Do Governmental Regulators Regarding COVID-19 Affect People's Spending Habits and Outdoor Activities?

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I. Abstract

To cope with the coronavirus pandemic, numerous governments are taking critical policy measurements and enforcing their own social distancing laws. How strict governments impose laws regarding COVID-19 vary across countries and governments are seeking effective regulations day by day to slow down the spread of disease. However, actions that governments take could not only influence the number of confirmed cases, but also our lifestyle. Recognizing the changes in lifestyle allows us to foresee our lives in the post-COVID-19 eras and realize the significance of government regulations. So we studied the impact of governmental response on people's lives in particular to spending and outdoor activities. To determine whether varying governmental guidelines influence the public's expenditures and cultural life, we used consumer and mobility data of two countries that took radically different government policies: Sweden and Taiwan. Using high-performance computing technology, we extracted, processed, and compared Sweden and Taiwan data. We found correlations between different tables and validated the impact of government responses on consumer spending and outdoor activities in regards to predictability, autonomous control of activities, and the duration of effect. As a result, we approved that government guidelines do influence people's expenditures and lifestyles.

II. Introduction

Annually, millions of visitors travel to Taiwan from China. Outburst of travels made Taiwan one of the most exposed countries to epidemics arising from China. The Central Epidemic Command Center(CECC) in Taiwan created a graph model for predicting the number of COVID-19 cases in Taiwan. However, the prediction of the graph model generally did not match the number of 'actual' COVID-19 cases. The numbers of COVID-19 cases were far fewer than the prediction. This unexpected positive result was accomplished by the Taiwan government by putting strict government regulations in order to control the spread of the COVID-19.

Unlike Taiwan's response to COVID-19, Sweden pursued a 'herd immunity strategy' with relatively light governmental regulations. Sweden's containment strategy was shown most liberal among countries. Sweden disputed whether a less restrictive is more efficient over intense restriction. Sweden met the highest COVID-19 related per capita deaths in the world in May 2020. However, we believed that this human casualty did not solely result from the absence of government guidelines on protecting oneself from the epidemic. Through detecting changes in spending and outdoor activities, we focused our study on uncovering the relationship between government confrontation methods and changes in these people's lives. The issue of how well individual citizens modified their lifestyles in those two countries in order to contain the spread of coronavirus induced our team to explore the changes in consumer spending and mobility boundaries.

Figure 1 presents the progression of our research. In order to investigate the issue, each of the team members gathered data sets from scholarly websites. We found how the

number of visitors to grocery, pharmacy, parks, outdoor spaces, and residential areas changed compared to the baseline days.

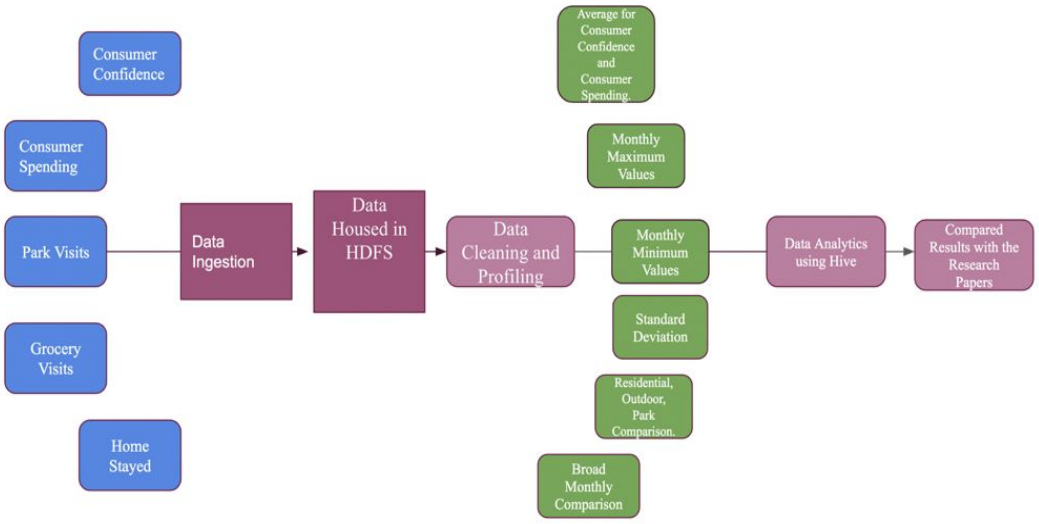


Figure 1: Data flow diagram

We discovered that some data sets contain information not relevant to our study. Our group cleaned those data by using the MapReduce on Hadoop on NYU Dumbo. Then we extracted Taiwan and Sweden's values that could indicate revealing shifts between the year 2018 and 2020. We noticed changes in people's spending habits by comparing Pre-coronavirus and current coronavirus data sets of living expenses in Sweden where people's lifestyles are not restricted by their government. From those changes, we would be able to compare the same data sets from Taiwan where the government imposes strict regulations on COVID-19. Our use of SQL queries on Hive allowed us to do two countries' maximum, minimum, monthly average values, yearly average values, and standard deviation set side by side in a short amount of time. We gained insights about correlations between governmental regulations and people's spending habits.

III. Motivation

The COVID-19 pandemic has led to dramatic loss of human life worldwide. Response to the COVID-19 differed significantly by countries. Some countries had performed aggressive responses, and some did not. Despite the decrease in the number of COVID-19 cases in some countries, we cannot assume that it resulted from their people complying with the governmental regulations. Therefore, we tried to find the correlation between governmental regulation and change in people's lifestyles. We decided to investigate the impact of governmental response on people's spending and outdoor activities. Our research would benefit all private businesses, economists, and industry groups, stepping up to fight the COVID-19. Primarily, our insights would help countries to have better governmental regulations and to adapt more smoothly to the new normal, post Coronavirus lives.

IV. Related Work

We compared our results on the following data sets to the published research paper that had studied correlation of COVID-19 pandemic and change in consumer behavior. From the National Bureau of Economic Research, Hung-Hao Chang and Chad Meyerhoefer concluded in their research paper that the number of customers in demand for grocery increased by 4.9% in Taiwan. Our data sets on how the number of visitors to grocery changed compared to the baseline days also showed a similar trend.

We were also able to verify our data analysis on residential data sets from the published research paper. The Bank of Finland Bulletin had research on the economy by comparing three countries: Finland, Sweden, and Germany. According to their report, the COVID-19 has reduced population mobility in Sweden until May. Then it began to rise in

late May. Similarly, we also had a high residential stay rate until late May. Then starting from June, the rate began to show an opposite trend.

Our group also substantiated our analysis through extra research. During the analysis, we discovered that the graphs and data values radically change around the month of June. Through our research, we found out that Swedish government switched their policy from 'no regulation' to 'certain degree' of regulation by shutting down bars, restaurants, and more. According to the paper written by Jon Pierre, *Nudges against pandemics: Sweden's COVID-19 containment strategy in perspective*, talked about how the death toll in Sweden passed 4000 by late May 2020. Due to the rapid increase in the number of deaths, people raised questions about whether the 'herd immunity' strategy is actually effective. As a result, Swedish government gradually began to impose regulations.

V. Description of Datasets

For each country, we used 7 data sets for comparison purposes. Figure 2 shows how the number of visitors to grocery stores had changed. We extracted the data set between February 2020 and November 2020. Entity and code show whether the selected data set's country is Sweden or Taiwan.

Entity	Code	Date	grocery_and_pharmacy	Entity	Code	Date	grocery_and_pharmacy
Taiwan	TWN	2/17/20	-5	Sweden	SWE	2/17/20	-3.333
Taiwan	TWN	2/18/20	-4.25	Sweden	SWE	2/18/20	-2.5
Taiwan	TWN	2/19/20	-4.2	Sweden	SWE	2/19/20	-1.8
Taiwan	TWN	2/20/20	-4.333	Sweden	SWE	2/20/20	-1.333
Taiwan	TWN	2/21/20	-3.714	Sweden	SWE	2/21/20	-1.143
Taiwan	TWN	2/22/20	-3	Sweden	SWE	2/22/20	-1.286

Figure 2

In Figure 3, the following data sample gives a picture of how the rates of visiting park and outdoor spaces have changed since the COVID-19 outbreak. We also set the date from February 2020 to November 2020.

Entity	Code	Date	parks	Entity	Code	Date	parks
Sweden	SWE	2/17/20	-10	Taiwan	TWN	2/17/20	-12.33
Sweden	SWE	2/18/20	-4.25	Taiwan	TWN	2/18/20	-10
Sweden	SWE	2/19/20	1.8	Taiwan	TWN	2/19/20	-6.4
Sweden	SWE	2/20/20	1.333	Taiwan	TWN	2/20/20	-6
Sweden	SWE	2/21/20	-1.143	Taiwan	TWN	2/21/20	-4.286
Sweden	SWE	2/22/20	4.286	Taiwan	TWN	2/22/20	-3.571

Figure 3

In Figure 4, the data sample presents a change in duration of residential areas for Taiwan and Sweden. Each country has a unique entity and code. The following data set shows the date from February 2020 to November 2020.

Entity	Code	Date	residential	Entity	Code	Date	residential
Sweden	SWE	2/17/20	1.333	Taiwan	TWN	2/17/20	3.333
Sweden	SWE	2/18/20	1.25	Taiwan	TWN	2/18/20	3.75
Sweden	SWE	2/19/20	1.2	Taiwan	TWN	2/19/20	3.8
Sweden	SWE	2/20/20	1.167	Taiwan	TWN	2/20/20	3.33
Sweden	SWE	2/21/20	1.143	Taiwan	TWN	2/21/20	3.571
Sweden	SWE	2/22/20	1.286	Taiwan	TWN	2/22/20	4.143

Figure 4

In Figure 5 (a), the data table shows values for consumer spending along with its date. Each country is defined by their unique country name. Figure 5 (b) shows the same data table information with different categories. The following table gives values for consumer confidence.

Country	Category	DateTime	Value	Frequency	HistoricalDataSymbol	LastUpdate
Sweden	Consumer Spending	2019-03-31T00:00:00	563394	Quarterly	SWEDENCONSPE	2020-08-28T10:53:00
Sweden	Consumer Spending	2019-06-30T00:00:00	567664	Quarterly	SWEDENCONSPE	2020-08-28T10:53:00
Sweden	Consumer Spending	2019-09-30T00:00:00	570490	Quarterly	SWEDENCONSPE	2020-08-28T10:53:00
Sweden	Consumer Spending	2019-12-31T00:00:00	576241	Quarterly	SWEDENCONSPE	2020-08-28T10:53:00
Sweden	Consumer Spending	2020-03-31T00:00:00	559734	Quarterly	SWEDENCONSPE	2020-08-28T10:53:00
Sweden	Consumer Spending	2020-06-30T00:00:00	516524	Quarterly	SWEDENCONSPE	2020-08-28T10:53:00

(a)

Country	Category	DateTime	Value	Frequency	HistoricalDataSymbol	LastUpdate
Sweden	Consumer Confidence	2020-01-31T00:00:00	92.9	Monthly	SWECCI	2020-08-27T08:06:00
Sweden	Consumer Confidence	2020-02-29T00:00:00	99.6	Monthly	SWECCI	2020-10-28T08:24:00
Sweden	Consumer Confidence	2020-03-31T00:00:00	89.4	Monthly	SWECCI	2020-09-29T07:41:00
Sweden	Consumer Confidence	2020-04-30T00:00:00	75.1	Monthly	SWECCI	2020-09-29T07:41:00
Sweden	Consumer Confidence	2020-05-31T00:00:00	78.3	Monthly	SWECCI	2020-10-28T08:24:00
Sweden	Consumer Confidence	2020-06-30T00:00:00	84.4	Monthly	SWECCI	2020-10-28T08:19:00

(b)

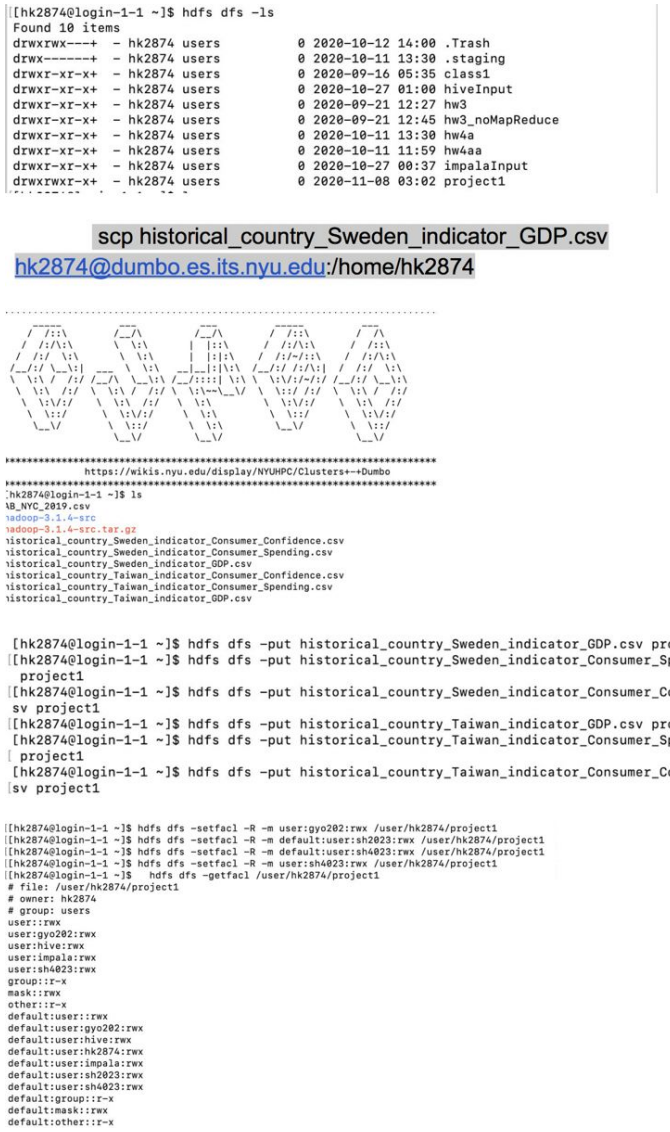
Figure 5

VI Analytics Stages

a. Ingestion Process Detailed

We first did the data ingestion for our data sets in order to perform the MapReduce on Hadoop cluster on Dumbo. We created directories to store data sets we found. Using secure copy protocol, we transported all 7 data set files to the home directory from our desktop. Then we moved those files in the Dumbo cluster to the HDFS project1 directory that we

created previously. HDFS files were shared by our team members using ‘hdfs dfs -setfacl’ command.



b. Dataset Cleansing

Followed by the data ingestions, for better implication for our data analytics, we used the MapReduce to clean the data. In Figure 6 (a), we created a comma separated list, and excluded “Historical Date” and “Last Update” columns for consumer confidence and

consumer spending files. The reduce function in Figure 6 (b) was not needed for the following job.

```
@Override
public void map(LongWritable key, Text value, Context context) throws
    IOException, InterruptedException {
    String s = value.toString();
    if (!s.startsWith("Country")){
      String[] line = s.split(",");

      String country = line[0];
      String category =line[1];

      String date_time = line[2];
      String data_value = line[3];
      String frequency = line[4];

      context.write(new Text("Country, Category, Date, Value, Frequency"),new
          Text(country + "," + category + "," + date_time + "," + data_value +
          "," + frequency));
    }
}
```

(a)

```
@Override
public void reduce(Text key, Iterable<IntWritable> values, Context context)
    throws IOException, InterruptedException {


}
```

(b)

Figure 6

In Figure 7 (a), the following Map function was used for the rest of the files. We cleaned the data by removing columns that had the country's name not corresponding to Taiwan or Sweden. In the end, to make sure that we did not drop information by fallacy and to inspect the change in file size, we again made use of MapReduce on the original file, output file, and excel file for counting rows.

```
@Override
public void map(LongWritable key, Text value, Context context) throws
    IOException, InterruptedException {
    String s = value.toString();
    if (s.startsWith("Sweden") || s.startsWith("Taiwan")){
      String[] line = s.split(",");

      String entity = line[0];
      String code = line[1];

      String date = line[2];
      String values = line[3];

      context.write(new Text(""), new Text(entity + "," + code + "," + date +
          "," + values));
    }
}
```

(a)

```
@Override
public void reduce(Text key, Iterable<IntWritable> values, Context context)
    throws IOException, InterruptedException {


}
```

(b)

Figure 7

c. **Dataset Profiling**

We used data profiling to explore our data by comparing the rows of our original data sets with those of cleaned data sets. For the data profiling, we also used the MapReduce on the Dumbo. The MapReduce function counted the number of records in each data set. For the consumer confidence and consumer spending files, the cleaned data set matched with the original data set since we just took out some columns. For the grocery-visits, park-visits, and residential-visits files, the number of lines did not match because we took out numerous rows from the original files during the process of cleaning. As we completed the process of data cleaning and profiling, the cleaned files were ready for the analytics steps.

d. **Dataset Analytics Code and Trials Completed**

We first started our Analytics Codes by creating tables for each data set. Our group created a total of 10 tables in order to run queries. In addition, we created input directories for each table and moved all input files to the corresponding input directories to run queries on HIVE.

1) Creating Tables

sweden_parks = "Sweden Parks"
```
create external table sweden_parks(entity string, code string, date string, parks float) row format delimited fields terminated by
',' location '/user/sh4023/sweden_parks_input/';
```

sweden_res = "Sweden Residence"
```
create external table sweden_res(entity string, code string, date string, parks float) row format delimited fields terminated by ','
location '/user/sh4023/sweden_res_input/';
```

sweden_groc = "Sweden Grocery"
```
create external table sweden_groc(entity string, code string, date string, parks float) row format delimited fields terminated by
',' location '/user/sh4023/sweden_groc_input/';
```

taiwan_parks = "Taiwan Parks"
```
create external table taiwan_parks(entity string, code string, date string, parks float) row format delimited fields terminated by
',' location '/user/sh4023/taiwan_parks_input/';
```

taiwan_res = "Taiwan Residence"
```
create external table taiwan_res(entity string, code string, date string, parks float) row format delimited fields terminated by ','
location '/user/sh4023/taiwan_res_input/';
```

taiwan_groc = "Taiwan Grocery"
```
create external table taiwan_groc(entity string, code string, date string, parks float) row format delimited fields terminated by
',' location '/user/sh4023/taiwain_groc_input/';
```

sw_cs = "Sweden Consumer Spending"
```
create external table sw_cs (country string, category string, date_time string, data_value int, frequency string) row format
delimited fields terminated by ',' location '/user/hk2874/hiveInput/';
```

tw_cs = "Taiwan Consumer Spending"
```
create external table tw_cs (country string, category string, date_time string, data_value int, frequency string) row format
delimited fields terminated by ',' location '/user/hk2874/hiveInputTW/';
```

sw_cc = "Sweden Consumer Confidence"
```
create external table sw_cc (country string, category string, date_time string, data_value int, frequency string) row format
delimited fields terminated by ',' location '/user/sh4023/hiveInput2/';
```

tw_cc = "Taiwan Consumer Confidence"
```
create external table tw_cc (country string, category string, date_time string, data_value int, frequency string) row format
delimited fields terminated by ',' location '/user/sh4023/hiveInput/';
```

We initially focused on the consumer spending and consumer confidence tables. Our group started out by running a query that compares Taiwan and Sweden original data values. This query gave us an intuitive sense of what the graph may look like if we plot the values. We thought that comparing average values(grouped by year) may give us some insightful information. Thus, we ran the following codes with the following partial outputs. As there were a small number of columns in the Consumer Spending and Consumer Confidence tables, the queries we can run on these two tables were very limited.

```
select substring(date_time, 0,4) as YEAR, avg(data_value)
from sw_cs
group by substring(date_time, 0,4);

select substring(date_time, 0,4) as YEAR, avg(data_value)
from sw_cc
group by substring(date_time, 0, 4);

select substring(date_time, 0,4) as year, avg(data_value)
from tw_cc
group by substring(date_time, 0, 4);

select substring(date_time, 0,4) as year, avg(data_value)
from tw_cs
group by substring(date_time, 0, 4);
```

year	_c1
1999	87.0
2000	84.0
2001	65.16666666666667
2002	74.91666666666667
2003	78.0
2004	77.16666666666667
2005	73.41666666666667
2006	68.25
2007	65.83333333333333
2008	58.333333333333336

The other tables (Grocery, Parks, Resident), on the other hand, had much more flexibility to run queries. Similar to consumer spending and confidence tables, we first began by simply running a very broad query that displayed all mobility data at once. In order to achieve this process, we inner-joined the dates. Then we ran a query that showed the average value per month for each table, which we thought it may possibly give us meaningful information.

```
select sg.date, sg.val as sweden_grocery, tg.val as taiwan_grocery,
sr.val as sweden_residential, tr.val as taiwan_residential,
sp.val as sweden_outdoor, tp.val as taiwan_outdoor
FROM sweden_groc sg
INNER JOIN taiwan_groc tg on tg.date=sg.date
INNER JOIN sweden_res sr on sr.date=sg.date
```

```
INNER JOIN taiwan_res tr on tr.date=sg.date
INNER JOIN sweden_parks sp on sp.date=sg.date
INNER JOIN taiwan_parks tp on tp.date=sg.date;
```

sg.date	sweden_grocery	taiwan_grocery	sweden_residential	taiwan_residential	sweden_outdoor	taiwan_outdoor
2020-02-17	-3.3329999446868896	-5.0	1.3329999446868896	3.3329999446868896	-10.0	-12.333000183105469
2020-02-18	-2.5	-4.25	1.25	3.75	-4.25	-10.0
2020-02-19	-1.7999999523162842	-4.199999809265137	1.2000000476837158	3.799999952316284	1.7999999523162842	-6.400000095367432
2020-02-20	-1.3329999446868896	-4.333000183105469	1.1670000553131104	3.3329999446868896	1.3329999446868896	-6.0
2020-02-21	-1.1430000066757202	-3.7139999866485596	1.1430000066757202	3.571000099182129	4.285999774932861	-4.285999774932861
2020-02-22	-1.2860000133514404	-3.0	1.2860000133514404	4.14300012588501	2.428999900817871	-3.571000099182129
2020-02-23	-0.28600001335144043	-1.2860000133514404	1.0	3.7139999866485596	10.0	2.8570001125335693
2020-02-24	0.14300000667572021	-0.7139999866485596	0.8569999933242798	3.428999900817871	13.857000350952148	5.714000225067139
2020-02-25	1.4290000200271606	-0.42899999022483826	0.8569999933242798	3.0	13.142999649047852	6.714000225067139
2020-02-26	1.5709999799728394	-0.28600001335144043	0.8569999933242798	2.7139999866485596	10.0	6.0
2020-02-27	2.0	0.28600001335144043	0.8569999933242798	2.1429998874664307	11.571000099182129	5.285999774932861
2020-02-28	2.2860000133514404	1.8569999933242798	0.8569999933242798	3.1429998874664307	10.71399974822998	13.71399974822998
2020-02-29	3.0	1.8569999933242798	0.7139999866485596	3.1429998874664307	13.28600025177002	17.714000701904297
2020-03-01	2.7139999866485596	1.5709999799728394	0.8569999933242798	3.0	9.0	17.285999298095703

```
select
MONTH(TO_DATE(FROM_UNIXTIME(UNIX_TIMESTAMP(sg.d
ate,
'yyyy-MM-dd')))) as month,
avg(sg.val) as grocery_SW , avg(tg.val) as grocery_TG,
avg(sr.val) as res_SW , avg(tr.val) as res_TG,
avg(sp.val) as outdoor_SW , avg(tp.val) as outdoor_TG
FROM sweden_groc sg
INNER JOIN taiwan_groc tg on tg.date=sg.date
INNER JOIN sweden_res sr on sr.date=sg.date
INNER JOIN taiwan_res tr on tr.date=sg.date
INNER JOIN sweden_parks sp on sp.date=sg.date
INNER JOIN taiwan_parks tp on tp.date=sg.date
GROUP BY
MONTH(TO_DATE(FROM_UNIXTIME(UNIX_TIMESTAMP(sg.d
ate, 'yyyy-MM-dd'))));
```

month	grocery_sw	grocery_tg	res_sw	res_tg	outdoor_sw	outdoor_tg
2	-0.09630768115703876	-1.7855384601996496	1.0290769246908336	3.3243076617901144	6.012999974764311	1.1853077411651611
3	-0.06912902478248842	1.8202258079282698	4.958516147828871	2.2580967526282034	16.728129156174198	-2.1106129461719143
4	-5.15723333756129	0.895199986298879	9.785633325576782	4.32850002447764	63.461966323852536	-6.157133344809214
5	-1.6083548338182512	2.8663548433011576	7.672838672514884	2.6634838811812864	82.02306464410597	-7.834032231761563
6	4.4952666640281675	6.385633345444997	3.6856666723887126	1.6428333361943563	187.45240020751953	-0.9809667110443115
7	3.7188387224751134	8.88016128540039	5.967774175828503	1.5347096881558817	233.78338524603075	3.5022580729376886
8	0.8064193485244628	6.359451624654954	2.8294516032741917	1.6083548338182512	228.3594215146957	1.7327741730597712
9	-2.747666676839193	2.542833352088928	2.5713666796684267	0.21903333167235056	94.45243326822917	-4.2333666751782095
10	-2.2395806552902346	5.133580619289029	4.013806443060598	0.6820322582798619	43.61290347191595	1.5529999963698848
11	-6.059499993920326	2.9107499917348227	7.791666686534882	0.17845832804838815	19.87504158417384	-5.732083360354106

Another two important queries we ran were regarding the monthly maximum and minimum values of all outdoor, residential, and grocery data. To obtain the maximum and the minimum, we ran the following two queries.

```
select
MONTH(TO_DATE(FROM_UNIXTIME(UNIX_TIMESTAMP(sg.date,
'yyyy-MM-dd')))) as month,
max(sg.val) as sweden_grocery_max,
max(tg.val) as taiwan_grocery_max,
max(sr.val) as sweden_resident_max,
max(tr.val) as taiwan_resident_max,
max(sp.val) as sweden_outdoor_max,
max(tp.val) as taiwan_outdoor_max
FROM sweden_groc sg
INNER JOIN taiwan_groc tg on tg.date=sg.date
INNER JOIN sweden_res sr on sr.date=sg.date
INNER JOIN taiwan_res tr on tr.date=sg.date
INNER JOIN sweden_parks sp on sp.date=sg.date
INNER JOIN taiwan_parks tp on tp.date=sg.date
group by MONTH(TO_DATE(FROM_UNIXTIME
(UNIX_TIMESTAMP(sg.date,  'yyyy-MM-dd'))));
```

month	sweden_grocery_max	taiwan_grocery_max	sweden_resident_max	taiwan_resident_max	sweden_outdoor_max	taiwan_outdoor_max
2	3.0	1.8569999933242798	1.3329999446868896	4.14300012588501	13.857000350952148	17.714000701904297
3	4.85699987411499	5.85699987411499	9.571000099182129	3.1429998874664307	38.42900085449219	17.285999298095703
4	0.8569999933242798	2.428999900817871	12.857000350952148	7.428999900817871	97.0	4.428999900817871
5	5.428999900817871	6.85699987411499	9.71399974822998	4.14300012588501	140.85699462890625	9.0
6	11.571000099182129	10.28600025177002	5.0	3.7139999866485596	268.2860107421875	19.14299964904785
7	5.85699987411499	12.0	7.14300012588501	4.0	319.4289855957031	15.71399974822998
8	3.428999900817871	8.428999900817871	5.85699987411499	2.571000099182129	304.5710144042969	7.714000225067139
9	-1.0	7.0	3.2860000133514404	2.2860000133514404	110.0	0.14300000667572021
10	1.0	9.571000099182129	5.85699987411499	2.2860000133514404	65.28600311279297	15.857000350952148
11	-1.4290000200271606	4.14300012588501	9.571000099182129	0.8569999933242798	36.2859992980957	2.2860000133514404

```
select
MONTH(TO_DATE(FROM_UNIXTIME(UNIX_TIMESTAMP(sg.date,
'yyyy-MM-dd')))) as month,
min(sg.val) as sweden_grocery_min,
min(tg.val) as taiwan_grocery_min,
min(sr.val) as sweden_resident_min,
min(tr.val) as taiwan_resident_min,
min(sp.val) as sweden_outdoor_min,
min(tp.val) as taiwan_outdoor_min
FROM sweden_groc sg
INNER JOIN taiwan_groc tg on tg.date=sg.date
INNER JOIN sweden_res sr on sr.date=sg.date
INNER JOIN taiwan_res tr on tr.date=sg.date
INNER JOIN sweden_parks sp on sp.date=sg.date
INNER JOIN taiwan_parks tp on tp.date=sg.date
group by MONTH(TO_DATE(FROM_UNIXTIME
(UNIX_TIMESTAMP(sg.date, 'yyyy-MM-dd'))));
```

month	sweden_grocery_min	taiwan_grocery_min	sweden_resident_min	taiwan_resident_min	sweden_outdoor_min	taiwan_outdoor_min
2	-3.3329999446868896	-5.0	0.7139999866485596	2.1429998874664307	-10.0	-12.333000183105469
3	-5.571000099182129	-0.7139999866485596	0.8569999933242798	1.4290000200271606	5.14300012588501	-10.571000099182129
4	-12.28600025177002	-0.7139999866485596	7.571000099182129	2.8570001125335693	22.429000854492188	-14.142999649047852
5	-6.571000099182129	-3.2860000133514404	4.285999774932861	1.4290000200271606	44.143001556396484	-25.714000701904297
6	-1.5709999799728394	1.8569999933242798	2.2860000133514404	0.14300000667572021	116.42900085449219	-12.142999649047852
7	2.571000099182129	4.285999774932861	3.2860000133514404	1.1430000066757202	133.0	-6.14300012588501
8	-1.0	3.0	1.2860000133514404	0.8569999933242798	105.57099914550781	-6.571000099182129
9	-4.14300012588501	-0.5709999799728394	1.7139999866485596	-0.7139999866485596	66.85700225830078	-12.857000350952148
10	-4.0	1.7139999866485596	2.8570001125335693	-0.42899999022483826	22.0	-9.0
11	-8.428999900817871	1.7139999866485596	5.85699987411499	-0.42899999022483826	4.14300012588501	-13.428999900817871

VII. Graphs- Visual Representations

In the process of proving our hypothesis, we were able to derive interesting insights. We were able to figure out changes in people's spending habits by comparing pre-coronavirus and current coronavirus data sets of living expenses in Sweden and Taiwan. Sweden is a country where the government imposed barely any regulations until recently. The government strongly supported the idea of "herd immunity," in which all people would be immune to the disease when everyone gets infected. On the other hand, Taiwan is a country where the government has imposed strict restrictions and regulations on people from the very early stage of COVID-19. Thus, this process of comparison inspired us to expand our study into finding correlation between government regulations and people's spending habits. To verify this correlation between government regulation and spending habits, our group analyzed the queries we ran on Hive and created a visual representation of the results.

Figure 8: Consumer Confidence and Consumer Spending Graph from Year 2018 to 2020

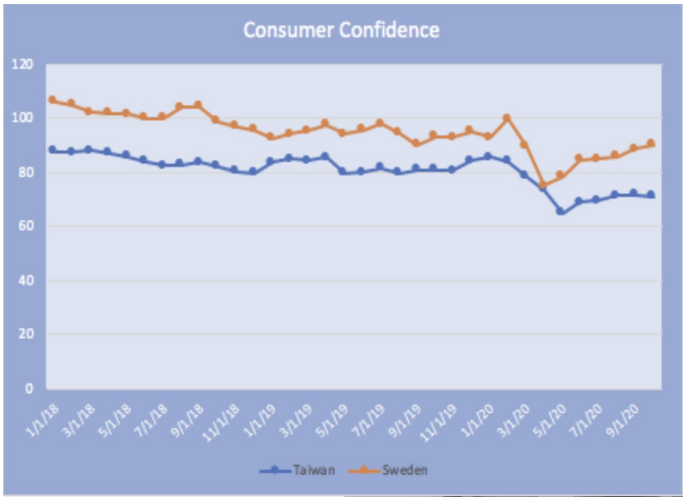
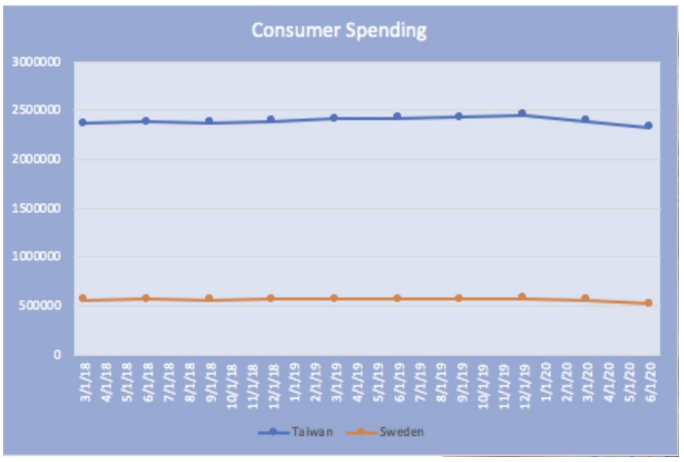


Figure 9: Consumer Confidence and Consumer Spending Graph from Year 2018 to 2020



As we had explained in the dataset analytics section, our group ran several queries to look at consumer confidence and consumer spending trends in Sweden and Taiwan specifically from 2018 and 2020. We assumed that the dates prior to 2018 would be irrelevant to the analysis. The two graphs above show average consumer confidence and consumer spending trends. The x-axis represents dates, and the y-axis represents consumer confidence and spending. First, by looking at the consumer confidence graph, one notable trend can be observed. Both graphs move in a very similar fashion with steady movement. They both barely showed any radical changes. The only time the graphs showed some kind of change is between January 2019 and March 2019. Interestingly, both graphs decreased by a small

amount. Looking at the Consumer Spending graph, there were even less noticeable changes. Both Sweden and Taiwan showed a straight line. We interpreted this analysis of two graphs as having no meaningful implications about the correlation between government regulations and people's spending habits. Thus, our group created another visual representation of the rate of change in visits to park, time spent at home, and visits to grocery stores.

Figure 10: Rate of Change in Visits to Park, Visits to Grocery Stores, and Time Spent at Home

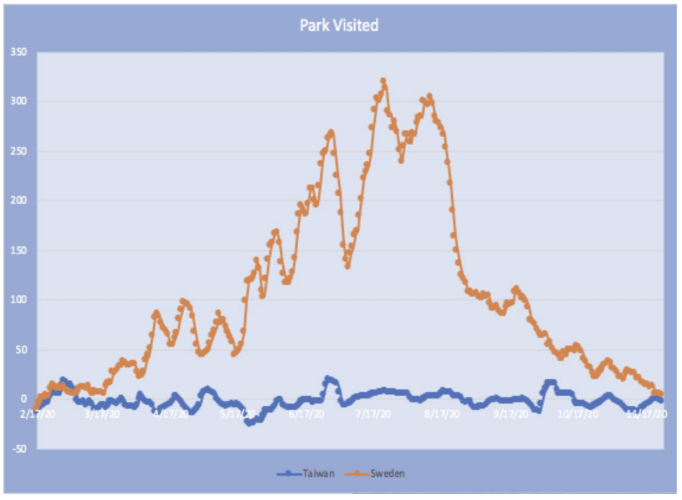


Figure 11: Rate of Change in Time Spent at Home for Sweden and Taiwan

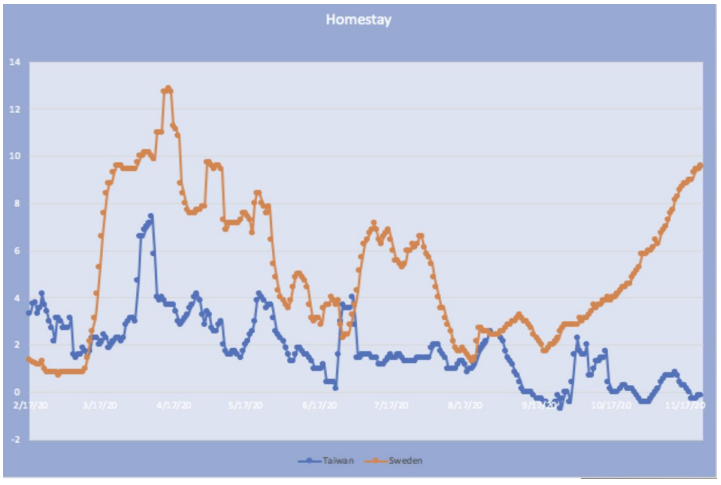
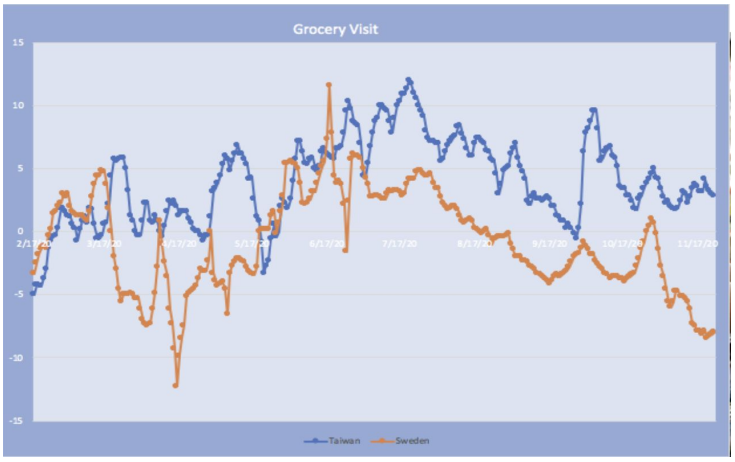


Figure 12: Rate of Change in Visits to Grocery Stores for Sweden and Taiwan



The three graphs above showed the rate of change in visits to park, visits to grocery, and time spent at home. Unlike the previous two graphs, we were able to extract several important insights. There was an evident difference between Taiwan and Sweden that is observable in the parks graph. While the rate of change for Taiwan did not change, the rate of change of Sweden changed significantly the graph. The visits to the park increased significantly until June but dropped afterwards. These contrasting results implied few critical points. First, regarding the stability of Taiwan's trend on the graph, the government's strict enforcement of social distancing, in fact, has an effect on social behavior and daily activities. As a result, people's behaviors are relatively predictable. Second, Sweden's unpredictable and varying graph patterns possibly demonstrate that Sweden's lenient governmental regulations led people to autonomously control their behaviors in terms of social distancing.

From the grocery visits graph, we can see a certain degree of changes in Taiwan's graph. Although there are generally fluctuations in Taiwan's graph, it doesn't actually go down or up significantly if you look at them from a larger perspective. Thus, we can assume that the trend of Taiwanese people's visits to grocery stores is relatively stable and steady like that of the parks graph. However, the graph of Sweden showed even more unpredictable patterns. For example, the trend goes down and up until June 2020. After June, it gradually

declines below the baseline. Once again, like the parks graph, we saw a similar inclination. While Taiwan's was relatively unchanging, Sweden's graph was capricious. We finally analyzed the time spent at home graph.

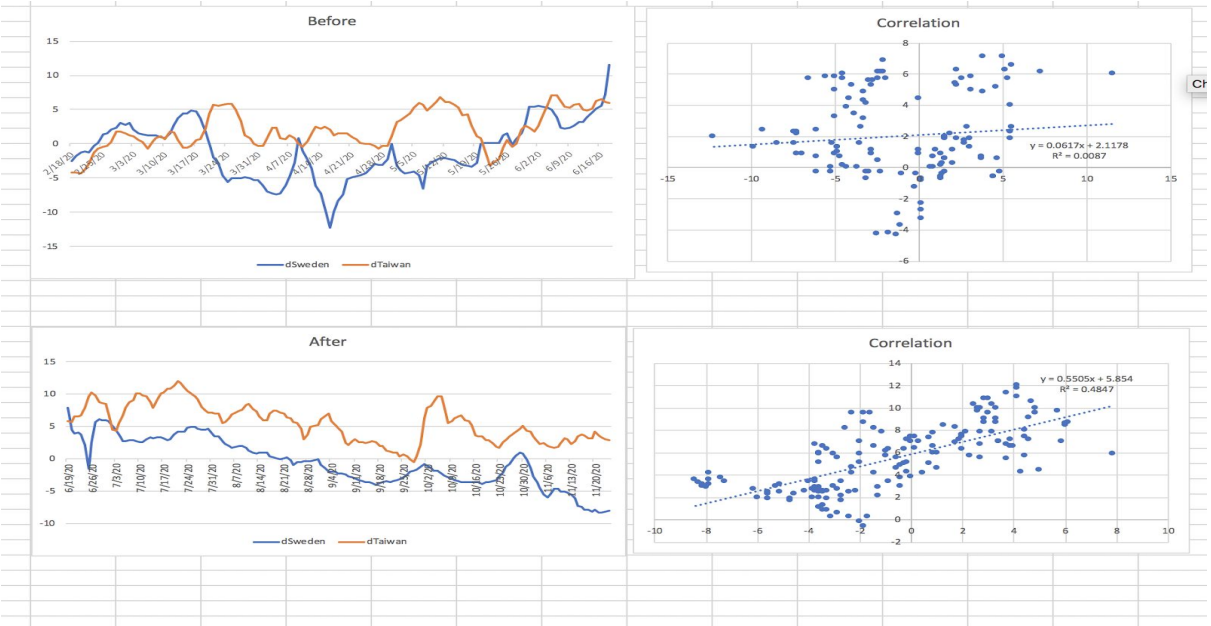
One of the interesting aspects about the time spent at home graph was that Swedish people actually spent more time at home than the Taiwanese did. According to the graph, the change goes up remarkably until April. After April, the overall shape of the graph is going down. For Taiwan, we noticed that the graph is reasonably steady and gradually goes down from April. This possibly indicates that the strict regulation was indeed successful, which made people go out more often later on. To better attest the validity of our thesis, we created graphs that show correlations between data sets of Sweden and those of Taiwan.

Before creating new correlations graphs, we discovered some insightful points in the figures 10, 11, and 12 above. For example, Sweden's graphs showed a sudden turning point in the month of June. Especially for the parks graph, we noticed a complete shift starting from June. Our group construed this shift as pivotal and examined deeply. As we conducted our research on the web, we found out that the Swedish government stopped its 'herd immunity' strategy around June. The Swedish government could no longer handle the rising death tolls. Thus, the government admitted its mistake and imposed strict regulations. Using this fact, we separated the data sets into two sections to see the correlation more clearly: values before June and after June. If Taiwan and Sweden show opposite trends before June and show parallel trends after June, this would prove that the governmental regulations do affect people's behaviors.

Figure 13: Correlation between Sweden and Taiwan's Data Sets (Park)

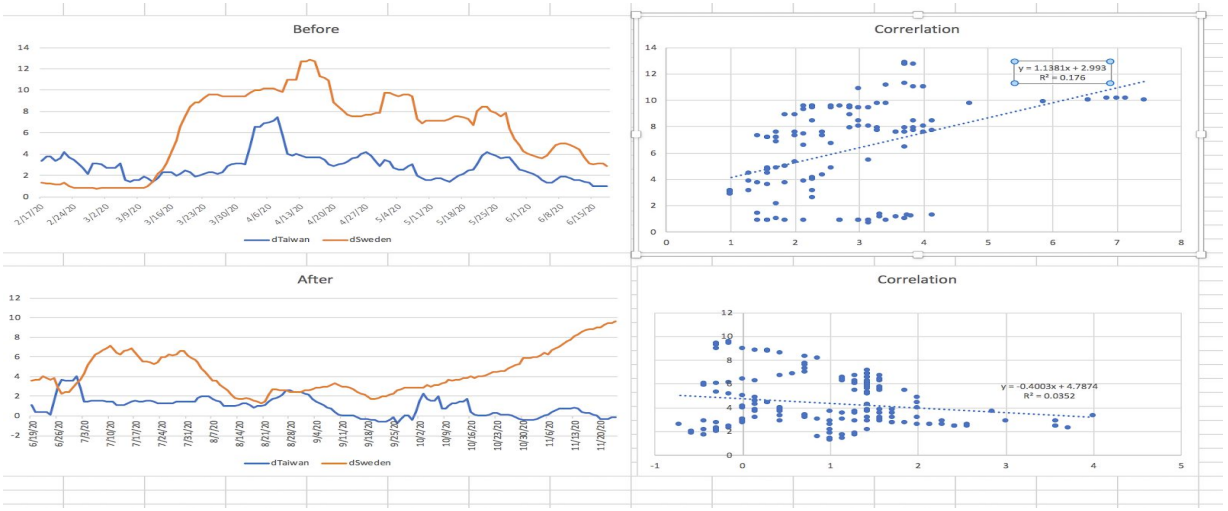
Figure 10 exhibits the overall trend of Sweden and Taiwan's Park data and their correlation. As mentioned above, the crucial aspect of this representation is the fact that it is divided into two sections. First, when we take a look at the correlation prior to June, the graph shows negative correlation between data of Sweden and Taiwan. At this point, the two governments pursued the exact opposite regulations. After June, positive correlation can be undoubtedly observed. We interpreted this as inconsistencies in people's behavior because their behaviors are prone to change instantly when the government does not enforce strict regulations. On the other hand, when governments impose heavy regulations like the Taiwanese government, people's behaviors become very stable as the graphs of Taiwan indicate.

Figure 14: Correlation between Sweden and Taiwan's Data Sets (Grocery)



Unlike the previous graph, this graph showed a slightly different result. To elaborate, if we take a look at the correlation between Taiwan and Sweden before June, it is positive. A possible explanation for this would be that grocery is an indispensable part of life. People must go to grocery stores to buy food, drinks, and other necessary supplies for the household. But going to a park is not necessarily a mandatory routine in life. As a result, visits to grocery stores are less affected by the government regulations. After June, we can clearly observe that the correlation becomes positive, which indicates that the Swedish and Taiwanese behave similarly when strict government regulations are imposed.

Figure 15: Correlation between Sweden and Taiwan's Data Sets (Time Spent at Home)



The final visual representation, which shows the correlation of rate of change in time spent at home between Sweden and Taiwan, displayed an interesting pattern. Before June, Sweden and Taiwan showed positive correlation. Positive correlation means that Swedish and Taiwanese behaved in a similar way: they both tend to stay home. After June, however, the correlation became slightly negative. Negative correlation indicates that people behaved in an opposite manner. If we take a look at Figure 11, the Swedish people spent much more time at home than Taiwanese. Especially during April, the y-axis reached its peak. As the two governments applied similar governmental policies, the extreme behavior of Swedish people got alleviated to a certain degree. And thus, the correlation line between Sweden and Taiwan forms a slightly negative, horizontal line.

VIII. Conclusion

We attested that strategies governments took to prevent COVID-19 affect people's spending and outdoor activities. The epidemic itself is transforming our life patterns, keeping us distant to each other for safety. But how the government deals with this disease also

contributes to how we modify our lifestyles. From the self-regulatory social distancing effect that could be expected from Sweden's result, we concluded that less stringent governmental regulations could induce individuals' voluntary social distancing. Sweden's strategy of herd immunity and mutual trust based on the respect of an individual's autonomy resulted in an individual's autonomous social distancing without suppressive measures by the government. Especially through examining the period where Sweden made changes in policies, we were able to identify the impact of an individual's autonomy in preventing the disease.

However, through our analytics and visualization of our result, we realized that changes in people's lifestyle under less stringent regulations are hard to predict than ones under severe restrictions. Inconsistent fluctuations noticeable from Sweden data can be referred to as the unpredictability of people's behaviors. On the other side, regarding the stability of Taiwan's trend on the graph, we interpreted it as the government's strict enforcement of social distancing having a long-term effect on controlling people's spending patterns, social behavior, and daily activities. This predictability could benefit in the epidemiologic investigation of the infection.

In addition, from the correlation analysis, contrasting correlation coefficients as of June gave us a more incisive perspective of our idea. When Sweden started to withdraw the idea of herd immunity and enforced more regulations regarding covid-19 in June, correlation values between Sweden and Taiwan's mobility data turned positive from negative, which illustrates the effect of government response. However, no significant correlation shifts in spending, especially grocery data was derived from the feature of grocery spending being indispensable.

Although our research presented a methodology for the analysis of government response in our lifestyles and reasonable thesis, refinements could be made from our study for better practical implementation.

First, comparing more than two countries could give better insights. Although our study focused on Taiwan and Sweden, which we chose based on our limited literature reviews, more analysis of other countries that took different measures is one way to expand our study.

Second, variables other than mobility data and consumer spending could be taken into account. We noticed various criteria that could imply changes in our lifestyles. For example, Sweden is a country where more than half of the citizens are single-person households. Among Europe, Sweden is also one of the countries with the highest proportion of single adult households. Low population density and individualized cultural custom could have influenced as well. For Taiwan, geographical location and the lessons learned from severe acute respiratory syndrome (SaRs) in 2003 could have elicited more sensitive government response to COVID-19. Consideration of these with cultural, historical, geographical, demographic factors with the help of quantitative measurements could improve overall understanding of our idea.

Lastly, estimating the impact of the disease itself could strengthen our thesis because economic contraction and social distancing could be caused by the virus itself rather than government response. Dealing people's reactions to the disease and reactions to restrictions separately is a way to disclose a more coherent causal relationship between government response, the disease, and people's life patterns.

Despite we have left some improvements for some future research, our study pinpointed the importance of government response regarding coronavirus in our lifestyles. Based on our study, governments should adequately decide policies based on their societal characteristics to effectively mitigate the spread of disease. We also hope that our study could provide insights to not only governments but economists, businesses, and other organizations in improving restrained lives during this pandemic era.

IX. References

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