MATH189Z: COVID19 DATA ANALYTICS

PROF WEIQING GU

FINAL REPORT

ANALYZING THE CONNECTIONS BETWEEN COVID19, INFLUENZA, AND SOCIAL DISTANCING OVER THE COURSE OF THE PANDEMIC

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ABSTRACT

WHO's declaration of the COVID19 pandemic was a wake-up call for the many countries that had yet to lock down their borders earlier this year. Despite the risks of infection, however, not all countries immediately sealed off their borders; instead, countries like Sweden kept their borders open, and other countries like the U.S. have given considerable power to its sub-regions in deciding whether or not to declare lockdown and/or stay-at-home orders. Meanwhile, countries like Italy declared a lockdown much earlier than the pandemic as a result of its fatal death and infection count. For our final project, we decided to study the efficacy of both the states' and these country's approaches in battling COVID19. Additionally, we decided to study how these states' and country's approaches have affected influenza as well.

INTRODUCTION

Considering the variability in approaches to battling COVID19, we thought that it would be interesting to analyze the infection rate of both COVID19 and influenza in the countries Sweden, Italy, and the U.S. over time. We also decided to analyze the rate of infection both before and after lockdown within these regions to determine how effective lockdown and stay-at-home orders have been within these given regions. Particularly, we hypothesized the following:

I. States that declared an earlier lockdown period should have experienced a slower rate of infection for both influenza and COVID19 following lockdown.

II. The rate of infection for influenza should be significantly lower this year compared to the past ten years in all regions.

III. States that aren't well observing social distancing guidelines should be experiencing a higher rate of COVID19 infection.

BRIEF BACKGROUND INFO

	Approach	**Date**
Italy	**Lockdown**	**March 9th**
U.S.	**Lockdown**	**Varies by state**
Sweden	**Social Distance Guidelines**	**----------**

METHODS

Comparison of COVID19 Country-Level Cases to Lockdown Dates:

To compare the rate of infection of COVID19 to the lockdown dates at the country level, we plotted the rate of change of COVID19 cases over time against the dates at which these rates occurred.

Comparison of U.S. State-Level Mobility Rates to COVID19 Infection Rates:

Although some states have officially declared lockdowns or stay-at-home orders, not everyone has properly observed them over the past few months. As a result, it wouldn't be accurate to assume that a state that underwent an earlier

Comparison of U.S. State-Level Influenza Cases to Lockdown Dates:

To assess how lockdowns have affected the change in influenza cases in the United States, we used influenza data from each state from the past decade to create a sinusoidal regression. We used this regression to calculate deviations from the trend by subtracting the regression equation from the actual case data. Finally, to compare the trends of the data across states, we normalized the data by dividing it by the maximum absolute value.

RESULTS

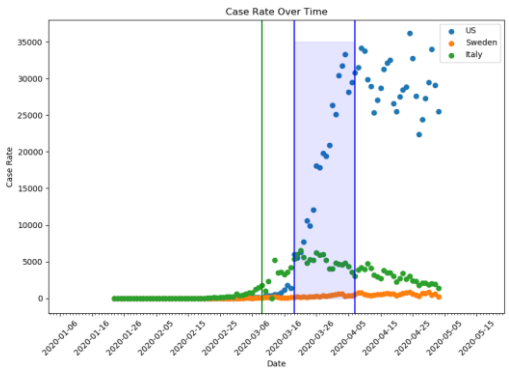

Fig 1. The shaded region highlights the period of time in which lockdown orders began to be enacted in the United States (This will be the case for all future graphs). The green vertical line represents the national lock down order date of Italy. Within two weeks of the lockdown order in Italy the case rate for COVID19 decreases. In the US, after the period of time of the lockdown dates, the case rate does not increase much past the peak in the shaded region, however there is not an obvious decline like in Italy. In Sweden, the case rate slightly increases.

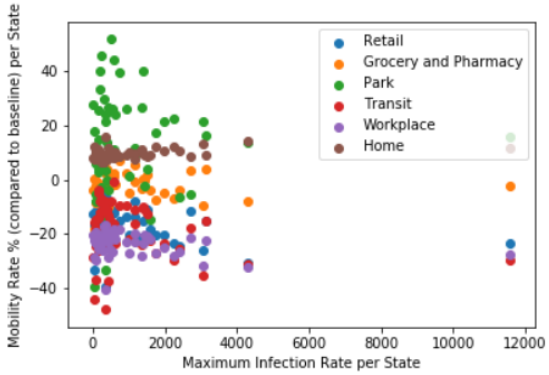

Fig 2. The mobility rate % is a measurement of the amount of actual mobility compared to the ideal mobility rates. This graph compares the average mobility rate for each state (i.e. visiting the park, grocery shopping, or going to work) with the maximum infection rate within the state following its lockdown date (if it underwent lockdown). We expected for there to be a higher maximum infection rate in a state should there be greater variation from the baseline (where y = 0); however, we can see that there isn't any correlation of the sort.

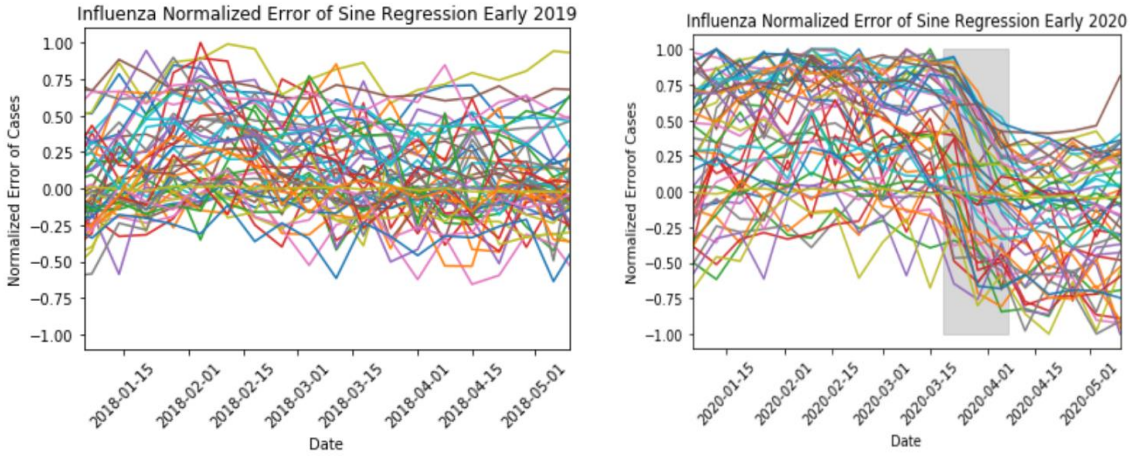

Fig 3. These graphs depict normalized error of influenza from a sinusoidal regression by state for the first five months of the year. The left graph contains 2019 data as a reference for typical error of this model and the right graph contains 2020 data with the shaded region indicating the varying lockdown dates of different states.

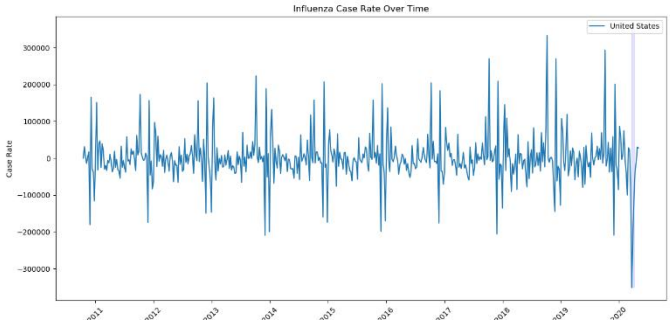

Fig 4. In comparison to previous years, the trough occurring in the time frame of the lockdown order in the United States is deeper than that of other years.

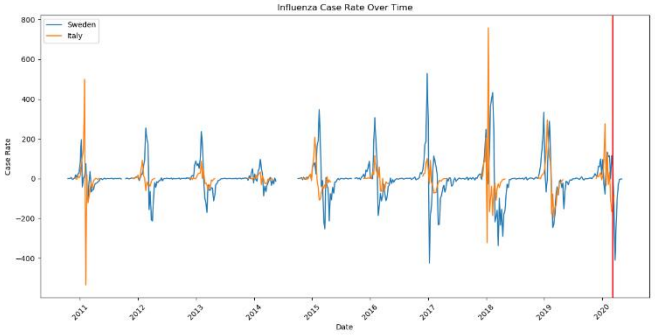

Fig 5. The red vertical line represents Italy's lockdown date. Compared to certain years, the trough occurring near this time is relatively deep. At the same time, Sweden's infection case rate also dips quite low during this period.

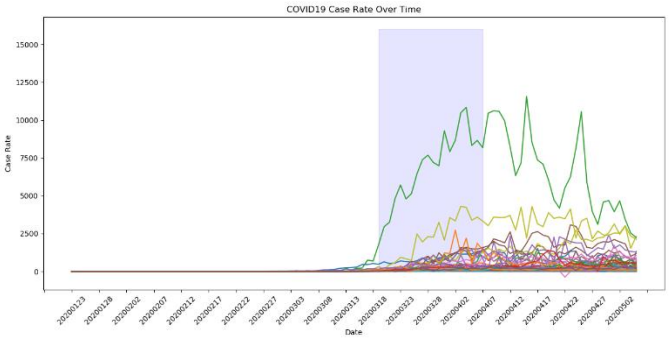

Fig 6. For some states, after the period of time of lockdowns being enacted, there was a decrease in the rate of COVID19 cases.

DISCUSSION

Revisiting our Hypotheses

I. Being in lockdown will result in a smaller rate of infection for both COVID19 and Influenza.

For the US, given figure 4, it is evident that during lockdown, there has been a significant decline in the rate of cases of influenza. During this influenza season, the rate dipped to a value much lower than the past 10 years. However, given figure 1, the COVID19 rate of infection is still relatively high despite these lockdown orders. Comparing this to Sweden, where there were no official lockdown orders, and Italy, where there was a strict nationwide lockdown order, it is evident that being in lockdown does not result in a smaller rate of infection for both COVID19 and influenza. Figure 5 demonstrates that during the 2019-2020 flu seasons, the case rates for both countries are comparable to that of previous years. In contrast to this, Figure 1 demonstrates that COVID19 rates of infection for Italy have clearly decreased since the lockdown order, and for Sweden, while it

is very slight, there has been a trend of the case rate increasing slightly. The evidence, in this case, contradicts the hypothesis.

II. The rate of infection for influenza should be significantly lower this year compared to the past ten years in all regions.

Figure 3 shows that around the dates of the lockdowns for different U.S. states, influenza cases dramatically dropped below the regression model based on the past decade. This drop is also clearly not a seasonal trend because the influenza cases from the previous year show a steady noise pattern for the same time interval (January to May). This suggests that state-issued lockdown orders had a significant effect on the spread of influenza. Unfortunately, in Figure 6 it can be seen that the COVID19 cases by state don't reflect this drastic decrease. Although there does appear to be a decrease in COVID19 cases after the initiation of statewide lockdowns, this decrease lags well behind the lockdown dates and it isn't very drastic.

III. States that aren't well observing social distancing guidelines should be experiencing a higher rate of COVID19 infection.

In plot 2, we can see that activities like visiting the park are highly out of bounds (around +40%) for numerous states. Other activities that require close contact with others -- particularly transit -- have been either temporarily cancelled or largely avoided by all state populations as evidenced by the negative mobility rates. People have been appropriately abiding by social distance guidelines when grocery shopping or going to the pharmacy (since the mobility rate varies around 0%). Additionally, we can see a constant -20% mobility rate for visiting the workplace for all 50 states. This should be expected considering that all non-necessary workplaces have been shut down. Lastly, people have been mostly staying at home, as evidenced by the constant rate of about +20%. Considering the common trend lines between each state, it shouldn't come as a surprise that the maximum infection rates don't significantly differ between them (save for the outliers of New York and New Jersey). New York had a maximum infection rate of ~12,000 cases/day; New Jersey followed behind with a maximum rate of ~4,000 cases/day. These two states were experiencing high rates of infection that prompted their lockdowns, thus why their infection rates are significantly higher than the rest. Conclusively, though, we can see that due to activities like visiting the park (and other recreational activities which weren't explicitly stated here), people haven't been effectively social-distancing. Despite this, there doesn't appear to be any correlation between low mobility rates and maximum infection rates following lockdown. We know very well from previous studies that there should be a positive correlation between sheltering in place and reduced infection rates. The reason why we don't observe that here could be because not all states have been testing at the rates they should be. Additionally, the variation in lockdown dates and circumstances (i.e. whether there was a severe outbreak prior to lockdown) doesn't indicate whether social distancing has been effective.

CITATIONS

https://apps.who.int/flumart/Default?ReportNo=12 was utilized to find weekly influenza data for Italy and Sweden.
https://gis.cdc.gov/grasp/fluview/main.html was utilized to find weekly influenza data for the US.
https://en.wikipedia.org/wiki/U.S._state_and_local_government_response_to_the_COVID-19_pandemic was used to retrieve the lockdown dates for each state.
https://covidtracking.com/?fbclid=IwAR3WwZ1nX8qhwJkAi1uYahgpyV94V3xPs0v_RzBBycMPB7p01DMKyDcc9Bk was used to download our coronavirus data.