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Variation in US states' responses to COVID-19

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This working paper is updated frequently. Check for most recent version here: www.bsg.ox.ac.uk/covidtracker

The most up-to-date version of technical documentation will always be found on the project's GitHub repo: www.github.com/OxCGRT/covid-policy-tracker

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Abstract: Since the outbreak of COVID-19 in the United States, individual states have responded with a wide range of measures to break the chain of infection and manage the broader impacts of the disease. The lack of a unified federal response in the United States places additional importance on these state-level responses. The Oxford COVID-19 Government Response Tracker's (OxCGRT) US state-level data provides a systematic way to measure and compare government responses to COVID-19 across states from January 1, 2020 to the present, and will updated continuously going forward. We combine individual indicators into a series of novel indices that aggregate various measures of government responses. These indicators and indices can be used to describe variation in government responses, explore whether the government response affects the rate of infection, and identify correlates of more or less intense responses.

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1. Introduction

As COVID-19 has spread through the United States, state governments have responded with a wide range of extraordinary measures. Common responses include school and workplace closings, travel restrictions, bans on public gatherings, stay-at-home orders, emergency investments in healthcare facilities, income support, contact tracing and other interventions to contain the spread of the virus, augment health systems, and manage the economic consequences of these actions.

However, states have varied substantially in the measures they have adopted, how quickly they adopted them, and how long they have kept them in place. Limited national level coordination, combined with the federal structure of the United States, makes variation in state policies particularly significant for understanding efforts to contain COVID-19 in the US. Differences in approaches between states has also generated debate as policymakers and publics deliberate over the level of response that should be pursued and how quickly to implement or roll back restrictions, and as public health experts learn in real time the measures that are more or less effective.

The Oxford COVID-19 Government Response Tracker (OxCGRT) provides a systematic measure across governments and across time to understand how government responses have evolved over the full period of the disease's spread. In addition to covering around 180 countries and Brazilian states and capital cities, OxCGRT now includes data for the 50 US states, as well as the District of Columbia and the US Virgin Islands from January 1, 2020 to the present.[1]

The project tracks governments' policies and interventions across a standardized series of indicators and creates a suite of composites indices to measure the extent of these responses. Data is collected and updated in real time by a team of over one hundred Oxford students, alumni , staff, as well as external collaborators. Over 50 trained volunteers have contributed to the collection of data for US data.

This working paper briefly describes the data OxCGRT collects and presents some basic measures of variation across states. It will be updated regularly as the pandemic and governments' responses evolve, and as the technical specifications of the database evolve. For the most current and up-to-date technical documentation, please refer to our GitHub repository.[2]

[1] Puerto Rico and Guam are recorded in the OxCGRT international level dataset, available: https://github.com/OxCGRT/covid-policy-tracker

[2] https://github.com/OxCGRT/covid-policy-tracker has data alongisde other countries (and includes national US government policies in the calculations), and https://github.com/OxCGRT/USA-covid-policy has a dataset that records only state-level policy.

2. Data and measurement

For US states, OxCGRT reports publicly available information on 14 of 18 indicators (see Table 1) of government response. The indicators are of three types:

- **Ordinal**: These indicators measure policies on a simple scale of severity or intensity. These indicators are reported for each day a policy is in place.
    - Many have a further flag to note if they are "targeted", applying only to a sub-region of a jurisdiction, or a specific sector; or "general", applying throughout that jurisdiction or across the economy. (Note, the flag for indicator E1 means something different.)
- **Numeric**: These indicators measure a specific monetary value in USD. These indicators are only reported on the day they are announced.
- **Text**: This is a "free response" indicator that records other information of interest.

Table 1: OxCGRT Indicators[3]

ID	Name	Type	Targeted/ General?	US states
Containment and closure				
C1	School closing	Ordinal	Geographic	✓
C2	Workplace closing	Ordinal	Geographic	✓
C3	Cancel public events	Ordinal	Geographic	✓
C4	Restrictions on gathering size	Ordinal	Geographic	✓
C5	Close public transport	Ordinal	Geographic	✓
C6	Stay at home requirements	Ordinal	Geographic	✓
C7	Restrictions on internal movement	Ordinal	Geographic	✓
C8	Restrictions on international travel	Ordinal	No	✓
Economic response				
E1	Income support	Ordinal	Sectoral	✓
E2	Debt/contract relief for households	Ordinal	No	✓
E3	Fiscal measures	Numeric	No	
E4	Giving international support	Numeric	No	
Health systems				
H1	Public information campaign	Ordinal	Geographic	✓
H2	Testing policy	Ordinal	No	✓
H3	Contact tracing	Ordinal	No	✓
H4	Emergency investment in healthcare	Numeric	No	
H5	Investment in Covid-19 vaccines	Numeric	No	
Miscellaneous				
M1	Other responses	Text	No	✓

[3] See Github repository for detailed coding information: https://github.com/OxCGRT/covid-policy-tracker/blob/master/documentation/codebook.md

Data is collected from publicly available sources such as news articles and government press releases and briefings. These are identified via internet searches by a team of over 50 Oxford University students, staff, and collaborators and partners. OxCGRT records the original source material so that coding can be checked and substantiated, available in the "notes" version of the data files on Github.

OxCGRT measures for US states do not include federal policies that apply to the country as a whole (e.g. international travel bans, the March 2020 CARES Act). However, the dataset does include a measure for the US federal government itself, which records only federal level policies. This information can also be found in our measures for the United States as a whole in the country dataset on Github.

3. Policy indices of COVID-19 government responses

Governments' responses to COVID-19 exhibit significant nuance and heterogeneity. Consider, for example, C1, school closing: in some places, all schools have been shut; in other places, universities closed on a different timescale than primary schools; in other places still, schools remain open only for the children of essential workers. Moreover, like any policy intervention, their effect is likely to be highly contingent on local political and social contexts. These issues create substantial measurement difficulties when seeking to compare government responses in a systematic way.

Composite measures – which combine different indicators into a general index – inevitably abstract away from these nuances. This approach brings both strengths and limitations. Helpfully, cross-jurisdiction measures allow for systematic comparisons across different states. By measuring a range of indicators, they mitigate the possibility that any one indicator may be over- or mis-interpreted. However, composite measures also leave out much important information, and make strong assumptions about what kinds of information counts. If the information left out is systematically correlated with the outcomes of interest, or systematically under- or overvalued compared to other indicators, such composite indices may introduce measurement bias.

Broadly, there are three common ways to create a composite index: a simple additive or multiplicative index that aggregates the indicators, potentially weighting some; Principal Component Analysis (PCA), which weights individual indicators by how much additional variation they explain compared to the others; Principal Factor Analysis

(PFA), which seeks to measure an underlying unobservable factor by how much it influences the observable indicators.

Each approach has advantages and disadvantages for different research questions. In this paper we rely on simple, additive unweighted indices as the baseline measure because this approach is most transparent and easiest to interpret. PCA, PFA, or other approaches can be used as robustness checks.

For US states, the indicators described above are aggregated into four policy indices, each of which measures a different set government responses (the indicators that make up each index are listed in Table 2):

1. a **containment and health** index, showing how many and how forceful the measures to contain the virus and protect citizen health are (this combines 'lockdown' restrictions and closures with health measures such as testing policy and contact tracing)
2. an **economic support** index, showing how much economic support has been made available (such as income support and debt relief)
3. a **stringency** index**,** which records the strictness of 'lockdown style'[4] closure and containment policies that primarily restrict people's behaviour
4. an **overall government response** index which records how the response of states has varied over all indicators, capturing the full range of government responses

Table 2: OxCGRT Indices

Index name	C1	C2	C3	C4	C5	C6	C7	C8	E1	E2	H1	H2	H3
Government response index	x	x	x	x	x	x	x	x	x	x	x	x	x
Containment and health index	x	x	x	x	x	x	x	x			x	x	x
Stringency index	x	x	x	x	x	x	x	x			x		
Economic support index									x	x			

Each index is composed of a series of individual policy response indicators. For each indicator, we create a score by taking the ordinal value and adding an extra half-point if the policy is general rather than targeted, if applicable. We then rescale each of

4 Because the term "lockdown" is used in many different ways, we do not define this term here but instead refer to the number and restrictiveness of closure and containment polcies.

these by their maximum value to create a score between 0 and 100, with a missing value contributing 0.[5] These scores are then averaged to get the composite indices.[6]

In the United States, the four indices reveal aggregate trends over time (Figure 1). States moved to adopt a wide range of measures in the first weeks of March, though economic support policies lagged behind closure and containment and health policies. Closure and containment policies (measured in the Stringency Index) were relaxed in May and June before ramping up again toward the end of July. Economic support measures, however, have slightly decreaed over that period.

Importantly, the indices should not be interpreted as a measure of the appropriateness or effectiveness of a government's response. They do not provide information on how well policies are enforced, nor does it capture demographic or cultural characteristics that may affect the spread of COVID-19. Furthermore, they are not comprehensive measures of policy. They only reflect the indicators measured by the OxCGRT (see Tables 1 and 2), and thus may miss important aspects of a government response.

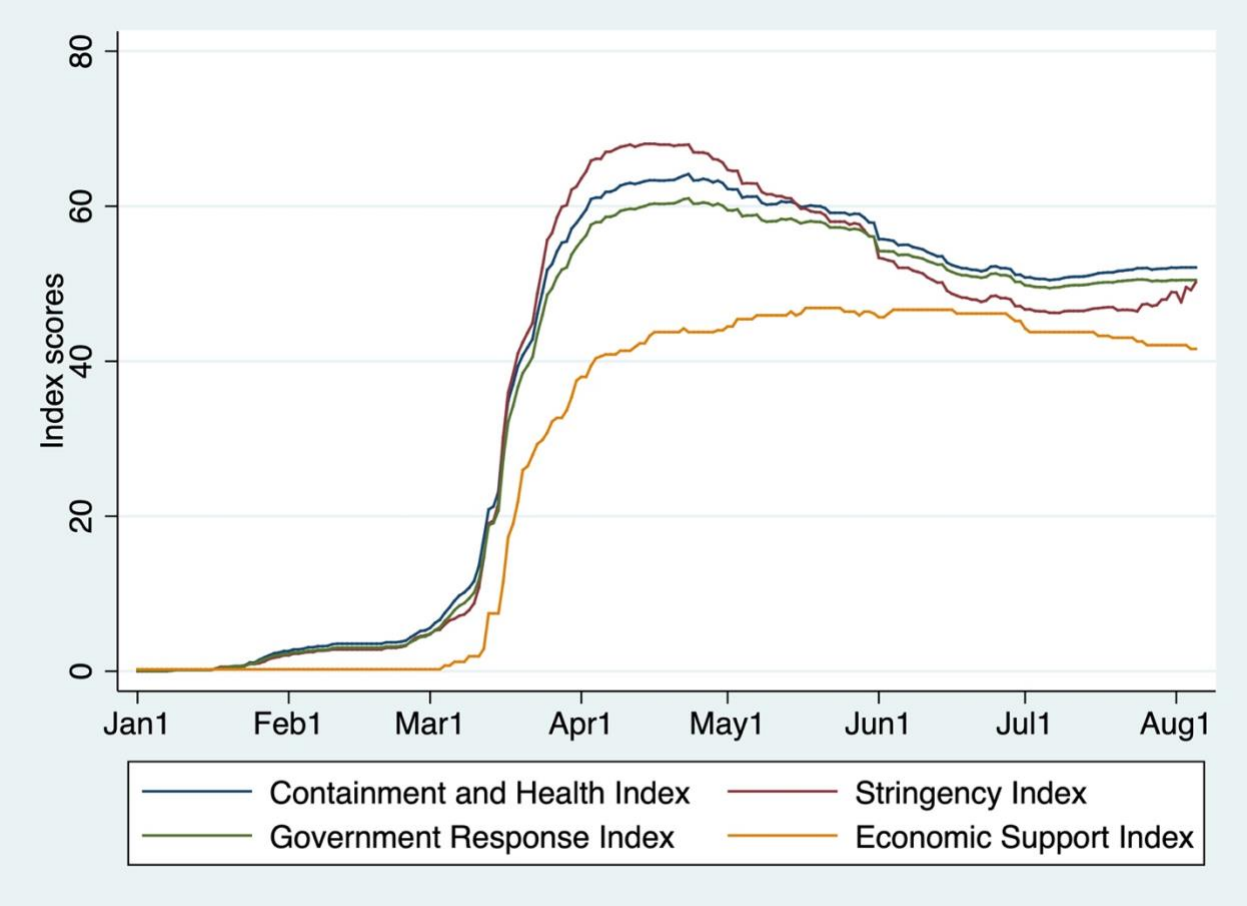
The value and purpose of the indices is instead to allow for efficient and simple cross-state comparisons of government interventions. Any analysis of a specific state should be done on the basis of the underlying policy, not on an index alone.

In the sections that follow, we display principally the Containment and Health Index, which is most relevant for measuring efforts to break the chain of infection.

Figure 1: Mean index values for 50 states, DC, and US Virgin Islands over time (source: OxCGRT)

[5] We use a conservative assumption to calculate the indices. Where data for one of the component indicators are missing, they contribute "0" to the Index. An alternative assumption would be to not count missing indicators in the score, essentially assuming they are equal to the mean of the indicators for which we have data for. Our conservative approach therefore "punishes" states for which less information is available, but also avoids the risk of over-generalizing from limited information.

[6] Full details on the construction of the indices is available on Github: https://github.com/OxCGRT/covid-policy-tracker/blob/master/documentation/index_methodology.md



4. Variation in state responses

In general, we find significant variation in responses across US states. The lack of a unified national policy and the federal system of government, as well as rising political contestation around virus response measures, has generated a heterogenous landscape of policies across the United States. Several key patterns emerge.

First, though COVID-19 spread to different states at around the same time—reaching most states in early March (with the exception of a few earlier outbreaks)—initial government responses were spread over a broader period.[7] Figure 2 maps this variation. It records the date a state experienced its 100th case (white diamond) and 10th death (black diamond), proxies for when the disease was established in jurisdiction. It also records when states reached a threshold of 50 on the Containment and Health Index (blue dot), representing a significant government response, as well as when states subsequently reduced their index level below this threshold (red dot). Many states

[7] This is a weaker version of the "bandwagon" effect we observed internationally, where most countries implemented stringent policies within a brief two-week period. See: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3641927

applied strong measures from the start of their own outbreak (the blue dots are closely aligned to the diamonds), or even before the virus began to spread significantly. For example, Delaware, Alaska, Vermont, and Montana we fast-movers relative to the spread of the disease. But this was not true in every state. States with early outbreaks, like California, New York, and Washington adopted measure much later, relative to the spread of the disease. And a few states like North Dakota or Massachusetts waited a month or longer before implementing a vigorous response. In general, it also seems that states that responded later are more likely to reduce their response level earlier, making for a shorter overall duration.

Second, while most states adopted a strong response in March, by April US states began to sharply diverge from each other. Each states' Containment and Health Index is show in Figure 3, alongside the daily number of cases.

Figure 2: The point at which states reached a stringency index score of 50, plotted alongside dates of their 100th confirmed COVID-19 case and 10th confirmed COVID-19 death (sources: OxCGRT and CDC)

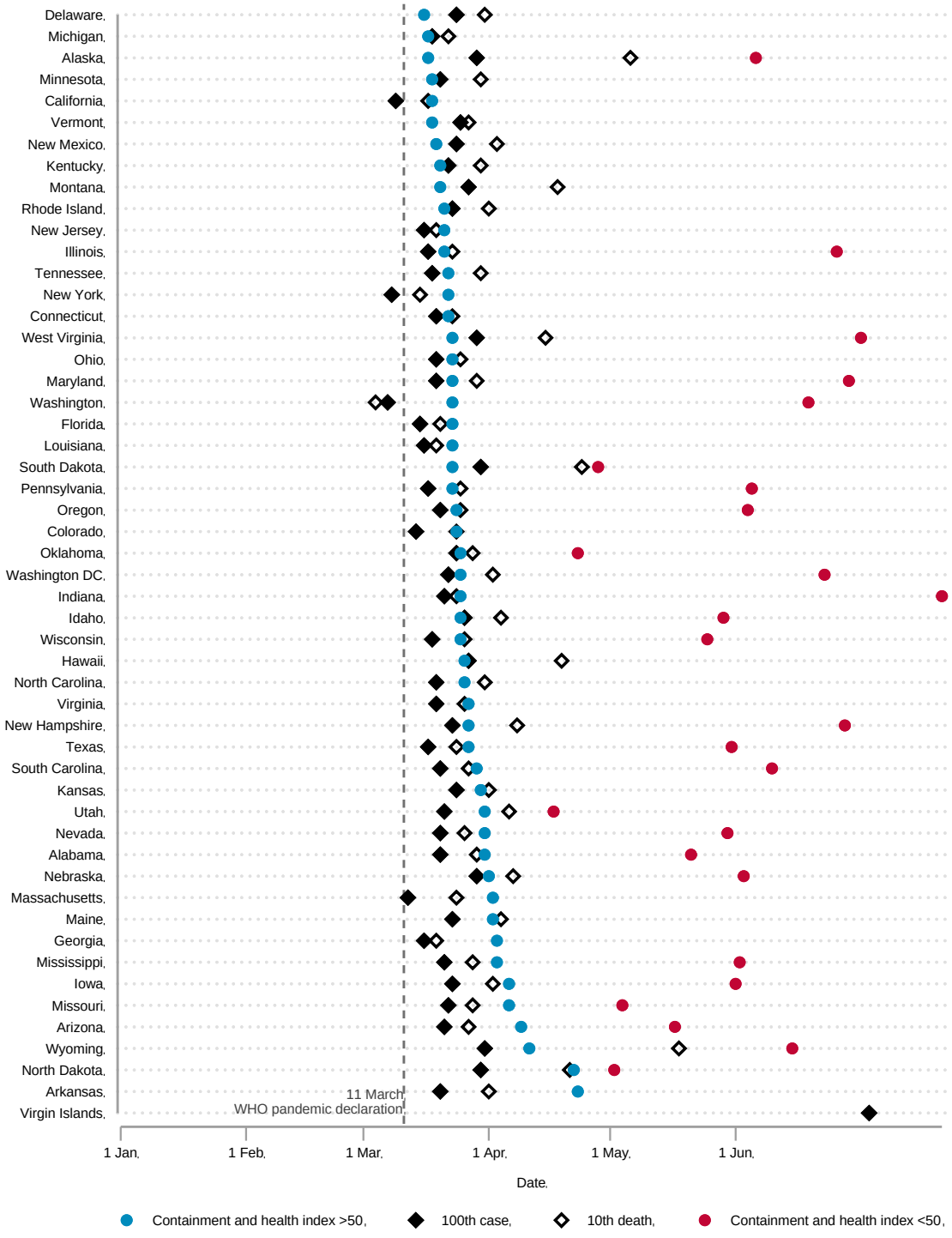


Figure 3a: Containment and Health Index and cumulative caseload for 50 states, the Federal government, DC and US Virgin Islands (sources: OxCGRT and CDC)

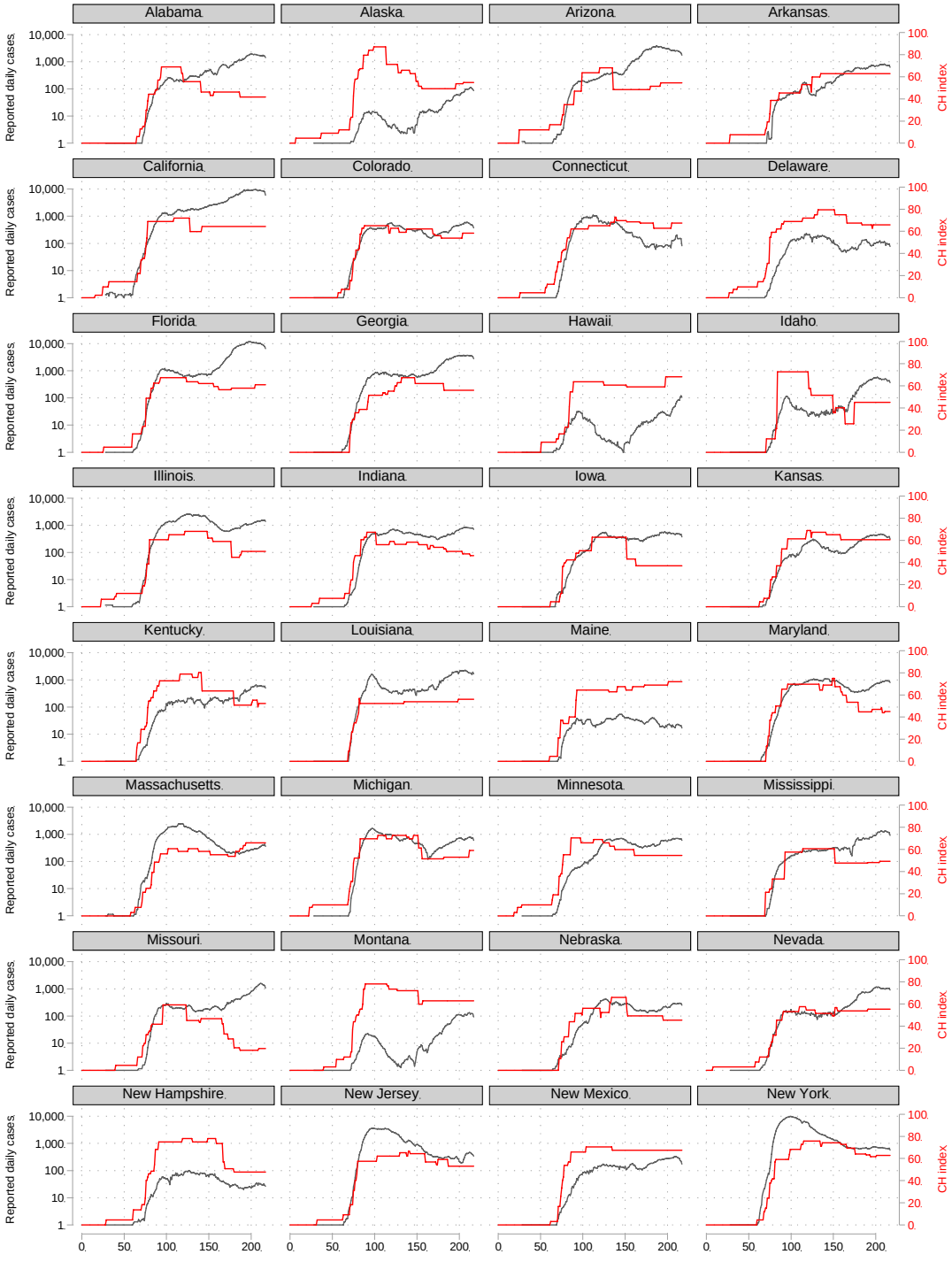
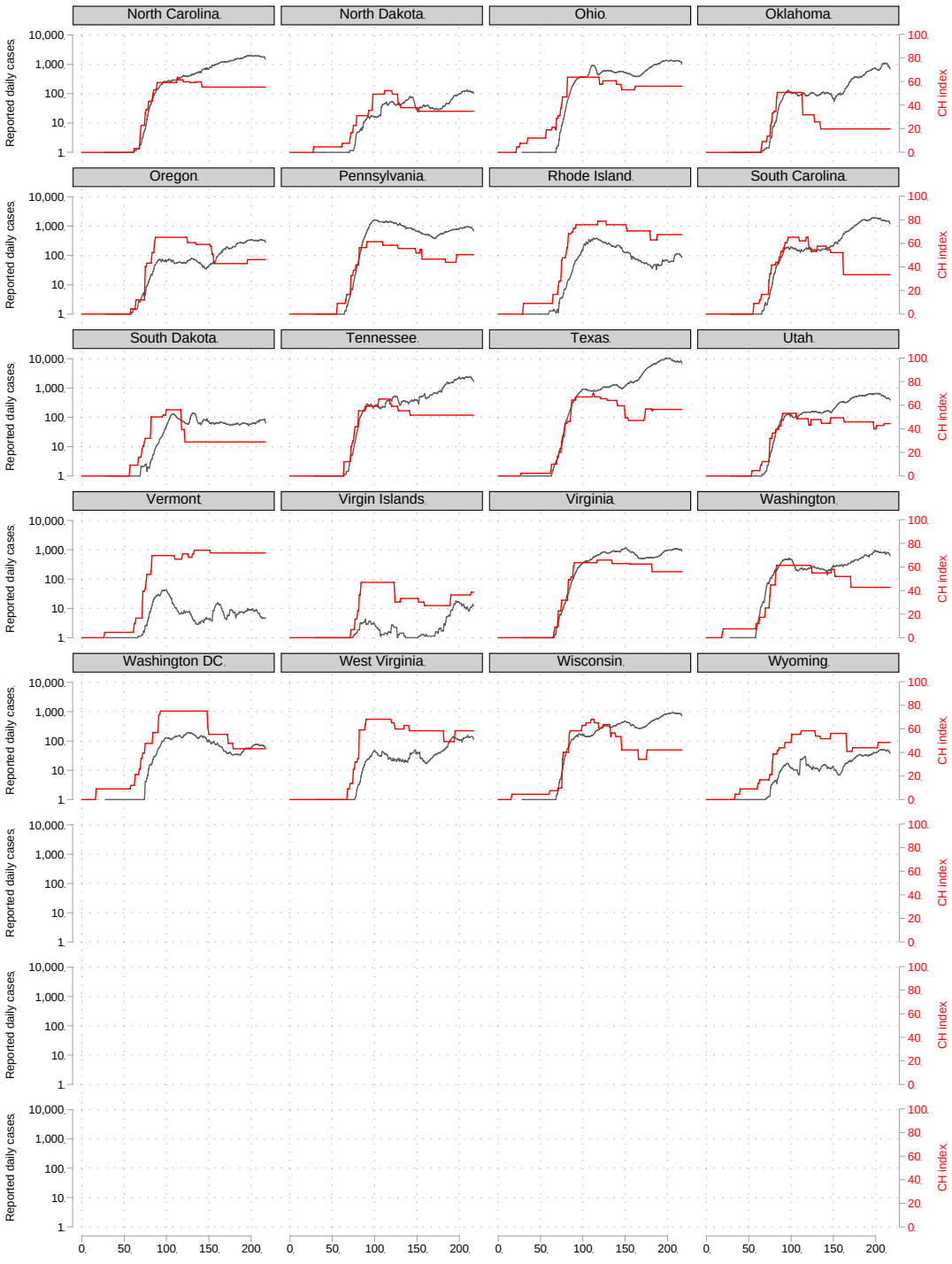


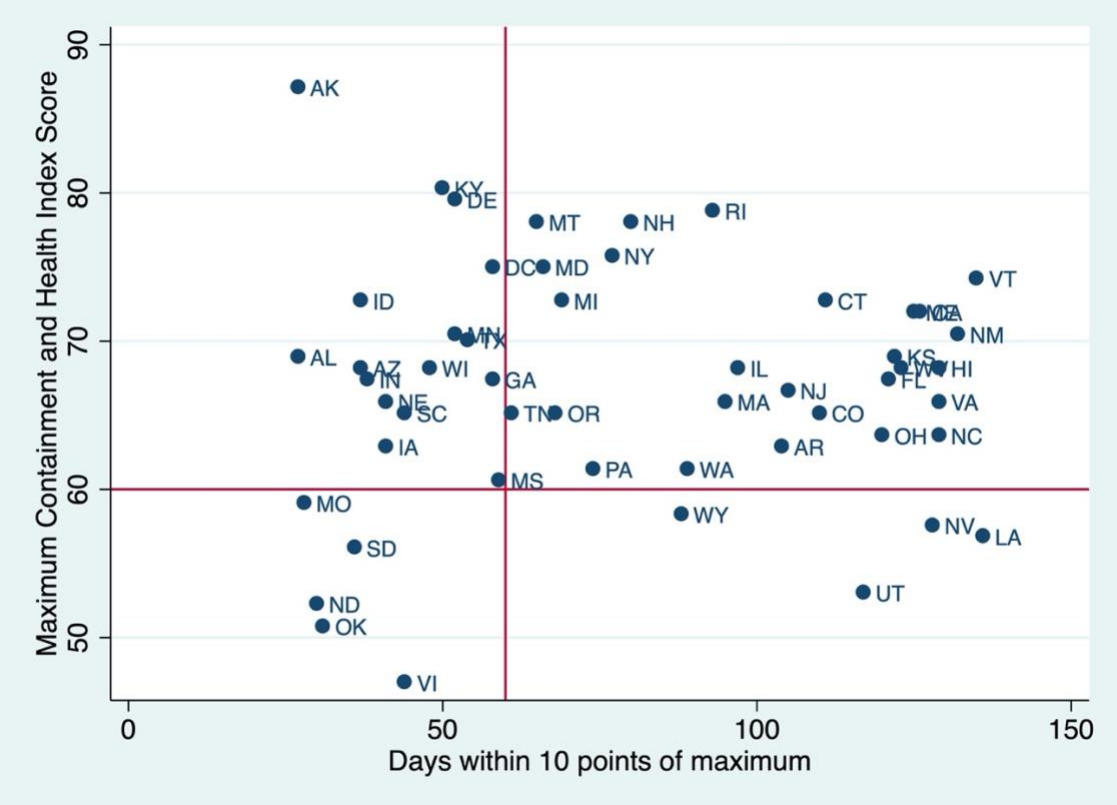
Figure 3b: Containment and Health Index and cumulative caseload for 50 states, the Federal government, DC and US Virgin Islands (sources: OxCGRT and CDC)



As Figure 3 shows, US state responses have varied significantly, nearly as much as countries' responses have varied globally. Figure 4 categorirzes this variation by showing three different types of state responses based on how robust they have been and how long they have been maintained. We consider robust responses to be defined at those states that achieve a Containment and Health Index score of at least 60, the horizontal redl ine, sometime between January 1 and August 1, 2020. In turn, we define a lasting response as one in which the Containment and Health Index score remains within 10 points of the maximum value achieved by the state for at least 60 days. This is marked by the vertical red line in Figure 4. State responses can be grouped by where they fall along these two dimensions.

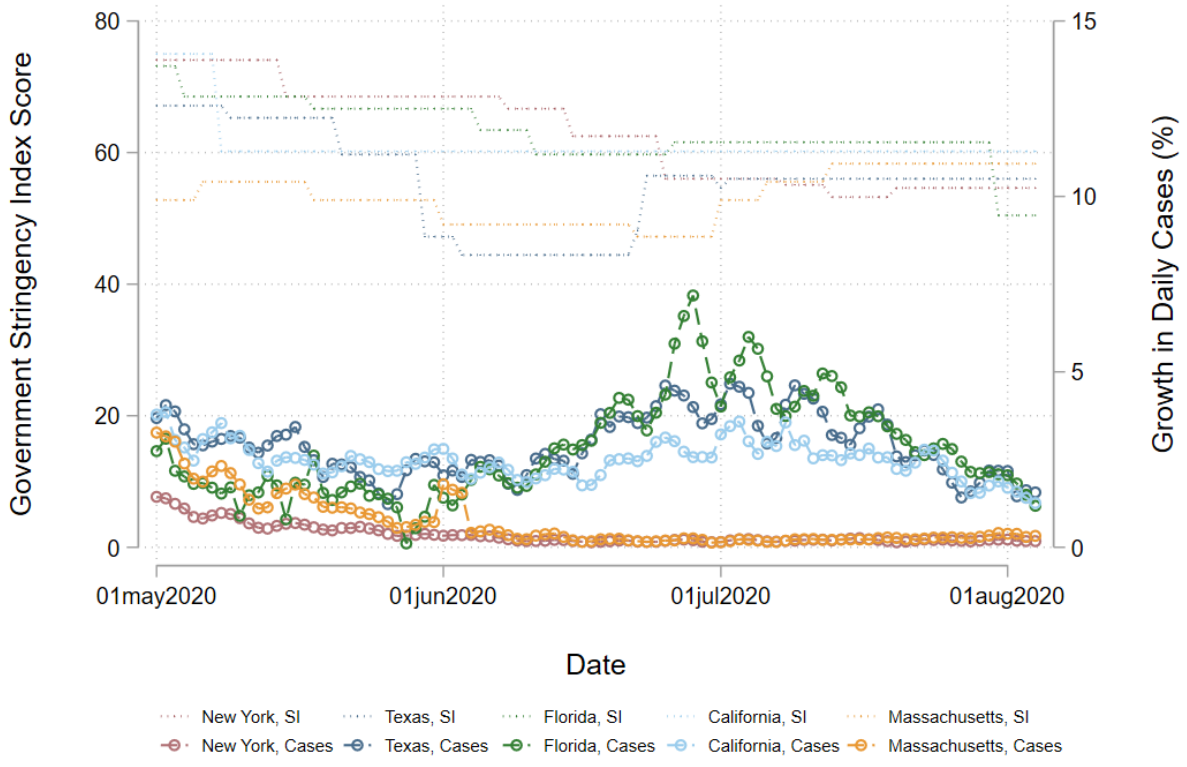
- "**Lasting robust response**" states, in the top-right corner, adopted and maintained robust containments and testing and contact tracing systems.
- "**Rapid rollback**" states, in the top-left corner, adopted a robust response initially, but then began to roll back policies relatively quickly.
- '**Low response"** states, in the bottom-right and bottom-left corners, never adopted particularly restrictive containment measures or robust testing and contact tracing systems, regardless of how long they maintain a value near their maximum.

Figure 4: Robsutness and length of state responses (source: OxCGRT)



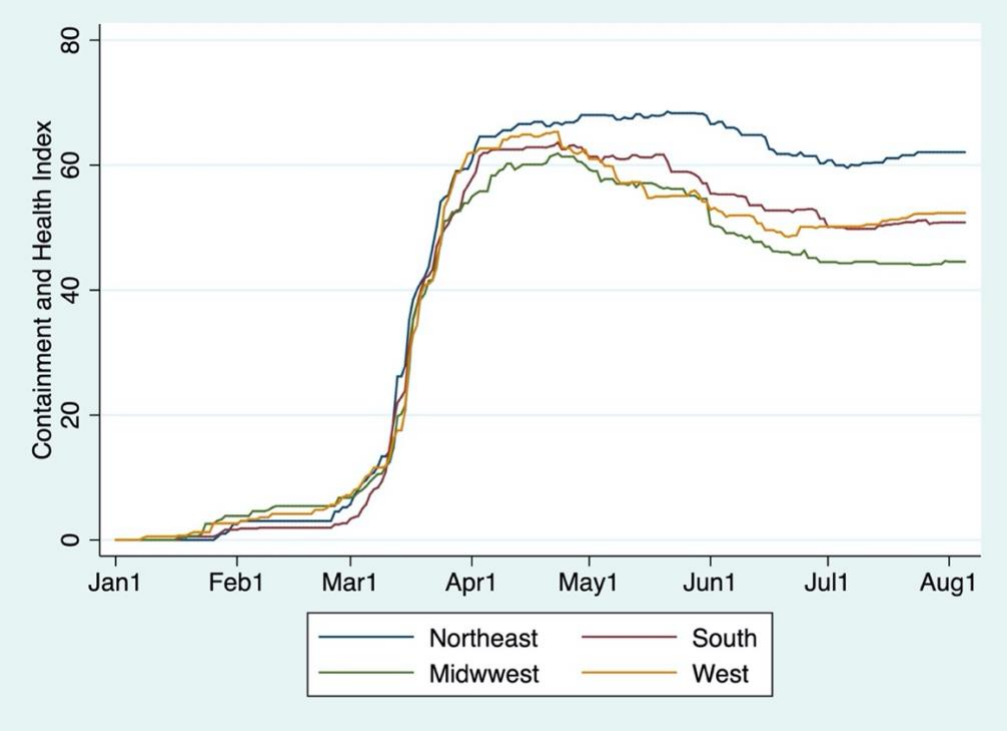
Researchers are currently studying how the split between states with a lasting robust response and those with rapid rollbacks or an overall low response has shaped the progression of of the outbreak in the United States. Figure 5 shows how the data can be used to explore this important question. It compares the Stringency Index and the growth rate in new cases per day for five states in the most recent months. In May and June, Texas, and Florida all lowered the strinency of their responses significantly. New York and California lowered significantly less, while Massachusetts remained essentially constant. In parallel, the growth rate in cases, while declining overall, remained significantly above zero in all states but New York throughout this period. Then, toward the end of June and into July, the growth rate in deaths began climbing sharply in Texas and Florida, and increasing moderately in California. In response, measures tightened again in California, Florida, and Texas. New York maintained relatively constant stringency, while Massachusetts increased its restricitons. In these two states, cases remained constant. It is not possible to infer causal effects from a small number of descriptive examples. However, these patterns suggest that rolling back measures while the disease is still spreading in a state can lead to a new surge in infection, which in turn necessitates a reimposition of control measures.

Figure 5: Government Stringency Index score and growth rate in daily deaths for selected states, May – August 2020 (sources: OxCGRT and CDC)



Third, as Figure 4 suggests, there is substantial variation in government responses across different types of states. Figure 6 shows regional variation. While all states followed similar patterns in the early phase of the outbreak, Midwestern states never rose as high on the Containment and Health Index as most other parts of the country. As the pandemic progressed, Northeastern states have uniquely maintained robust responses over the spring and summer, while most of the country, and the Midwest in particular, rolled back their responses. These patterns are significant given that the disease has over time shifted from more urban coastal areas to more rural inland areas.

Figure 6: Average US state government response by region (source: OxCGRT)



Figures 7 and 8 show political variation across US states, noting how states with Republican governors differ from states with Democratic governors, and how states that voted for Donald Trump in the 2016 election differ from those that voted for Hilary Clinton. The figures also show the cummulative number of confirmed COVID-19 cases in each category of states. Strikingly, all state responses moved together in the early days of the outbreak, but then began to diverge by the end of March. The total number of cases was higher in Democratic-learning states during this time, as were government responses, reflecting in part the geographic pattern describe above, but also likely political differences. On average, Republican-leaning states have not implemented as robust government responses as Democratic-leaning states, and they roll measures back more quickly. However, "Red" and "Blue" states are again converging in terms of caseload, with Republican-leaning states catching up to Democratic-leaning states in total number of cases, even as their responses remain significantly lower.

Figure 7: Average US state Containment and Health Index and total cases by political party of governor (sources: OxCGRT, CDC)

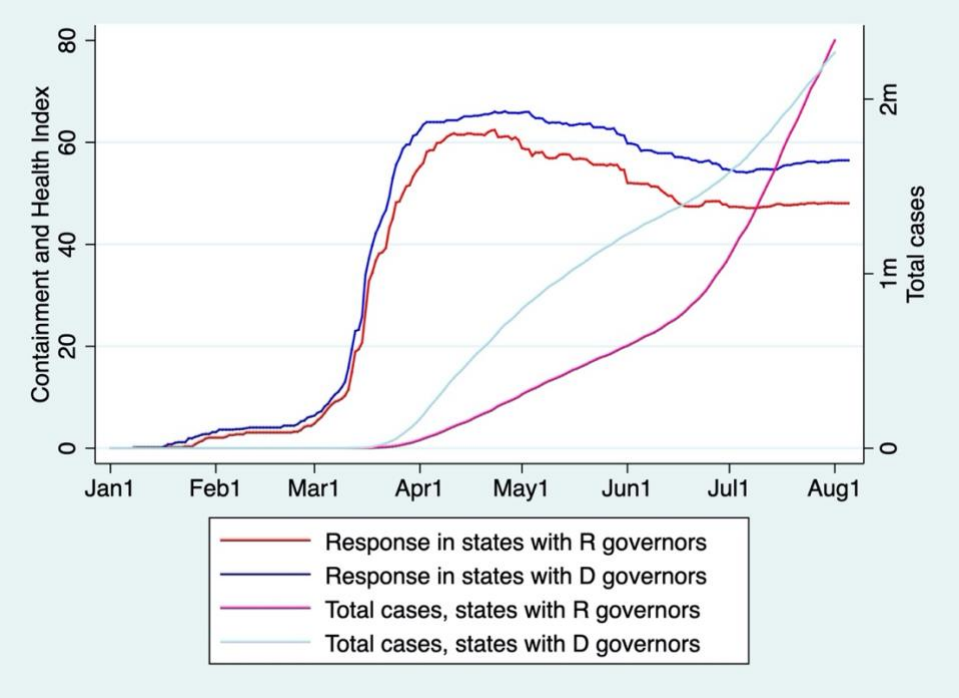
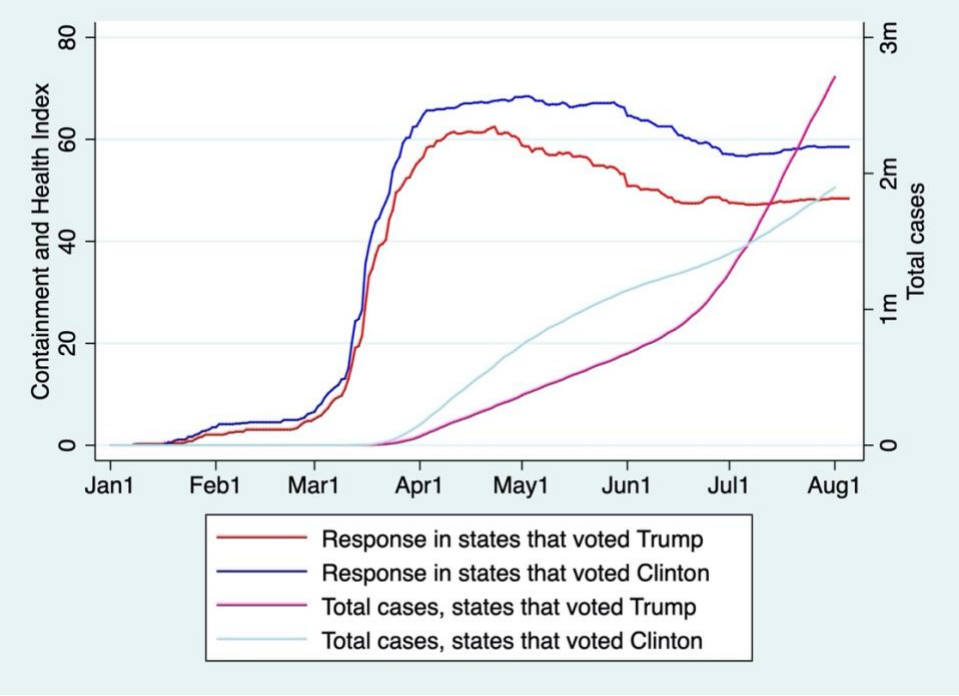


Figure 8: Average US state Containment and Health Index and total cases by 2016 presidential election vote (source: OxCGRT, CDC)



5. Conclusion

As states continue to respond to COVID-19, it is imperative to study what measures are effective and which are not. While the data presented here do, of course, not measure effectiveness directly, they can be useful input to studies that analyse factors affecting disease progression. OxCGRT seeks to contribute to this knowledge gap by providing comparable measures of individual policy actions, as well as several comparable aggregate indices. We find significant variation in both the measures that states adopt and when they adopt them. Going forward, governments at all levels will benefit from adopting an evidence-based approach to the measures they deploy.

OxCGRT will continue to evolve over the coming months as the pandemic progresses. We envision not only updating the data on a regular basis, but also refining and improving the indicators we record for each country. The most up-to-date technical documentation can always be found on our GitHub repository.[8]

It is our hope that scholars, medical professionals, policymakers, and concerned citizens will make use of the OxCGRT data to enhance all countries' responses to the COVID-19 pandemic. We welcome constructive feedback and collaboration on this project as it evolves.

[8] https://github.com/OxCGRT/covid-policy-tracker

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