

1           **Relationship among state reopening policies, health**  
2           **outcomes and economic recovery through first wave of the**  
3           **COVID-19 pandemic in the U.S.**

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5           **Supporting Information**

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7           **S1. Limitations**

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9           The limitations of this analysis must be considered when our results are interpreted. One  
10          limitation is our classification of state lockdown and reopening interventions into categories  
11          based on the CDC/White House guidelines. State decisions do not always match the guidelines  
12          perfectly. One issue is that each phase of the CDC/White House guidelines includes a number of  
13          different requirements, and for some states it is not obvious to determine the exact date when all  
14          requirements for a phase transition were satisfied. Moreover, in Pennsylvania and several other  
15          states interventions were not implemented in all counties at the same time and were often  
16          conditional on the state of COVID-19 spread or other factors. Another limitation is the  
17          retrospective and observational nature of data in this and other COVID-19 studies, which makes  
18          it difficult to identify the effect of unobserved factors [1]. In particular, the variation in consumer  
19          card spending may not be related with government mandates alone but affected also by other  
20          state-specific factors such as unemployment levels, population densities, local incidence and

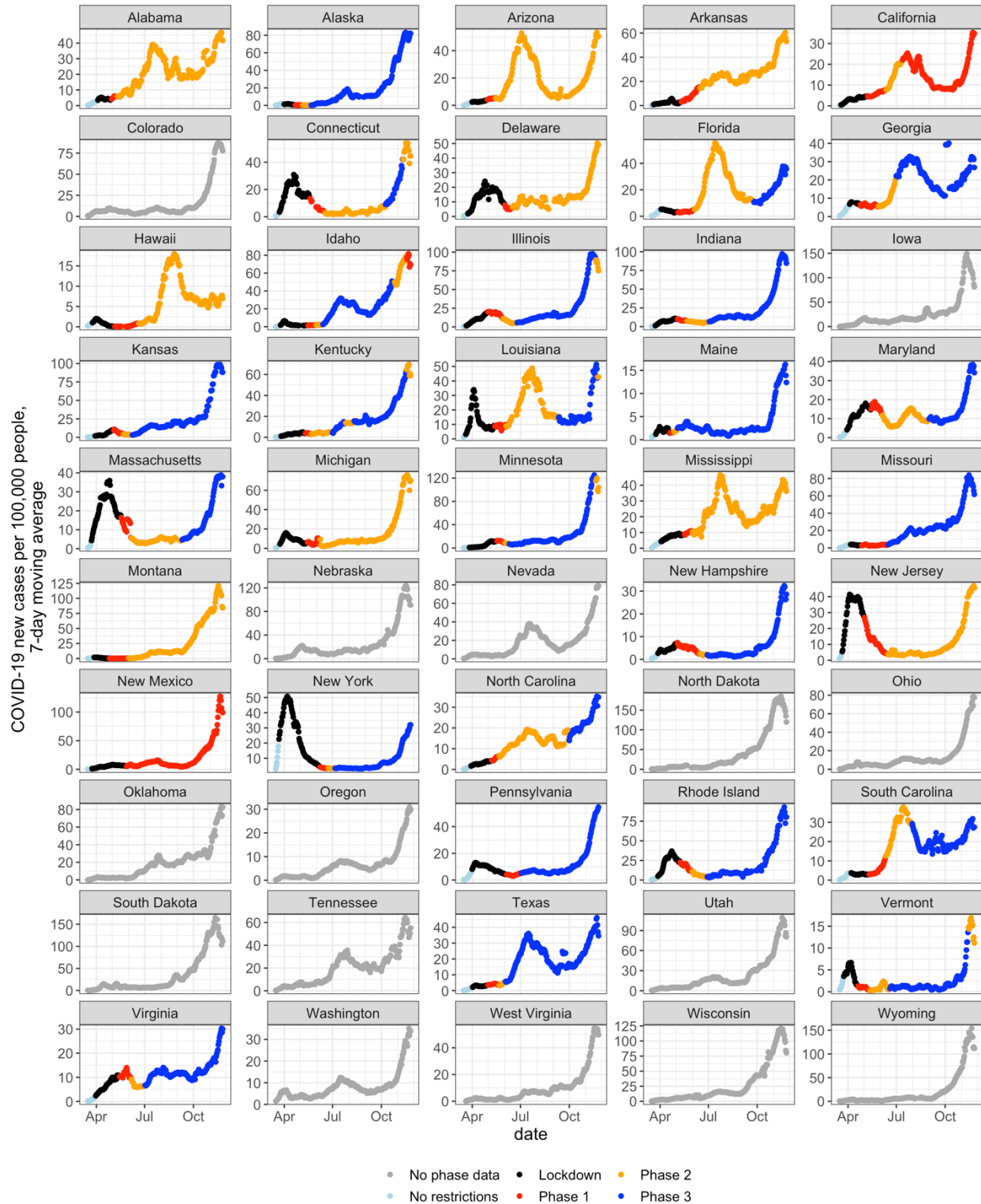
21 prevalence of COVID-19, changing hospital capacities, or even an over-emphasis on attempting  
22 to return to a sense of normality. Although we have added state political majority and state  
23 median income to our difference-in-differences estimate to account for state heterogeneity, we  
24 acknowledge that other unobserved confounding factors may be present.

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## 26 **S2. Results**

27 Trends on COVID-19 spread and consumer card spending for all 50 states

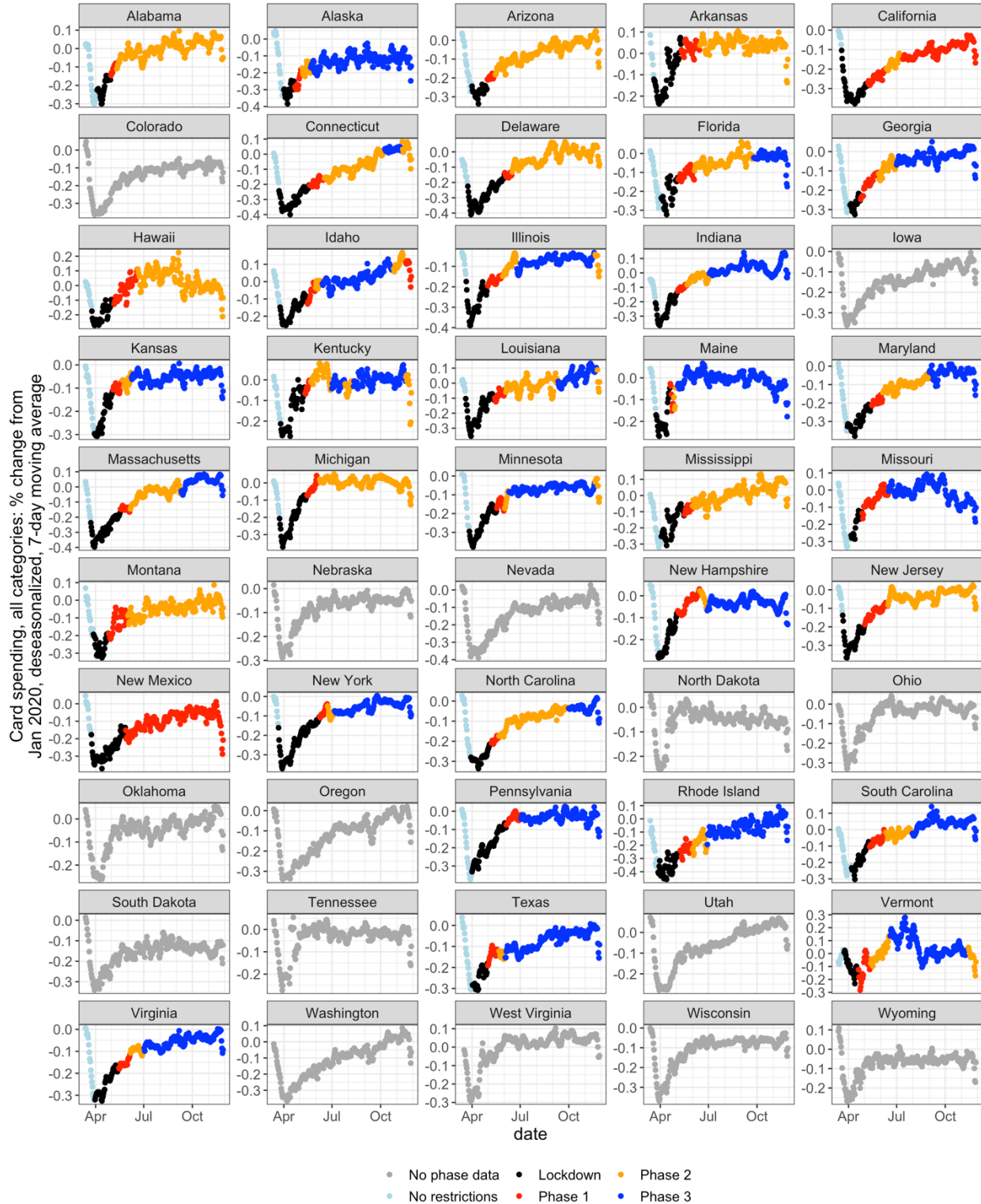
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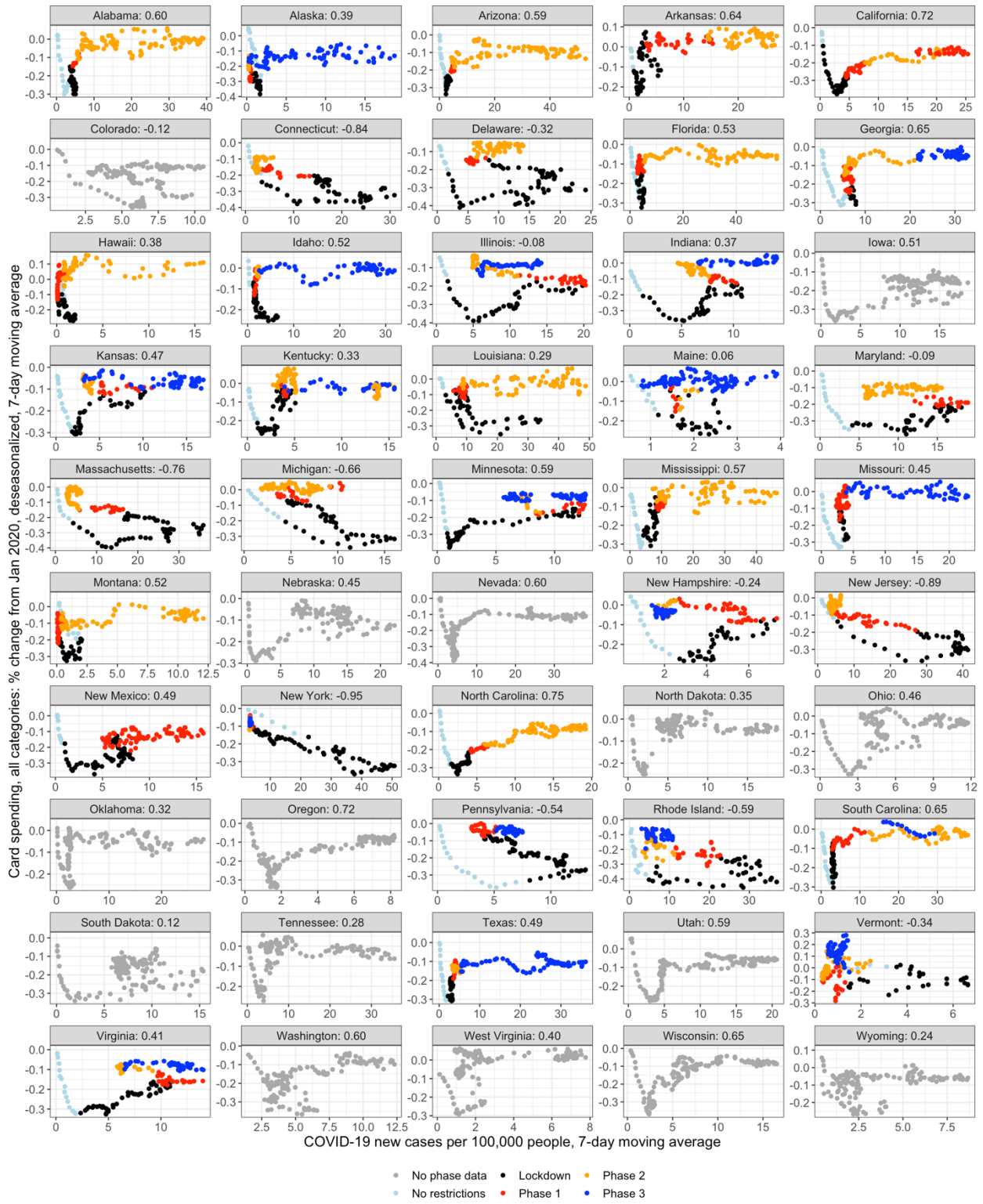
Figure S1. Seven-day moving average of new daily COVID-19 cases per 100,000 people per state. The colors represent our classification of state interventions into the three phases of the White House/CDC reopening guidelines (where phase classification could be performed).

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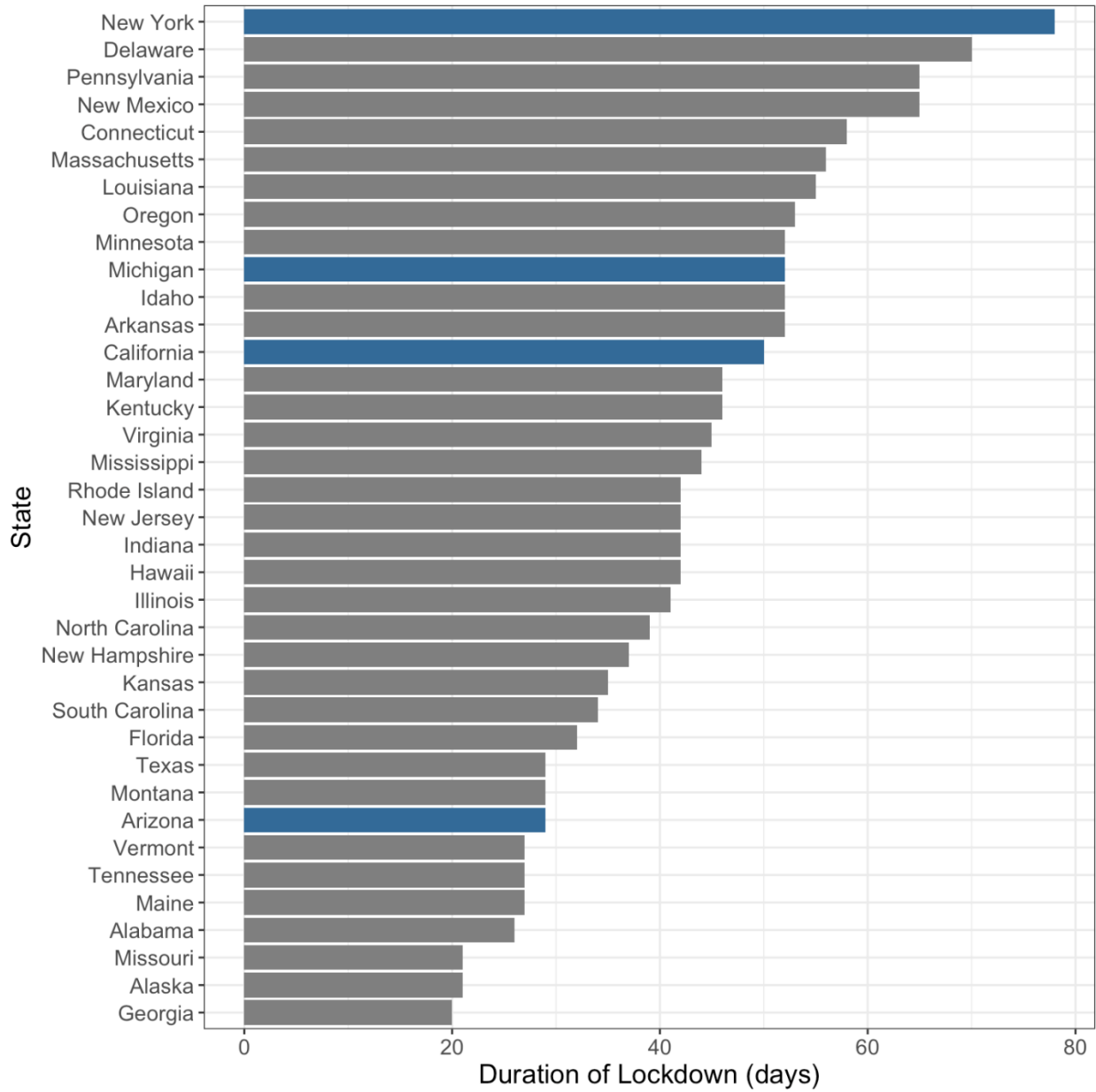


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Figure S2. Seven-day moving average of de-seasonalized change in consumer card spending (relative to January 2020) over time. The colors represent our classification of state interventions where phase classification could be performed.



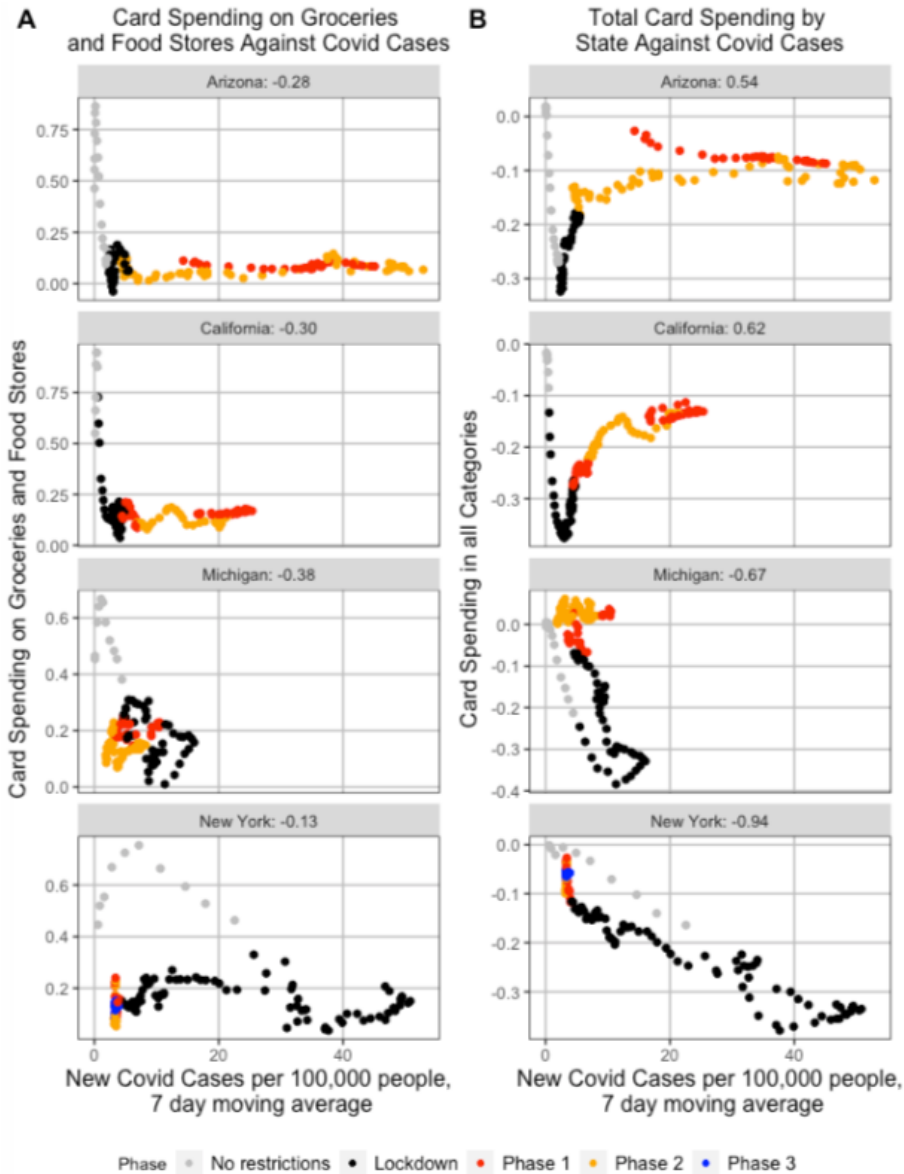
39 *Figure S3. Seven-day moving average of de-seasonalized change in consumer card spending (relative to January 2020) as a*  
 40 *function of seven-day moving average of new daily COVID-19 cases per 100,000 people.*



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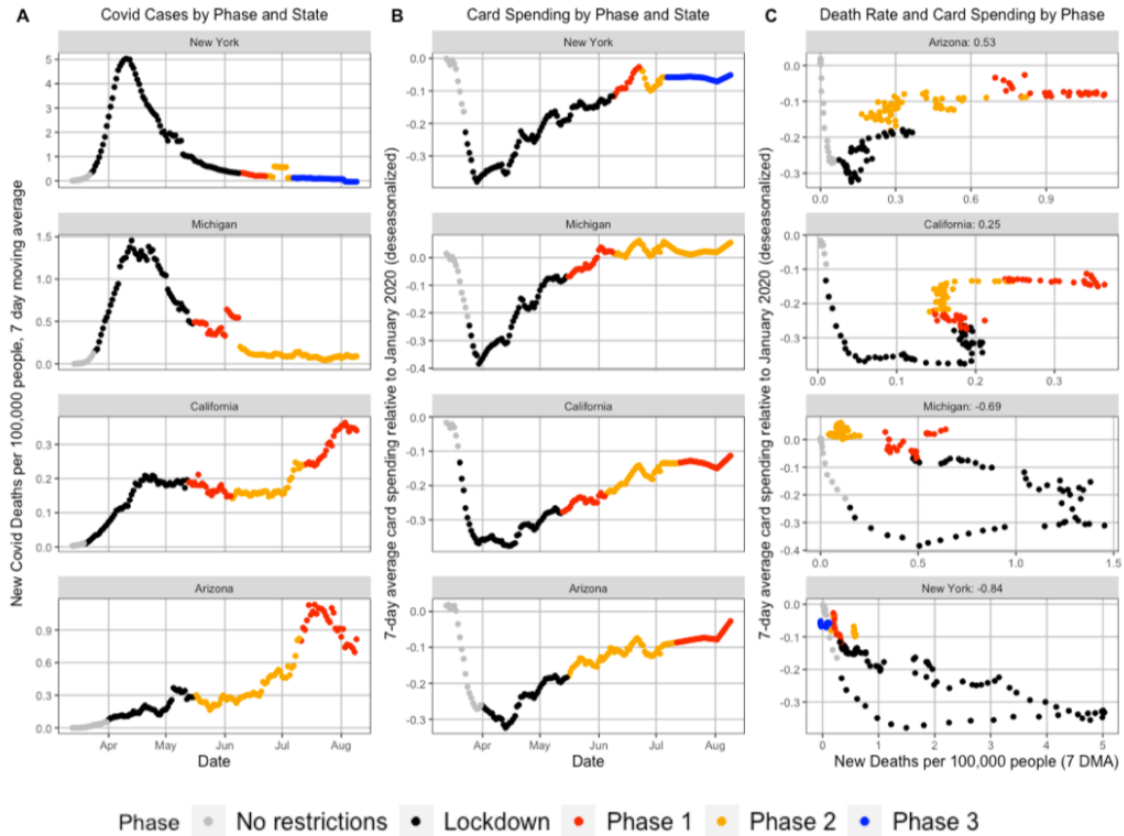
42 *Figure S4. Duration of lockdown (in days) per state between March 13 and August 9, 2020 for the 37 states where we were able*  
 43 *to identify state transitions. The states highlighted (blue) are the examples described in Fig. 1.*

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46 *Figure S5. (A) Seven-day moving average of de-seasonalized change in consumer card spending on groceries and food stores*  
 47 *(relative to January 2020) as a function of seven-day moving average of new confirmed daily COVID-19 cases per 100,000*  
 48 *people. (B) Seven-day moving average of de-seasonalized change in consumer card spending (all categories relative to January*  
 49 *2020) as a function of seven-day moving average of new confirmed daily COVID-19 cases per 100,000 people, in the period*  
 50 *between March 13 and August 9, 2020 for New York, Michigan, California and Arizona. The colors represent our classification*  
 51 *of state policies into lockdown and the three phases of the White House/CDC reopening guidelines.*



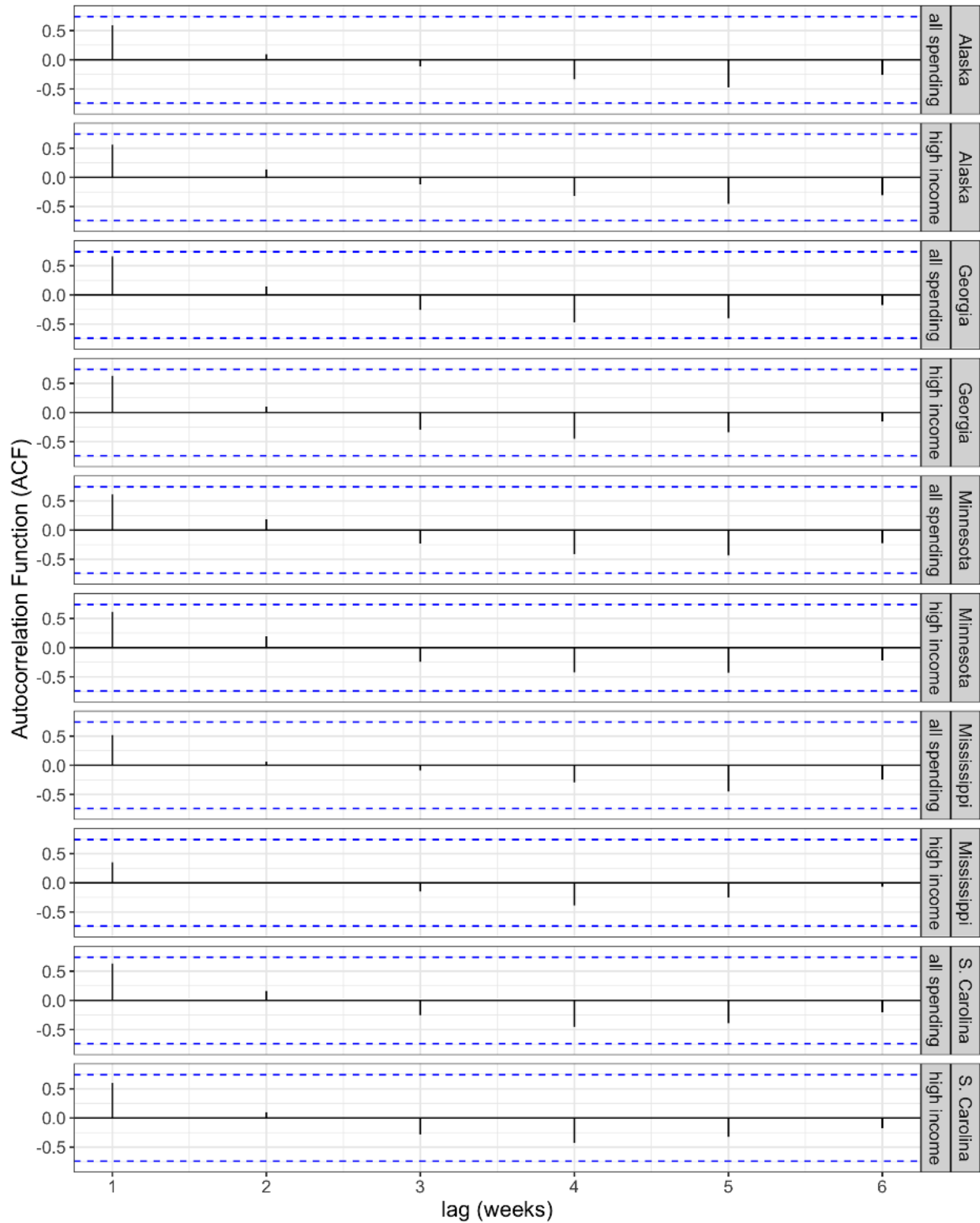
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53 *Figure S6. Temporal Patterns between March 13 and August 9, 2020 for New York, Michigan, California and Arizona of (A)*  
 54 *seven-day moving average of daily COVID-19 deaths per 100,000 people over time. (B) seven-day moving average of de-*  
 55 *seasonalized change in consumer card spending (relative to January 2020) over time. (C) Consumer card spending as a function*  
 56 *of COVID-19 deaths. The colors represent our classification of state policies into lockdown and the three phases of the White*  
 57 *House/CDC reopening guidelines. The Pearson correlations in (C) are -0.84 for New York, -0.69 for Michigan, 0.25 for*  
 58 *California, and 0.53 for Arizona.*

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60 Fig. S7 shows the autocorrelation function of consumer card spending for the states that  
 61 reopened in late April 2020. The leftmost bar in each chart shows that autocorrelation for 1-week  
 62 lag is above 0.5 in most states, indicating that consumer card spending in a week is highly  
 63 correlated with spending in the week before. The strong autocorrelation requires corrections in  
 64 the DiD estimator such as averaging over time recommended in [2] and performed in this paper.

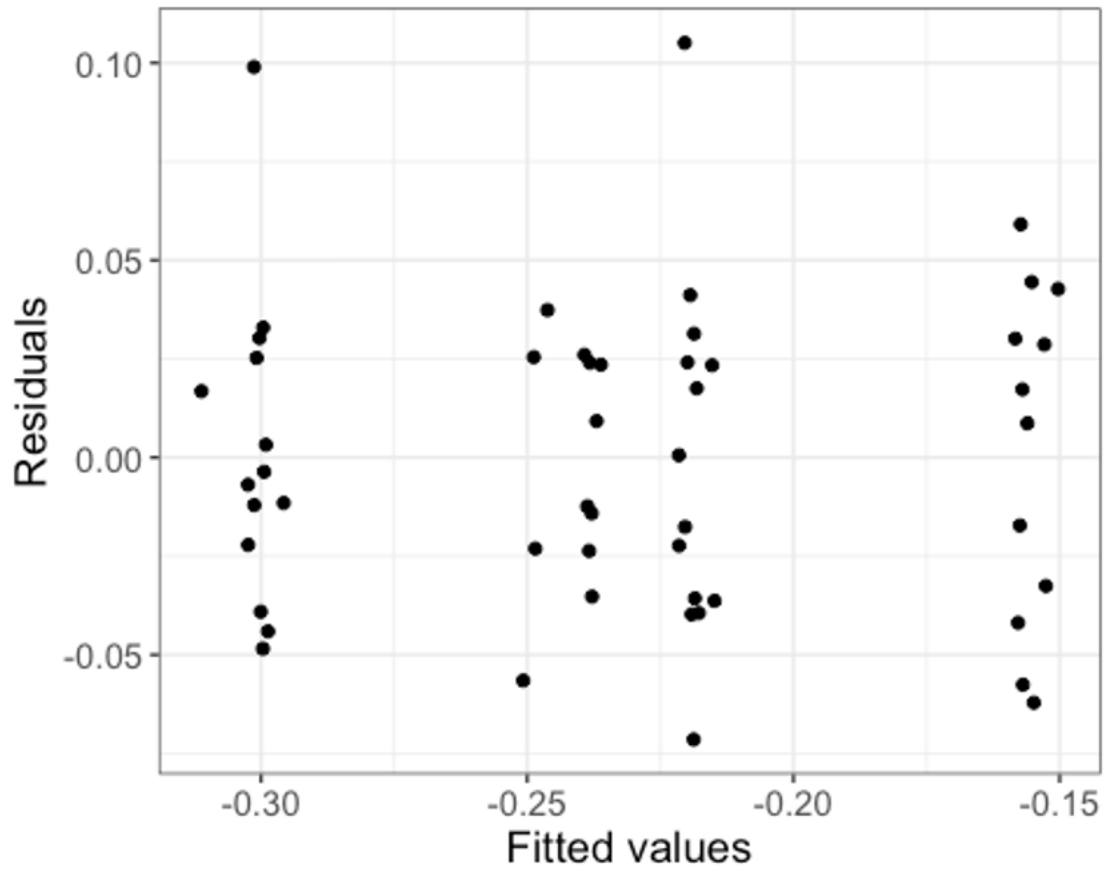
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67 *Figure S7. Autocorrelation in consumer card spending for the period three weeks before and three weeks after April 24<sup>th</sup>, 2020.*  
 68 *The states shown are the “reopening” states considered in the difference-in-differences analysis. “All spending” refers to overall*  
 69 *changes in consumer card spending (relative to January 2020). “High income” refers to the change in card spending by*  
 70 *consumers living at zipcodes in the top quartile of median income.*

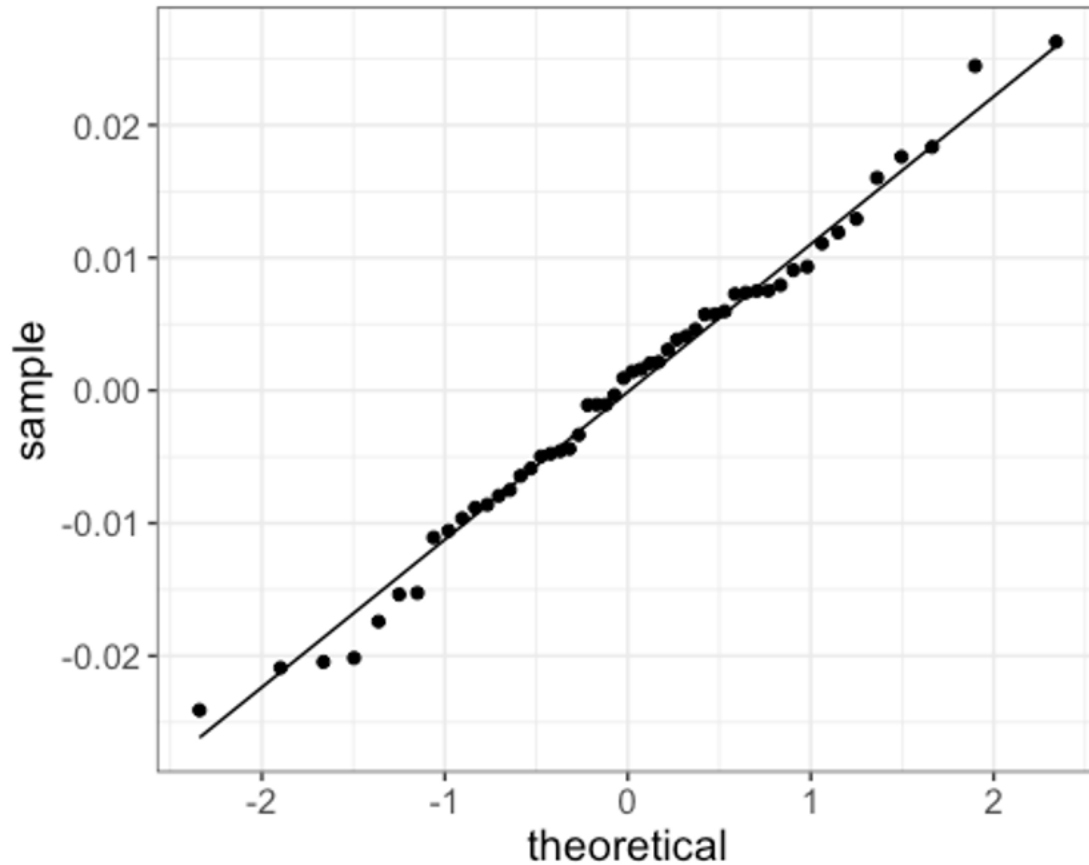
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73 *Figure S8. Scatterplot of the residuals of the difference-in-differences panel regression of overall consumer card spending –*  
74 *model (1) of Table I, as a function of the fitted values of the change in consumer card spending. The plot suggests that the*  
75 *variance of the residuals is approximately constant across fitted values. This suggests homoskedasticity of the residuals, and*  
76 *therefore the standard errors are not underestimated.*

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79 *Figure S9. QQ plot of the residuals of the difference-in-differences panel regression of overall consumer card spending – model*  
 80 *(1) of Table I. Since the regression residuals are approximately distributed on a straight line, the plot indicates that the residuals*  
 81 *are normally distributed, and therefore the regression estimates (especially the standard errors) are reliable.*

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### 83 **S.3. References**

- 84 1. Brauner JM, Mindermann S, Sharma M, Johnston D, Salvatier J, Gavenčiak T, et al.  
 85 Inferring the Effectiveness of Government Interventions Against COVID-19. *Science* (80-  
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