The Role of Transportation in *Driving* Early Covid Spread

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Research Question

March 19th, 2020: Governor Gavin Newsom declares a *Stay at Home* order for the state of California

We aimed to investigate: How did compliance with the order, affect early COVID-19 spread within the San Francisco Bay Area?

Why we care: The SF Bay Area was a primary point of entrance for the COVID virus into the state of California.

Background

Stay at home orders have empirically demonstrated that they slow the spread of COVID-19

- “Regions in which mandates were implemented late experienced a prolonged duration to reaching both peak daily case and death counts” (Medline et al., 2020).

The measure of compliance that we used in our project is being used in various places around the world since the start of the pandemic

- “Measuring compliance with physical distancing is crucial to inform modelling deliberations and enable evidence-based policy making” (Sheikh et al., 2020).

Our data

- We looked at multiple sets of data for both of the variables in order to account for missing data, unusual trends, etc.

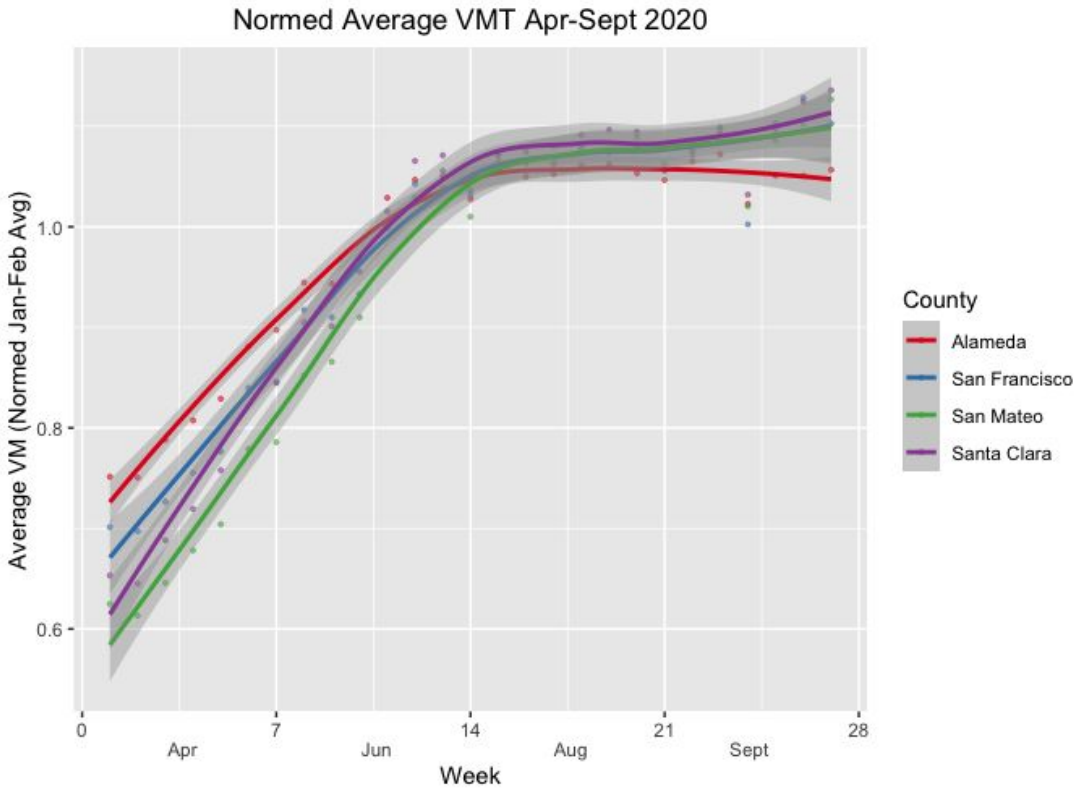
- Transportation
  a. VMT
  b. Trips

- COVID-19 spread
  a. case counts
  b. hospitalization data

Transportation data - CA DOT PeMS

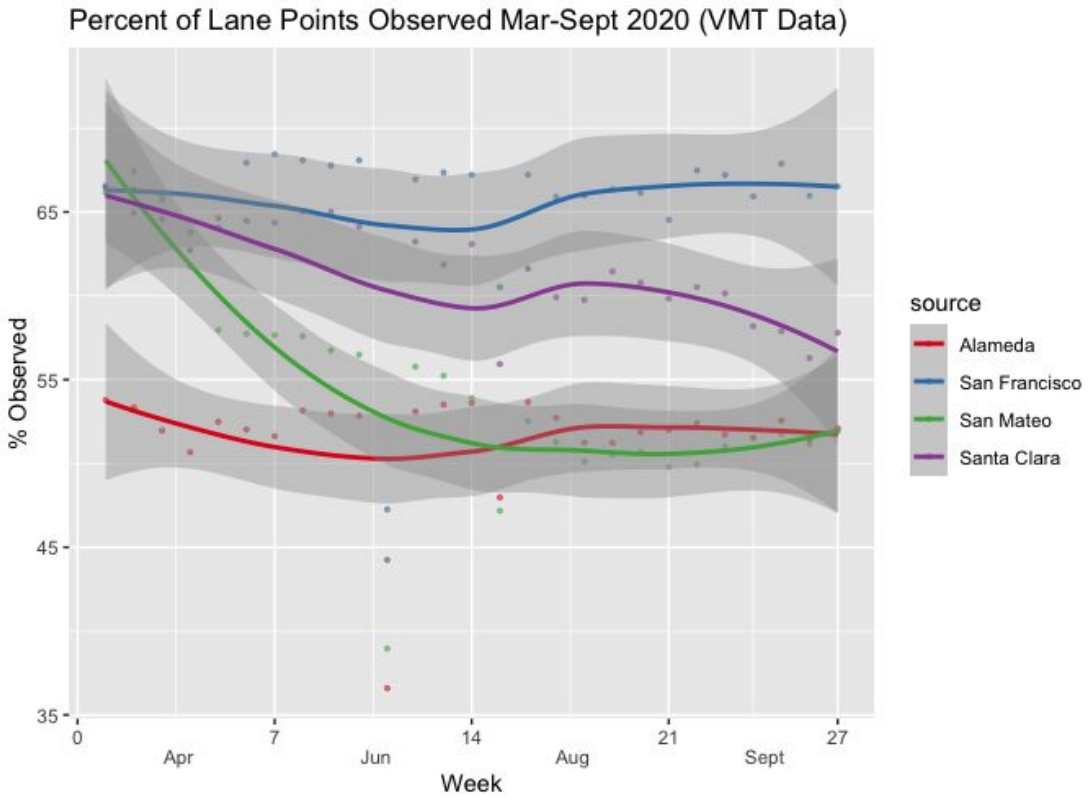
- freeway detectors

- VMT - Vehicle Miles Traveled: sum of miles driven by vehicles over time

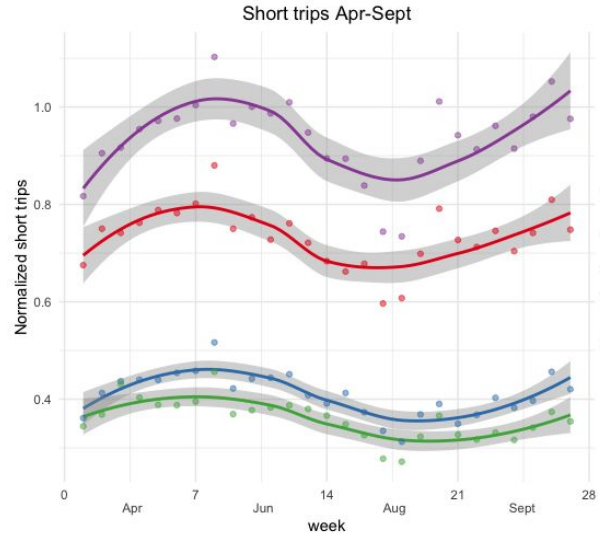


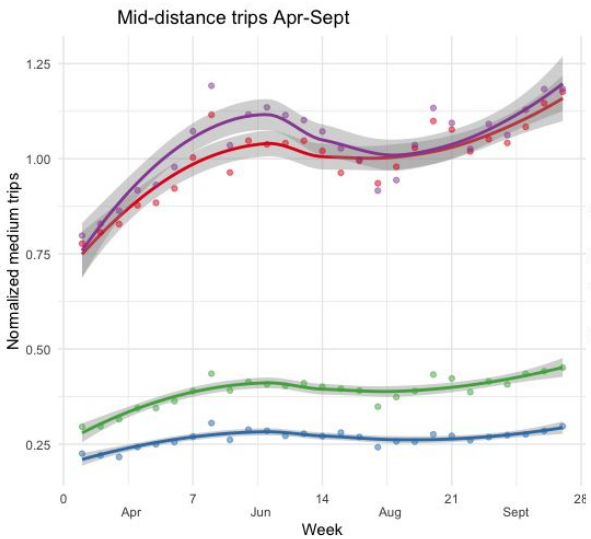
Fidelity of CA DOT PeMS Data

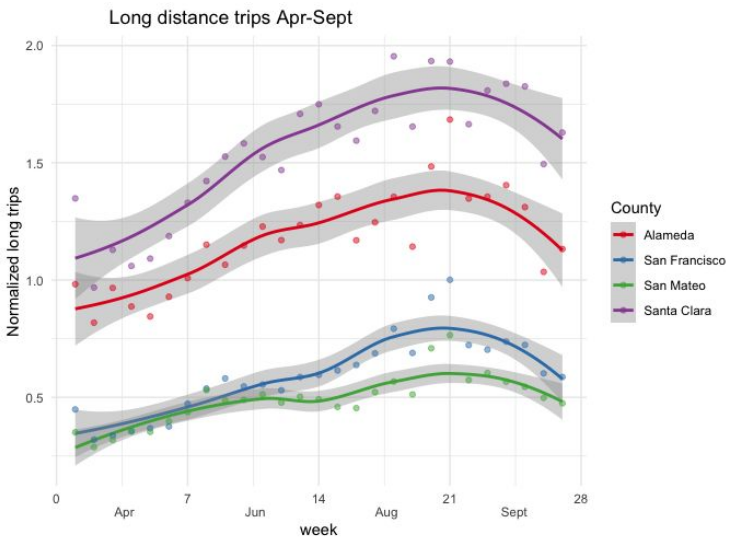
- Data is collected real time from 40,000 individual detectors
- % Observed: this shows how many points in the data set were imputed
- We removed data that was 2sd below the avg % obs (value 43).



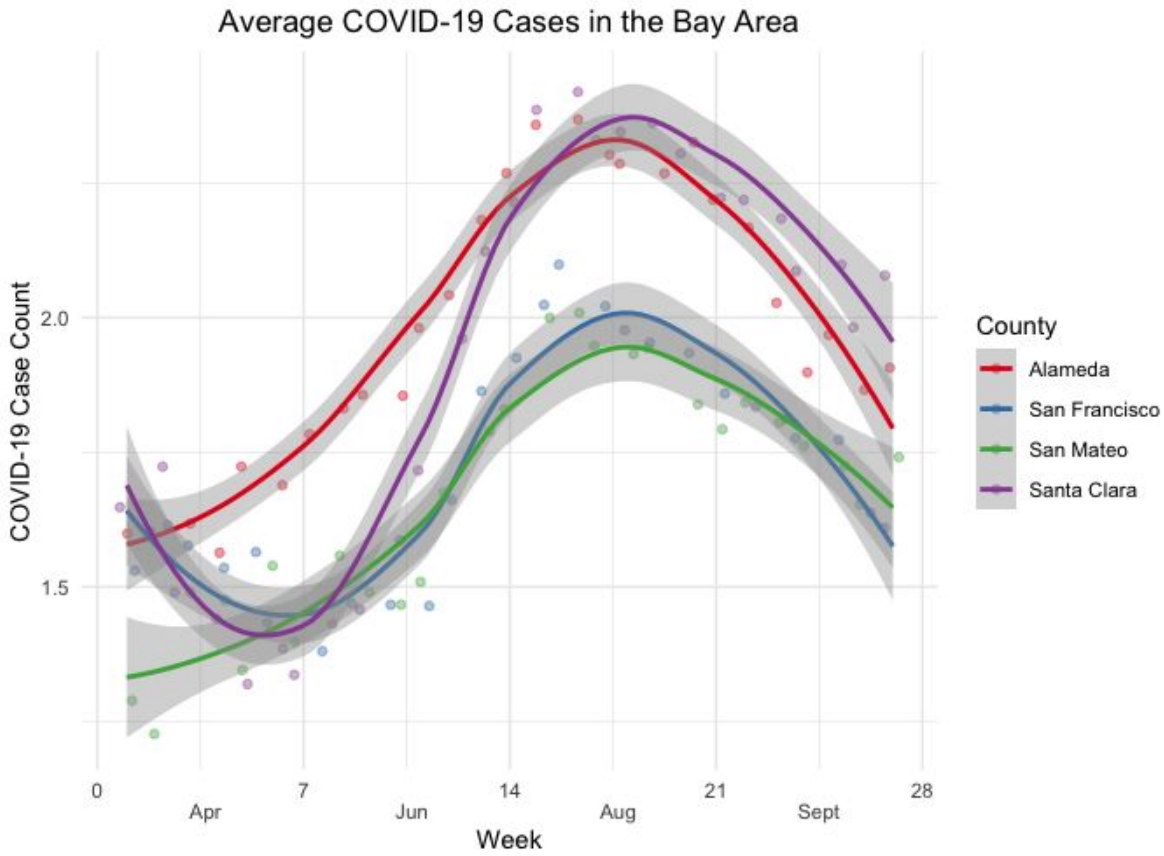
Transportation data



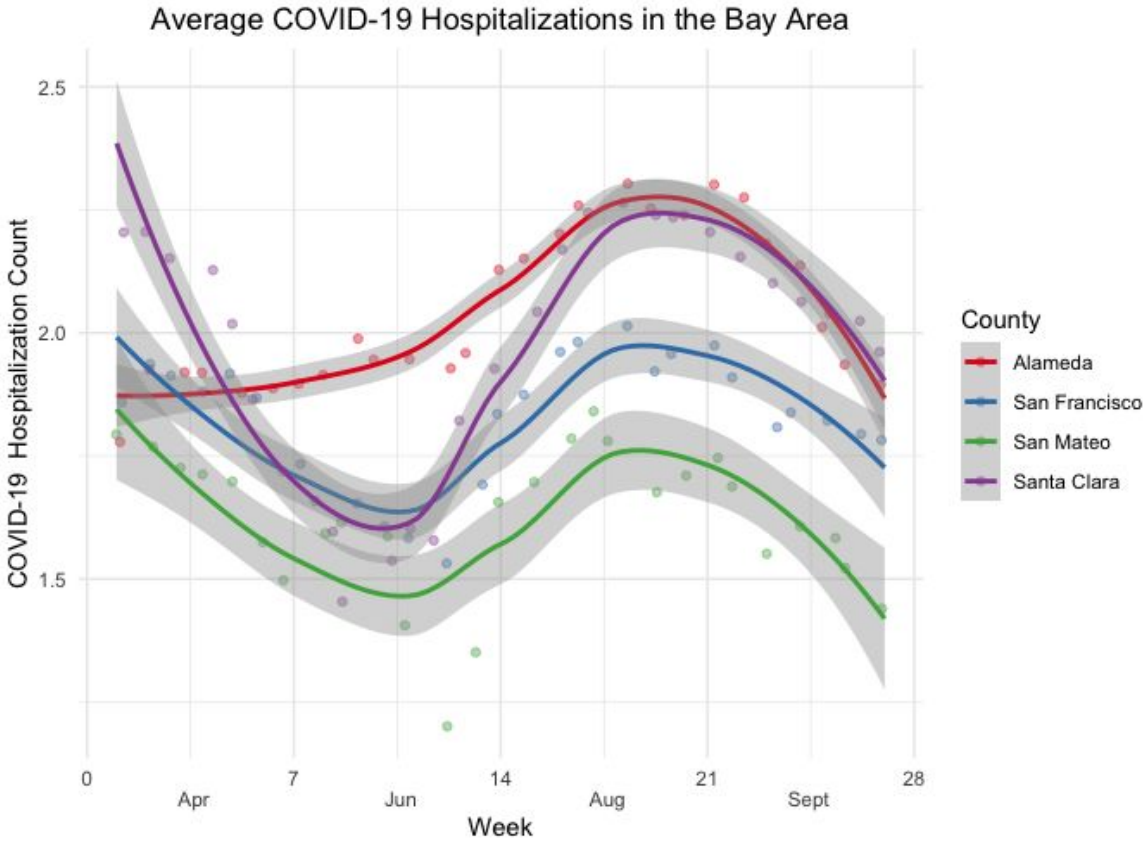




Covid data - Cases



Covid data - hospitalizations



Results

COVID-19 spread as a function of movement

- We found a main effect of time (measured in weeks), region, vehicle movement, short trips, and long trips on the number of COVID-19 cases.
- There is an interaction between the county type and the number of short trips (less than 10 miles) taken.

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Analysis of Variance Table

Response: log10(m_cases)
              Df Sum Sq Mean Sq  F value    Pr(>F)
week           1 3.4010  3.4010 166.6428 < 2.2e-16 ***
County         3 1.9155  0.6385  31.2849 2.607e-14 ***
mi_norm        1 1.2088  1.2088  59.2306 1.068e-11 ***
normal_short   1 1.1556  1.1556  56.6223 2.464e-11 ***
normal_medium  1 0.0776  0.0776   3.8003  0.054073 .
normal_long    1 0.1805  0.1805   8.8437  0.003694 **
Residuals     99 2.0205  0.0204
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Results

COVID-19 hospitalizations as a function of movement

- As with COVID-19 cases, we found a main effect of time (measured in weeks), region, vehicle movement, short trips, and long trips on the number of COVID-19 cases.
- Likewise, there is an interaction between the county type and the number of short trips taken.

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Analysis of Variance Table

Response: log10(m_hosp)
               Df  Sum Sq Mean Sq F value    Pr(>F)
week            1 0.16396 0.16396  9.3692 0.0028404 **
County          3 2.86273 0.95424 54.5276 < 2.2e-16 ***
mi_norm         1 0.28378 0.28378 16.2158 0.0001108 ***
normal_short    1 1.02386 1.02386 58.5057 1.345e-11 ***
normal_medium   1 0.00091 0.00091  0.0521 0.8198719
normal_long     1 0.11662 0.11662  6.6640 0.0113033 *
Residuals      99 1.73252 0.01750
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Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
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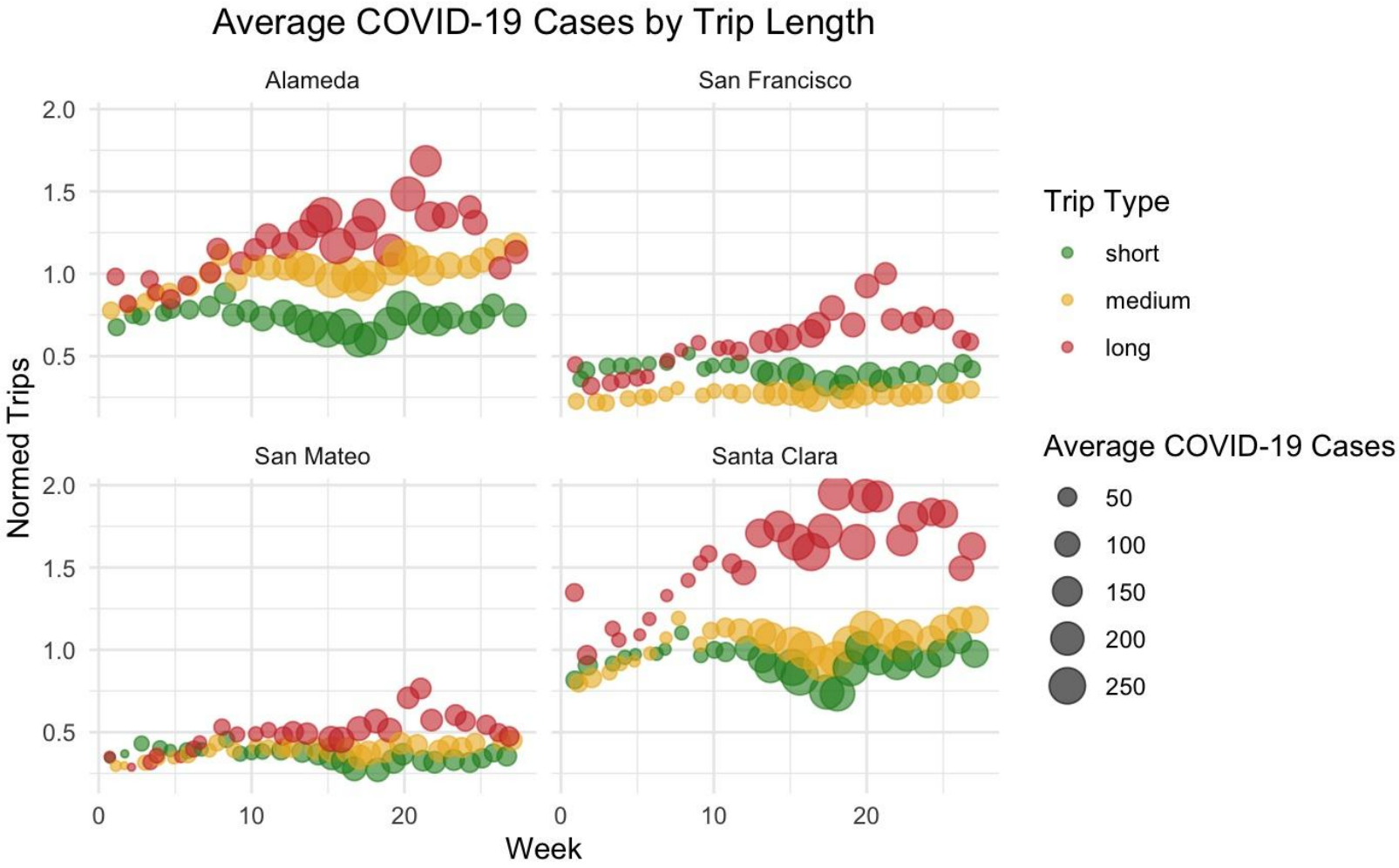
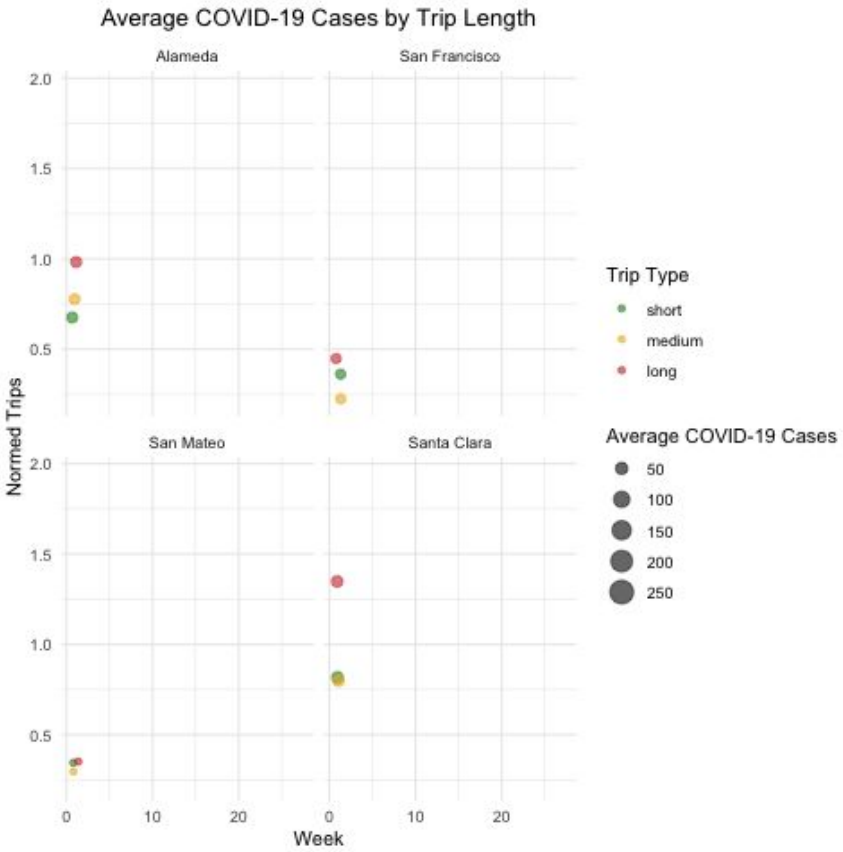

Average COVID-19 Cases by Trip Length
Alameda
San Francisco
San Mateo
Santa Clara
Normed Trips
2.0
1.5
1.0
0.5
0
10
20
Week
Trip Type
short
medium
long
Average COVID-19 Cases
50
100
150
200
250

COVID-19 case spread as a function of movement



Limitations and Future Research

- It would be useful to look at a longer window of time to see how people behaved later in the pandemic, and as policies changed
- There are alternative ways to directly measure compliance -- taking a car ride does not necessarily result in COVID-19 transmission (CA Notify)
- Didn’t look at the difference of restrictions between counties. We assumed that they were all similar since there was a state order in effect, although this might not be the case.
- Variables that we did not include: socioeconomic status, geography, population density

Thank you! Question?

References:

Medline, A., Hayes, L., Valdez, K., Hayashi, A., Vahedi, F., Capell, W., Sonnenberg, J., Glick, Z., & Klausner, J. D. (2020). Evaluating the impact of stay-at-home orders on the time to reach the peak burden of covid-19 cases and deaths: Does timing matter? *BMC Public Health*, *20*(1). https://doi.org/10.1186/s12889-020-09817-9

Sheikh, A., Sheikh, Z., & Sheikh, A. (2020). Novel approaches to estimate compliance with lockdown measures in the covid-19 pandemic. *Journal of Global Health*, *10*(1). https://doi.org/10.7189/jogh.10.010348