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Variation in US states' responses to COVID-19

BSG-WP-2020/034

Version 2.0

December 2020

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December 17, 2020

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: US states continue to display significant variation in responses to COVID-19. This working paper updates the assessments of policy stringency by region, political leadership, and COVID-19 spread amid a critical policy moment in the US. We use OxCGRT indicators and aggregate stringency indices to describe variation in government responses, explore the relationship between government response and the rate of infection, and identify correlates of more or less intense responses. We find that Midwestern states, as well as Republican-voting states have less stringent policy measures overall, while Northeastern states have more stringent and longer lasting policies. We also apply the OxCGRT 'Risk of Openness Index' to the US context, showing high risk levels across all regions. In combination, this paper provides an overview of US states' COVID-19 policy action as well as unique applications of OxCGRT indicators and risk of openness index scores to inform policy making and research at this key moment in the US COVID-19 response.

Recommended citation for this paper: Laura Hallas, Ariq Hatibie, Saptarshi Majumdar, Monika Pyarali, Thomas Hale. "Variation in US states' responses to COVID-19 2.0." Blavatnik School of Government Working Paper. Available: www.bsg.ox.ac.uk/covidtracker

Recommended citation for the dataset: Hale, Thomas, Noam Angrist, Emily Cameron-Blake, Laura Hallas, Beatriz Kira, Saptarshi Majumdar, Anna Petherick, Toby Phillips, Helen Tatlow, Samuel Webster (2020). Oxford COVID-19 Government Response Tracker, Blavatnik School of Government. Available: www.bsg.ox.ac.uk/covidtracker

Acknowledgements: The authors thank the OxCGRT US Subnational Coders for their tremendous, ongoing efforts. We are grateful to the strong support from students, staff, and alumni of the Blavatnik School of Government, colleagues across the University of Oxford, and partners around the world for contributing time and energy to data collection and the broader development of Oxford COVID-19 Government Response Tracker. We welcome further feedback on this project as it evolves.

The OxCGRT US Subnational Coders are: Andrew Brown, Anna Welsh, Anthony Sudarmawan, Ariq Hatibie, Barbora Bacyte, Christian Lumley, Edward O'Brien, Erin Kanzig, Helene Jow, Henry Annan, Hunter McGuire, India Clancy, Joy Carveth, Kaitlyn Green, Katherine McCreery, Kelly Daniels, Laura Chamberlain, Laura de Lisle, Laura Hallas, Mariam Raheem, Michelle Sharma, Monika Pyarali, Nate Dolton-Thornton, Quynh Lam Vo, Rachel Dixon, Rahima Hanifa, Seun Adebayo, Stephanie Guyett, Thomas Stubbs, Veronique Gauthier, Zelie Kasten, Zoha Imran

Data presented in this paper is available via GitHub:
https://github.com/OxCGRT/USA-covid-policy

1. Introduction and Summary

The US is now the country most affected by COVID-19 cases, surpassing 16 million total cases and 300,000 total deaths (more than 2,000 deaths per day) due to COVID-19.[1] After evidence of a Thanksgiving-related surge in COVID-19 cases and the beginning of the holiday season for many Americans, there is cause for concern that the epidemiological situation in the US will not improve in the winter months. And while the beginnings of vaccine distribution is now underway in the US, non-pharmaceutical interventions (NPIs) remain states' primary tools to mitigate COVID-19 spread until widespread vaccination is achieved. Taken together, the present moment marks a sobering inflection point for US policymakers, and a dynamic policy landscape where NPIs continue to be (re)instated even in the days prior to this publication's release,

This paper focuses on the period late August to early December for all 50 states and Washington DC, capturing key policy decision points including school reopenings, the 2020 presidential election, and policy impacts of the immediate post-Thanksgiving period.[2] We continue to find significant variation across states, with several patterns continuing from the summer. For example, Republican-led and Midwestern states have the lowest levels of policy stringency even as they face increasing case counts. These trends hold particular relevance in the absence of a centralized, federal response.

This paper additionally looks in detail at school reopenings, income support, and facial coverings policies. OxCGRT data to show that following initial periods of coordinated shutdown, school reopenings varied significantly over time as decision making shifted to localities. Income support centered around policies to expand unemployment eligibility for US CARES Act funding, with Republican-led states being more likely to offer minimal or no expanded access to state or federal income support. Policies requiring face coverings were adopted across the US in late summer, with Northeastern states leading implementation and having nearly twice as many days on average with facial covering requirements in place compared to other regions.

Finally, to further inform policymakers and assess policy decisions in context of risk to public health this paper also makes a novel contribution in reporting a 'Risk of Openness Index' (RoOI) measure for each state. This tool approximates the risk of a jurisdiction not having in place closure and containment policies, using a range of data sources to estimate the extent to which transmission is controlled and the risk that imported casing seeding more outbreaks. RoOI scores for states are mapped month by month, showing that states' risk of openness have steadily increased, even as the

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[1] https://coronavirus.jhu.edu/data/new-cases

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

strength of containment policies has lessened in many states. In the past month, the average RoOI scores of the majority of states were at the maximum as measured on the current OxCGRT scale.

This paper accompanies the publication of the continuously updated, publicly available OxCGRT subnational dataset for the US—data we hope will be used by journalists, researchers, and policymakers. We hope this work will help to inform the difficult questions facing US policymakers and help to identify useful patterns of policy making amid a fragmented national response.

2. Data and Measurement

For US states, OxCGRT reports publicly available information on 16 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. o 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 has a different interpretation.)
- 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	✓

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

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	
H6	Facial coverings	Numeric	No	✓
H7	Vaccination policy	Numeric	Payment source	✓
Miscellaneous				
M1	Other responses	Text	No	✓

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. Data that considers both applicable federal policies as well as state policies are viewable in the country dataset on Github.

In order to ensure accuracy and consistency in the interpretation of the sources, all data collectors are required to complete a thorough training process. We also hold weekly meetings to discuss and clarify how to code edge cases, building a shared understanding of the codebook and its interpretation in light of concrete examples. Every data point is reviewed by a second coder, who examines the data entry and the original source, and either confirms the coding choices of the original coder or flags the data entry for escalation. Data may be corrected via this review process or following external feedback. Substantial revisions are rare.

The US subnational data is presented in a US-only subnational dataset as well as part of the main OxCGRT dataset, both of which are publicly available on GitHub.[4] In the US-only dataset, the data includes measures taken by an individual level of government and by lower levels of government within that jurisdiction, connotated by the suffix "_WIDE". This US-only data also includes the suffix "_GOV" where policy responses are tracked for only a single level of government. At present the US-dataset includes this "_GOV" distinction for federal policy data only. This level of coding without higher-level policies is used in the first 6 sections of this paper. In the main OxCGRT dataset, the data captures the total set of policies that apply to a given jurisdiction. This is identified by the suffix "_TOTAL" and includes measures adopted at higher levels of government that may supersede local policies, for example, a ban on international arrivals adopted by the federal government that applies to all subnational units. This data is used to calculate the Risk of Openness Index in section 7.

Data-collection occurs in once-a-week cycles and the database will continue to be updated and reviewed to provide accurate real-time information on the US subnational government response. The data is published in real time and made available immediately on GitHub, via an API and licensed under the Creative Commons Attribution CC BY 4.0 standard.

3. Policy indices of COVID-19 government responses

[4] https://github.com/OxCGRT/covid-policy-tracker has data alongside 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.

Governments' responses to COVID-19 exhibit significant nuance and heterogeneity. Moreover, like any policy intervention, their effects are 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 of 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)[5]
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' closure and containment policies that primarily restrict people's behavior
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

[5] 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 policies.

Table 2: OxCGRT indices

Index name	C1	C2	C3	C4	C5	C6	C7	C8	E1	E2	H1	H2	H3	H6	H7
Government response index	x	x	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	x	x
Stringency index	x	x	x	x	x	x	x	x			x				
Economic support index									x	x					

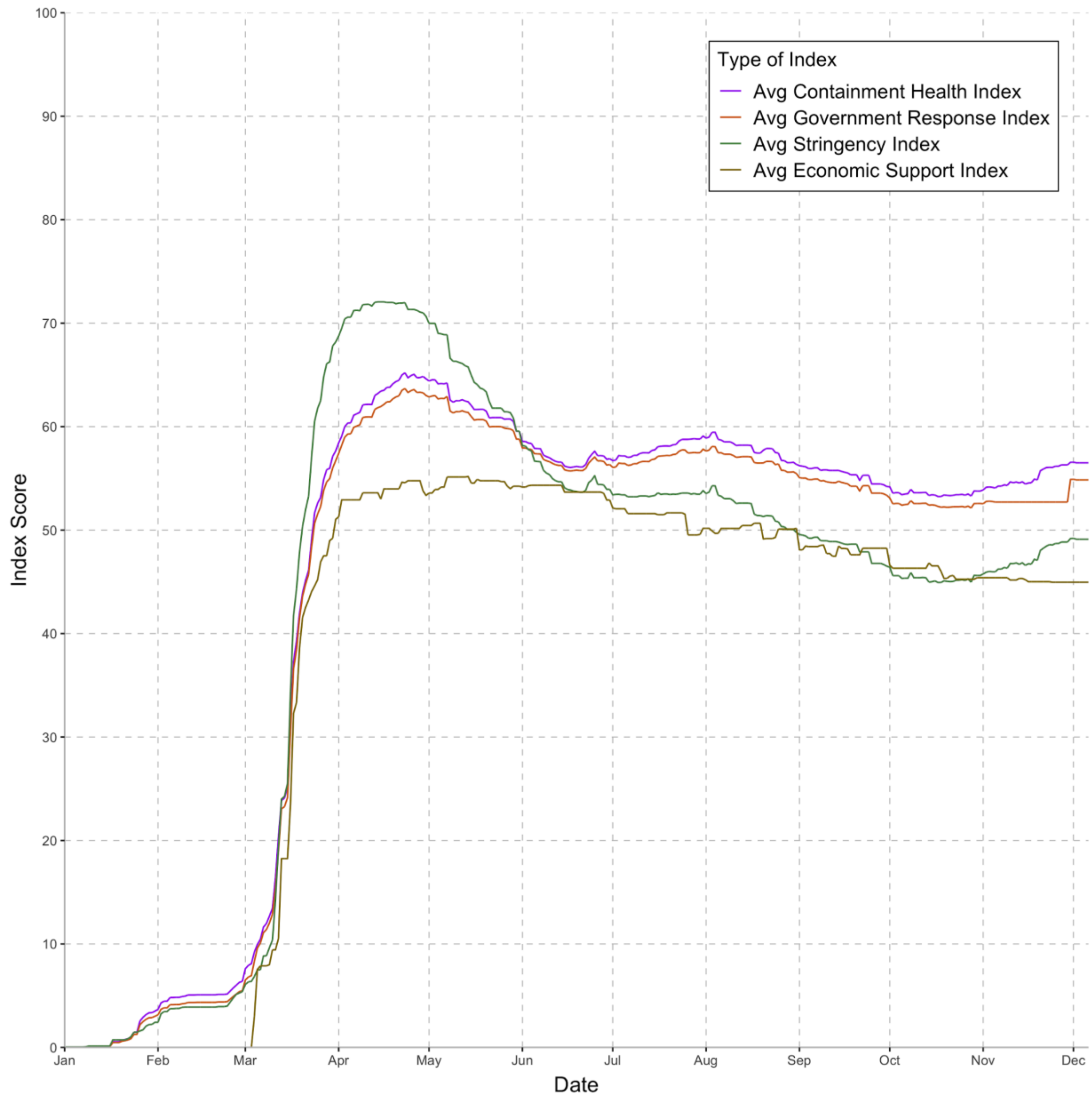
Each index is composed of a series of individual policy response indicators. For each indicator, we create a score by deducting half a point from the ordinal value for a targeted flag, where such a geographic flag exists. We then rescale each of these by their maximum value to create a score between 0 and 100, with a missing value contributing 0.[6] These scores are then averaged to get the composite indices.[7]

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 Stringency Index, as it correlates most closely with the kinds of policies considered as 'lockdown' measures.

Figure 1: Mean index values for 50 states and DC, over time, weighted by share of US population (source: OxCGRT)

[6] 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.

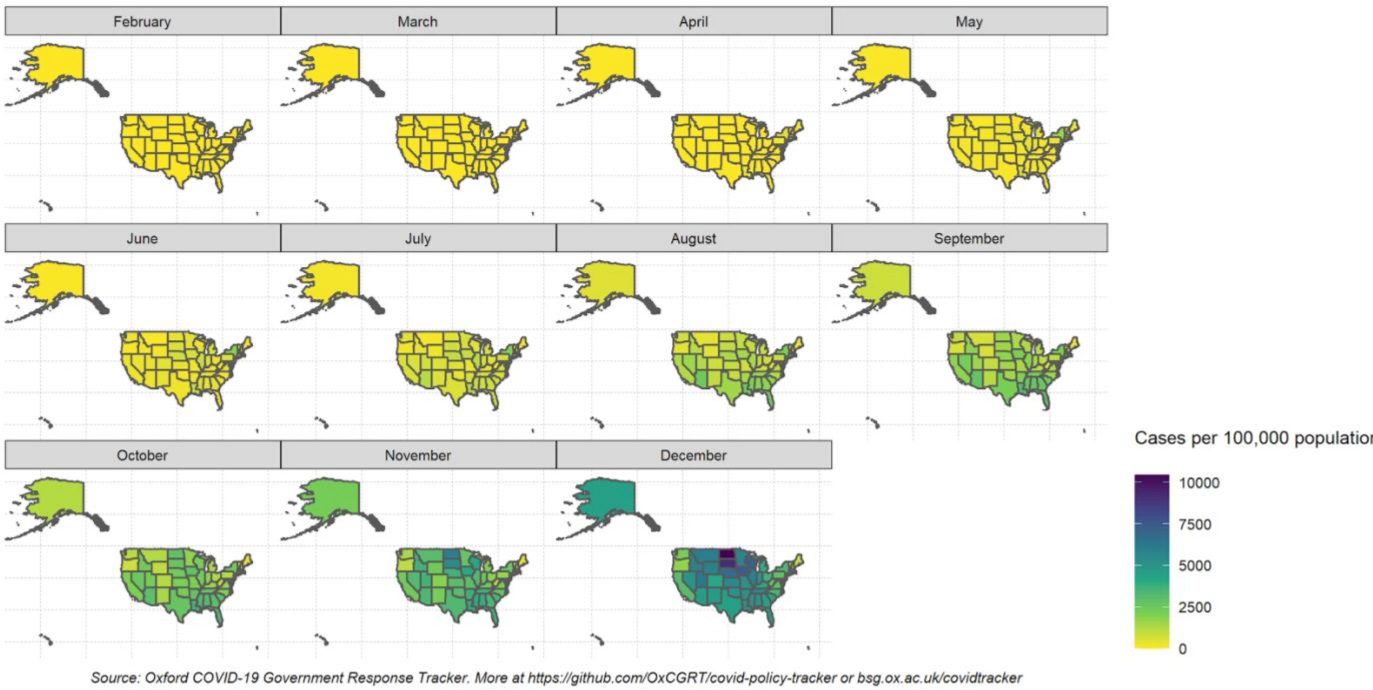
[7] Full details on the construction of the indices is available on Github: https://github.com/OxCGRT/covid-policytracker/blob/master/documentation/index_methodology.md



4. The US context: increasing cases and minimal federal policy

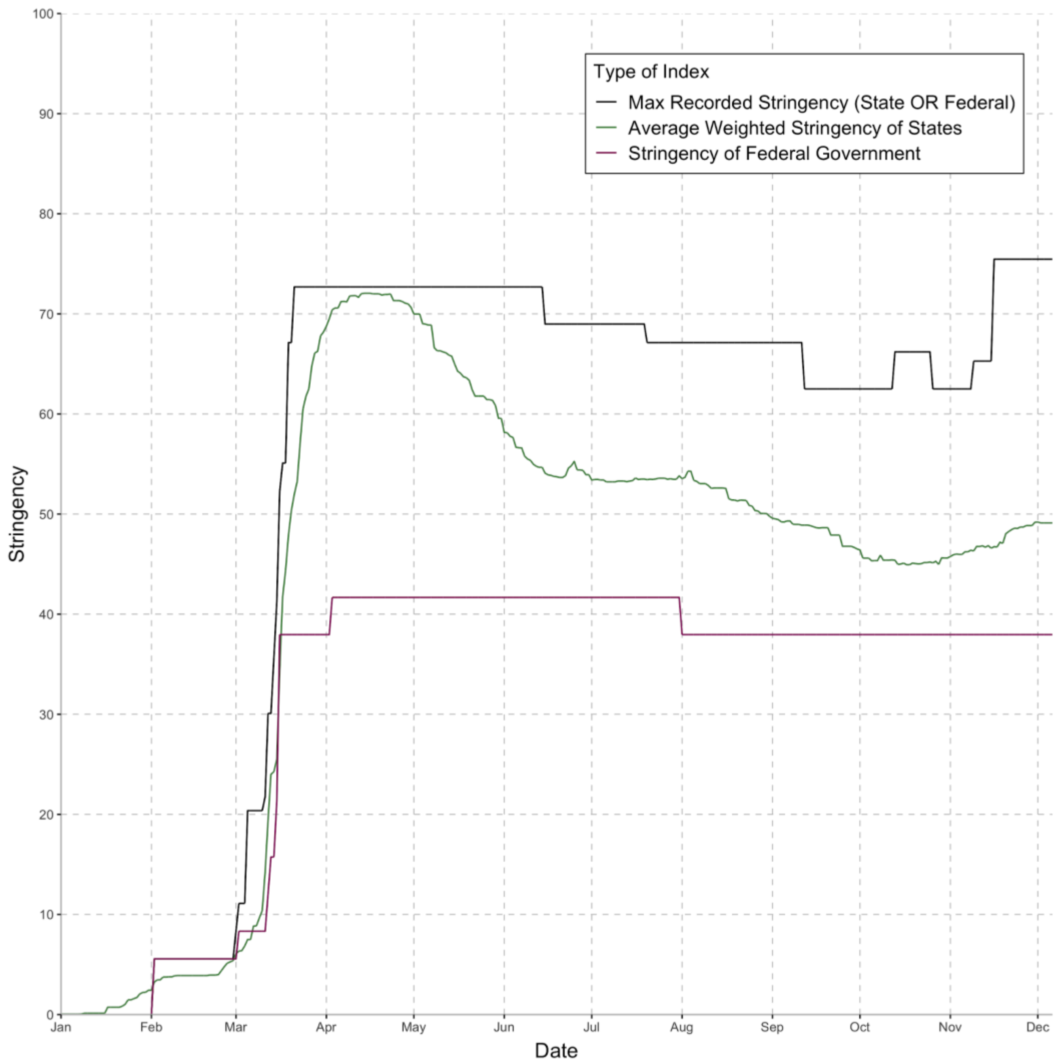
The COVID-19 outbreak was not widespread at the outset, focusing mainly in Washington and New York City. However, the outbreak quickly spread throughout the country, primarily affecting the Northeast and South before early fall, where cases began to shift to the Midwest and West. In most states, such a second ‘wave’ reached significantly higher peaks in terms of case counts and deaths than the first.

Figure 2: Cases per 100,000 for each state as of the first date of each month (source: JHU)



The response to COVID-19’s spread has been consistently determined at the state level, with Figure 3 showing federal policies displaying lower stringency than average, population-weighed state policies at almost every time period. Even so, there is significant variation state to state, as is evident when comparing a weighted average of state policies as coded in the US-focused OxCGRT dataset compared to the separate US country coding occurring in the national OxCGRT dataset.

Figure 3: Federal-only COVID-19 policy stringency index as compared to average state stringency index weighted by population, and highest-coded stringency index (Source: OxCGRT)



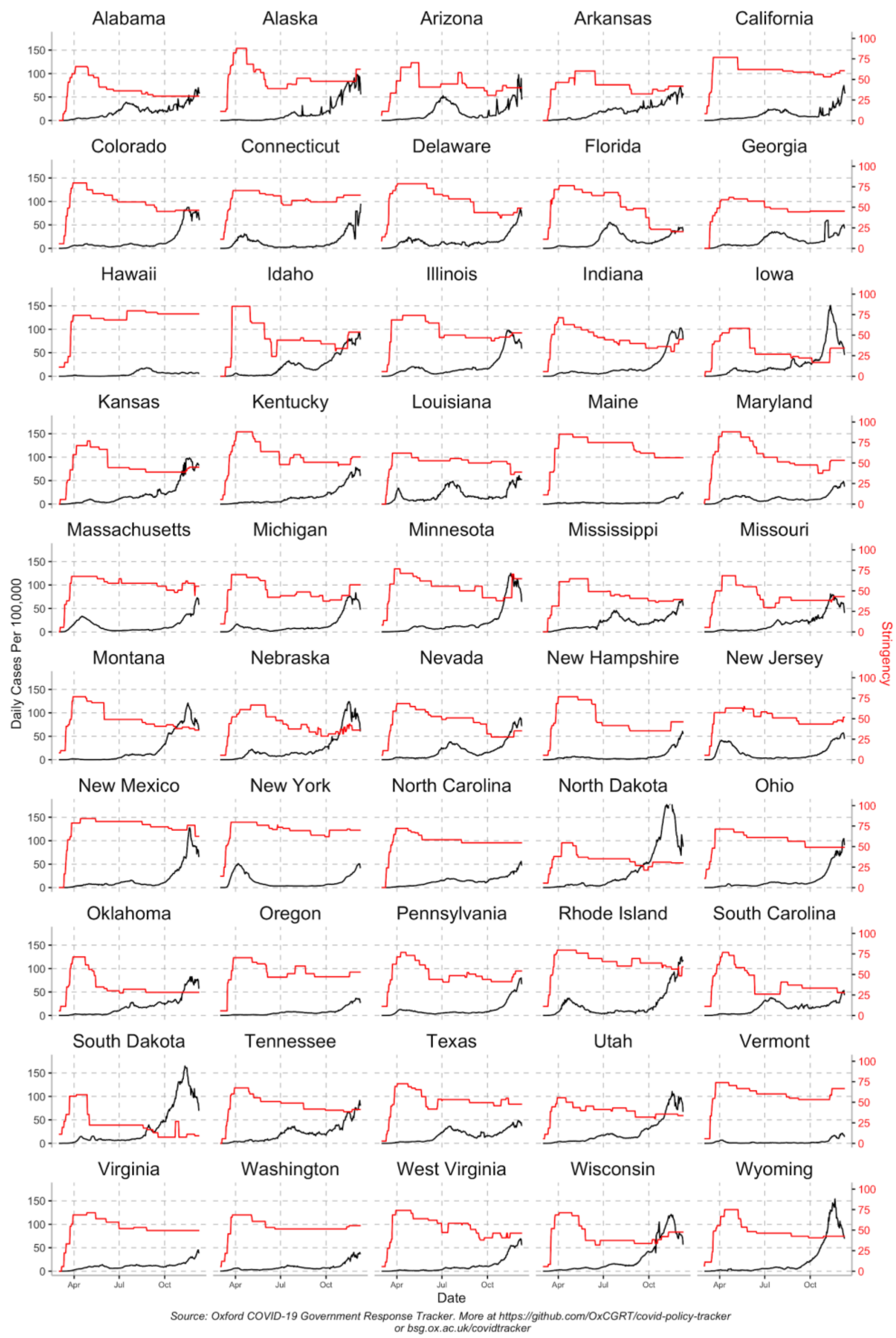
While initial analyses of January 1 to the end of August illustrated the fragmentation apparent in the US COVID-19 policy response, data collected in the period of August to mid-December shows this trend exacerbating. Indeed, the only policies to exist above a level '1' non-zero minimum were for international travel restrictions and income support primarily related to the CARES Act. On average, states drove the policy response, and it was states, not the federal government, that consistently drove higher levels of stringency.

5. Variation in state responses

Regional and political trends

This paper finds continued variation between states' in the stringency and duration of the public policy response and a continuation of trends identified in the first version of this working paper. As Figure 4 shows, states' stringency of policy response has varied substantially relative to their daily case rate, with many states experiencing a rise in cases in the summer and fall even as levels of stringency remained approximately constant or fell (Figure 5, Appendix, Figure 15).

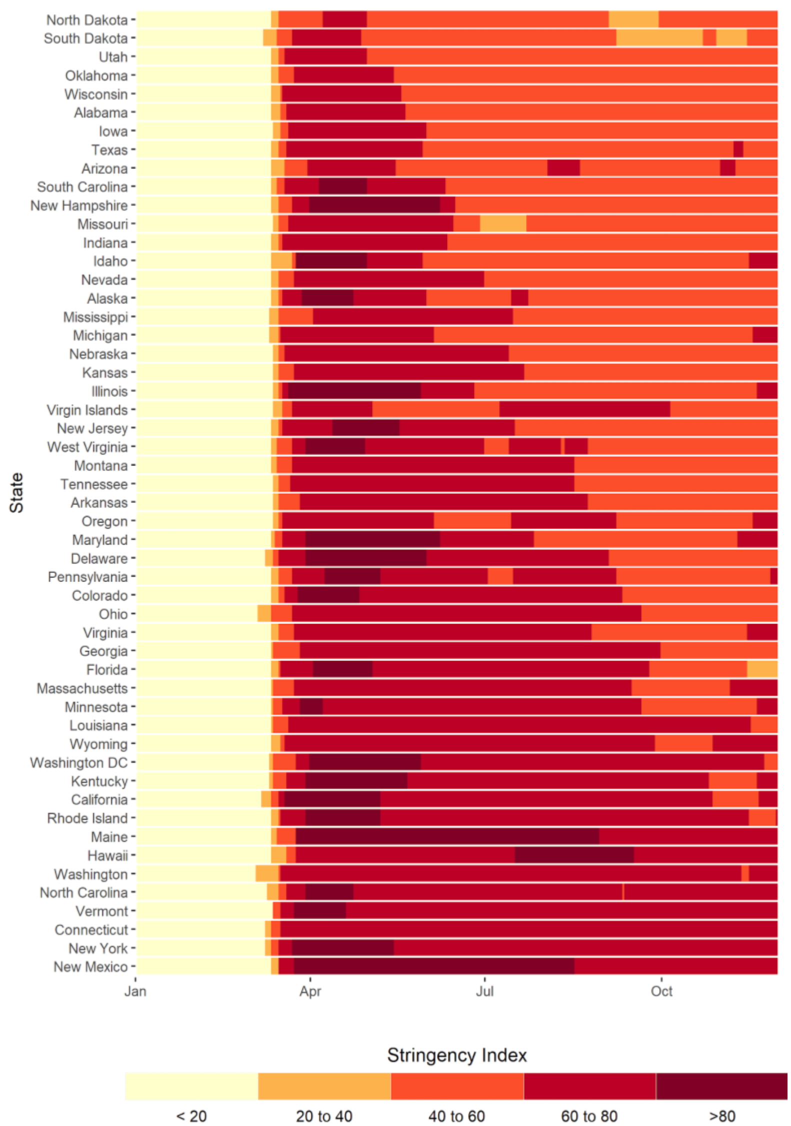
Figure 4. Stringency Index and daily cases per 100,000 for 50 states and DC to December 1 (sources: OxCGRT and JHU)[8]



8 In some states, case counts in the most recent period may not necessarily reflect actual totals due to typical variation in reporting delays

Figure 5 provides a more detailed view of this trend by highlighting the strength of containment measures and how long they were maintained by states. Figure 5 shows the variation in state decision making of when, or if at all, to lessen the stringency of their measures, with many states lifting restrictions over the summer months, and the most stringent state responses remaining between stringency index levels of 60 to 80 for the duration of their response. Despite swift and coordinated policy action in spring in which most states reached a stringency index level of 50 within the same couple of weeks, the movement below this level has varied much more (Figure 5, Appendix, Figure 14). Overall, Midwestern states had the fewest days spent at a higher level of stringency, having only an average of 92 days spent above a stringency index value of 50, with the next-lowest region (the South) having 139 days (Appendix, Table 4).

Figure 5: Chart showing time periods states spend under different stringency index values, ordered by length of time spent at stringency index > 60 (Source: OxCGRT)



Political differences also manifested in the length and stringency of states' responses. Republican-led states spent fewer days at a higher level of stringency compared to their case growth rates (Figure 5, Table 4, Appendix). Figure 6 further shows that each of the ten least-stringent states had Republican governors. This is notable given that cumulative cases in Republican-led states have firmly surpassed those in Democrat-led states, continuing the trend that emerged at the publication of the first OxCGRT US working paper (Figure 7).

<u>Figure 6. Top ten least and most stringent states by average stringency from July to December, with their case growth and colored by governor's political party. (Sources: OxCGRT and JHU)</u>

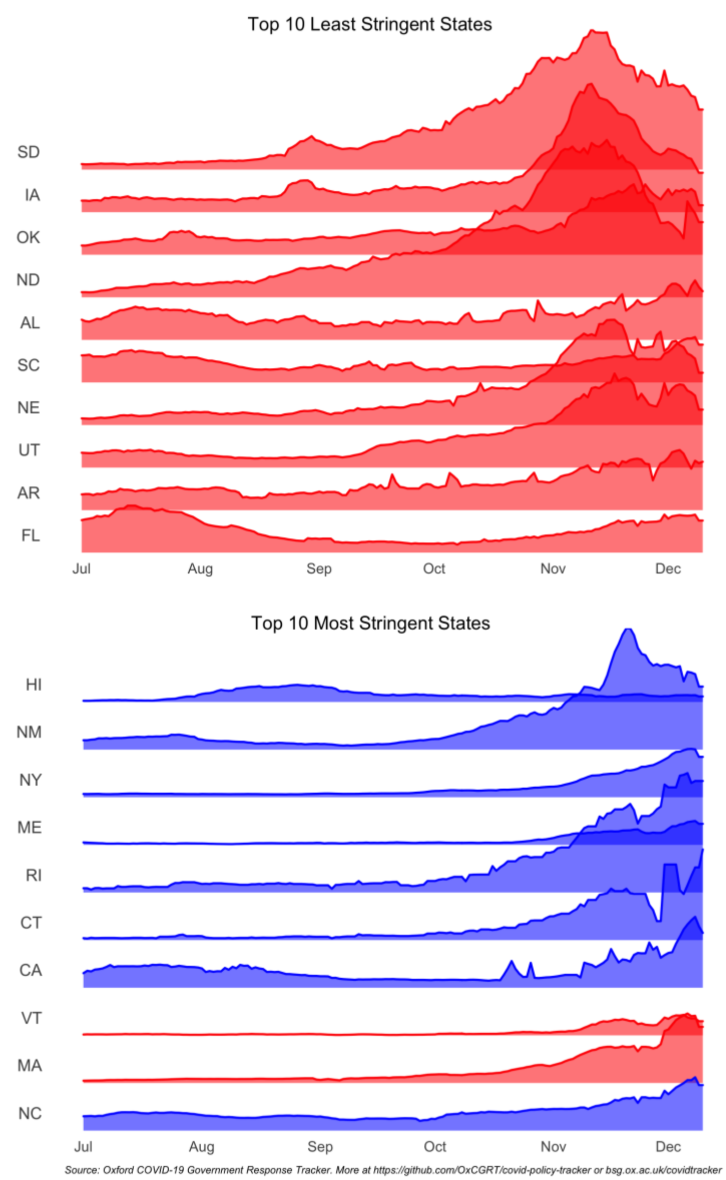
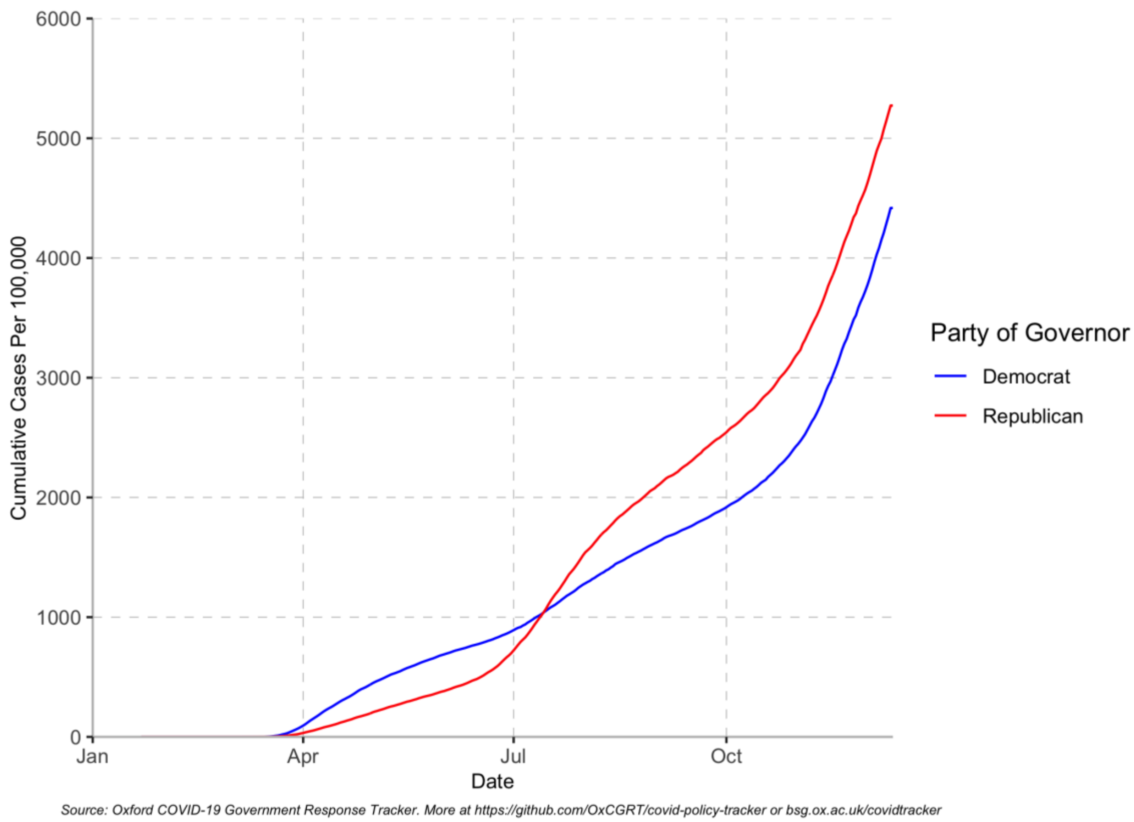
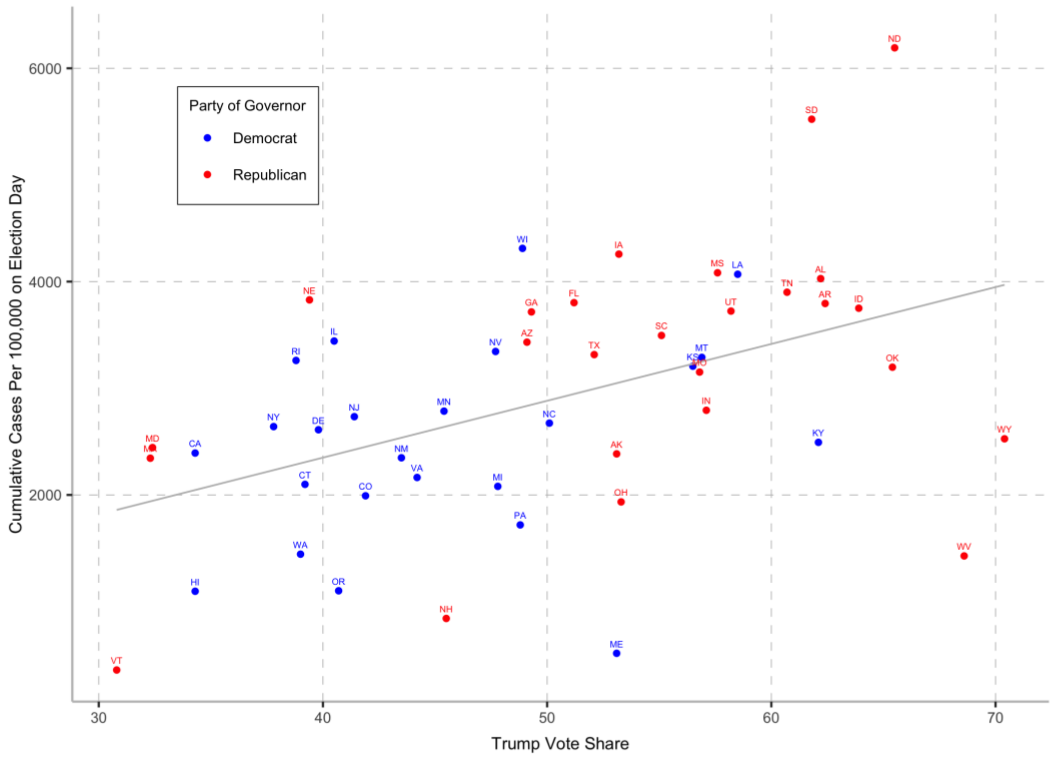


Figure 7: Cumulative case counts per 100,000 in states by party of governor (Sources: OxCGRT and JHU)



The COVID-19 pandemic was also central to the US elections this November, not only as a high-priority issue to voters but also in limiting the intensity of physical campaigning and spurring dramatic increases in postal voting. Figure 8 suggests that states with higher vote shares for incumbent Donald Trump during the 2020 elections experienced higher cumulative cases per 100,000 as of Election Day. A similar trend is observable when comparing case growth to average stringency, where Democratic-led states tended to have higher stringency and lower case growth than Republican-led states (Figure 6, Appendix, Figure 15).

Figure 8: Relationship between cumulative cases per 100,000 and share of state that voted for Trump in 2020 presidential election (Sources: OxCGRT and JHU)


Party of Governor
Democrat
Republican
Cumulative Cases Per 100,000 on Election Day
Trump Vote Share
6000
4000
2000
30
40
50
60
70
ND
SD
WI
IA
MS
LA
AL
TN
NE
GA
FL
UT
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6. Variation in individual policy areas

While overall stringency indices provide valuable estimates of overall state response, it is also important to examine the specific trends that make up these indices, as the granularity they represent is often more representative of specific areas of policy debate rather than an overall estimate. To that end, we present a detailed look at three areas of policy that have emerged as politically relevant during late summer and fall in the US: school closures and reopenings, facial coverings mandates, and income support.[9]

School (re)openings and (re)closures

While the earliest months of the COVID-19 pandemic largely corresponded to usual breaks in the US school year, the approach of the first school returns in August brought significant debate around when, and how, schools (both K-12 districts and universities) should reopen in the United States. This question was the focus of an OxCGRT series of research notes regarding school reopening policies from August 1 to October 1, of which main findings are presented below alongside updated information for school reopening changes from October 1 to present. Where there were not specific state or local policies in place regarding both public and private schools, coding focused on public K-12 school districts and public university systems as units of policy decision making. Figure 9 shows how these policies varied over given months.

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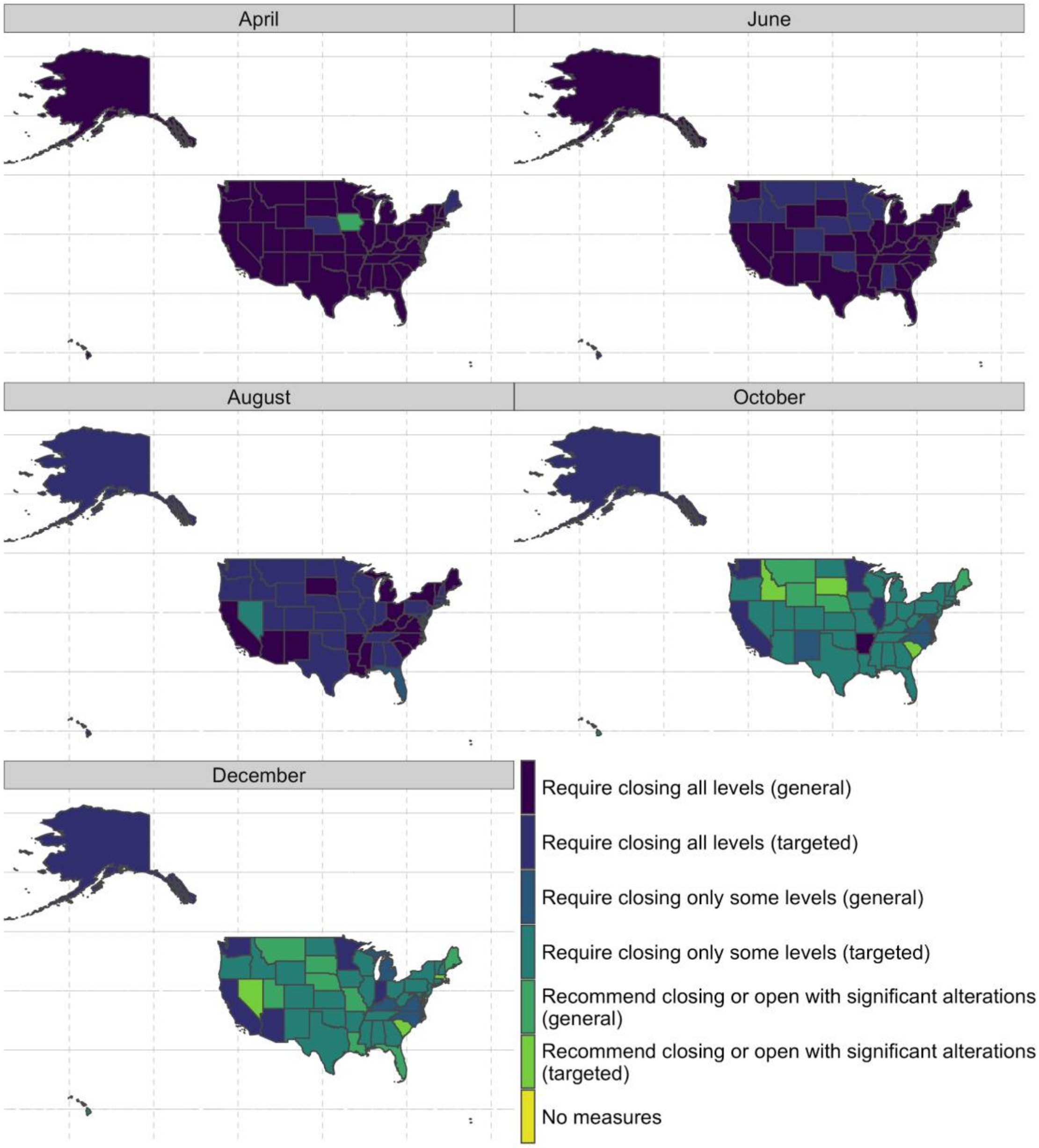
[9] Details on coding guidelines for each of these indicators can be found in the appendix.

Figure 9: Variation in school closures across states, first day of given months (Source: OxCGRT)



Overall, we found that reductions in stringency from March and April peaks were apparent from August to October, with rising cases prompting limited closures again in October and November. School closures in March and April followed a similar time period and stringency, with almost all states having schools closed at some or all levels by March 22. Most states remained at a high level of stringency in school closures over the summer. There was, however, significantly more variation in reopenings and (re)closures in early fall. School reopenings and corresponding lessening in school closure stringency were initially concentrated in the South, partially driven by typical regional variations in school schedules. Notably, the first 20 states that experienced school stringency reductions (from August 1 to August 22) accounted for less than half of the US population but more than half of August's new cases.[10]

September decreases in the school reopening policy stringency were largely driven by changes in K-12 school opening policies. Overall, states moved from the OxCGRT code of required closures at all levels to the code of geographically-targeted required closures at some levels being the most common policy. The first half of September led to more convergence of school reopenings across states than observed in August. 10 states experienced reductions in school closure policies, with most concentrated in the Northeast and Midwest. This, again, is partially due to normal variations in school reopening dates between regions. By late September, there were few changes to policy stringency, with only 5 additional states experiencing reductions between September 15 and September 30. In addition to continued K-12 school reopenings, universities continued to generate interest with campus reopenings leading to COVID-19 clusters and subsequently necessitating increased measures, including additional closures.

October was the first post-summer month where OxCGRT policy indicators reflected increases in stringency in some states, largely driven by K-12 schools closing in response to localized COVID-19 outbreaks (as was the case in Arizona and Indiana). Many of the states with such increased stringency took place in states where options for in-person learning had previously been mandated to some extent (such as in Texas and Arkansas) or states where in-person learning was widespread (such as Montana and Wyoming). Overall, October and November saw the continued movement to a majority of states experiencing only some closed schools at targeted geographic levels, with this level of policy being the most common at the start of December.

Facial coverings

In the absence of a national mask mandate, many states acted independently to implement policies regarding facial coverings—a leading non-pharmaceutical intervention (NPI) to limit COVID-19 transmission.[11] Mandates regarding facial coverings are tracked using a 5-point ordinal scale denoting whether policies are recommended or required, and if such requirements apply to different scenarios outside of the home. Similar to other OxCGRT ordinal indicators, geographic scope of the policy is indicated using a binary flag. Figure 10 shows how these policies varied over given months.

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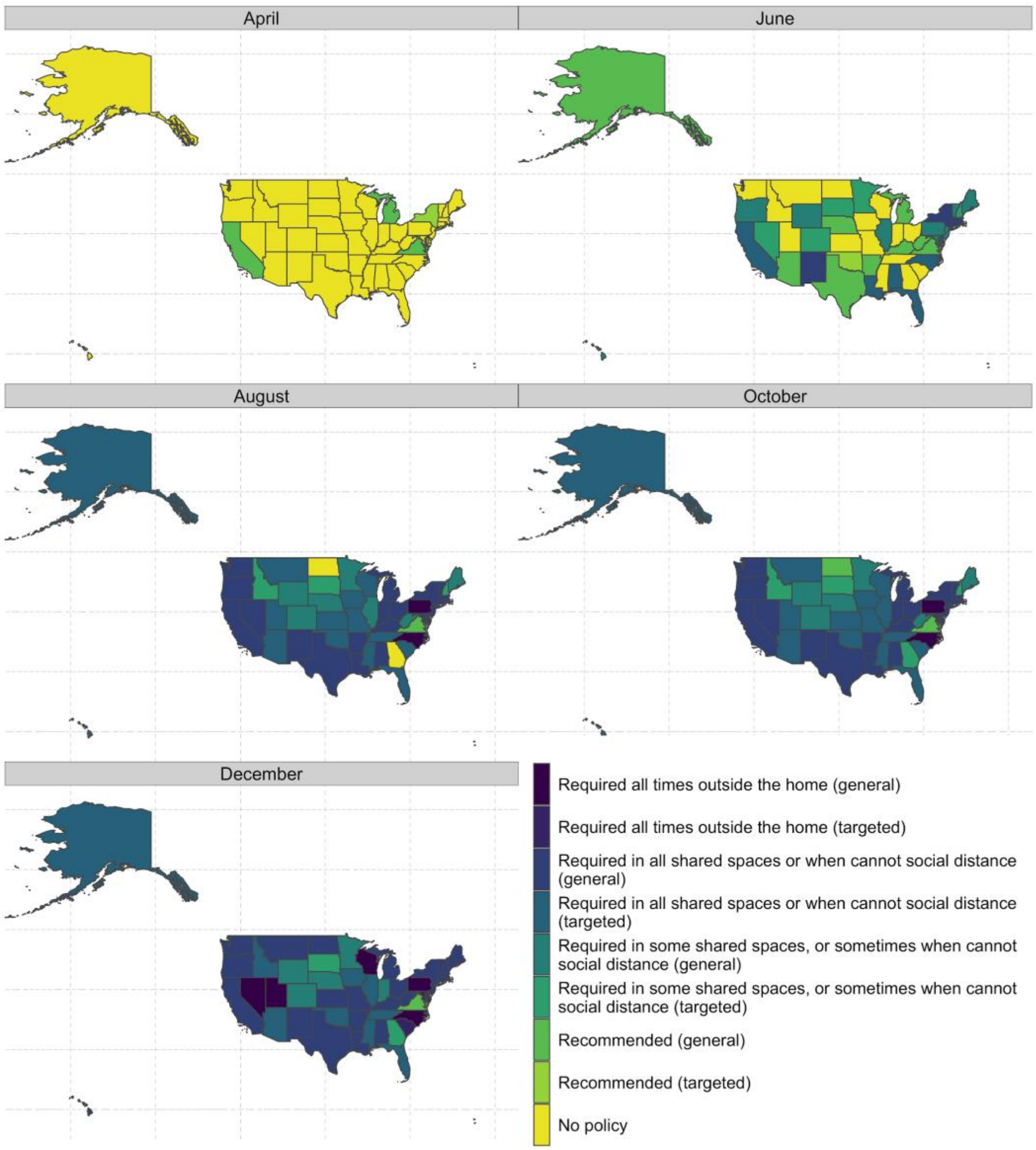
[10] https://github.com/OxCGRT/USA-covid-policy/blob/master/research%20notes/archived_research_notes/USA_school_closure_policy-09Sep2020.pdf

[11] An indicator to track the stringency of these policies was published to the OxCGRT database in October.

Figure 10: Variation in state policies on facial Coverings, first day of given months (Source: OxCGRT)



Face covering requirements did not occur until late summer in most states, with the Northeast region leading in required policies. Prior to the CDC's recommendation in early April that everyone should wear face masks in public, some state and local officials began recommending the use of face coverings in public as a means of reducing transmission. Recommendations for face coverings became increasingly common among both county- level and state- level policies in April, and state-level recommendations to wear facial coverings in public spaces was the most coded level across all regions in the US by May 1.

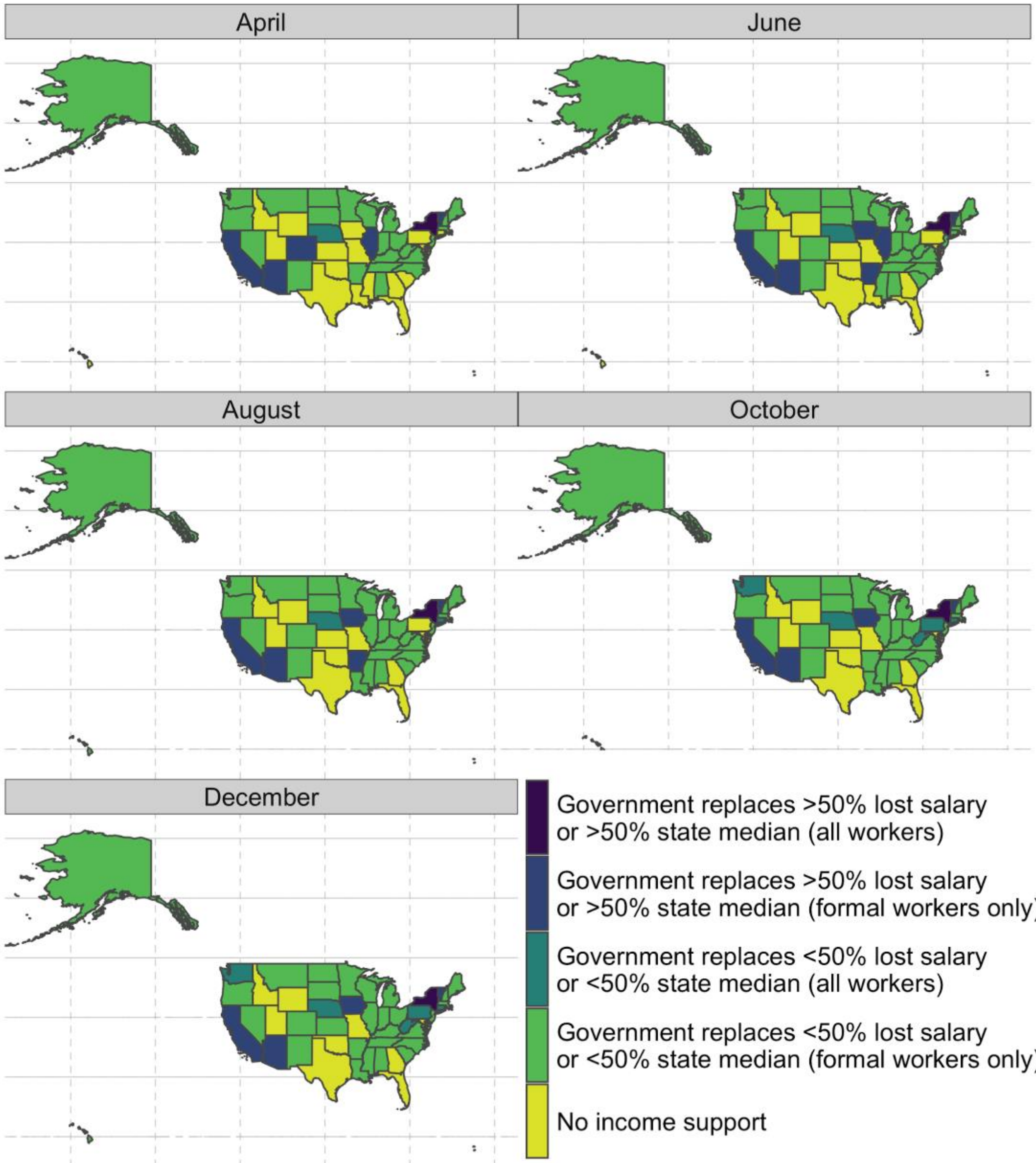
The Northeast was the first region to demonstrate an increase in this policy indicator by June 1. In other regions, this shift from recommended to required face coverings largely occurred in July. By August, the most common policy level was a requirement for face coverings in all public spaces where social distancing is not possible, and that policy being in place in all parts of the state. States in the Northeast maintained more stringent policies regarding face coverings for longer periods of time – on average, Northeastern states required face coverings in all public spaces where social distancing is not possible for nearly twice the number of days as the next most stringent region (South). Face covering requirements were also the most widespread throughout the Northeast, with all of the region's states reaching a state-wide requirement for facial coverings in all public spaces by December 1. In contrast, only 6 of 12 Midwestern states ever reached this level of stringency, even as Midwestern states ranked among the states with the highest case growth. South Dakota, for example, never had a state-wide policy requiring facial covering in public spaces.

Income support

State policy space for income support largely exists within broader frameworks of federal unemployment structures and guidelines, wherein states can take policy actions to expand eligibility or requirements for benefit receipt within this period. For example, the US CARES Act gave states the option of expanding unemployment compensation to larger categories of workers, within which states could take individual policy actions to take advantage of this expansion. Within this framework, OxCGRT data shows similar overall movement in stringency between states in their implementation of related policies, though with some variation by region and political affiliation of governor. Figure 11 shows how these policies varied over given months.

While many states were quick to enact policies for income support alongside business closures, responses varied significantly across states based on region and political affiliation. Among the first 11 states to enact income support policies in March, most were concentrated in the Midwest (5) and West (3). The majority of these states (8 of 11) were under Democratic leadership. By April and alongside the implementation of the CARES Act, income support policies became more uniform, with a proportional number of states implementing income support policies across all regions and an approximately equivalent political divide of 20 Democratic – led to 14 Republican- led states. States that did not have any policies for income support at the beginning of the month tended to be Republican- leaning and located most frequently in the South, followed by the Midwest. The most coded policy remained at a level of the government replacing more than 50% of median salary from April through July, at which point the end of the federal CARES Act funding drove a shift to a lower median level of stringency.

Figure 11: Variations in state-level Income support, first day of given months (Source: OxCGRT)



While these overall coded policy levels were largely similar between states, economic response policies also exhibited significant heterogeneity across states in terms of benefits provided, including access and eligibility to these benefits—qualitative differences described in the OxCGRT coding notes. Expedited ease of access to benefits was among the most common policies providing income support during the early period of response. Policies expanding eligibility to benefits were also commonly described in our database – for example, increased eligibility for workers in certain sectors such as healthcare or a broader definition of eligibility including language such as “anyone affected by COVID-19,” which could be used to obtain benefits for reduced hour or job loss.

7. Risk of Openness Index

In April 2020, the WHO’s technical guidance recommended six criteria for evaluating countries’ readiness for easing response policies. Briefly, the recommendations were:

1. COVID-19 transmission is controlled to a level of sporadic cases and clusters of cases 2. Sufficient public health workforce and health system capacities are in place
3. Outbreak risks in high-vulnerability settings are minimized
4. Preventive measures are established in workplaces
5. Manage the risk of exporting and importing cases from communities with high risks of transmission
6. Communities are fully engaged

As the disease continues to spread in the US, the same set of WHO criteria can be used to assess the risk that states face should they relax social distancing measures. First used in OxCGRT analyses of national policies and Brazilian subnational policies, a composite measure called the Risk of Openness Index (RoOI) can be used to roughly describe the risk of states' not having closure and containment measures in place. Importantly, the RoOI cannot say precisely the risk faced by each state, although it can be used to support decision making as governments seek to calibrate policy response to changes in context. We combine OxCGRT US subnational data with other publicly available sources of information to speak to four of the six WHO recommendations. The table below provides a brief description of the OxCGRT methodology for calculating each of the sub-indices that constitute the RoOI for US states.

Table 3: Calculation of the Risk of Openness Index for US states

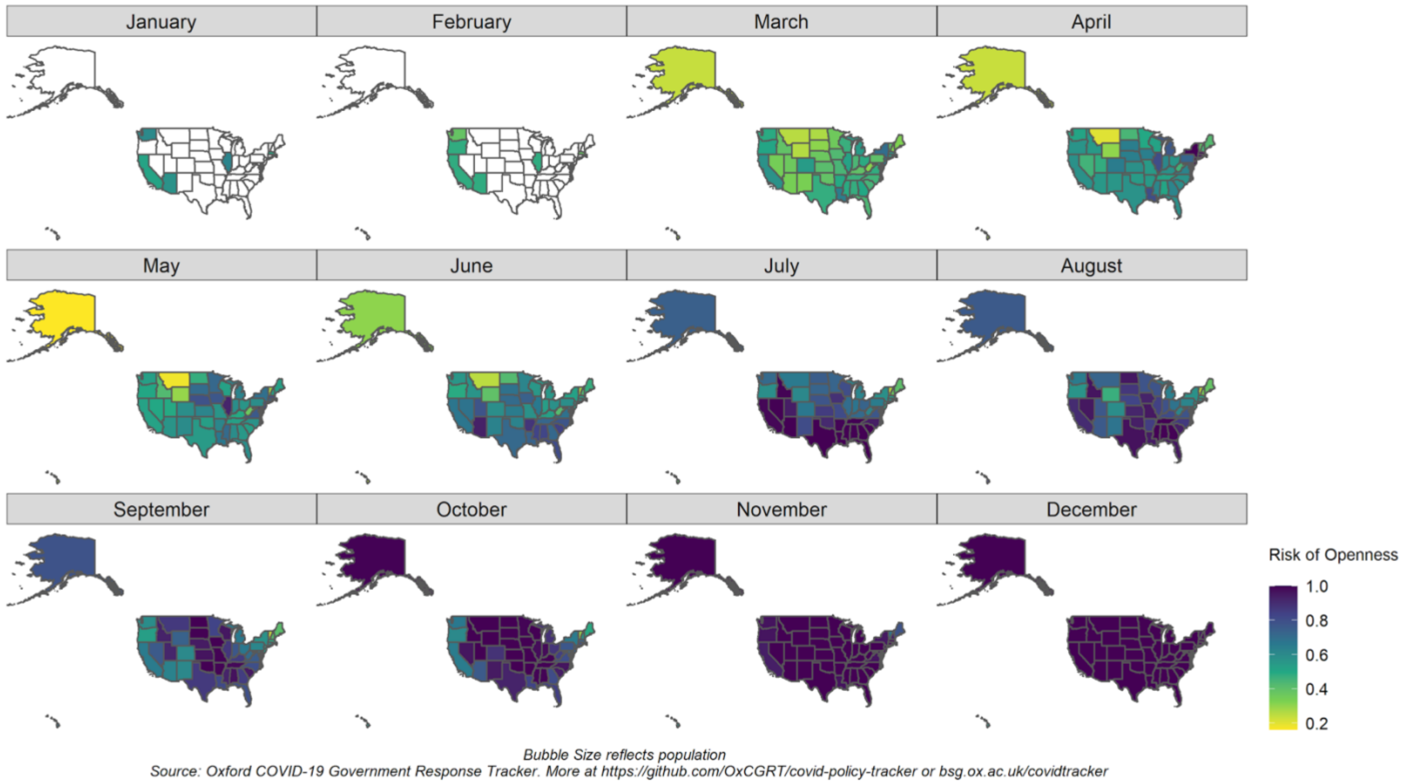
WHO Recommendation	**Data Sources**	**Sub-Index Description**
Transmission controlled (recommendation 1)	Cumulative cases data from JHU CSSE Covid-19 Data Repository	A metric between 0 and 1 based on new confirmed cases ($\Delta cases_t$) each day Cases controlled risk is automatically set to 1 if $\Delta cases_t \geq 50$
Test / trace / isolate (recommendation 2)	Testing policy (indicator H2) and contact tracing policy (indicator H3) from OxCGRT Number of tests conducted in each state, made available by The COVID Tracking Project	A metric between 0 and 1, half based on testing and contact tracing policy, and half based on the number of tests a state has conducted per recorded case, as compared to the highest and lowest tests per case conducted by a state on the given date.
Manage the risk of imported cases (recommendation 5)	International travel controls (indicator C8) Restrictions on internal movement (indicator C7) from OxCGRT	A metric between 0 and 1, half based on the stringency of international travel arrivals, and half based on restrictions on internal movement within and between states/cities (does not measure risk of exporting cases)

Communities understanding and behaviour change (recommendation 6)	Availability of public information campaigns (indicator H1) Data from Google on travel and mobility	A metric between 0 and 1 based on whether a city or state has a public information campaign and the level of mobility reduction, weighted for current transmission risk (cases controlled sub-index)

Lastly, the RoOI includes a check for states experiencing a very high level of transmission over the past week through the introduction of an endemic factor. Jurisdictions experiencing population-scale transmission are likely to be too 'high risk', although this isn't effectively captured by the four sub-indices described above. We record this as the endemic factor, and the source for this data is the daily new cases recorded in the state. When this is the case, it effectively creates a 'floor' on the risk level no matter how good the other sub-components are. The endemic factor is a measure between 0 and 1, and depends on the total number of new cases in a country, proportioned by population. To compute subnational units' Risk of Openness, we use OxCGRT data that combines federal government measures with those of the state (subnational) government. This produces indicators and indices that account for higher level policy in settings where the national government takes the leading stance, comparable between countries' subnational units.

Examining the RoOI for states month by month shows that risk of openness stayed below 0.5 in most states until April, where Northeastern and Southern states faced increased risk alongside case increases in hotspots such as New York and Louisiana. However, by July and August it was Western and Southern states which faced the highest risk of reopening, even as many of these states began to roll back the stringency of their policies. Figure 12 illustrates this, presenting the average stringency over each month. Risk continued to rise nationwide into September and October, and by December 1, the majority of states had maxed out at a value of 1 on the Risk of Openness Index.

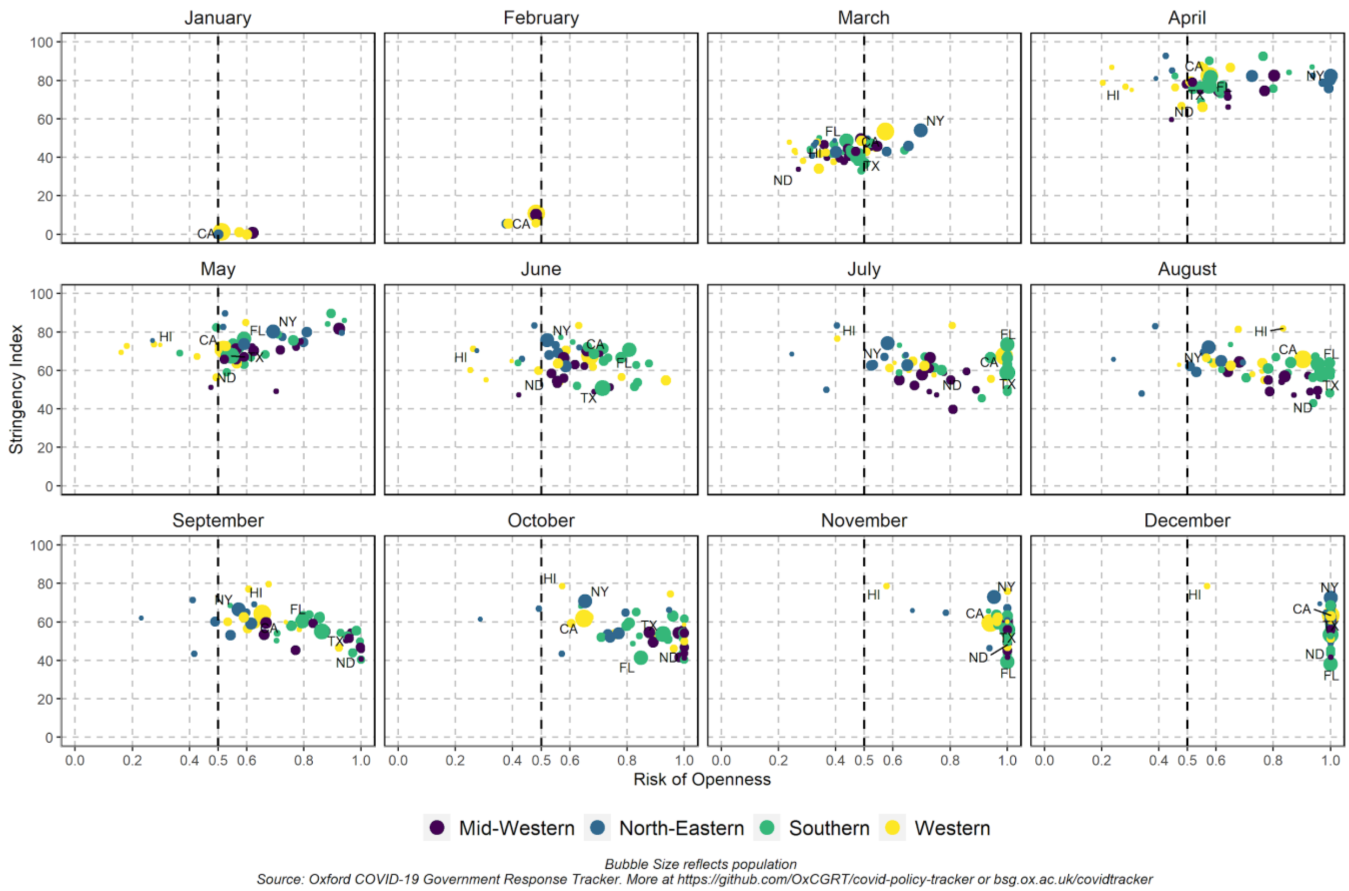
Figure 12: Monthly average Risk of Openness index scores of US states



While states reached a nearly universal point of high RoOI scores by December 1, states displayed a high level of variation in their RoOI scores up until that point. This is somewhat expected in line with the vast variations in policy stringency outlined previously, but nonetheless interesting for its reinforcement of regional trends and difference as compared to previous OxCGRT analysis on Brazilian states, where there was much less variation in RoOI.[12] Soberingly, US states appear to have maintained high RoOI scores throughout November and the beginning of December, maxing out the OxCGRT scale at the highest level of risk (Figure 13). While there is some regional variation, even those states with lower relative RoOI values score above a 0.5 on the scale, with all but three jurisdictions (Maine, Vermont, and Hawaii) scoring above a 0.9 in November, and only Hawaii maintaining that lower level of risk in early December. Considering Thanksgiving travel and recently increasing case counts—both key metrics in the OxCGRT RoOI calculations—the RoOI scores presented here indicate cause for increased caution and critical policy decision making ahead of winter holidays.

Figure 13: The stringency index and average monthly RoOI for US states

[12] https://www.bsg.ox.ac.uk/research/publications/brazils-fight-against-covid-19-risk-policies-and-behaviours



8. Conclusion

As US policymakers seek to balance rising COVID-19 case counts, ongoing political debates, and the concerns of holiday-related COVID-19 spread, this paper situates states' policy responses in relation to each other, their regions, and their own overall risk of openness. The data presented here illustrate patterns not only of the OxCGRT government stringency index, but also trends of indicators making up this index in order to provide a more detailed view of the US COVID-19 policy landscape.

Overall, the data shows that after initial peaks in stringency, policy variation by state, region, and political affiliation continued into the fall, with Northeastern and Democrat-led states experiencing more stringent responses overall. This was also suggested in individual policy areas such as facial coverings and school reopening decisions. While some policy areas such as income support and federal unemployment expansions were led by federal decision making, the decentralized structure of decision making in the US is also apparent. Overall federal stringency remained low, with states and localities leading the way in policy decisions. These decisions took place against a backdrop of increasing risk of openness across all states, where states in all regions reached the maximum levels of the OxCGRT Risk of Openness Index.

It is imperative to study which measures are effective (and which are not) to both limit COVID-19 spread and reduce disruption to life and livelihood. While the OxCGRT data presented is descriptive and cannot measure effectiveness of different policy measures directly, they can be useful input to studies that analyse factors affecting disease progression. OxCGRT seeks to contribute to this knowledge gap by providing efficient and simple comparisons of government interventions and individual policy actions in the US, as well as several comparable aggregate indices and risk of openness measures. These provide a starting point for building evidence-based policies and assessing effectiveness of non-pharmaceutical interventions.

It is our hope that scholars, medical professionals, policymakers, and concerned citizens alike will use the OxCGRT data to inform and improve responses to the COVID-19 pandemic. The data will continue to be updated on a regular basis, and will be refined and improved over time. The most up-to-date technical documentation can always be found on our GitHub repository.[13] We welcome constructive feedback and collaboration on this project as it evolves.

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

Appendix

Technical Appendix - Risk of Openness Index Calculations for subnational entities

1. Transmission under control

$$casescontrolled = \frac{\Delta cases_t}{50}$$

Where Δcases is the average new daily cases from the last 7 days.
Casescontrolled is automatically set to 1 if $\Delta cases_t \geq 50$

2. Testing and tracing

$$testingandtracing = 0.25(1-\frac{H2}{3})+0.25(1-\frac{H3}{2})+0.5(\frac{ln(tests_{global\_max}) - ln(tests)}{ln(tests_{global\_max}) - ln(tests_{global\_min})})$$

Where:

- H2 is the latest value of the testing policy indicator (H2) in OxCGRT database
- H3 is the latest value of the contact tracing policy indicator (H3) in the OxCGRT database
- ln(tests) is the natural logarithm of the number of tests-per-case conducted by that country
- $ln(tests_{global\_max/min})$ is the natural logarithm of the number tests-per-case conducted by the country that has conducted the most/least tests-per-case

3. Managing vulnerable settings

No data.

4. Putting preventative measures into workplaces

No data.

5. Manage the risk of imported cases

$$domestic\ imported\ cases = \begin{cases} 2 & if \quad C7 = 2 \quad \& \quad C7\_Flag = 1 \\ 1 & if \quad C7 = 1 \quad \& \quad C7\_Flag = 0 \\ 1 & if \quad C7 = 1 \quad \& \quad C7\_Flag = 1 \\ 0 & if \quad C7 = 1 \quad \& \quad C7\_Flag = 0 \\ 0 & if \quad C7 = 0 \end{cases}$$

$$international\ imported\ cases = \begin{cases} 1 & if \quad C8 = 0 \\ 0.5 & if \quad C8 = 1 \\ 0.25 & if \quad C8 = 2 \\ 0 & if \quad C8 = \{3, 4\} \end{cases}$$

$$manageimportedcases = 0.5 * internationalimportedcases + 0.5 * domesticimportedcases$$

Where C8 is the latest value of the international restrictions policy indicator in the OxCGRT, and C7 is the latest ordinal value of the travel restrictions policy indicator and C7_Flag is the geographic scope/flag of the C7 indicator.

6. Communities are fully engaged and understand

$$community = 0.5 * (1 + casescontrolled) * \frac{mob - 20}{100}$$

Where

- *casescontrolled* is the metric between 0 and 1 calculated in the first item above.
- mob is the level of mobility as a percentage of pre-COVID baseline levels reported by Google (average of “retail and recreation”, “transit stations”, and “workplaces” mobility types).

If a state does not have a national public information campaign (that is, the OxCGRT database reports H1≠2), then the entire metric is set to 1 (highest risk).

If mob is less than 20 (that is: a reduction to less than 20% of pre-COVID levels), it is set to 20.
If mob is greater than 120 (that is: mobility has increased to 120% of pre-COVID levels), it is set to 120.

Adjusting with an endemic factor

A state's risk of openness isn't completely reflected by the mean of these four sub-components. In particular, if a state has a very high level of transmission over the past week, we deem it to be 'high risk' to reopening, although this isn't effectively captured by the four indices above. Note that cases controlled by itself is a measure to alert for transmission outbreaks in a country; it reaches maximum risk at relatively low levels (50 new cases per day) and does not give an indication of countries where the virus is truly endemic. The endemic factor acts as a measure of this risk where there are not just a handful of new cases, but rather population-scale transmission. When this is the case, it effectively creates a ‘floor’ on the risk level no matter how good the other sub-components are. The endemic factor is calculated as:

$$EndemicFactor = \begin{cases} 0 & if \quad newcases\_per\_million < 50 \\ 1 & if \quad newcases\_per\_million > 200 \\ \frac{(newcases\_per\_million - 50)}{150} & if \quad 50 < newcases\_per\_million < 200 \end{cases}$$

Here, $newcases - per - million$ is the total number of new cases recorded per 1 million in population. Similar thresholds can be obtained by calibrating the number of new cases observed per hundred thousand of population. The threshold lower and upper limits would then be 5 and 20 respectively.

The Unadjusted Index is then calculated as:

$$RoOI_{unadjusted} = Mean(casescontrolled, testingandtracing, manageimportedcases, community)$$

The Unadjusted Index is then modulated by the Endemic Factor to yield the final Risk of Openness Index as:

$$RoOI_{final} = EndemicFactor + (1 - EndemicFactor)(RoOI_{unadjusted})$$

For the latest methodology, refer to the documentation on Github.

Technical Appendix - OxCGRT Indicator coding scales and interpretation

School closures and facial coverings additionally have binary flags to indicate geographically targeted or general policies, with income support policies having a binary flag indicating whether coverage supports formal workers only or all workers (with the expectation US states' policies consist primarily of the former).

School Closures

0 - No measures
1 - Recommend closing or all schools open with alterations resulting in significant differences compared to usual, non-Covid-19 operations
2 - Require closing only some levels or categories (eg just high school, or just public schools)
3 - Require closing all levels

Facial Coverings

0- No policy
1- Recommended
2- Required in some specified shared/public spaces outside the home with other people present, or some situations when social distancing not possible
3- Required in all shared/public spaces outside the home with other people present or all situations when social distancing not possible
4- Required outside the home at all times regardless of location or presence of other people

Income Support

0 - No income support
1 - Government is replacing less than 50% of lost salary (or if a flat sum, it is less than 50% median salary)
2 - Government is replacing more than 50% of lost salary (or if a flat sum, it is greater than 50% median salary)

Additional figures and tables

Figure 14: Points at which states reached stringency score of 50, point at which states' stringency score moved back below 50, plotted alongside confirmed COVID-19 100th case and 10th death

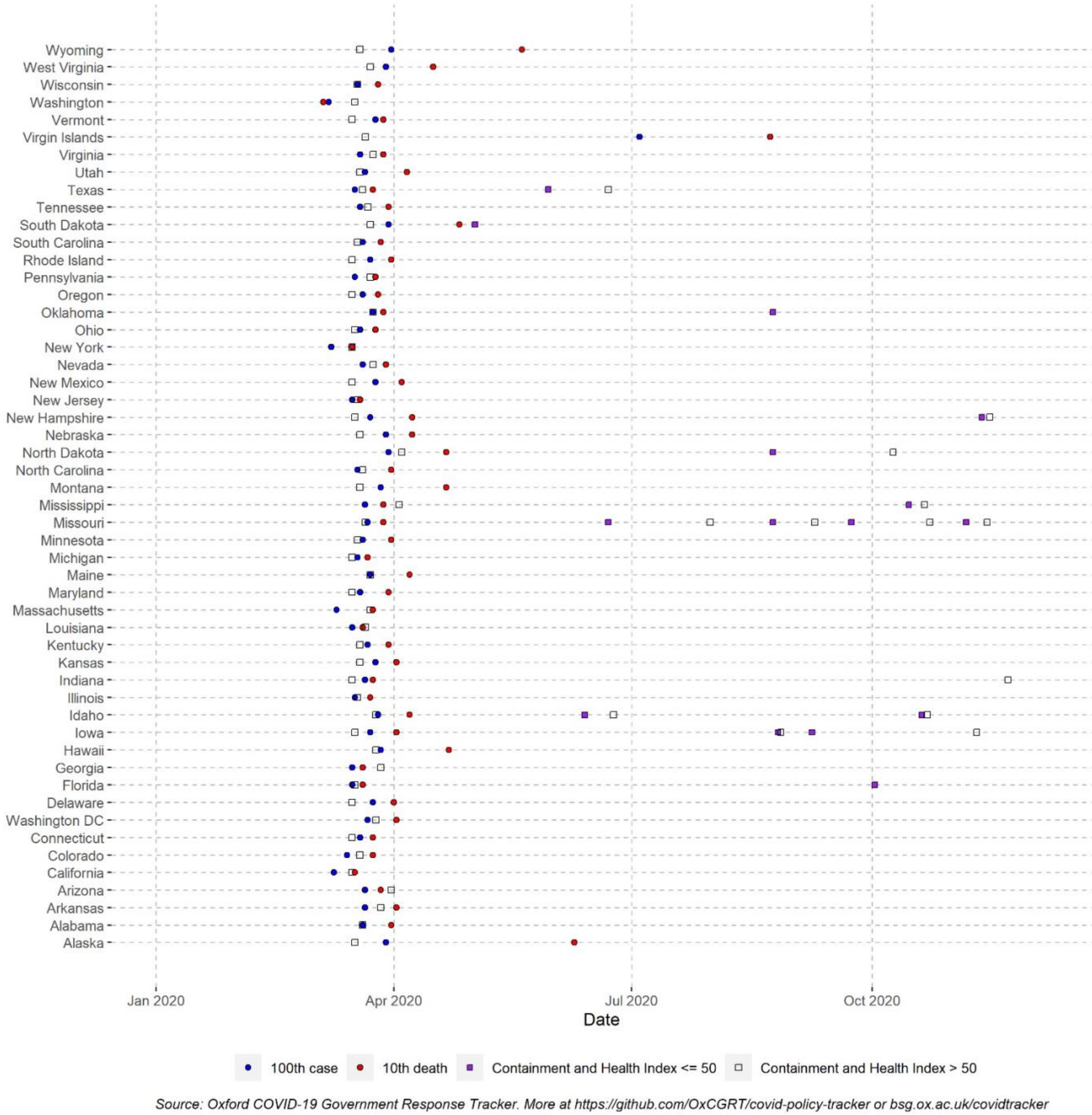


Figure 15: Relationship between case growth per 100,000 and average stringency index since August

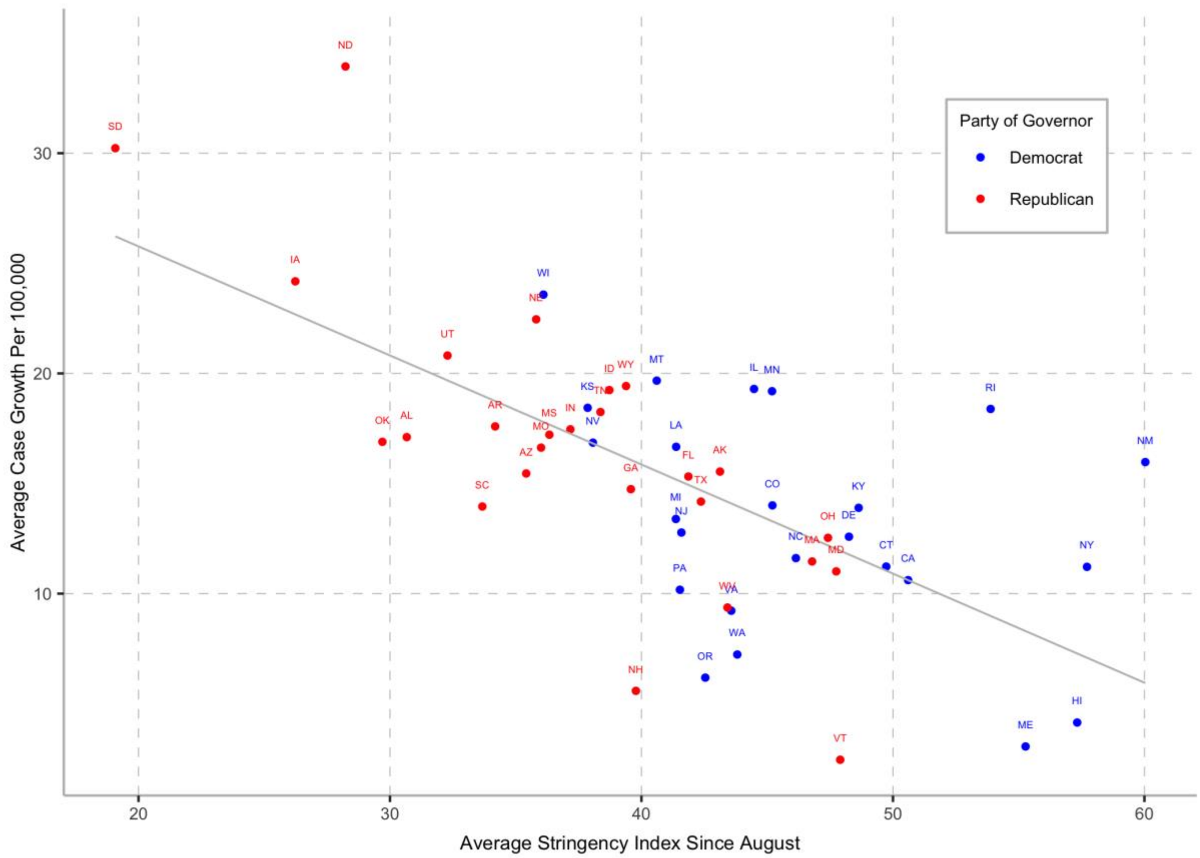


Table 4: Average days of stringency index coded above 50, by US region as of Dec. 14

U.S. census region	**Number of states in region**	**Total days > 50 SI**	**Average days > 50 SI**
Northeast	9	1978	220
South[14]	17	2369	139
Midwest	12	1098	92
West	13	1955	150

[14] Includes Washington DC