------------------------------
------------------------------------
```


Belgium
MEASURE
Economic measures 14.3%
Limit public gatherings 12.9%
Closure of businesses and public services 11.4%
General recommendations 8.6%
Strengthening the public health system 7.1%
Other public health measures enforced 5.7%
Schools closure 5.7%
Domestic travel restrictions 4.3%
Requirement to wear protective gear in public 4.3%
International flights suspension 4.3%
Emergency administrative structures activated or established 4.3%
Border closure 2.9%
Testing policy 2.9%
Isolation and quarantine policies 2.9%
Awareness campaigns 2.9%
Changes in prison-related policies 1.4%
Full lockdown 1.4%
Partial lockdown 1.4%
Psychological assistance and medical social work 1.4%

```
------------------------------------------------------------------------------------
------------------------------------
```

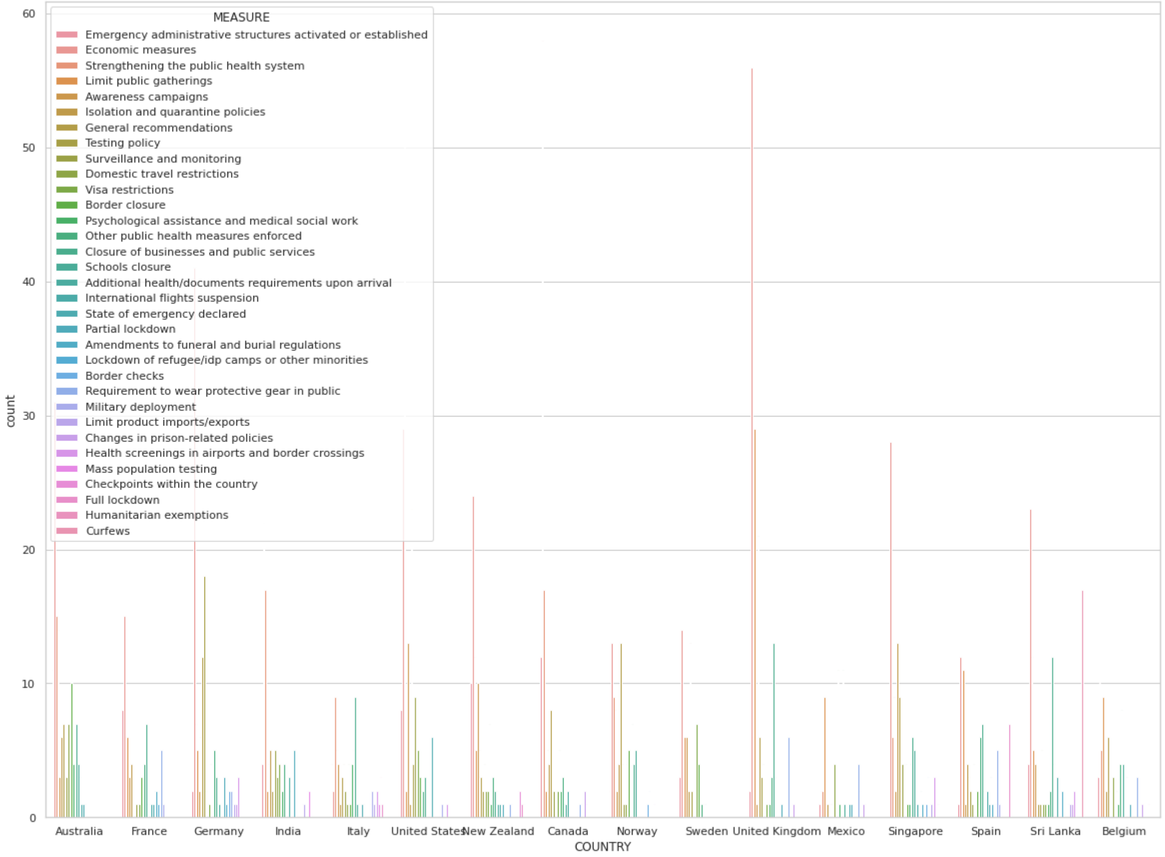
```
In [ ]:  print(df0.groupby('COUNTRY').size())
```

```
COUNTRY
Australia         136
Belgium            70
Canada            129
France             76
Germany           124
India              91
Italy              74
Mexico             55
New Zealand       105
Norway             86
Singapore         108
Spain              88
Sri Lanka         104
Sweden             61
United Kingdom    157
United States     162
dtype: int64
```

8) What is the count of different measures taken by each countries?

```
In [33]:  #This count plot shows the count of different measures taken by each country
          plt.figure(figsize=(20,15))
          sns.countplot(x='COUNTRY', hue='MEASURE', data=df0)
```

```
Out[33]: <matplotlib.axes._subplots.AxesSubplot at 0x7f03a26a1860>
```


MEASURE
Emergency administrative structures activated or established
Economic measures
Strengthening the public health system
Limit public gatherings
Awareness campaigns
Isolation and quarantine policies
General recommendations
Testing policy
Surveillance and monitoring
Domestic travel restrictions
Visa restrictions
Border closure
Psychological assistance and medical social work
Other public health measures enforced
Closure of businesses and public services
Schools closure
Additional health/documents requirements upon arrival
International flights suspension
State of emergency declared
Partial lockdown
Amendments to funeral and burial regulations
Lockdown of refugee/idp camps or other minorities
Border checks
Requirement to wear protective gear in public
Military deployment
Limit product imports/exports
Changes in prison-related policies
Health screenings in airports and border crossings
Mass population testing
Checkpoints within the country
Full lockdown
Humanitarian exemptions
Curfews
count
Australia
France
Germany
India
Italy
United States
New Zealand
Canada
Norway
Sweden
United Kingdom
Mexico
Singapore
Spain
Sri Lanka
Belgium
COUNTRY