

Analysis of Non-Pharmaceutical Interventions (NPIs) for COVID-19 Using County-Level Mandate Data

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Background

In response to the COVID-19 pandemic, local governments had various mandated Non-Pharmaceutical Interventions (NPIs).

Dataset:

- County-level NPI data for Virginia, Minnesota, Arizona, Hawaii, New Jersey, and Washington
- Business, school, religious, and college/university closures, mask mandates, and lockdowns

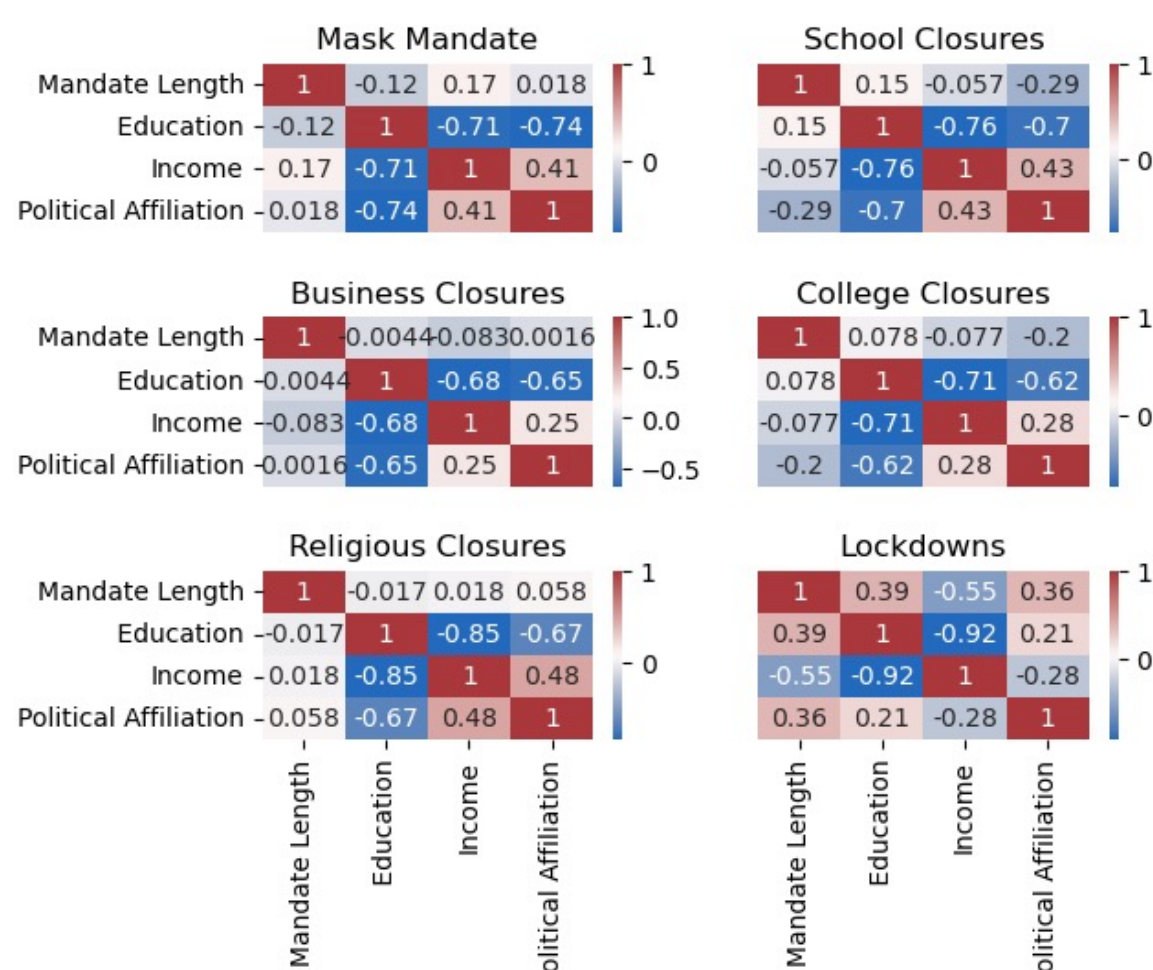
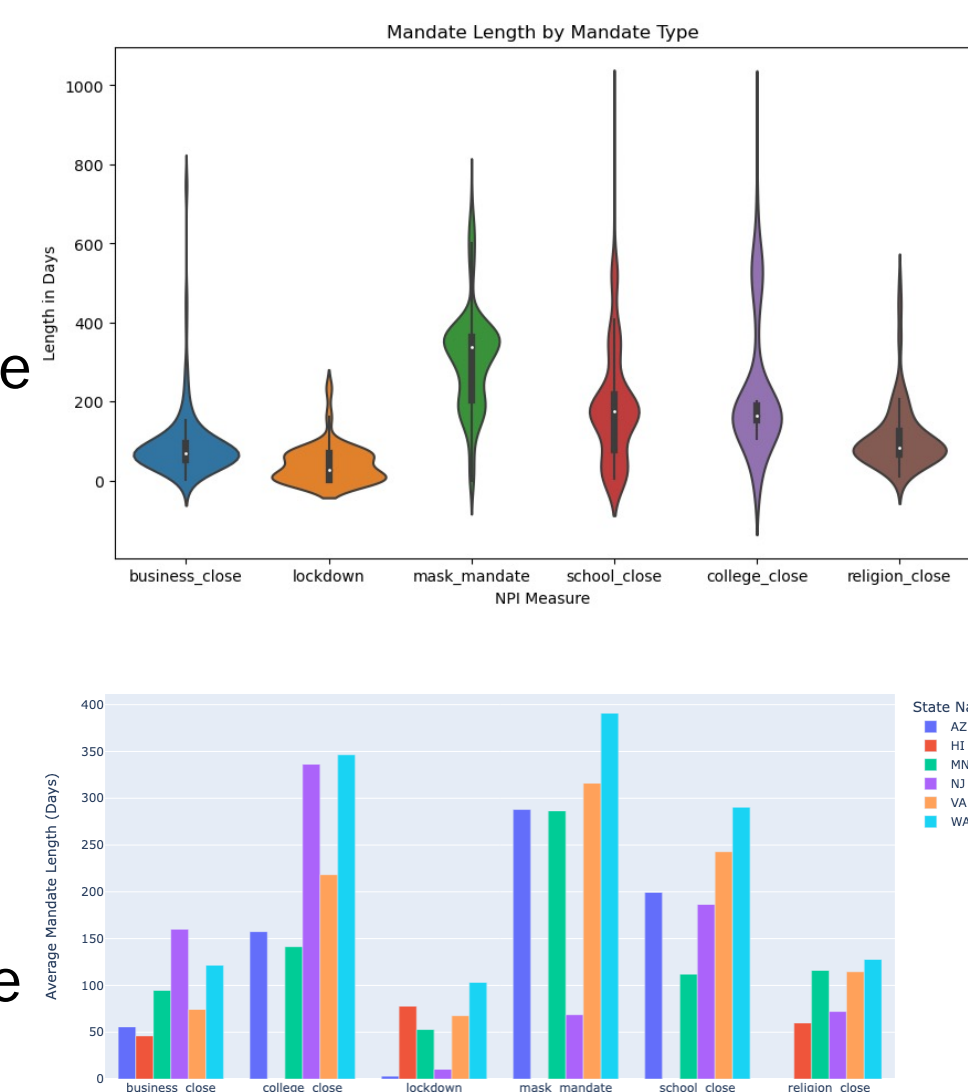
Goal: Improve understanding of relationship between NPIs and COVID-related cases

Data Analysis

Mandate Length:

Mandate length differed by mandate type and by state

- More restrictive mandates, like lockdowns and business closures, were shorter
- Mask mandates and school closures lasted longer overall
- Virginia and Washington had the highest average county-wide mandate lengths, while Minnesota and Hawaii had the shortest.

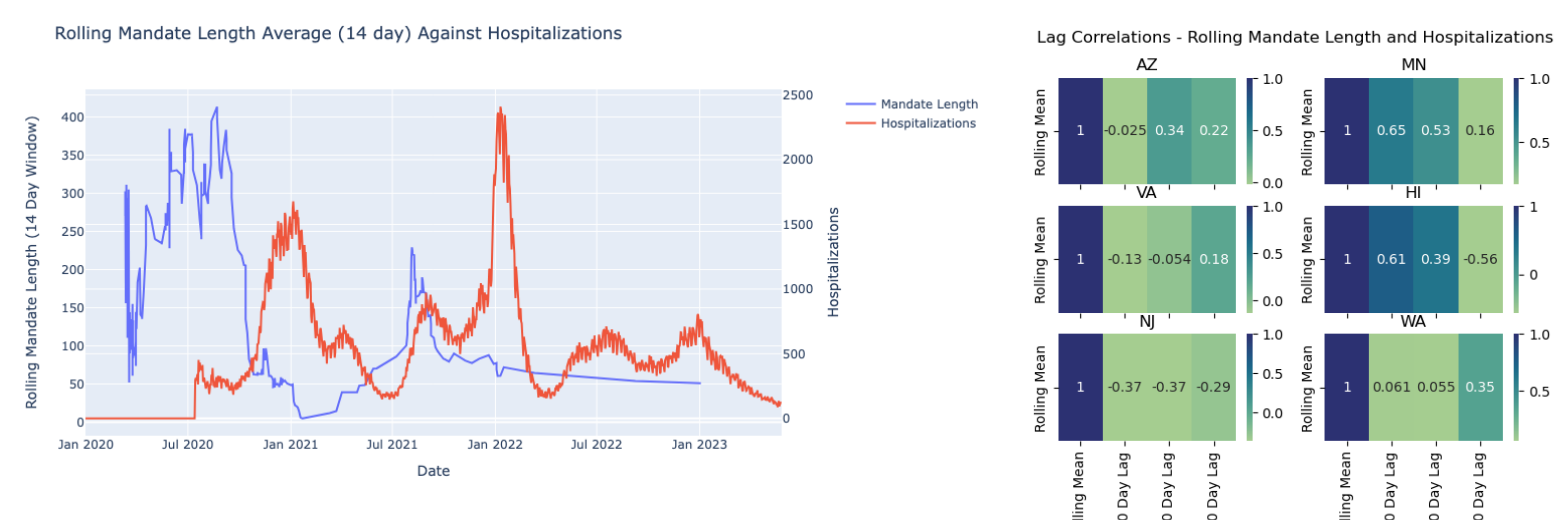


School closures and college closures are somewhat correlated with political beliefs: as counties lean more Republican, their mandate length gets shorter. We see the opposite trend for lockdowns, though counties that are more educated and wealthier tended to have longer lockdowns.

Cases + Hospitalizations:

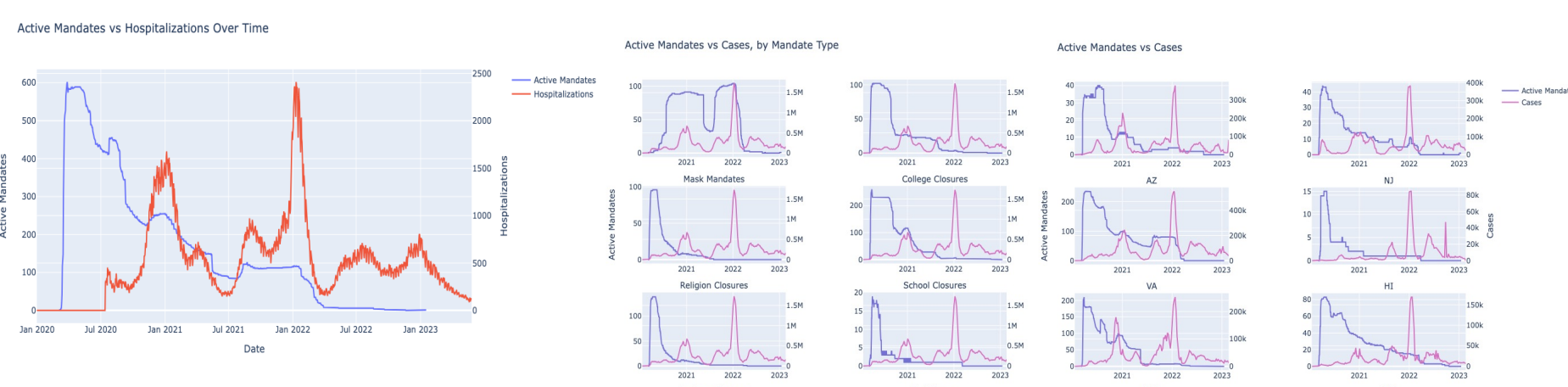
- Rolling average of mandate length by start date:

This metric matches up fairly well with peaks in cases/hospitalizations, with an overall lag of about 140 days. On a statewide level, this varies from 100-180 days



- Total active mandates:

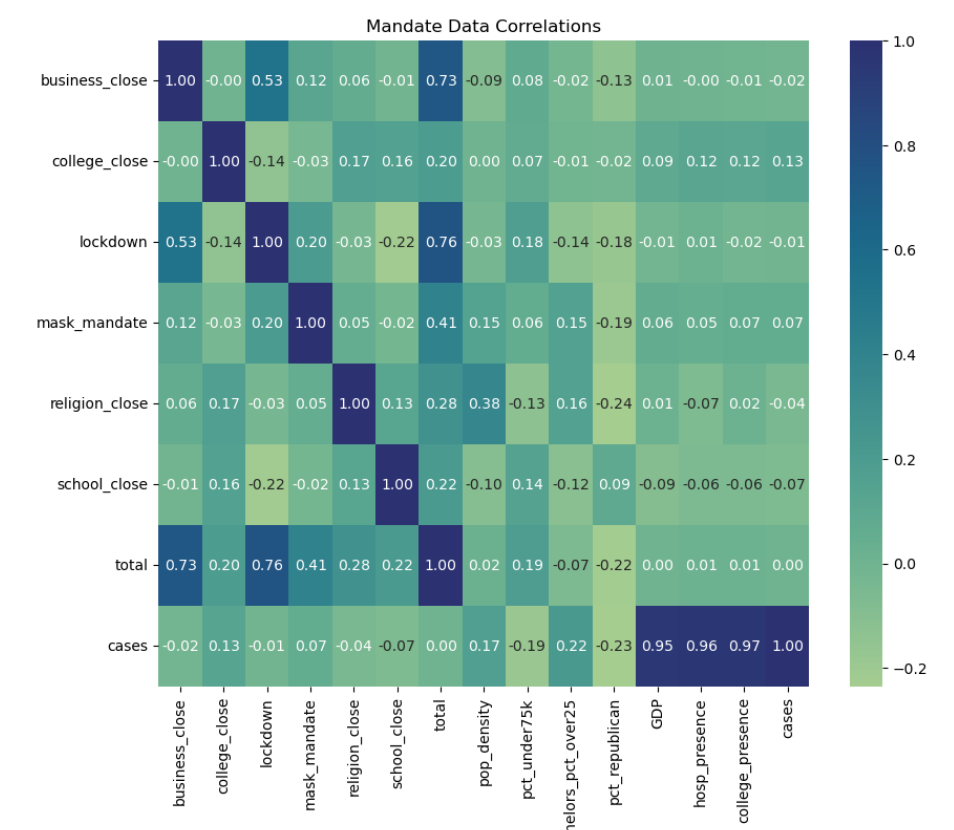
Active mandates peaked at the very beginning of the pandemic and gradually declined



Modelling

Variable Correlations:

- Number of business closures and lockdowns were fairly strong predictors of how many total mandates a county would have
- Political affiliation and income were somewhat related to total mandates implemented by a county



Model:

- Multi-output random forest classification model:
 - Predicts number of mandates implemented for a county within first 1.5 years of pandemic
 - Features: population density, percent earning below 75k/year, percent college educated, GDP, number of hospitals, number of colleges, and voting information.
 - Mean absolute error: 0.49
 - Hamming loss: 0.34
- About 90% of the incorrect predictions were only off by one mandate

Variable: FIPS	Importance: 0.19
Variable: pop_density	Importance: 0.15
Variable: pct_republican	Importance: 0.14
Variable: pct_under75k	Importance: 0.12
Variable: bachelors_pct_over25	Importance: 0.12
Variable: GDP	Importance: 0.12
Variable: hosp_presence	Importance: 0.09
Variable: college_presence	Importance: 0.07

Metric: Average Precision	Value: 0.38
Metric: Average Recall	Value: 0.43
Metric: Hamming Loss	Value: 0.34
Metric: Max depth of trees	Value: 15
Metric: Total Trees	Value: 1000
Metric: Mean Absolute Error	Value: 0.49

Future Work

- Further data collection:
 - Having a more robust and diverse dataset would be helpful for painting a clearer picture of the interactions between mandates, human behavior, and viral behavior
- Further predictive modelling:
 - Data is hard to collect and rapidly decaying, demonstrating the importance for accurate models
 - Further explore relationship between mandates, COVID-19, and other variables

References

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