

Late Stay at Home Orders Were Simply Late: Analyzing State-by-State COVID-19 Response

by Silas Morsink

for code, graphics, and data, see [github](#)

Intro

As the COVID-19 crisis exploded in the United States, individual states have responded differently. Some instituted regulations, such as Stay at Home orders, early on, while others held off. Some could argue that this decentralized approach to COVID-19 response is a strength of the US system. Theoretically, states can react to their individual circumstances, and variation in COVID-19 risk across states can be met with variation in government response. Others have criticized the federal government's lack of leadership, and perhaps a centralized government could better process and respond to the COVID-19 crisis.

In any case, with the early days of the COVID-19 crisis now complete, we can study the variation in state-by-state response. Was this variation justified by different conditions in different states? Or did states face similar situations, and later responses were simply late? In this post, I will analyze the speed with which US states responded to the COVID-19 crisis. First, I'll present a method for determining the risk posed by the virus to each state on each day. Then, I'll analyze how states responded to that risk, namely by looking at when they issued Stay at Home orders.

This methodology yields a few striking conclusions. First and foremost: later Stay at Home orders were overdue; they were NOT issued later because they were apt responses to the particular state's situation. States that issued Stay at Home orders later had basically the same risk as states that issue Stay at Home orders earlier – they just dragged their feet. Second, I find slight-but-insignificant support for the narrative that Democratic governors responded more quickly to the crisis than Republican governors. Finally, I find no correlation between governor experience and speedy response to the COVID-19 crisis.

Methodology

The first step in my methodology is defining a risk score: quantifying the threat posed to each state, on each day, by COVID-19. Notably, many regulatory responses to COVID-19 have aimed to “flatten the curve” – efforts to decrease the chance of the hospital system being overrun. Taking this as my cue, I settled on a risk score that reflects the number of time periods until COVID-19 hospitalizations would exceed hospital beds in each state.

Disclaimer: there is uncertainty at many stages of estimating the risk score. These nuances are important and worthy of study, and as such I'll do my best to point them out. However, my findings don't rely on small differences in calculated risk score and are trend-based. I welcome further research to improve this risk score, however these modifications will not alter the conclusions.

I estimate the capacity of the healthcare system by the number of hospital beds in each state.¹ Estimates of available hospital beds are recent but not necessarily current, also I ignore variation in type of hospital bed (eg ICU vs non-ICU) and baseline (non-COVID) hospitalizations. To gauge future hospitalizations from COVID-19, I estimate the number of active cases in each state on each date² and estimates of COVID-19's reproduction number in each state on each date³ (these estimates could also be flawed). I use the number of confirmed cases and the reproduction number to project the number of COVID-19 cases in the next time period. To convert cases to expected hospitalizations, I use the age demographics of each state⁴ and hospitalization rates by age group⁵ (again, these estimates could be wrong). I assume that people at every age were equally likely to become infected for ease of calculation, however this assumption is almost certainly wrong. Economic theory suggests that those with more to lose from becoming infected with COVID-19 (such as the elderly) will engage in more self-protective activity, and thus will become infected at lower rates. However, I avoided trying to estimate this effect as to not introduce additional error, but pretending the effect doesn't exist is flawed too.

Combining healthcare capacity with projected hospitalizations (if COVID-19 continues reproducing at the estimated rate), I can project the number of time periods until hospitalizations exceed hospital beds. I caution against interpreting this risk score directly. But the point is that we now have a way of quantifying the relative risk posed by COVID-19 to each particular state on a given date.

Analysis

I use state Stay at Home orders to stand in for state response to COVID-19. Of course, these orders are only one tool in the state policy toolbox, and a more holistic measure of policy response would be ideal. But given the saliency and widespread nature of Stay at Home orders, date of Stay at Home order will stand in for state policy response.

Now, we can finally gauge the speed of each state's response to COVID-19. Formally: for each state, how many high-risk⁶ days passed before the state issued a Stay at Home order? Here's what I found.

Finding #1: Later Stay at Home Orders Were Simply Overdue

Different states issued Stay at Home orders at different dates. Was this because later-responding states were dragging their feet, or because their COVID-19 risk was low for longer and they were simply responding aptly to the situation in their state? My analysis resoundingly suggests that the former explanation is correct.

¹ Data from <https://www.kaggle.com/ikiulian/global-hospital-beds-capacity-for-covid19>

² Data from <https://github.com/nytimes/covid-19-data/>

³ Estimates from <https://rt.live>

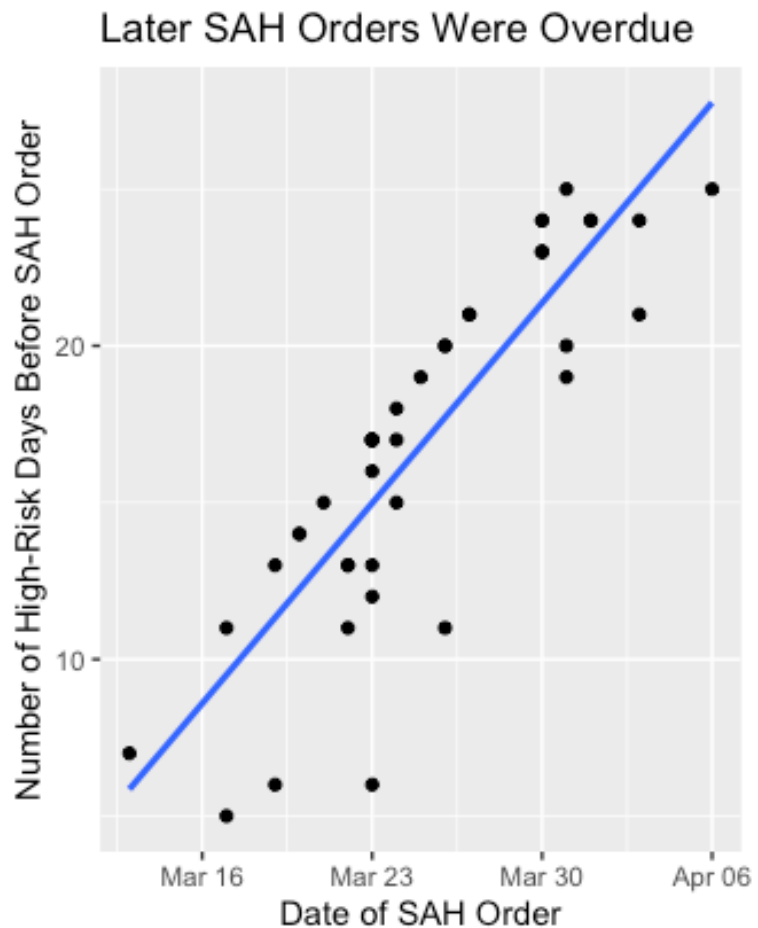
⁴ Data from <https://www.census.gov/data/tables/time-series/demo/popest/2010s-state-detail.html>

⁵ Estimates from <https://www.usnews.com/news/health-news/articles/2020-03-30/odds-of-hospitalization-death-with-covid-19-rise-steadily-with-age-study>

⁶ High-risk days: days on which the number of time periods until hospital overrun was less than 100

Here, I've plotted date of Stay at Home order against the number of high-risk days before the Stay at Home order for each Stay-at-Home-order-issuing state. Remember that risk is defined for each state.

If all states responded to their particular situation with equivalent speed, then we would see a horizontal trendline. If all states were facing the exact same COVID-19 conditions, and some simply waited longer before issuing Stay at Home orders, then we would see a trendline with slope 1 (each day that passes without an order is one more high-risk day before the order). Clearly, there is a positive relationship between date of response and speed of response, suggesting that later Stay at Home orders were slower responses to the state's particular conditions.



The statistics here are striking. The positive relationship is statistically significant, with a remarkable R-squared value of 0.73. Perhaps most importantly, the estimated slope coefficient is 0.91 (+/- 0.09). Recall that a slope coefficient of 1 suggests that states that issued orders on later dates faced the exact same conditions as states that issued orders on earlier dates. The slope coefficient isn't quite 1, but is pretty close: for every day that a state did not issue a Stay at Home order, the number of high-risk days before a Stay at Home order increased by 0.9. The slope coefficient is clearly a far cry from 0, proving that it is NOT the case that late responding states were responding aptly to crisis conditions in their particular state.

Finding #2: Democrats Responded Faster, But Not Significantly So

News coverage has compared partisan attitudes towards COVID-19, finding that Democrats have higher estimates of the threat posed by COVID-19 than Republicans.⁷ Some coverage has been devoted to the very question of how quickly governors of either party responded to the crisis, finding that Democratic governors reacted more quickly.⁸ However, this analysis lacks

⁷ <https://www.deseret.com/indepth/2020/3/20/21182345/coronavirus-covid-19-politics-republicans-democrats-donald-trump-fear>

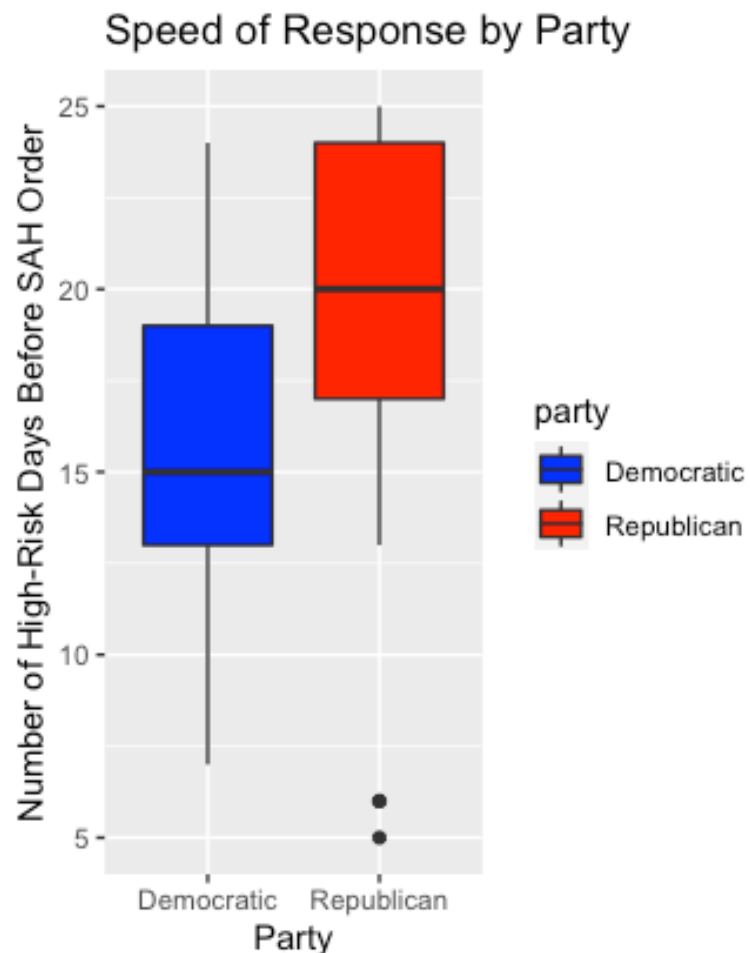
⁸ <https://theconversation.com/democratic-governors-are-quicker-in-responding-to-the-coronavirus-than-republicans-135599>

discussion of statistical significance, and does not seriously account for variation in the threat posed by COVID-19 across states.

Combining the number of high-risk days before Stay at Home order with data on the party of each state's governor,⁹ we can perform a better analysis of how the COVID-19 response varied by party.

To the right, I've produced a boxplot of number of high-risk days before Stay at Home order for Democratic-governed states and Republican-governed states. This lends some credence to the idea that Democratic governors responded more quickly to the threat posed by COVID-19 in their state.

Using a t-test for difference in means, however, the differences between speed of response by party do not appear significant.¹⁰ Democrats, on average, issued Stay at Home orders after 15.9 high-risk days, while Republicans issued them after 18.4 days. But the 95% confidence interval for difference in means ranges from Democrats responding 6.2 days faster to Republicans responding 1.1 days faster. Though I caution against anything more specific than trend-based analysis, I will note that the three fastest responding states relative to conditions in their state all had Republican governors (West Virginia, Alaska, and Idaho).



Finding #3: Governor Experience Didn't Help

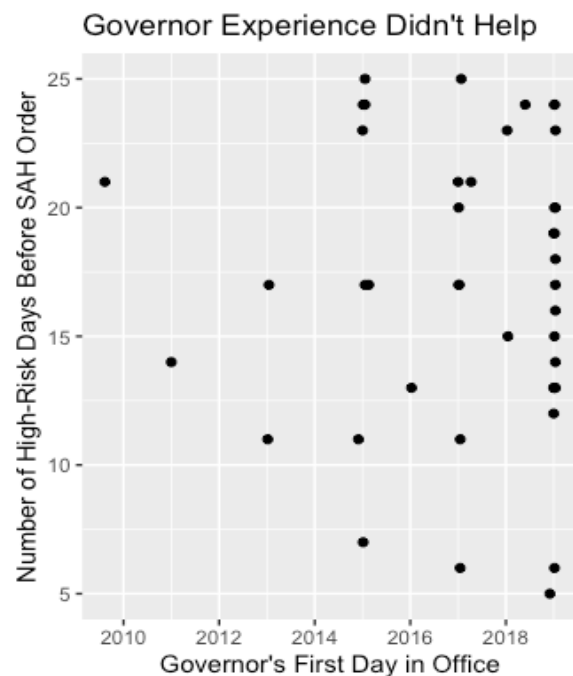
Another interesting variation by state is the experience of the governor. One might think that more experienced governors would more sagely gauge the threat of COVID-19, and perhaps have more confidence to take extreme actions to respond. On the other hand, the rarity of an event like the COVID-19 crisis suggests that no prior experience could prepare a governor for this situation.

⁹ Data from https://ballotpedia.org/Partisan_composition_of_governors

¹⁰ p-value = 0.1588

My findings support the later interpretation: governors with more experience did not respond more quickly to the threat posed by COVID-19 to their state's healthcare system. In fact, the scatterplot to the right shows no correlation between governor experience and speed of response.

Looking at individual features of governors may be an interesting research direction, however. Perhaps governors with higher re-election probability, or governors without elections coming up, would be more empowered to undertake extreme regulations like issuing a Stay at Home order.



Conclusions

This post presents a methodology for gauging state-by-state response to COVID-19, accounting for the particular conditions of each state. It is true that individual estimates of risk are likely to be wrong, owing to the uncertainties throughout the estimation process. This is why I only use risk scores for the coarse categorization of high-risk vs. low-risk days, and keep the focus on overall trends. I believe this maintains the robustness of my analysis to the nuances in estimation.

It is important to account for the variation in the threat posed by COVID-19 to each state. This variation might come from differences in hospital capacity, differences in number of cases, differences in reproduction potential of the virus, or different age demographics of the population. Arguably, the strength of the US's state-by-state response lies in the ability to address heterogeneity in COVID-19 risk by state.

However, my findings resoundingly suggest that heterogeneity in state COVID-19 response was not justified by heterogeneity in the risk posed by COVID-19 to states. States that issued Stay at Home orders at later dates were simply under high-risk from COVID-19 for longer than states that issued Stay at Home orders at earlier dates. Despite the theoretical benefits of a state-by-state response, in this case, an early national response would have been much more effective.

I also challenge the narrative that Democratic governors responded faster, highlighting the need to account for conditions in individual states and test for statistical significance. Though, on average, Democratic governors did respond faster relative to conditions in their state, this difference was not statistically significant.

Lastly, I find no relationship between governor experience and speed of COVID-19 response.