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HEALTH IMPACTS OF FEDERAL PANDEMIC AID TO STATE AND LOCAL GOVERNMENTS

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ABSTRACT

The COVID-19 pandemic led to unprecedented levels of federal transfers to state and local governments. Did this funding impact population health? To answer this question, we leverage the fact that U.S. states that enjoy excess representation in Congress received substantially more fiscal assistance than did relatively underrepresented states. We find that the aid driven by excess representation had substantial impacts on population health. For each $1,000 increase in federal fiscal aid per state resident, we estimate that states experienced 38 fewer deaths from all causes per 100,000 residents from 2020 through 2022, of which 2/3 came from reductions in COVID-19 mortality. We estimate that the last $331 billion in federal pandemic aid, which corresponds with our in-sample variation, generated $591 billion in value through life years saved. Additional aid also reduced rates of COVID-19 related hospitalizations and emergency room visits, though not in the total number of positive cases detected. Plausible mechanisms for these improved outcomes include higher rates of COVID-19 vaccination, which plausibly account for nearly half of the mortality reductions we observe, and higher rates of COVID-19 testing. Medicaid enrollments and hospital capacity do not appear to play substantial mediating roles. Our robustness analyses provide evidence that the effects we estimate cannot be explained by pre-existing mortality trends, by the pandemic's differential impacts on relatively dense vs. rural areas, or by the pandemic's differential impacts on populations with more elderly individuals or with higher prevalence of chronic conditions. The mortality impacts we estimate were substantially greater for non-Hispanic Black Americans than for non-Hispanic White Americans, such that federal funds are associated with a reduction in population-wide health disparities over the course of the pandemic.

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1 Introduction

The COVID-19 pandemic imposed substantial economic costs by both directly impacting health and by reducing economic activity. Early in the pandemic, for example, Cutler and Summers (2020) estimated that the pandemic's 2-year impact would amount to roughly $16 trillion dollars, with similarly sized losses from declines in economic activity and health. Indeed, with the Centers for Disease Control reporting just over 1.2 million deaths from COVID-19 through December 2024 (Centers for Disease Control 2024), the health cost forecast by Cutler and Summers can be accounted for through lost lives alone when assessed using conventional estimates of the value of a statistical life.

The U.S. federal government's effort to mitigate the COVID-19 pandemic's damages were substantial. Across four major pieces of pandemic relief legislation, the federal government authorized roughly $6 trillion in expenditure. The impacts of these expenditures on economic activity have been widely studied.[1] Beyond research on the effectiveness of the COVID-19 vaccines (Schneider et al. 2021), however, relatively little research has addressed the question of whether government spending mitigated the pandemic's health impacts, either in total or in particular for relatively disadvantaged groups. We take this question up with a focus on the fiscal assistance the U.S. federal government distributed to state and local governments.

The COVID-19 pandemic confronted state and local governments with a mix of conventional recessionary pressures and unconventional public health pressures. The conventional recessionary pressures include expectations for declining tax revenues, rises in Medicaid enrollments and expenditures, and strains on states' unemployment insurance systems (Clemens and Veuger 2020*b*, 2021). The less conventional pressures involve additional de-

[1] On the effects of the Paycheck Protection Program, for example, see Hubbard and Strain (2020); Autor et al. (2022); Splinter et al. (2023). On the effects of the Economic Impact Payments, alternatively known as the stimulus checks, see Chetty, Friedman, and Stepner (2024); Parker et al. (2022). On the effects of enhanced unemployment insurance benefit payments, for example, see Ganong et al. (2024); Holzer, Hubbard, and Strain (2024).

mands for health care and public health services that relate directly to the pandemic's threat to population health.

Federal aid to state and local governments was meant to address both the conventional and unconventional pressures of the pandemic. As described by Deputy Secretary of the Treasury Wally Adeyemo in the release of the final rule on State and Local Fiscal Recovery Funds, for example, "[the COVID-19 relief funds] ensure that governments across the country have the flexibility they need to vaccinate their communities, keep schools open, support small businesses, prevent layoffs, and ensure a long-term recovery." State and local relief was thus meant to finance the public health response to the pandemic, to support the routine activities of state and local governments, and, more broadly, to support economic activity.

Studying the effect of federal fiscal aid on health outcomes, as is our focus, is difficult due to standard endogeneity and omitted-variable concerns. Aid will tend, at least to some degree, to be targeted towards states in greatest need, which will tend to bias estimates of aid's impact on health outcomes towards less desirable values. To overcome this challenge, we employ an instrumental variables strategy. Following Clemens et al. (2024) and Clemens et al. (2023), who study the effect of aid on states' budgets and macroeconomic activity, we leverage the fact that pandemic assistance varied based on Congressional representation. In particular, as shown by (Clemens and Veuger 2021), an additional senator or representative per million residents predicts roughly $1,000 dollars in additional aid per capita. By predicting aid levels using Congressional representation as an instrument, we seek to isolate the effect of federal fiscal aid on health outcomes.

We find that the aid driven by excess representation had substantial impacts on population health. For each $1,000 increase in federal fiscal aid per state resident, we estimate that states experienced 38 fewer deaths from all causes per 100,000 residents, of which 2/3 came from reductions in COVID-19 mortality. They also experienced substantially fewer COVID-19 related hospitalizations and emergency room visits per 100,000 residents. Plausible mechanisms for these improved outcomes include substantially higher rates of COVID-19 testing and moderately higher rates of COVID-19 vaccination. Further, the mortality impacts we estimate were greater for Black Americans than for non-Hispanic Whites, such that federal funds are associated with a reduction in population-wide health disparities over the course of the pandemic. Through our event-study estimation framework and assorted robustness checks, we provide evidence that the effects we estimate cannot be explained by the pandemic's differential impacts on relatively dense vs. rural areas, on populations with more elderly individuals, on populations with a higher prevalence of chronic conditions, on relatively Republican versus relatively Democratic leaning areas, by baseline differentials in pandemic response preferences, or by pre-existing differences in mortality trends.

This paper makes three primary contributions. First, the most direct implications of our analysis relate to the role of state and local governments in pandemic response within the US federal system. At the pandemic's outset, estimates from a number of sources projected that state and local revenue shortfalls would rise easily into the hundreds of billions and might reach as high as $1 trillion dollars (Auerbach et al. 2020; Bartik 2020; McNichol, Leachman, and Marshall 2020; Clemens and Veuger 2020*b*,*a*; Whitaker 2020). Subsequent research has turned to the question of what state and local governments did with their federal dollars and what impact these actions had on outcomes of interest to policy makers. Clemens et al. (2024) study how states utilized their federal funds. Clemens, Hoxie, and Veuger (2022) and Clemens et al. (2023) estimate the effect of aid on state and local government employment and on the roll out of COVID-19 testing and vaccination operations. Our analysis provides the first evidence on the effectiveness of federal transfers to state and local governments in mitigating the pandemic's severity, alongside supportive analysis of the potential role of several mechanisms. In doing so, it also informs the relative efficacy of various pandemic response measures in reducing mortality, suggesting that direct federal transfers to state and local governments had larger mortality impacts than mandated non-pharmaceutical interventions (NPIs) (Agrawal et al. 2021; Stype, Yaya, and Osika 2023; Herby, Jonung, and Hanke 2023).[2]

Second, our paper adds to a body of research on cost-benefit analyses of policy interventions for which health gains have the potential to be as, if not more, impactful than narrowly defined financial or other economic gains. The relative importance of health versus financial gains has been an ongoing source of debate, for example, in welfare analysis of public policy towards health insurance, where health gains have sometimes been found to be surprisingly illusory (Finkelstein et al. 2012; Finkelstein and McKnight 2008). Nonetheless, sizeable health gains have been documented in recent studies of the Affordable Care Act (Miller, Johnson, and Wherry 2021) and of an intervention designed to increase insurance uptake among individuals who are eligible for substantial subsidies (Goldin, Lurie, and McCubbin 2021). The importance of documenting and accounting for health impacts has also emerged in recent analyses of disability insurance benefits (Gelber et al. 2023), cash equivalent benefits (Hoynes, Schanzenbach, and Almond 2016; Bitler and Currie 2005), environmental regulation (Currie and Walker 2019), as well as seemingly less health-oriented programs including student employment (Gelber, Isen, and Kessler 2016). In our analysis, we estimate that the last $331 billion in federal pandemic aid, which corresponds with our in-sample variation, generated $591 billion in value through life years saved.[3]

[2]Herby, Jonung, and Hanke (2023)'s meta-analysis concludes that mandated shelter-in-place policies led to COVID-19 mortality reductions that, at most, are only half as large as the reductions we find for federal aid to state and local governments in a conservative counterfactual that we present in Section 4.4. Other prominent analyses of shelter-in-place policies, e.g., Agrawal et al. (2021), find no evidence of an effect on all-cause mortality. Studies of the effects of other NPIs, such as school closures, bar and restaurant closures, and mask mandates find COVID-19 mortality reductions that tend to be small in magnitude, with evidence often limited and inconsistent across papers, whether the analyses consider such interventions in isolation or in combination, e.g., by aggregating across individual NPIs into indices (Herby, Jonung, and Hanke 2023; Stype, Yaya, and Osika 2023).

[3]This estimate is derived using inputs from Table 9 panel C which employs the assumption that a death averted within an age group would translate into a gain of the life expectancy at the median age of that group with an additional downward adjustment for quality of life, utilizing the Department of Health and Human Services' central value of a statistical life (VSL). The table presents benefits (in millions of $) for the last $100 million in federal aid or for 100,000 residents. To calculate the dollar value of benefits for the full 2020 U.S. population of 331.4 million, then, we multiple the estimates in the table by 3,314. The same calculation for our most conservative assumption (panel D, low VSL) yields total benefits of $167 billion and that for our least conservative assumption (panel A, high VSL) yields total benefits of $1.040 trillion.

Finally, our paper contributes to research on the drivers of disparities in health outcomes and the role of government programs in alleviating gaps between the health outcomes of individuals from disadvantaged groups relative to advantaged groups. Members of disadvantaged groups are often poised to enjoy the greatest mortality gains from effective interventions, as has been seen in analyses of Medicaid's enactment (Goodman-Bacon 2018) as well as subsequent Medicaid expansions (Wherry and Meyer 2016). In the pandemic context, it has been documented that Black and Hispanic Americans initially experienced substantially higher rates of excess all-cause mortality (Alsan, Chandra, and Simon 2021). We find that states that received more federal funds experienced particularly strong reductions in mortality among non-Hispanic Black Americans. As detailed in Section 4.2, our estimates suggest that the last $1,000 in federal aid per resident, or $331 billion nationwide, narrowed the age-adjusted COVID-19 mortality gap between non-Hispanic Black and White Americans by 21.6 percent.

The remainder of this paper proceeds as follows. In Section 2 we present the data we analyze. In Section 3 we present our estimation frameworks. In Section 4 we present our results and in Section 5 we conclude.

2 Data

This section provides an overview of the data sources used for our analyses. Section 2.1 discusses the sources for the outcomes we analyze, Section 2.2 describes our measure of fiscal aid, Section 2.3 describes our instrument, and Section 2.4 discusses the sources for covariates that are included in our analysis. A more detailed discussion of data sources and variable construction is provided in Appendix C. Summary statistics for the variables used in our primary analyses can be found in Tables 1 and 2.

2.1 Outcomes

Our primary outcomes of interest are mortality from all causes and from COVID-19. We construct these measures using data from the Centers for Disease Control's (CDC) Wonder database for yearly (or monthly) contemporaneous deaths in both categories. We construct a death rate per 100,000 state residents by dividing the deaths by the state's population in 2019 and multiplying by 100,000.[4] We use the 2019 state population from the CDC Wonder as a constant population scaling measure throughout the years to avoid incorporating population changes that may be endogenously determined by the severity of the pandemic.[5]

Additional health outcomes in our analysis include hospital admissions and emergency department visits attributed either to all causes or to COVID-19. For all causes, we obtain these state-level data from the Kaiser Family Foundation (KFF) State Health Facts. For COVID-19, these metrics are available at the hospital level from the HHS COVID-19 Reported Patient Impact and Hospital Capacity by Facility dataset. We construct our state-level measures by aggregating hospital level measures by state and year for hospitals that reported for at least 127 of the 130 total weeks, retaining 95.2% of all hospitals in the data. Data for COVID-19 cases are from the Hopkins Center for Systems Science and Engineering (CSSE).

In our analyses of mechanisms, we obtain data on monthly number of COVID-19 vaccine doses administered from the CDC and tests administered from the Hopkins CSSE. For some analyses we aggregate these data to generate annual observations. Tests include total viral and antigen tests administered in 89% of state-years and only viral tests in 2% of the state-years, with no data available for the remaining 9% of state-years. To understand the rate at which tests convert to positive cases, we construct a ratio of COVID-19 cases to tests

[4] Although the focus of our analyses is this crude death rate, we account for differential age compositions in states by adding a covariate for the share of a state's population ages 65 and above. We also directly use age-adjusted death rates from the CDC or age-adjusted death rates that we construct ourselves as outcomes (see Tables 6, B.6 and B.7).

[5] We use the 2020 CDC population to scale fiscal aid per capita and Congressional representation per million residents since it is more plausible to think that this is the population underlying Congressional decision making on fiscal aid disbursement. For the same reason, we use the 2020 state populations as population weights wherever we incorporate them.

using the aforementioned case data and testing data from the Hopkins CSSE. Data for hospital beds are obtained from the KFF State Health Facts. Separately, we obtain data on total Medicaid and CHIP enrollments from the Centers for Medicare and Medicaid Services (CMS).

Our analysis also considers heterogeneity in mortality effects and vaccination by age, gender and race. Data for mortality within each demographic category are obtained from the CDC Wonder database just as they are for overall mortality. The population data by which these within-group deaths are scaled for analyses of group-specific death rates (as in Tables 5, 6, B.7, B.6 and B.10 and Figures A.6 and A.7 and A.10) are the group's own population in the 2019 CDC Wonder. For analyses in which we decompose total mortality across groups (as in Table B.11), we scale each group's deaths by the total 2019 state population. Data on vaccination by age and gender are obtained from the CDC whereas data on vaccination by race are obtained from the National Immunization Survey reports. The definitions of vaccination used in these heterogeneity analyses are either the number of individuals with at least one dose of a COVID-19 vaccine by gender or age, or the share of individuals belonging to a given racial group that had taken at least one dose of a COVID-19 vaccine. These definitions capture in spirit the same concept as, but technically differ from, the definition of vaccination in the analyses of overall mechanisms. Additionally, while almost all of our data sources are administrative and capture a close proxy of the universe of data for that outcome, the data on vaccination by race are from a survey and are thus subject to all the usual concerns about survey data reliability.

2.2 Fiscal Aid

Our measure of federal aid to state and local governments reflects spending authorized by the four major pieces of relief legislation that were passed during the COVID-19 pandemic: the CARES Act, the Families First Coronavirus Response Act (FFCRA), the Response and

Relief Act (RRA), and the American Rescue Plan Act (ARPA).[6] In particular, our analysis focuses on the nearly $1 trillion in funds that were allocated by these bills to state and local governments. As in Clemens and Veuger (2021) and Clemens et al. (2023), data from the Committee for a Responsible Federal Budget (2021) form the basis of our fiscal assistance variable, supplemented by information from several additional sources.[7] Our analysis focuses on the grand total of aid committed to each state across all four major pieces of COVID-19 fiscal relief.[8] That is, our main independent variable is the grand total of aid allocated to each state per resident in thousands of dollars.

2.3 Instrument

We use a state's number of Congressional representatives per million residents as our measure of Congressional representation. Rosters of the House of Representatives and Senate during the 116th and 117th Congresses come from Lewis et al. (2021). We note that because 2020 Congressional representation was allocated according to state population from the 2010 census, Congressional representation is not affected by variations in population driven by the COVID-19 pandemic. Variations in aid distributions and Congressional representation across states are displayed in Figure 1.

[6]The Response and Relief Act is Division M of the omnibus Consolidated Appropriations Act of 2021 (H.R. 133).

[7]We use data from the CRFB's COVID-19 Money Tracker as of August 19th, 2021. As in Clemens and Veuger (2021), "[w]e obtain information on the distribution of transit funds for the RRA and ARPA from the US Federal Transit Administration (2021). Data on the allocation of ARPA assistance to nonpublic schools come from the US Office of Elementary and Secondary Education (2021). We obtain estimates of ARPA Section 9817 matching increases from Chidambaram and Musumeci (2021). We approximate the allocation of ARPA Section 9819 federal matching funds for uncompensated care using FY2021 estimates of federal disproportionate share hospital allotments by state from the Medicaid and Chip Payment Access Commission (2021)." The Coronavirus Capital Projects Fund outlined in ARPA is distributed according to guidance from the United States Department of the US Department of the Treasury (2021*a*).

[8]The main drivers of our identifying variation are state level appropriations in the CARES Act and the ARPA which allocated substantial aid through funding formulas that included floor functions. Additionally, we focus on cross-state variation and not sub-state variation because federal funds to counties were largely allocated in amounts proportional to population, and allocations to cities were in some instances at the discretion of states.

2.4 Covariates

Our baseline regression specification includes two covariates. The first, which proxies for an area's natural susceptibility to the pandemic's spread, is population density, which we construct using the 2019 state population numbers from CDC Wonder and the state's land area in square miles in 2020 from the U.S. Gazetteer Files.[9] As a proxy for the state's political preferences, which correlate strongly with vaccine hesitancy and variations in preferences for various pandemic mitigation measures, we also include the share of the state's votes that went to Donald Trump in the 2016 presidential election, constructed using data from the MIT Election Lab. In additional analyses, we test the robustness of our key results to the exclusion of these baseline covariates and, separately, to the inclusion of additional covariates. A first added covariate is a proxy for states' chronic disease burdens as measured by the 2019 death rate for diabetes from the CDC's Chronic Disease Indicators tool. A second, which also proxies for population vulnerability to COVID-19 mortality, is the share of each state's population ages 65 and above, which is constructed using 2019 population from the CDC Wonder. A third, which proxies for states' baseline pandemic response preferences, is the March 2020 average of the Oxford Stringency Index, a measure of economic restrictions that we obtained from data used in Clemens et al. (2023).

3 Methods

The goal of our analysis is to estimate the causal effect of federal aid to state and local governments on population health outcomes. A general difficulty in estimating the effects of pandemic fiscal assistance is that fiscal assistance may have been targeted, at least to some extent, towards the states in greatest need. Naïve regressions of health outcomes on aid

[9] In addition to using this conventional measure of population density, we also implement specifications with a county-population weighted measure of each state's population density, which may in principle be an even stronger proxy the severity COVID-19's potential spread, but turns out in practice to have no stronger predictive power than the more conventional measure.

would thus tend to yield estimates that are biased towards negative outcomes (e.g., higher rates of mortality and hospitalization or lower rates of testing and vaccination).

As a solution to this endogeneity problem, we emphasize reduced form estimates of the relationship between health outcomes and an instrumental variable, as well as results from the associated two-stage-least-squares (2SLS) instrumental-variables (IV) estimation framework. The instrument we propose makes use of the fact that federal aid distributions were far more generous to states that enjoy overrepresentation in the U.S. Congress. This arises primarily from the U.S. Senate's overrepresentation of individuals from low-population states, though house apportionment also plays a minor role. Appendix Figure A.1 displays the relationship between per capita representation and per capita federal funding, showing that the statistical fit is strong and roughly linear throughout the distribution.

Appendix Figure A.1 connects directly to the first stage of the IV estimator we present below. As shown in earlier work (Clemens et al. 2024; Clemens, Payson, and Veuger 2024), and as reproduced in our analysis, an additional Senator or representative per million residents was associated with an additional \$1,000 in federal aid per state resident across the four major pieces of fiscal relief legislation. While much of our analysis presents the reduced form relationship between health outcomes and overrepresentation, it is useful to keep this estimate of \$1,000 per additional Senator or representative in mind for purposes of scaling, as this is the first stage relationship we estimate when implementing the 2SLS framework described below.

Before discussing our 2SLS framework, we begin by discussing the reduced form analyses we implement to generate our initial sets of results. For reasons discussed below, we find it useful to present both "cumulative" impacts and the associated sets of "contemporaneous" impacts. Both cumulative and contemporaneous impacts can be derived from the following event-study framework:

$$\text{Health Outcome}_{s,t} = \phi_s + \phi_t + \sum_{t \neq 2019} \rho_t \text{Reps Per Million}_s \times \text{Time}_t + X_{s,t}\gamma + \epsilon_{s,t} \qquad (1)$$

where ϕ_s and ϕ_t are state and time fixed effects, respectively, and where $X_{s,t}$ is a vector of covariates, which typically consists of pre-pandemic, time-invariant, state-level covariates that are interacted with a set of time dummy variables.[10] The coefficients ρ_t, on interactions between Reps Per Million$_s$ and a set of time dummy variables, trace out the relationship between Reps Per Million$_s$ and Health Outcome$_{s,t}$ over time. Because the interaction between Reps Per Million$_s$ and 2019 is omitted, each ρ_t can be interpreted as a continuous difference-in-differences style estimate of the relationship between representation and health outcomes in the reference period relative to 2019. While the bulk of our estimates utilize annual data, we also study our key outcomes (namely mortality, vaccination and testing) at the monthly level. For both our annual and monthly analyses, we use the full 2019 calendar year as the base period, as we have found that using a single month as the base period results in precision losses.

While the bulk of the analyses we present conclude with data from 2022, our initial presentation of estimates of equation 1 uses mortality data that extend through 2023. As shown later, this analysis reveals that the contemporaneous relationship between representation and both COVID-19 and all-cause mortality is an economic and statistical 0 in 2023. With respect to our estimates of cumulative effects, the inclusion of 2023 data thus reduces precision while not impacting the point estimate. Additionally, we note that the quality of data related to pandemic-specific outcomes including testing, vaccination, and COVID-19 specific hospitalizations deteriorated significantly in 2023, making 2022 an attractive stopping point for many of the outcomes we analyze.

In our annual analyses, the coefficients ρ_{2020}, ρ_{2021}, and ρ_{2022} are thus estimates of the causal effect of additional representation on health outcomes during the pandemic. Each of these three coefficients can be described as a contemporaneous effect, while the sum of ρ_{2020}, ρ_{2021}, and ρ_{2022} can be described as an estimate of the cumulative effect through 2022. We

[10] We typically anchor our covariates, as described in Section 2.4, to a single point in time prior to the pandemic to avoid capturing potential effects of the pandemic on the covariate levels.

emphasize at the outset that for our outcome of greatest interest, namely all-cause mortality, estimates of ρ_{2020}, ρ_{2021}, and ρ_{2022} in the event-study framework of equation 1 have a natural interpretation as estimates of the effects of additional representation on excess mortality.[11] Next, we note that estimates of ρ_{2016}, ρ_{2017}, and ρ_{2018} provide evidence of whether the health outcomes of interest moved on parallel trends in over- relative to under-represented states during the years prior to the pandemic.

Note that the identifying assumption underlying this reduced form framework mirrors the exclusion restriction that will apply to the associated 2SLS estimator, in which we use Reps Per Million_s as an excluded instrument. That is, conditional on any additional covariates in our model, Reps Per Million_s must be uncorrelated with health outcomes through other channels. A number of pieces of evidence support the plausibility of this assumption.

First, we emphasize that the event-study estimator provides a standard platform for testing for the relevance of pre-existing trends that differ when comparing relatively over- and under-represented states. A challenge facing research on the effects of the pandemic is that for pandemic-specific outcomes, it is of course not possible to generate informative estimates of pre-existing trends. Our initial outcome of interest is all-cause mortality, which is an outcome for which differential pre-existing trends are directly testable. The fact that we find statistical and economic null relationships between our over-representation instrument and pre-pandemic changes in all-cause mortality supports the validity of our research design. Our ability to conduct such a test is an advantage of the present analysis relative to pandemic research for which pandemic-specific outcomes are the primary or exclusive focus. We also analyze COVID-19 mortality specifically, however, as well as mechanisms including rates of COVID-19 testing and vaccination. For these outcomes, we acknowledge that the event-study's test for pre-existing trends is uninformative, as the outcomes are uniformly 0 for all pre-pandemic years and months in our analyses. For these outcomes, it is our analyses of the

[11] Excess mortality captures deaths at a given location and time that occur during an atypical period of crisis, in excess of projections based on historical trends for that location (World Health Organization 2025).

robustness of our estimates to controlling in various ways for pandemic-specific factors that provide informative tests for the validity of our estimates. We further discuss the nature of this evidence in what follows.

Second, we show in Appendix Table B.1 that our instrument is uncorrleated with pre-pandemic (2019) levels of all-cause mortality, the fraction of states' population age 65+, and death rate from diabetes. The latter two variables proxy for population susceptibility to mortality from COVID-19. Additionally, earlier work has shown the variation in federal aid driven by over- and under-representation was unrelated to a number of plausible correlates of the needs states faced as a consequence of the pandemic. Clemens and Veuger (2021) show, in particular, that the small-state advantage is more or less orthogonal to state and local government funding needs as proxied by forecasts of pandemic-driven revenue shocks, pandemic-driven economic shocks, and the size of their public sector at baseline. This earlier paper shows that controlling for these proxies for need has little effect on the relationship between federal aid distributions and our instrument. It is thus unlikely that any effects on mortality or other mechanisms we estimate are in fact caused by these or similar other factors.

Third, we directly explore the robustness of our analysis by ruling out a role for some of the primary dimensions along which the pandemic differentially impacted states' economies. First, as is widely recognized, tourism-intensive states like Nevada, Hawaii, and Florida suffered more dramatically from the pandemic's initial impacts on their overall economic activity. Second, as noted by Clemens et al. (2024), the pandemic's early impacts on oil and gas prices, as well as on the initiation of new resource extraction activity, had a substantial impact on the revenues of Alaska, Wyoming, and North Dakota, which rely to a far greater degree on severance and other resource-related revenue streams than other states. We explore robustness to the potential relevance of these issues by showing that our results are little changed if we drop the most impacted states from the sample. We also show that our results are robust to whether or not we control for time-varying impacts of plausibly exogenous pre-pandemic proxies for variations in political and pandemic-policy preferences, for population density, or for variations in the prevalence of comorbidities or in the age distribution of states' populations.

Additionally, because equation 1 can be described as difference-in-differences style estimation with a continuous treatment, we consider the implications of the "strong parallel trends" assumption as articulated by Callaway, Goodman-Bacon, and Sant'Anna (2024). While it is, of course, not possible to test directly for whether higher-treatment states would have followed the same path as lower-treatment states had they received lower doses of treatment, it is possible to check in a more granular fashion for whether these groups were on similar pre-treatment trends. Our robustness analysis presents evidence on this question. We further acknowledge the caveat that it is not possible to test directly for whether the "dose response" is constant across values of the instrument, as the strong parallel trends assumption requires. We return briefly to this issue in our discussion of the leading mechanisms for which we find supporting evidence, namely increased rates of testing and vaccination.

In addition to the event-study framework described by equation 1, we present complementary estimates of cumulative reduced form effects using the equation below:

$$\text{Health Outcome}_{s,2022} = \gamma_0 + \gamma_1 \text{Reps Per Million}_s + X_s \gamma + \epsilon_s, \tag{2}$$

where Health Outcome$_{s,2022}$ are constructed to capture cumulative mortality or other cumulative outcomes from the beginning of the pandemic through the end of 2022. For all-cause mortality, we subtract a state's 2019 mortality from each of its 2020, 2021, and 2022 mortality such that γ_1 can, like estimates of ρ_{2020}, ρ_{2021}, and ρ_{2022} from equation 1, be interpreted as causal effects on excess mortality. Because COVID-19 mortality, testing and vaccination rates uniformly take values of zero prior to 2020, the event-study estimates of equation 1 and the cross-sectional cumulative estimates of equation 2 are more obviously comparable.[12]

[12] More specifically, both the outcomes and covariates (X) are defined such that γ_1 from equation 2 equals the sum of ρ_{2020}, ρ_{2021}, and ρ_{2022} from equation 1. With respect to covariates, it may be worth noting here that the vector $X_{s,t}$ from 1 consists

Finally, we present an equivalent set of cumulative cross-sectional estimates using the 2SLS framework described by the following set of equations:

$$\frac{\text{Total Aid}_s}{\text{Pop}_s} = \gamma_0 + \gamma_1 \text{Reps Per Million}_s + X_s\gamma + \epsilon_s \tag{3}$$

$$\text{Health Outcome}_{s,2022} = \beta_0 + \beta_1 \widehat{\frac{\text{Total Aid}_s}{\text{Pop}_s}} + X_s\beta + u_s \tag{4}$$

The validity of this instrumental variables estimation framework depends on two factors. As noted above, the exclusion restriction requirement mirrors the identifying assumption for our reduced form estimation frameworks. Consequently, we do not further discuss this assumption. The second requirement is that Congressional representation must be a strong, or relevant, predictor of the amount of aid each state received per resident. This fact has been established by Clemens and Veuger (2021), who explain that the bias toward overrepresented states in federal funding arose in large part from the use of floor functions similar to those used to determine Congressional representation in the otherwise proportional-to-population formulas for distributing general purpose fiscal relief.[13]

The formal test of our instrument's strength involves the F-statistic on the excluded instrument in the first stage of our specifications. As shown in Table 4, the relevant F-statistic for our baseline specification is just over 170, with an additional representative or senator per million residents predicting roughly \$1,000 in additional aid per state resident. As shown in Clemens and Veuger (2021), the strength of the relationship between Reps Per Million and federal fiscal aid is little impacted by adding any of a number of covariates to the

of interactions between the X_s from equation 2 and sets of time dummy variables. Additionally, while the estimates of 1 and 2 are more obviously comparable for COVID-19 outcomes than for all-cause mortality, we emphasize that the construction of All-Cause Mortality$_{s,2022}$ as $\sum_{2020-22}$[All-Cause Mortality$_{s,t}$ − All-Cause Mortality$_{s,2019}$] retains the equivalence of γ_1 and the sum of ρ_{2020}, ρ_{2021}, and ρ_{2022}.

[13] We note that we do not use parameters of the CARES Act or American Rescue Plan Act's floor functions themselves because the parameters of each particular provision within the pandemic relief legislation would fail the exclusion restriction. An initial difficulty is that the primary floor functions differed from one another in ways that meaningfully impacted the relative distribution of funds across states. Further, evidence from Clemens and Veuger (2021) illustrates that low-population states' advantage from the floor functions was partially offset by the formulas used to distribute aid to transportation agencies. The offsetting effects of this form of Congressional "horsetrading" create exclusion restriction violations for instruments that focus on any one provision, but are plausibly accounted for by our representation instrument.

regression model. In the present analysis, we see that either dropping our baseline covariates from the model or augmenting the covariate set with proxies for population health and early-pandemic policy preferences result in an F-statistic just above 200. In the population-weighted version of our baseline specification we obtain an F-statistic of 50, due in part to a moderate reduction in the first stage coefficient, but due primarily to a 49 percent increase in the magnitude of the standard error (from 0.075 to 0.112). Both the strength of the first stage relationship and the appropriateness of the linear functional form are well illustrated by Appendix Figure A.1, which plots the bivariate relationship between the instrument and per capita fiscal aid.

4 Results

Our presentation of results is structured as follows. We begin in Section 4.1 by presenting estimates of mortality impacts using both reduced form evidence from equations 1 and 2, as well as 2SLS estimates of equations 3 and 4, including robustness analyses. We extend these analyses with a consideration of heterogeneity across demographic groups in Section 4.2 and evidence on potential mechanisms in 4.3. In Section 4.4 we turn to a discussion of the cost-benefit analysis implied by the magnitude of the estimated mortality impact of each dollar allocated by the federal government.

4.1 Baseline Reduced Form Mortality Results and Robustness Checks

Table 3 and Figures 2 and 3 present estimates of equation 1, which generates our reduced form estimates of the relationship between Congressional representation and mortality during the COVID-19 pandemic. Panel A of Figure 2 presents year-by-year estimates of the relationship between Congressional representation and changes in all-cause mortality. The orange circles present estimates of each ρ_t, while the blue circles present cumulative estimates, as described in Section 3, such that the estimate for 2021 is the sum of ρ_{2020} and ρ_{2021}, the estimate for 2022 is the sum of ρ_{2020}, ρ_{2021}, and ρ_{2022} and the estimate for 2023 is the sum of ρ_{2020}, ρ_{2021}, ρ_{2022} and ρ_{2023}. We find that an additional senator or representative per capita predicts roughly 16 fewer deaths per 100,000 residents from all causes in 2020, an additional 15 fewer deaths in 2021, and roughly 7 fewer deaths in 2022. The contemporaneous estimate for 2020 is statistically differentiable from 0 at the 95 percent level and the contemporaneous estimates for 2021 and 2022 are negative but are not differentiable from 0, while the estimate for 2023 is an economic zero. The cumulative effects are strongly differentiable from 0 through 2022, with the estimated cumulative effect through 2022 approaching 38 fewer deaths per 100,000 residents. The cumulative effect on all-cause mortality becomes statistically weaker through 2023 due to a loss in precision. Panel B presents monthly estimates, illustrating that the gains we estimate unfolded gradually but steadily between spring 2020 and early 2022. Estimates for years and months prior to 2019 illustrate that all-cause mortality in high and low representation states evolved along parallel trends in the years preceding the pandemic.

Figure 3 presents equivalent estimates for mortality specifically from COVID-19. The overall profiles of the estimates are quite similar to the all-cause mortality estimates from Figure 2, but modestly smaller in magnitude. Roughly 2/3 of the reduction in all-cause mortality is estimated to come through reductions in COVID-19 mortality, with the estimated cumulative effect through 2022 approaching 26 fewer COVID-19 deaths per 100,000 residents. This provides evidence that reductions in mortality from COVID-19 were not offset by increases in mortality from other causes, and were if anything augmented by modest declines in mortality from other causes. For 2023, we estimate a statistically precise economic 0 for the contemporaneous effect on COVID-19 mortality.

The null contemporaneous effects on both all-cause and COVID-19 mortality that we find in 2023 merit additional discussion for two reasons. First, had either estimated effect remained strongly positive through 2023, these results may have cast doubt on our estimation strategy, as large effects would have been implausible due to the waning pandemic. Second, the budgetary incidence analysis in Clemens et al. (2024) finds that states had largely used the funds that are predicted by our instrument by the end of Fiscal Year 2022, which concluded in June 2021 for the vast majority of states. The precise null we find for COVID-19 mortality effects in 2023 thus supports the view that the mortality effects of aid were temporally linked to the associated expenditures. Third, in combination with this earlier evidence from state budgets, the precise null on 2023 COVID-19 mortality enhances the completeness of the cost-benefit analyses we conduct later, as it appears that both the costs and health benefits of federal aid had been largely realized by the end of 2022.

Table 3 presents a robustness analysis for the cumulative all-cause (panel A) and COVID-19 specific (panel B) mortality impacts of an additional senator or representative from 2020 through 2022. Column 1 reports the estimates from our baseline specification (the same specification for which year-to-year estimates are presented in Figures 2 and 3), which includes each state's population density and Trump's 2016 vote share as covariates, and in which each state is given equal weight. The cumulative impact on all-cause mortality is estimated at -38.0 with a standard error of 17.5, while the cumulative impact on COVID-19 mortality is a substantially more precisely estimated -25.6 with a standard error of 5.1. The specification reported in column 2 includes the same covariates, but weights each state according to its population, such that the estimates can be interpreted as reflecting the effects of the average dollar spent as opposed to estimating the impact of an additional dollar per resident in a typical state; the resulting estimates come with moderately larger standard errors and entail a moderately higher point estimate for all-cause mortality and an essentially unchanged estimate for COVID-19 mortality. The estimates in column 3 use a county-population weighted measure of population density rather than a statewide measure of population density as a covariate, and the estimates are again very little changed. The estimates in column 4 exclude the population density and 2016 Trump vote share covariates; the resulting estimates are modestly changed in magnitude from the baseline, while the standard errors are larger, in particular for the estimated effect on COVID-19 mortality. This reflects the fact that while the 2016 Trump vote share has very strong predictive content (the associated t-statistic for its relationship with cumulative COVID-19 mortality is on the order of 4), but is essentially orthogonal to our representation instrument such that its inclusion has little impact on the point estimate. Finally, in column 5 we add as controls covariates associated with each state's population age structure, the prevalence of combordidities, and the stringency of the economic restrictions they enacted in March 2020. The inclusion of these covariates, of which the measure of population age structure (namely the fraction of the population ages 65 or higher) has strongest predictive content, has little impact on our point estimates and very marginally improves precision relative to the baseline specification from column 1.[14]

The scatterplots presented in Appendix Figure A.2 provide a transparent look at the relationship between our overrepresentation instrument and our mortality outcomes, with emphasis on how the fit of the relationship is impacted by the covariates we include in our baseline and more saturated specifications. To that end, the plots in panels A and B present the unadjusted bivariate relationships between our overrepresentation instrument and either all-cause mortality (panel A) or COVID-19 mortality (panel B). The relationships depicted in panels A and B thus correspond directly with the "no controls" specification from column 4 of Table 3. The plots in panels C and D are residualized with respect to the population density and 2016 Trump vote share covariates. A comparison with panels A and B reveals that the slope of the best fit lines are little changed, but the fit is substantially improved. The data in panels E and F are further residualized with respect to the baseline prevalence of comorbidities, the baseline share of individuals ages 65 plus, and the March 2020 measure of the stringency of states' economic restrictions. Consistent with what can be seen in the point estimates and standard errors from Table 3, the addition of these covariates has little impact on either the slope of the best fit line or the goodness of the relationship's fit.

[14] Appendix Table B.2 provides coefficients and standard errors for all covariates in the estimation of reduced-form effects of additional representation on COVID-19 mortality.

Table 4 presents our 2SLS estimates of equations 3 and 4. The strength and robustness of the first stage relationship between Congressional representation and federal aid were discussed earlier and will thus not be discussed here in additional detail. A key point is that because an additional senator or representative per million residents predicts an additional \$1,000 in per resident federal funds, the scaling of our variables is such that the first stage coefficient is approximately one and, as a result, the "reduced form" and 2SLS coefficients are essentially the same. As shown in panels B and C, we thus estimate that an additional \$1,000 in federal aid per resident resulted in roughly 39 fewer deaths from all causes per 100,000 residents and roughly 26 fewer deaths from COVID-19 per 100,000 residents. The robustness of the IV results is very similar to the robustness observed in our reduced form results. Additionally, Appendix Table B.3 reveals that OLS estimates of the relationship between aid and both all-cause and COVID-19 mortality are attenuated towards 0 relative to the IV estimates. This supports our conjecture that aid may have been targeted towards states more adversely impacted by the pandemic's underlying severity, implying that a naive OLS estimate of the effect of aid on mortality would be biased towards zero, or smaller reductions in mortality.

Appendix Table B.4 and Appendix Figure A.3 present estimates from additional robustness checks in which we check for the relevance of individual states or specific subsets of states in driving the results. For Appendix Figure A.3 we run our baseline specification 50 times, each time dropping a separate state from the regression so as to check for whether any outlier states are exerting substantial leverage in our analysis. The estimates are quite similar across these 50 regressions, with the evidence suggesting that perhaps Vermont could be viewed as exerting more influence on the regressions than other states; Vermont's exclusion from the regressions leads the point estimates to rise moderately in magnitude in the analysis of all-cause mortality.

Guided by our knowledge of the pandemic's impact on states' economies, the exercise deployed in Appendix Table B.4 is to drop the three most tourism intensive states (Hawaii, Nevada, and Florida) and the three states whose revenues are most impacted by resource extraction industries (Alaska, Wyoming, and North Dakota), as these states were hard hit at the pandemic's outset. The estimates in columns 3 and 4 exclude the resource extraction states, the estimates in columns 5 and 6 exclude the tourism intensive states, and the estimates in columns 7 and 8 exclude both sets of states. Our point estimates are modestly impacted by these exclusions, in particular for COVID-19 mortality. Notably, however, because the resource intensive states are among the most over-represented states, their exclusion non-trivially reduces the strength of the first stage relationship between representation and federal aid, and is associated with increases in both the second stage and reduced form standard errors, such that the estimated impacts on all-cause mortality become statistically indistinguishable from 0 while the estimated effects on COVID-19 mortality remain statistically significant.

As a check for the sensitivity of our estimates to the use of alternative data sources, Appendix Figure A.4 presents estimates using the Hopkins CSSE measure of COVID-19 mortality. Both the cumulative endline estimate and the estimated monthly dynamics look quite similar to the monthly dynamics we estimate using CDC's data, as shown in Figure 3.

Finally, we present some evidence on the potential relevance of the "strong parallel trends" assumption that applies in difference-in-differences settings with continuous treatment variables (Callaway, Goodman-Bacon, and Sant'Anna 2024). In our setting, this assumption implies that all-cause mortality in states with more Congressional representatives per capita would have evolved similarly to all-cause mortality in states with fewer Congressional representatives per capita in the period after pandemic aid disbursement, had the former category of states received lower per capita representation. To probe the plausibility of parallel trends throughout the distribution of our overrepresentation instrument, Appendix Figure A.5 presents trends in all-cause mortality from 2016 through 2022 for either large and small values of our instrument (panels A and B), or for the four quartiles of our instrument (panels C and D). Values in panels A and C are unadjusted mortality rates while values in panels B and D are indexed relative to each group's 2019 mortality rate, such that the magnitudes of changes over time are more readily interpreted in percent terms. Reassuringly, we see that all groupings' pre-pandemic all-cause mortality rates move on very similar trends. Appendix Table B.5 shows further that we obtain similar estimates if our instrument is discretized into an indicator for large vs. small states (panel A) or into quartiles of our instrument (panel B). Reassuringly, the estimated mortality impacts per dollar of federal funds are similar to what we obtain using our continuous instrument, though the coarsening of the instrument results, unsurprisingly, in a reduction in the power of the first stage relationship and a corresponding reduction in second-stage precision.

4.2 Analysis of Heterogeneity

Tables 5 and 6 and Appendix Figures A.6 and A.7 present an analysis of heterogeneity in our estimated mortality impacts across demographic groups. Appendix Figure A.6 presents event-study estimates for the effects of additional representation on all-cause mortality, Appendix Figure A.7 presents event-study estimates for the effects of additional representation on COVID-19 mortality, and Tables 5 and 6 present point estimates and standard errors for estimated cumulative effects through 2022 for both COVID-19 and all-cause mortality.

We begin by discussing heterogeneity by sex and age. Columns 1 and 2 of Table 5 present results separately by sex. The estimates reveal that an additional representative or senator per state resident predicts 31 fewer COVID-19 deaths per 100,000 males and 21 per 100,000 females, and 42 fewer all-cause deaths for males compared with 35 fewer all-cause deaths for females. Because males experienced moderately higher rates of COVID-19 and all-cause mortality during this time period, the differential effects of representation on mortality are roughly proportional to the COVID-19 disease burden for males relative to females.

Columns 3, 4, 5, and 6 of Table 5 present results separately for individuals ages 0 to 24, ages 25 to 64, ages 65 to 74 and ages 75 plus, respectively. Like the incidence of COVID-19 mortality, our estimated mortality reductions are highly skewed towards individuals ages 65 to 74 and ages 75 plus. The estimates reveal that an additional representative or senator per state resident predicts 88.6 fewer COVID-19 deaths per 100,000 individuals ages 65 to 74, a reduction of 11.8% relative to the counterfactual, and 142.6 per 100,000 individuals ages 75 plus, a reduction of 6.3% relative to the counterfactual. These reductions are far larger than the reduction of 19.4 per 100,000 individuals ages 25 to 64 and less than 1 per 100,000 individuals ages 0 to 24, although the reductions for these non-elderly age groups are relatively larger in percent terms (12.8% and 18.7% reductions respectively), reflecting the low overall rates of COVID-19 mortality for these groups. The all-cause mortality improvements we estimate are similarly skewed towards the elderly, with the differential due to causes other than COVID-19 loading primarily (though noisily) onto mortality among individuals ages 75 plus. Taken together, the evidence thus suggests that health impacts of federal aid had a disproportionately favorable impact on the elderly. A potential implication of this finding is that policy towards nursing homes or towards the testing and vaccination of the elderly may have played an important role.

Table 6 presents results separately for Hispanics, non-Hispanic Blacks, and non-Hispanic Whites on both an age-unadjusted and age-adjusted basis. We note that it is of interest to consider both age-adjusted and age-unadjusted mortality in the context of heterogeneity by race because the non-Hispanic White population's more elderly age structure can lead unadjusted figures to understate racial gaps in the pandemic's age-adjusted impact (Centers for Disease Control and Prevention 2023). The results are striking in that estimated mortality gains for non-Hispanic Blacks are substantially larger than the estimated mortality gains for non-Hispanic Whites on both an age-unadjusted and age-adjusted basis.[15] For COVID-19 mortality, these differences are strongly statistically distinguishable zero, implying strong

[15] We also find that the estimated age-adjusted mortality gains for Hispanics are larger than those for non-Hispanic Whites when we use our age-adjustment methodology, but not when we use the CDC's age-adjusted death rates as outcomes.

evidence that federal aid reduced the underlying disparity in age-adjusted COVID-19 mortality.[16]

To put this impact into context, consider the cumulative means of age-adjusted COVID-19 mortality as reported in columns 6 and 8 of Table 6. For non-Hispanic Black Americans, age-adjusted COVID-19 mortality (realized in the presence of fiscal aid) was 291.87, or 1.37 times the age-adjusted COVID-19 mortality rate of 213.61 experienced by non-Hispanic White Americans. Our estimated effects of an additional representative or senator per state resident, which correspond with an additional $1,000 in aid, suggest that had states received $1,000 less in aid the age-adjusted COVID-19 mortality rates would have been 55.14 higher for non-Hispanic Black Americans and 22.84 for non-Hispanic White Americans, implying a ratio of 1.47 (i.e., of 347.01 divided by 236.45). Our estimates thus suggest that the last $1,000 in federal aid per resident, or $331 billion nationwide, narrowed the age-adjusted COVID-19 mortality gap by 32.3 deaths per 100,000 in absolute terms, or by 21.6 percent.[17]

4.3 Analysis of Potential Mechanisms

In this section we analyze a range of outcomes that may speak to the sources of the mortality gains discussed above. A first set of outcomes are informative regarding the extent to which the mortality gains we estimate are accompanied by reductions in hospitalizations and/or differences in overall estimated disease prevalence. The second set of outcomes are informative regarding a set of potentially relevant public health or health system inputs to pandemic

[16] We obtain similar findings whether conduct our own two-category age-adjustment, as in Table 6, our own three-category age-adjustment, as in Appendix Table B.6, or build from age-adjusted data directly extracted from the CDC Wonder database, as in Appendix Table B.7. However, because the CDC's age adjustment makes use of more granular underlying age groups, it is subject to greater suppression of age-adjusted death rate values for data confidentiality reasons. Consequently, we prefer estimates that arise from our own adjustment procedure.

[17] Looking to our analysis of mortality from all-causes, the realized ratio of age-adjusted mortality was 1.127 (i.e., 3,057.06 for non-Hispanic Black Americans divided by 2,713.2 non-Hispanic White Americans). Our estimated effects of an additional representative or senator per state resident, which correspond with an additional $1,000 in aid, suggest that had states received $1,000 less in aid the age-adjusted COVID-19 mortality rates would have been 58.00 higher for non-Hispanic Black Americans and 32.42 for non-Hispanic White Americans, implying a ratio of 1.135 (i.e., of 3115.06 divided by 2745.62). Our estimates thus suggest that the last $1,000 in federal aid per resident, or $331 billion nationwide, reduced the all-cause age adjusted mortality gap by just under 6 percent.

management, namely the number of tests and vaccines administered, hospital capacity as measured using the number of beds, and Medicaid enrollment.

Table 7 and Figure 4 present our estimates of the relationship between additional Congressional representation, overall COVID-19 case rates, and rates of hospitalization. The first four columns of Table 7 show that additional representation was not associated with declines in hospitalization (either admissions or visits to emergency departments) from all causes. Additional representation was, however, strongly associated with reductions in both admissions and emergency department visits associated with either confirmed or suspected cases of COVID-19. Taken together, these results imply that hospitalizations for other reasons offset differential rates of COVID-19 hospitalization. This is interesting in light of our earlier finding that deaths from all causes declined moderately more than deaths from COVID-19 alone. The offsetting hospitalizations are thus unlikely to be driven by a higher (and thus offsetting) incidence of non-COVID health conditions. In light of our mortality findings, these hospitalizations more probably arise from a relaxation of capacity constraints or from preventive and curative care being less likely to be foregone. Consistent with this interpretation, Appendix Table B.8 shows that among the non-COVID-19 causes of death, we find evidence of moderate reductions from respiratory diseases and hypertension as a result of additional representation.[18]

The estimate in column 6 of Table 7, which reports a moderately positive but statistically insignificant effect on total COVID-19 cases, transitions our discussion to outcomes including COVID-19 prevalence, rates of testing, rates of vaccination, hospital capacity, and Medicaid enrollment. Turning to Table 8, we first briefly note two null results. Specifically, in columns 4 and 5 we see no evidence that states that received more federal funds used those funds to increase hospital capacity (measured using the number of beds) or to be more solicitous in

[18] Additionally, we find no effect of additional representation on deaths from external causes such as injuries, accidents and natural disasters. Under the assumption that additional representation and associated fiscal aid should not have an effect on mortality from external causes, this finding could be taken as reassuring that our estimated effects on all-cause and COVID-19 mortality are not spurious.

the management of their Medicaid programs. State residents became neither more nor less likely to be insured by Medicaid in overrepresented relative to underrepresented states.

We now discuss a combination of results that relate to rates of COVID-19 testing and prevalence. First, recall from column 6 of Table 7 that our estimated declines in COVID-19 mortality and hospitalizations are not accompanied by a decline in COVID-19 case rates. Accompanied with the dynamics shown in panel 6 of Figure 4, the estimates give an impression of increasingly more COVID-19 cases detected over time, although the estimates are not statistically distinguishable from 0. Table 8 presents evidence on rates of COVID-19 test administration that help to round out this picture. Consistent with evidence from Clemens, Hoxie, and Veuger (2022), additional Congressional representation predicts strongly higher rates of COVID-19 testing. Indeed, the dynamics displayed in Figure 5 (annual) and Appendix Figure A.8 (monthly) reveal that increased rates of COVID-19 testing began to materialize the month after the CARES Act's March 2020 passage. Also relevant is the finding reported in column 3 of Table 8, which shows that additional representation has a negative relationship with the ratio of detected COVID-19 cases to the number of tests. This ratio, which relates closely to the widely discussed test-positivity rate, provides evidence that the higher testing volumes in states with greater Congressional representation were likely associated with a greater propensity to catch cases early. This would, in turn have health benefits both by enhancing the efficacy of treatment and by enabling earlier and thus more effective self-isolation by those who had tested positive so as to reduce COVID-19's spread.

Table 8's column 1, Figure 5's panel 1 (annual dynamics), and Appendix Figure A.9 (monthly dynamics) present estimated effects of additional representation on COVID-19 vaccination rates. We find positive and statistically significant effects, which emerge most strikingly in the first months of states' COVID-19 vaccination campaigns, namely January through June of 2021. Notably, as can be seen in panel B of Figures 2 and 3, this period corresponds with a second substantial burst of gains in both COVID-19 and all-cause mortality reductions, suggesting that enhanced early vaccination campaigns played an important role in shaping the gains associated with states' receipt of additional federal funds.

A more granular look at vaccination and mortality patterns by age continues to quite strongly imply an important role of the federal funds in increasing vaccination and generating associated mortality gains. Appendix Figure A.10 presents the relationship between our representation instrument and vaccination trends separately by age group. A key finding that emerges from the monthly data is that vaccination of the most elderly sub-set of the population (panel D) was impacted almost instantaneously upon the vaccines' arrival, whereas vaccination among individuals ages 0-24 (panel A) exhibits impacts in the months immediately following the expansion of vaccine eligibility to children ages 12-15 years old and again for children ages 5-11 years old.[19] Mirroring these results are the effects on COVID-19 mortality by age presented in Figure A.11 which shows that early mortality gains were most striking among adults (panels B and C) around January 2021 as adult vaccination campaigns scaled up in earnest. Mortality gains for the youngest age group (panel A) are most visible between May and October 2021.

The strength of our vaccination results can be contrasted with the results from Clemens et al. (2023), who conclude that the weight of the evidence supports the view that the effect of federal aid on vaccination rates was not strongly statistically distinguishable from 0. As emphasized in the earlier paper, the relationship between Congressional representation and vaccination rates was more sensitive to specification choice than was the relationship between Congressional representation and COVID-19 testing rates. Our reading of the data here is similar. As reported in Appendix Table B.9, when we subject our testing and vaccination results to the same set of specification checks to which we subject our mortality rates, we find

[19] Appendix Table B.10 provides additional evidence on heterogeneity in effects on vaccination across demographic groups. With respect to age, the table presents additional evidence, using high quality vaccination data from the CDC, that the largest effects on vaccination were experienced by relatively elderly Americans. The CDC's data also allow for the analysis of vaccination rates by gender; this analysis reveals substantial and statistically similar impacts on vaccination for males and females. Administrative data on heterogeneity in vaccination status by race are not available from the CDC. Using lower quality data from the National Immunization Survey, we find no evidence of differential effects for non-Hispanic Black Americans relative to non-Hispanic White Americans.

uniformly strong effects on testing and a stronger degree of sensitivity across specifications in the analysis of vaccination rates. While specifications differ with respect to their degree of statistical significance, however, we emphasize that the confidence interval surrounding our baseline estimate includes the baseline point estimate from Clemens et al. (2023), and that the confidence interval from Clemens et al. (2023) similarly includes the current paper's point estimate. Additionally, we note that the earlier paper's event-study estimates report statistically significant impacts on the early stages of states' vaccination campaigns, which is also consistent with the findings we develop here.

Next, we calculate the proportion of our mortality results that may be attributable to vaccination. A key parameter for this calculation is the medium-to-long run efficacy of initial vaccine doses against COVID-19 mortality. This is a difficult to parameter to estimate, as it cannot be inferred from clinical trial data, which tend to be short-run in nature and may not apply to the general population. We thus draw on a set of observational analyses, including estimates from the UK Health Security Agency (2023) and the CDC (2023). Our baseline estimate of medium-to-long run vaccine efficacy is 50%, and we emphasize that our conclusions would be qualitatively similar if we applied estimates ranging from 35% to 65%.[20]

In our sample, mean COVID-19 mortality across states is 283 per 100,000 (Table 4). If we add back our estimated reduction of 26 deaths per $1,000 in federal aid per resident, we can infer that the baseline mean in the absence of the last $1,000 in aid per resident is 309. The out-of-sample implication of both these figures together is that if the federal aid took

[20]Vaccine efficacy is commonly defined in epidemiological literature as (1 - *risk ratio*) × 100%, where the *risk ratio* is the ratio of the share of deaths among the vaccinated to the share of deaths among the unvaccinated. We calculate vaccine efficacy from Table 2 in CDC (2023) for the "Overall" group to be 49%. Restricting to the medium run defined as 180-364 days since the last vaccine dose gives us an estimate of 39% and restricting to the long run defined as greater than 364 days gives us an estimate of 51%. Pooling the medium and long run samples results in a vaccine efficacy estimate of 44%. Our second source for the vaccine efficacy estimate is Table 4 in UK Health Security Agency (2023) where this metric is reported to be 50% for the medium-to-long run of 40+ weeks within the set of individuals receiving 2 vaccine doses, and 57% within the set of individuals receiving 3 doses. Given that these two sources give us estimates of vaccine efficacy that range from 39% to 57%, we find it reassuring to settle on a central value of 50%. A caveat worth nothing about the sources is that while both studies estimate vaccine efficacy using a case-control study design, the UK Health Security Agency sample is adults ages 65 and over and the CDC sample is all adults who were admitted to a hospital, and is consequently likely to be selected on poorer health.

vaccination coverage from 0 to 100% of the population, and if we apply a medium-to-long run vaccine efficacy estimate of 50%, we would obtain a mortality decline of 155. We find in our analysis that $1000 dollars per resident generates an additional 7,755 vaccinations per 100,000 residents (Table 8) i.e. 7.8% of the population.[21] Then, an additional $1000 per resident through its effect on vaccinations accounts for 155 times 0.078, i.e., 12 fewer deaths. Since our point estimate for the effect of aid on mortality is 26 fewer COVID-19 deaths, this implies that vaccination may account for around 46% of the reduction in mortality.

A similar exercise allows us to calculate the proportion of our estimated declines in COVID-19 hospital admissions that could plausibly be attributed to vaccination. Estimates from Ferdinands et al. (2022) and the UK Health Security Agency (2023) support the assumption that the medium-to-long-run efficacy of COVID-19 vaccination against hospitalization is similar to its efficacy against mortality, namely around 50%.[22] In our sample, mean hospital admissions for individuals with confirmed COVID-19 cases is 1540 per 100,000 (Table 7). If we add our estimated reduction of 214 hospitalizations per $1,000 in federal aid per resident back to the sample mean, we can infer a mean of 1754 hospitalizations in the absence of the last $1,000 in federal aid. Then through its effect on vaccinations, the last $1000 in aid per resident can account for a reduction of $1754 \times 0.5 \times 0.078 = 68$ fewer hospitalizations. This, in turn, implies that increases in vaccination can account for 32% (i.e., 68 out of 214) of our estimated reduction in hospital admissions.

To support the plausibility of vaccination and testing as key mechanisms through which federal relief funds improved health outcomes, we highlight potential channels through which state governments could have directed funds to these efforts. Both ARPA's State and Local

[21] Note that column 1 in Table 8 presents the effect of additional representation on COVID-19 vaccine doses. Thus the 7,755 estimate we use in this calculation may be an overestimate of the additional individuals vaccinated. A reasonable way to adjust for this aspect may be to use a lower estimate of vaccine efficacy.

[22] We calculate vaccine efficacy against hospitalization using data from Table 1 in Ferdinands et al. (2022). To maintain consistency in our definition of the medium-to-long-run, we derive our efficacy estimate using data reported for 8-10 months after an individual's last dose. This yields an efficacy estimate of 41% for individuals with 2 doses and 54% for individuals with 3 doses. The comparable number from Table 1 in UK Health Security Agency (2023) for 9 to 11 months since an individual's last dose is 51% for individuals with either 2 or 3 doses. This leads us to settle on a central value of 50% as our baseline estimate for vaccine efficacy against hospitalization.

Fiscal Recovery Funds and CARES' Coronavirus Relief Funds allowed states the flexibility to use funds to mitigate the public health burden, including expenses related to vaccination and testing (U.S. Department of Treasury 2023; U.S. Department of the Treasury 2021*b*). Vaccine doses were directly purchased from manufacturers by the federal government and, in the early stages of the pandemic, allocated to states based on adult population (U.S. Department of Defense 2020). Although states were not initially endowed with the ability to purchase vaccines directly (CBS News 2021), they had the discretion to distribute doses to counties and local governments, or to vaccination centers directly (Center for American Progress 2021). Thus one way in which state funds could have enhanced vaccination is by targeting dose distribution to communities most in need. Indeed, Clemens et al. (2023) find that states with more fiscal resources were able to mitigate vaccination gaps across socioeconomic groups. Other examples of states' use of funds are setting up mobile or fixed vaccination clinics, promoting vaccination through social media campaigns, providing gift certificates or stipends in exchange for vaccination and providing PPE and protective equipment to health workers (U.S. Department of the Treasury 2022).[23] Similarly, states and local governments used funds to provide mobile units for testing, to enhance laboratory and specimen collection capacity, for testing at airports, for contact tracing, and to provide better testing access to under-served communities (U.S. Department of the Treasury 2022).

We next turn to a discussion of the magnitude of the potential expenditures associated with the additional deployments of COVID-19 testing and vaccination in overrepresented states relative to underrepresented states. In our baseline specification, an additional senator or representative per million state residents predicts an additional 83,228 tests and 7,755 vaccinations per 100,000 residents. Regarding the cost of tests, we follow Clemens et al. (2023) in using Centers for Medicare & Medicaid Services (2021) to suggest a typical test would have cost state or local governments roughly \$100.[24] The cost of additional tests

[23]There is evidence that financial and in-kind incentives increased vaccination uptake (Khazanov et al. 2023).

[24]This cost is driven by the lab testing component of RT-PCR tests.

may thus have amounted to roughly 8.3 cents out of each additional dollar received by a state with one additional senator or representative.[25] An analysis from Kates, Cox, and Michaud (2023) suggests that the typical cost of vaccine doses to the federal government was roughly \$20, with an additional \$40 in payment to providers for administration. The cost of the acquisition and administration of vaccine doses thus amounts to under 1 cent for each additional federal dollar.[26]

Our analyses suggest that improved testing and vaccination are the most plausible mechanisms behind the health gains we estimate, as we find no impacts of additional federal funds on alternative mechanisms like Medicaid enrollments and investments in hospital capacity. That said, the calculations from the previous paragraph reveal that incremental testing and vaccination can account for no more than 10 cents in expenditure per incremental dollar of federal funds. We thus view the evidence as suggestive that similar health gains may have been achievable at lower cost to the federal government had its funds been more effectively restricted to the financing of critical pandemic oriented health care inputs. That said, we emphasize the caveat that we cannot speak directly to whether distributions of funds dedicated more restrictively to these health care inputs could have achieved similar testing and vaccination increases.

The landscape of testing and vaccination also has relevance to the strong parallel trends assumption as discussed in Section 3. Large fixed costs in COVID-19 mitigation efforts would pose a potential violation of this assumption, as they would imply higher per capita funding needs for low vs. high population states. It is thus important to observe that, at the state level, the fixed costs associated with testing and vaccination infrastructure were likely

[25] The additional senator or representative per million residents predict 83,228 more tests per 100,000 residents, or 0.83 tests per resident at a cost of roughly \$83 per resident. Because an additional senator or representative predicts roughly \$1,000 in additional aid per resident, the cost estimate of \$83 amounts to roughly 8.3 percent of the additional federal dollars.

[26] Here the additional senator or representative per million residents predict 7,755 more vaccine doses per 100,000 residents, or 0.078 doses per resident at a cost of just under \$5 per resident if the costs of both acquisition and administration were to fall on the state government, which they did not. Because an additional senator or representative predicts roughly \$1,000 in additional aid per resident, the cost estimate of \$5 amounts to roughly 0.5 percent of the additional federal dollars, which is an upper bound given the federal government's role in financing these expenditures on the margin.

minor to the point of being ignorable. Clemens et al. (2023) note, for example, that testing and vaccination were administered through hundreds if not thousands of distinct sites in all states "suggesting that any returns to scale were exhausted". [27]

4.4 Discussion of Magnitudes and Implications

The magnitudes of the estimated relationships between instrumented fiscal aid and both all-cause and COVID-19 mortality merit further discussion. Following is an exercise that connects directly to our within-sample variation. For this counterfactual, we suppose that, rather than allocating more funds to overrepresented states, the federal government had instead allocated to all states the same funding it allocated to the least-represented state. More specifically, using our reduced form estimates we predict the counterfactual death rate for each state had its number of Congressional representatives equaled the lowest for any state.[28] We note that although California remains the most populous state, Texas residents were the least well represented at the pandemic's onset (with 1.294 combined senators and representatives per resident) due to the state's substantial population growth over the course of the preceding decade.

Figure 6 presents the results from running this counterfactual. Relative to realized mortality, this counterfactual exercise implies an average all-cause mortality increase of 1.3% (14.3 deaths per 100,000 residents, or 47,390 deaths nationwide) in 2020, 1.2% in 2021 (12.9 deaths per 100,000 residents, or 42,751 deaths nationwide), and about 0.5% in 2022 (5.6 deaths per 100,000 residents, or 18,558 deaths nationwide). Similarly, the counterfactual

[27] Non-durable medical supplies like testing and vaccination kits, labor costs, and the physical infrastructure costs associated with each of hundreds of testing and vaccination sites are variable costs in this context, and thus would not lead to a divergence in average cost for low relative to high population states. Software developed and deployed by states would constitute a relevant fixed cost that could contribute to such a divergence. Here, with respect to magnitudes, we thus note that even a $6 million software contract would amount to only $10 in per capita spending in Wyoming, which we view as a rounding error relative to the more than $3,000 per capita federal funding differential Wyoming enjoyed relative to Texas and California.

[28] We proceed by first estimating the contemporaneous ρ_t from equation 1, then multiplying the coefficient for each year by the change in representation faced by each state if it were shifted down to the 1.294 combined senators and representatives per resident in Texas. We then subtract this value from the state's realized death rate in each year to obtain the counterfactual death rate.

exercise implies an average COVID-19 mortality increase of 6.9% in 2020 (7.1 deaths per 100,000 residents, or 23,529 deaths nationwide), 8.8% in 2021 (10.7 deaths per 100,000 residents, or 35,460 deaths nationwide) and 7.4% in 2022 (4.3 deaths per 100,000 residents, or 24,524 deaths nationwide).[29] For scaling purposes, note that our first stage estimates of equation 3 imply that this exercise would involve an average reduction in aid of $845 per resident, which would amount to $280 billion in total nationwide.[30]

We next conduct cost-benefit analyses that deploy conventional estimates of the value of a statistical life as used by federal regulatory agencies. Our COVID-19 mortality variable is expressed in terms of deaths per 100,000 residents. The scaling of our variables is such that the estimate implies a reduction of 260 deaths per $1 billion spent, or roughly $3.8 million per COVID-19 death averted. For all-cause mortality, the estimated reduction of 390 deaths per $1 billion spent translates into roughly $2.6 million per death averted. Both estimates fall well below the thresholds recently used by U.S. federal agencies for estimates of the value of a statistical life (Federal Register 2023).[31]

Because our estimated impacts of federal aid on COVID-19 mortality are substantially more precise that our estimated impacts on all-cause mortality, the upper bounds on the estimated dollars spent per death averted are also much tighter. For all-cause mortality, the 95 percent confidence interval's lower bound of roughly 1 death averted per 100,000 residents translates into 10 deaths averted per $1 billion spent, or roughly $100 million per death. For COVID-19 mortality, by contrast, the lower bound estimate of 15 deaths averted per 100,000 residents translates into 150 deaths averted per $1 billion spent, or $6.7 million per death, which still falls below the thresholds recently used by U.S. federal agencies for estimates of the value of a statistical life.

[29] Note that the mean mortality gains we predict from this exercise are not weighted by the states' population such that the exercise predicts the effect of an additional representative on mortality gains relative to the counterfactual in a typical state.

[30] We obtain this figure by multiplying $845 by the 2020 U.S. population of 331.4 million.

[31] For additional background on the thresholds used by federal agencies, see Table 1 in Section II.B of Federal Register (2023).

Using our point estimates from Appendix Table B.11 for the number of deaths averted in various age groups,[32] Table 9 presents an exploration of the sensitivity of cost-benefit analysis calculations to deploying alternative assumptions regarding the number of life years saved and the quality of those life years. Following the U.S. Department of Health and Human Services (2021), we consider central, low, and high assumptions for the value of a statistical life (VSL),[33] then back out a constant implied value of a statistical life year (VSLY) using the approach recommended by the Millennium Challenge Corporation (2023).[34] We further consider quality adjustments derived from Hanmer et al. (2006).[35] Details regarding the underlying calculations can be found in Appendix D. The bottom line is that at the central valuation of a statistical life year, federal aid would be deemed cost effective on the basis of deaths averted alone (e.g., without consideration for the value of any economic impacts) regardless of whether we deploy conservative assumptions regarding the number of life years saved or the quality of life for individuals in each age group.[36] For the lower bound estimate of the VSL, our pessimistic assumptions (see panel D) yield the conclusion that the value of deaths averted would amount to roughly half the aid's cost to the federal government. Under our optimistic assumptions regarding life years saved, the value of deaths averted is close to, but just below, the aid's cost to the federal government.

[32] Note that we use the estimates from panel C of Appendix Table B.11 which are the IV second stage effects of aid on the 2022 cumulative all-cause death rate by age group. Unlike in the heterogeneity-by-age analyses elsewhere, here we decompose total mortality across age groups by scaling each age group's deaths by the total 2019 state population.

[33] See the 2020 estimate in Table D.1 of their updated guidelines (U.S. Department of Health and Human Services 2021).

[34] The Millennium Challenge Corporation (MCC) is a U.S. foreign aid agency established by the U.S. Congress and is required to conduct cost-benefit analyses for projects it implements.

[35] The health-related quality of life adjustment factors from Hanmer et al. (2006) are used by the U.S. Department of Health and Human Services (2021) in their derivation of quality-adjusted life years. See, for example, Figure D.3 in their guidelines (U.S. Department of Health and Human Services 2021).

[36] With respect to the number of life years saved, our generous assumption is that a death averted within a given age group would translate into a gain of the life expectancy at the median age of that group, whereas the more conservative assumption, reflecting the likelihood that deaths are averted among individuals in worse health than the typical member of their age group, is that a death averted within a given age group would translate into a gain of the life expectancy at the highest age of that group. With respect to quality, the downward adjustments come from Hanmer et al. (2006). The quality-adjustment factor is a utility-based score below 1 where 1 indicates full health and 0 indicates death.

A final note of interest relates to Section 4.3's discussion of mechanisms. As discussed there, if the health gains we estimate are indeed driven in large part by aid's impact on rates of testing and vaccination, then the cost of the key inputs for achieving these gains would have amounted to roughly 10 cents per dollar of federal aid. The associated spending on testing and vaccination would thus appear to quite easily pass cost-benefit tests under even our most pessimistic assumptions regarding the number of life years saved and the quality of life associated with those life years.

5 Discussion and Conclusion

This paper analyzes the unprecedented levels of federal transfers that were made to state and local governments during the COVID-19 pandemic. We find that federal aid had substantial impacts on population health, with an additional $1,000 in aid per state resident predicting 26 fewer deaths from COVID-19 and 38 fewer deaths from all causes, as well as substantial reductions in COVID-19 related hospitalizations and emergency room visits.

With respect to mechanisms, we find that more aid predicts substantially higher rates of COVID-19 testing and moderately higher COVID-19 vaccination rates. Further, the timing of mortality improvements suggests roles for both testing and vaccination, as some improvement occurred prior to the approval of COVID-19 vaccines, while a substantial additional mortality improvement occurred over the months immediately following the vaccines' initial roll out. In contrast, we find that Medicaid enrollments and hospital capacity are unlikely to have played substantial mediating roles, as neither appear to be meaningfully impacted by a state's receipt of additional federal funds.

Finally, the mortality impacts we estimate were substantially greater for non-Hispanic Black Americans than for non-Hispanic White Americans. Federal funds were thus associated with a reduction in population-wide health disparities over the course of the pandemic.

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Tables and Figures

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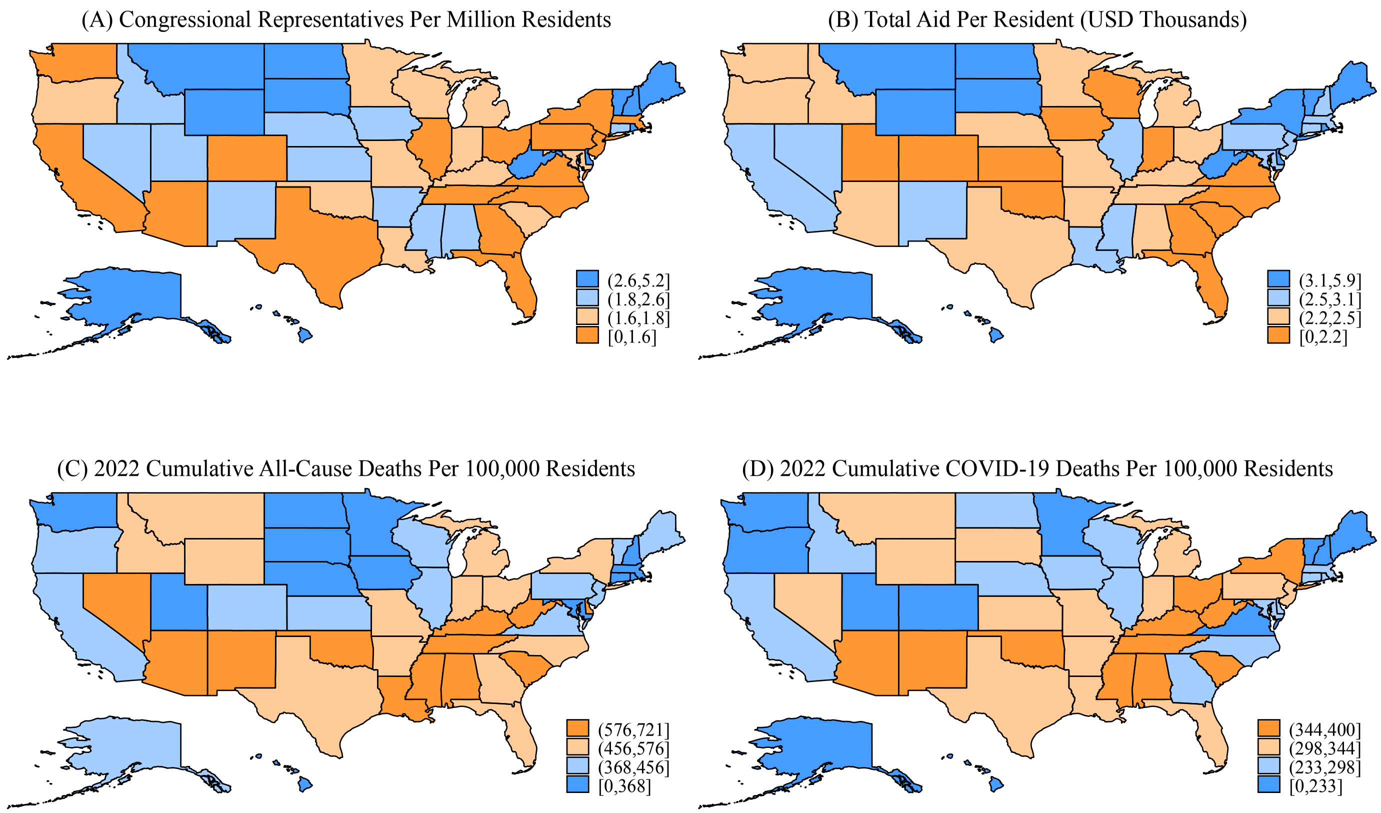
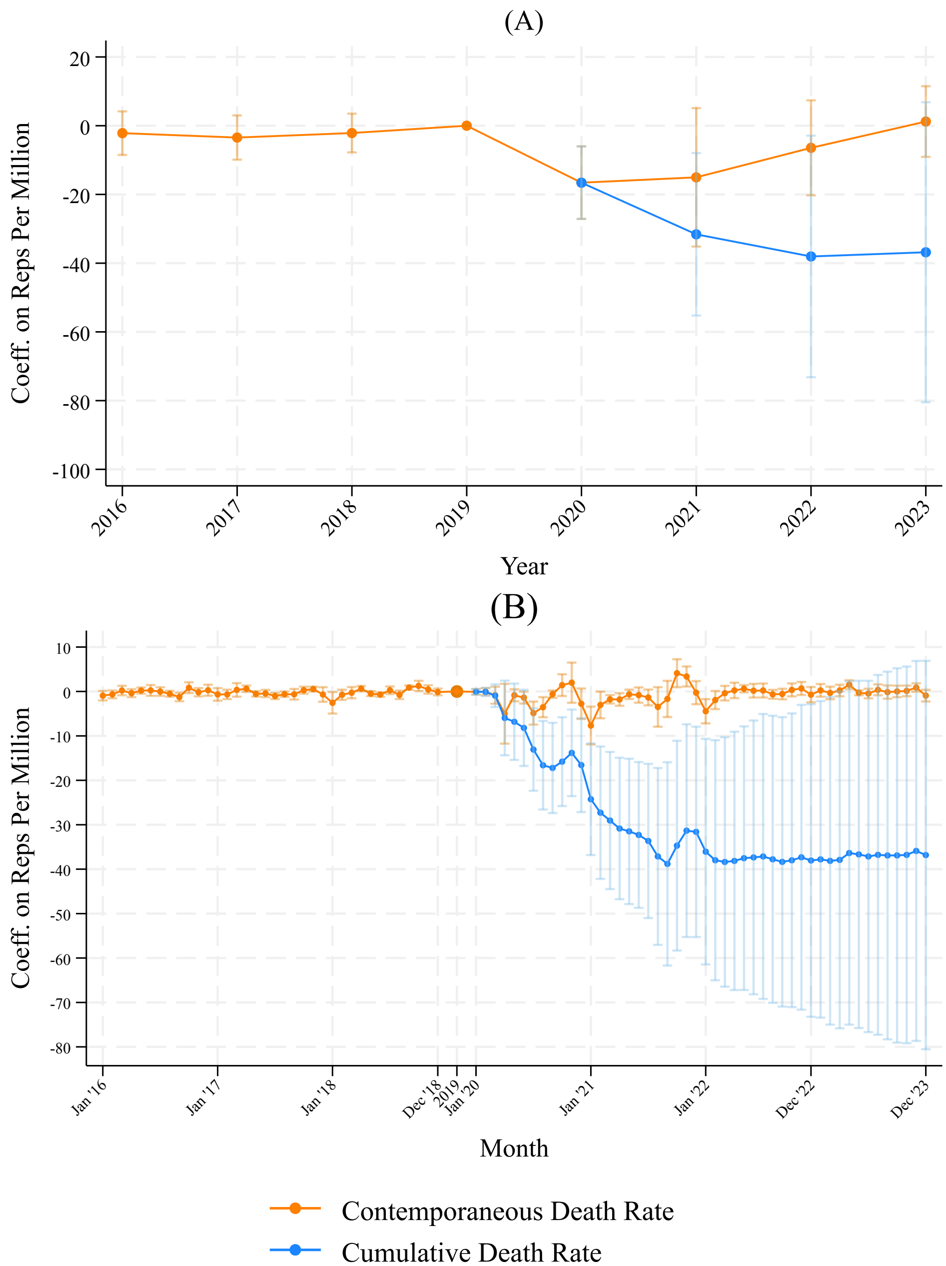
Figure 1: Variation in States' Per Capita Congressional Representation, Federal COVID-19 Aid, All-Cause Mortality and COVID-19 Mortality



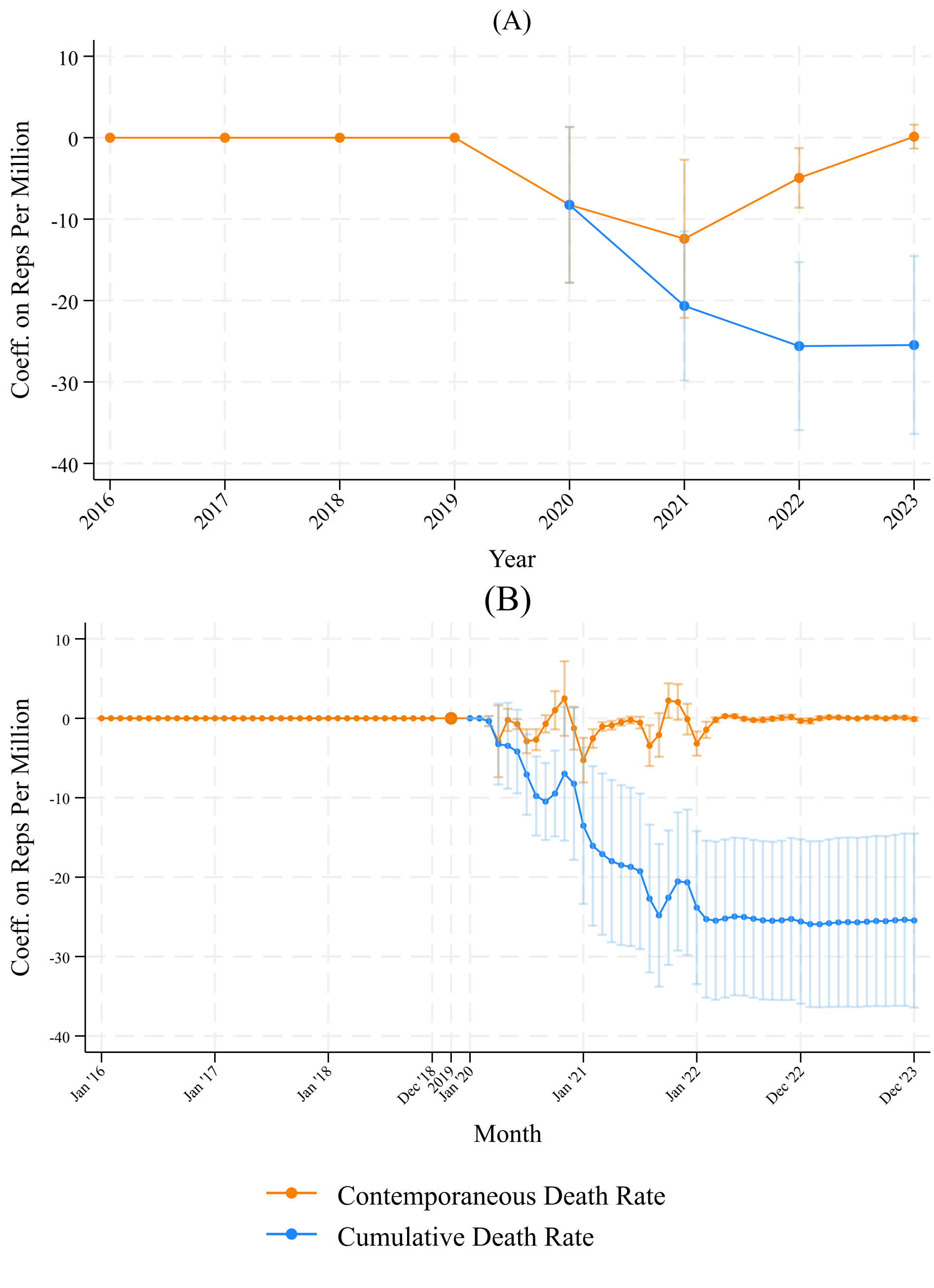
Notes: This figure displays variation in states' number of Congressional representatives per million residents in panel A, federal relief aid per resident in USD thousands in panel B, cumulative 2022 deaths per 100,000 residents from all causes in panel C and cumulative 2022 deaths per 100,000 residents from COVID-19 in panel D. The 2022 cumulative deaths are calculated by adding up the contemporaneous deaths from 2020 to 2022 in each state. To adjust for pre-existing differences in all-cause deaths among states receiving varying fiscal aid, we subtract three times the 2019 contemporaneous all-cause deaths from the raw cumulative value. We use these adjusted cumulative deaths for all causes and the raw cumulative deaths for COVID-19, scaled by state population, as outcomes. The displayed variation splits occur approximately at quartiles of the outcome variable. Data for Congressional representation are from Lewis et al. (2021), data for fiscal aid are from various sources described in detail in Clemens et al. (2023) and data for mortality are from the CDC Wonder database.

Figure 2: The Reduced Form Effect of an Additional Representative on Yearly and Monthly All-Cause Mortality



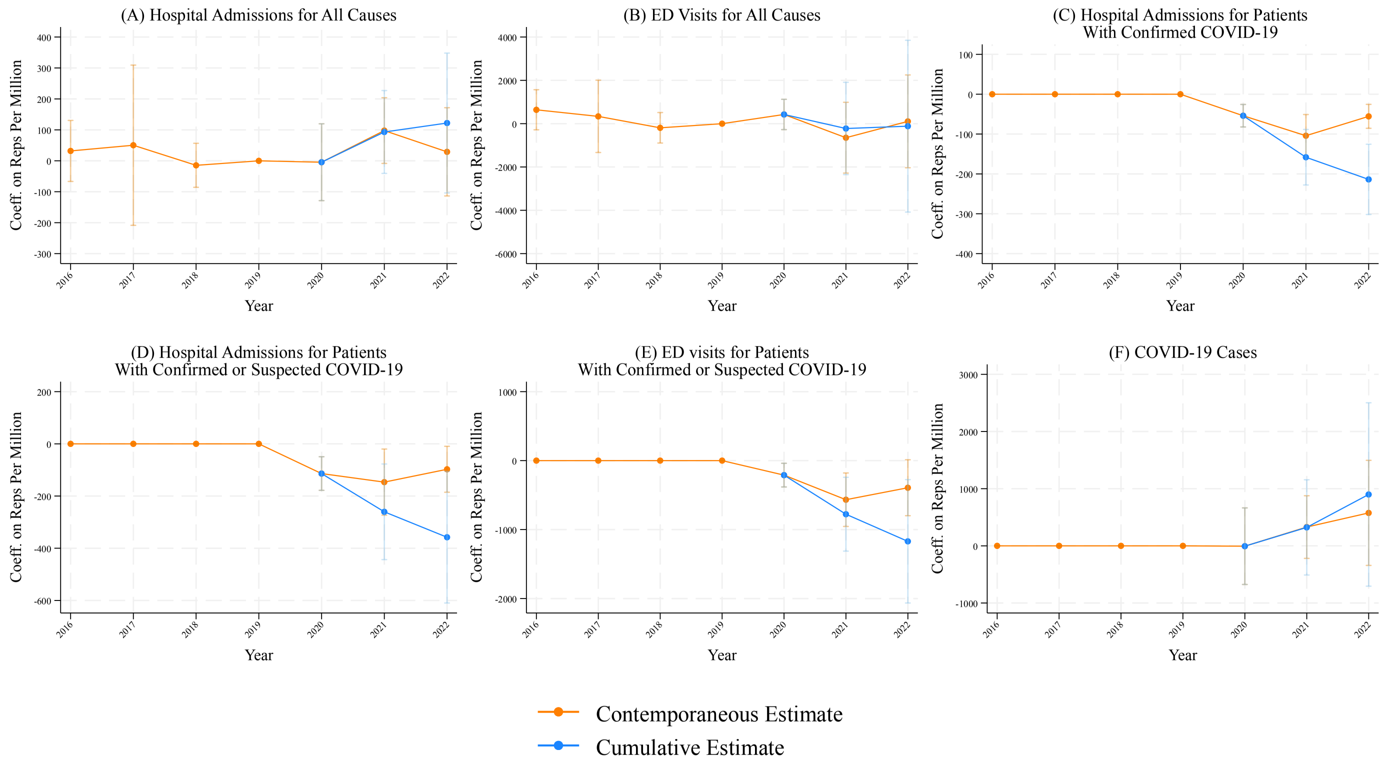
Notes: This figure shows the effect of an additional Congressional representative on a state's all-cause death rate per 100,000 residents across different periods. In the panel A using yearly data, the reference period is the calendar year 2019. In panel B using monthly data, the reference periods are all months in 2019. The coefficient for the contemporaneous death rate in a period t is the ρ_t from equation 1. The coefficient for the cumulative death rate for a period t is the sum of the coefficients for the contemporaneous death rates for periods 0 to t. The specification incorporates controls for the state's vote share for Donald Trump in the 2016 presidential election and the state's 2019 population density. It includes state and period fixed effects, with standard errors clustered at the state level.

Figure 3: The Reduced Form Effect of an Additional Representative on Yearly and Monthly COVID-19 Mortality



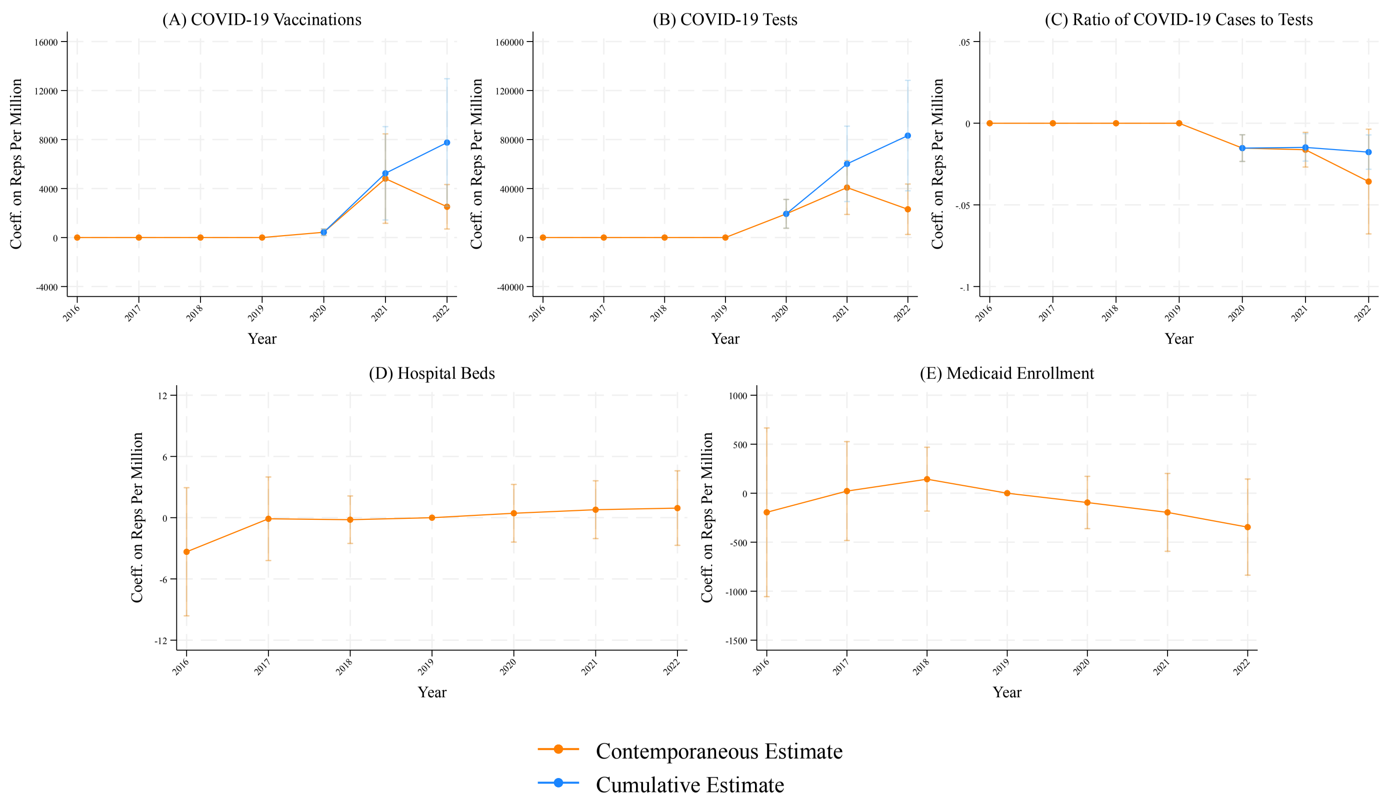
Notes: This figure shows the effect of an additional Congressional representative on a state's COVID-19 death rate per 100,000 residents across different periods. In panel A using yearly data, the reference period is the calendar year 2019. In panel B using monthly data, the reference periods are all months in 2019. The coefficient for the contemporaneous death rate in a period t is the ρ_t from equation 1. The coefficient for the cumulative death rate for a period t is the sum of the coefficients for the contemporaneous death rates for periods 0 to t. The specification incorporates controls for the state's vote share for Donald Trump in the 2016 presidential election and the state's 2019 population density. It includes state and period fixed effects, with standard errors clustered at the state level.

Figure 4: The Reduced Form Effect of An Additional Representative on Hospitalization, Emergency Department Visits and COVID-19 Cases



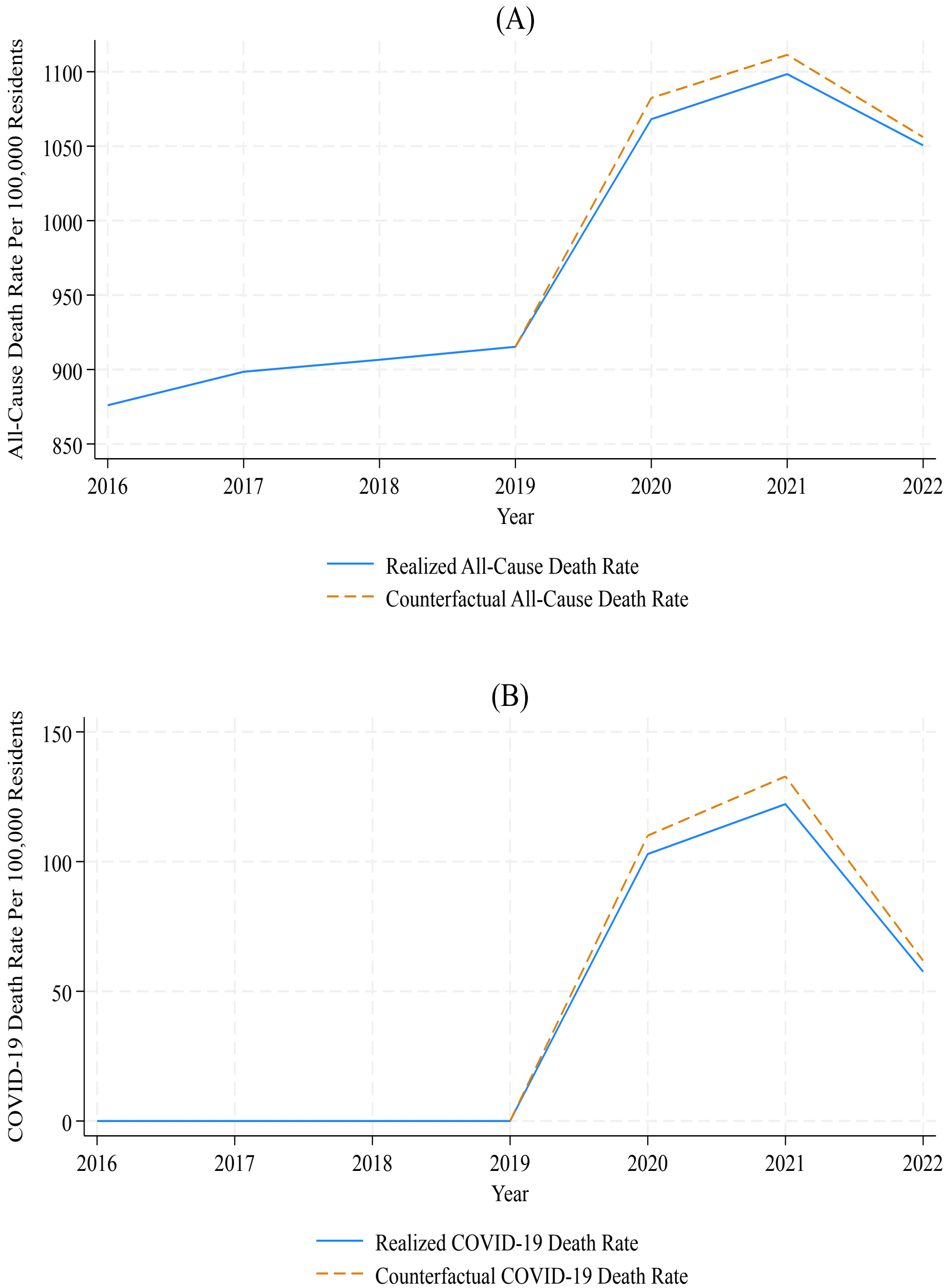
Notes: This figure shows the effect of an additional Congressional representative on a number of outcomes. The outcome in panel A is a state's total yearly hospital admissions for all causes. The outcome in panel B is a state's total yearly emergency department visits for all causes. In panel C, the outcome is yearly hospital admissions for patients confirmed to be suffering from COVID-19. In panel D, it is hospital admissions for patients confirmed or suspected to be suffering from COVID-19. In panel E, the outcome is yearly emergency department visits for patients confirmed or suspected to be suffering from COVID-19. In panel F we show the effect on total yearly COVID-19 cases. All outcomes are scaled to be per 100,000 of a state's residents in December 2019, just prior to the COVID-19 pandemic. Outcomes in panels A and B use yearly data from the Kaiser Family Foundation. Outcomes in panels C through E use facility-level data from the Health and Human Services' COVID-19 Reported Patient Impact and Hospital Capacity dataset, aggregated to the state and year level. Due to the HHS' data collection timeline, the year 2020 in our analyses represents data from June to December 2020, while the years 2021 and 2022 include all months of the year. The outcome in panel F uses data from the Hopkins CSSE. The contemporaneous coefficients for year t presented in the figure are the estimates ρ_t from equation 1. We then derive the cumulative effect of an additional representative in each year t by adding the contemporaneous effects from year 2020 to t. The baseline event-study specification used to estimate each of the effects incorporates controls for the state's vote share for Donald Trump in the 2016 presidential election and the state's 2019 population density, state and year fixed effects, and standard errors clustered at the state level.

Figure 5: The Reduced Form Effect of An Additional Representative on COVID-19 Vaccination, Testing Volume, Ratio of COVID-19 Cases to Tests, Hospital Capacity and Medicaid Enrollment



Notes: This figure shows the effect of an additional Congressional representative on the yearly number of COVID-19 vaccine doses administered in panel A, number of COVID-19 tests administered in panel B, the ratio of COVID-19 cases to tests in panel C, the number of hospital beds in panel D, and total Medicaid and CHIP enrollment in panel E. The outcome in panel B and the denominator of the outcome in panel C includes total viral and antigen tests administered in 89% of state-years and only viral tests in 2% of the state-years, with no data available for the remaining 9% of state-years. The data for vaccinations are obtained from the CDC while data for tests and cases are obtained from Hopkins CSSE. Data for hospital beds are obtained from the Kaiser Family Foundation. Data for Medicaid enrollment are from the Centers for Medicare and Medicaid Services and represent the total Medicaid and CHIP enrollment in the state as of December in a calendar year. Each outcome other than the ratio of cases to tests is scaled per 100,000 of a state's residents in December 2019, just prior to the COVID-19 pandemic. The contemporaneous coefficients for year t presented in the Figure are the estimates ρ_t from equation 1. For panels A and B, we derive the cumulative effect of an additional representative in each year t by adding the contemporaneous effects from year 2020 to t. For panel C the cumulative effect in each year is estimated by first explicitly constructing the cumulative ratio in each year equal to the cumulative cases divided by the cumulative tests in that year, and then estimating equation 2 with this cumulative ratio as the outcome. The baseline event-study specification used to estimate each of the effects incorporates controls for the state's vote share for Donald Trump in the 2016 presidential election and the state's 2019 population density, state and year fixed effects, and standard errors clustered at the state level.

Figure 6: Counterfactual All-Cause and COVID-19 Mortality Under Lowest Congressional Representation for All States



Notes: This figure represents the mean over all states of the death rate from all causes and COVID-19 by year. The solid line marks the realized mean death rate. The dotted line marks the mean death rate if all states had the number of Congressional representatives per million residents equal to the lowest for any state in the sample (1.294 in Texas). The counterfactual death rate for each state is constructed by applying the coefficient from column 1 of Table 3 to predict the additional death rate in every state given the magnitude of reduction in representatives for that state. The mean counterfactual reduction in representatives per million from this procedure is 0.86. The mean reduction in aid per capita, computed by multiplying the counterfactual reduction in representatives by the first stage effect of representation on aid from Table 4, column 1 is 0.845 thousand USD.

Table 1: Summary Statistics for Treatment and Control Variables

Variable	Mean	SD	Min	Max	N
Total federal aid per resident in USD thousands	2.85	0.96	1.82	5.88	50
Congressional representatives per million residents	2.16	0.91	1.29	5.15	50
Population density (2019)	202.61	266.22	1.28	1207.68	50
Population (2019) in thousands	6551	7389	579	39512	50
Vote share for Donald Trump in the 2016 Presidential election	0.49	0.10	0.29	0.69	50
Death rate for diabetes, a proxy for chronic disease (2019)	72.68	19.37	44.40	140.40	50
Share of population aged 65 or older (2019)	0.17	0.02	0.11	0.21	50
Oxford Stringency Index divided by 100 (average in March 2020)	0.43	0.05	0.32	0.55	50

Notes: This table represents summary statistics for the key covariates in our analyses which are all constant over time. Data to calculate the total federal aid and congressional representatives are derived from a variety of sources described in detail in Clemens et al. (2023). Both variables are scaled for population using the 2020 state population figures from the CDC Wonder database since this is the relevant population measure that applies to congressional decision-making relevant to the federal aid determination. For all other variables, the 2019 state population figures from the CDC Wonder database are used. The measure for land area in square miles used to calculate population density is derived from the U.S. Census' 2020 Gazetteer files. Data for Donald Trump's vote share in the 2016 presidential election come from the MIT Election Lab. The 2019 death rate for diabetes is from the CDC's Chronic Disease Indicators tool. The population share over the age of 65 in a state uses the CDC Wonder's state population data disaggregated by age. The Oxford Stringency Index measure is derived from data used in Clemens et al. (2023).

Table 2: Summary Statistics for Outcomes

	Contemporaneous Outcome					Cumulative Outcome				
Variable	Mean	SD	Min	Max	N	Mean	SD	Min	Max	N
Death rate for all causes	973.35	172.84	558.74	1646.24	350	2150.63	946.95	670.53	4637.79	150
Death rate for COVID-19	94.22	43.60	23.08	201.94	150	203.55	97.01	23.08	399.96	150
Hospital admission rate for all causes	9925.50	1720.87	5109.87	14396.92	350	19040.65	8566.06	5109.87	37520.70	150
Emergency department visit rate for all causes	43148.29	8090.53	23189.90	68762.83	350	80205.05	37032.26	25868.72	161949.97	150
Hospital admission rate for individuals with confirmed COVID-19	513.46	223.25	25.32	1497.22	150	971.53	607.17	25.32	3105.82	150
Hospital admission rate for individuals with confirmed or suspected COVID-19	938.60	419.92	193.43	2160.32	150	1799.45	1136.70	193.43	5386.11	150
Emergency department visit rate for individuals with confirmed or suspected COVID-19	4372.55	2303.57	299.36	11970.89	150	7530.93	5396.98	299.36	26495.58	150
COVID-19 case rate	10137.55	3645.82	1187.84	20063.89	150	17874.16	10424.95	1187.84	41878.55	150
COVID-19 test rate	107192.85	69427.38	10534.31	434535.34	136	201809.89	146779.37	30400.01	790175.88	136
COVID-19 vaccination rate	65675.18	65213.26	1030.53	207075.92	150	117710.67	87125.16	1030.53	277730.22	150
Ratio of COVID-19 cases to tests	0.13	0.12	0.01	1.02	136	0.10	0.06	0.01	0.40	136
Hospital beds rate	257.42	68.36	160.28	483.69	150					
Death rate for all causes : 65 years or older	4374.69	548.05	2940.34	5688.80	250	9320.00	3910.66	3448.05	16688.55	150
Death rate for all causes : under 65	319.58	77.96	178.34	612.78	250	686.26	331.70	201.47	1664.54	150
Death rate for all causes : males	1068.25	193.60	594.77	1763.07	250	2294.61	1018.07	701.34	4953.08	150
Death rate for all causes : females	948.77	159.05	544.95	1531.55	250	2010.01	881.13	620.35	4328.28	150
Death rate for all causes : Hispanic	329.31	132.29	139.22	943.81	250	756.26	417.84	160.34	2667.24	150
Death rate for all causes : non-Hispanic black	833.60	285.56	144.78	1427.32	250	1842.67	973.00	249.34	3993.63	150
Death rate for all causes : non-Hispanic white	1185.01	188.03	654.66	1720.58	250	2500.02	1098.11	723.28	4850.68	150
Death rate for COVID-19 : 65 years or older	422.30	182.70	95.36	894.49	150	924.41	411.52	95.36	1756.33	150
Death rate for COVID-19 : under 65	27.61	19.24	2.41	86.79	150	57.32	36.10	2.41	157.75	150
Death rate for COVID-19 : males	105.61	49.20	24.00	227.87	150	227.31	109.33	24.00	447.22	150
Death rate for COVID-19 : females	83.07	38.85	18.51	176.48	150	180.29	86.08	18.51	364.96	150
Death rate for COVID-19 : Hispanic	57.08	38.65	0.00	225.06	150	128.95	74.49	0.00	351.23	150
Death rate for COVID-19 : non-Hispanic black	86.07	53.65	0.00	276.00	150	191.73	110.57	0.00	455.37	150
Death rate for COVID-19 : non-Hispanic white	100.29	46.22	10.44	210.74	150	212.91	106.78	10.44	442.00	150

Notes: This table represents summary statistics for the key yearly outcomes in the our analyses. All variables termed rates are scaled for population so that they are interpreted to be per 100,000 state population. The population used for scaling is the 2019 state population from the CDC Wonder database of the relevant demographic group. Death counts for all causes and COVID-19 are from the CDC Wonder database. Hospital and emergency department admissions for all causes are obtained from the Kaiser Family Foundation, as are the total hospital beds in a state. Hospital and emergency department admissions for COVID-19 are from the Health and Human Services' COVID-19 Reported Patient Impact and Hospital Capacity by Facility database. Of these, the hospital admissions can be categorized as those for individuals who presented with either a confirmed case of COVID-19 or a suspected case of COVID-19 at the time of admission. Data for COVID-19 cases and tests are derived from the Hopkins CSSE and data for vaccinations are obtained from the CDC. Deaths for all causes and COVID-19 for different demographic groups are obtained from the CDC Wonder database and the population used for scaling is the group's 2019 population from the same dataset.

Table 3: The Reduced Form Effect of An Additional Representative on Mortality

A: Effect on 2022 Cumulative All-Cause Death Rate Per 100,000					
	(1)	(2)	(3)	(4)	(5)
Cumulative Effect of an	-38.04**	-56.37***	-36.93**	-28.20	-46.80***
Additional Representative	(17.48)	(21.50)	(18.29)	(18.14)	(16.88)
Covariates					
Trump Vote Share	Yes	Yes	Yes	No	Yes
State Population Density	Yes	Yes	No	No	Yes
Pop. Weighted Density	No	No	Yes	No	No
Additional Controls	No	No	No	No	Yes
Population Weights	No	Yes	No	No	No
Dep. Var. Mean in 2022	3,217.16	3,217.16	3,217.16	3,217.16	3,217.16
Observations	350	350	350	350	350

B: Effect on 2022 Cumulative COVID-19 Death Rate Per 100,000					
	(1)	(2)	(3)	(4)	(5)
Cumulative Effect of an	-25.59***	-26.32***	-23.69***	-22.36*	-29.41***
Additional Representative	(5.12)	(8.81)	(7.25)	(13.28)	(5.06)
Covariates					
Trump Vote Share	Yes	Yes	Yes	No	Yes
State Population Density	Yes	Yes	No	No	Yes
Pop. Weighted Density	No	No	Yes	No	No
Additional Controls	No	No	No	No	Yes
Population Weights	No	Yes	No	No	No
Dep. Var. Mean in 2022	282.66	282.66	282.66	282.66	282.66
Observations	200	200	200	200	200

Notes: This table shows the effect of an additional congressional representative on a state's yearly death rate per 100,000 residents cumulative up to 2022. To derive the coefficients presented in the table, we first estimate the ρ_t from equation 1 which represent the contemporaneous effect of an additional representative in the year t using 2019 as the reference period. We then derive the cumulative effect of an additional representative up to the year 2022 by adding the contemporaneous effects for years 2020 to 2022. The outcome in panel A is the all-cause death rate and the outcome in panel B is the COVID-19 death rate. The mortality data are from the CDC Wonder database. The baseline specification in column 1 includes controls for the state's vote share for Donald Trump in the 2016 presidential election and the state's 2019 population density. In column 2, the baseline coefficients are weighted by the 2020 state population. In column 3, the state population density is replaced with the 2019 population-weighted average county population density in a state. In column 4, no control variables are incorporated. The specification in column 5 incorporates controls from the baseline specification as well as the state's chronic disease prevalence as measured by the diabetes death rate in 2019, the share of the state's population over age 65 in 2019 and the Oxford Stringency Index from March 2020. Table B.2 provides a more detailed version of panel B with coefficients and standard errors for all covariates. All specifications include state and year fixed effects, with standard errors clustered at the state level.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 4: The Effect of COVID-19 Fiscal Relief on Mortality

A: First Stage Effect on Total Aid Per Resident (USD Thousands)					
	(1)	(2)	(3)	(4)	(5)
Cumulative Effect of an Additional Representative	0.981***	0.784***	1.020***	0.948***	0.983***
	(0.075)	(0.112)	(0.059)	(0.066)	(0.069)
Dep. Var. Mean	2.85	2.85	2.85	2.85	2.85
B: Second Stage Effect on 2022 Cumulative All-Cause Death Rate Per 100,000					
	(1)	(2)	(3)	(4)	(5)
Total Aid Per Resident	-38.78**	-71.88**	-36.19*	-29.75	-47.63**
(USD Thousands)	(18.89)	(28.67)	(18.74)	(19.54)	(18.74)
Dep. Var. Mean	471.39	471.39	471.39	471.39	471.39
C: Second Stage Effect on 2022 Cumulative COVID-19 Death Rate Per 100,000					
	(1)	(2)	(3)	(4)	(5)
Total Aid Per Resident	-26.09***	-33.56***	-23.21***	-23.59*	-29.93***
(USD Thousands)	(5.53)	(12.96)	(6.72)	(13.51)	(5.81)
Dep. Var. Mean	282.66	282.66	282.66	282.66	282.66
Covariates					
Trump Vote Share	Yes	Yes	Yes	No	Yes
State Population Density	Yes	Yes	No	No	Yes
Population Weighted Average County Population Density	No	No	Yes	No	No
Additional Controls	No	No	No	No	Yes
Population Weights	No	Yes	No	No	No
First Stage F-Stat	171.403	49.419	300.044	203.143	203.806
Observations	50	50	50	50	50

Notes: This table shows the effect of COVID-19 fiscal aid on the the cumulative 2022 death rate per 100,000 state residents using the instrumental variables 2SLS approach. The mortality data are from the CDC Wonder database. The baseline specification in column 1 includes controls for the state's vote share for Donald Trump in the 2016 presidential election and the state's 2019 population density. In column 2, the baseline coefficients are weighted by the 2020 state population. In column 3, the state population density is replaced with the 2019 population-weighted average county population density in a state. In column 4, no control variables or weights are incorporated. The specification in column 5 incorporates controls from the baseline specification as well as the state's chronic disease prevalence as measured by the diabetes death rate in 2019, the share of the state's population over age 65 in 2019 and the Oxford Stringency Index from March 2020. For each specification, in panel A we show the estimates from Equation 3 for the first stage effect of an additional congressional representative on total aid per resident measured in thousands of USD. In panels B and C we show the IV 2SLS estimate from equation 4 of the effect of total aid per resident on the all-cause death rate and COVID-19 death rate respectively. We report the first-stage F-statistic as a measure of the instrument's relevance. We perform a small-sample correction to obtain the relevant t-statistics for the second stage. The 2022 cumulative all-cause and COVID-19 deaths are calculated by summing the contemporaneous deaths from 2020 to 2022 in each state. To adjust for pre-existing differences in all-cause deaths among states receiving varying fiscal aid, we subtract three times the 2019 contemporaneous all-cause deaths from the raw cumulative value. We use these adjusted cumulative deaths for all causes and the raw cumulative deaths for COVID-19, scaled by state population, as outcomes in the 2SLS regression. Each regression contains 50 observations for states observed in the year 2022. Standard errors are robust to heteroskedasticity.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 5: Heterogeneity by Gender and Age in the Reduced Form Effect of An Additional Representative on Mortality

A: Effect on 2022 Cumulative All-Cause Death Rate Per 100,000						
	Gender		Age			
	(1) Female	(2) Male	(3) 0-24	(4) 25-64	(5) 65-74	(6) 75+
Cumulative Effect of an	-35.49*	-41.78**	-4.62*	-24.41**	-109.85***	-267.59*
Additional Representative	(18.68)	(17.98)	(2.37)	(10.21)	(39.21)	(137.34)
Dep. Var. Mean in 2022	3,004.98	3,434.47	200.67	1,535.19	6,648.94	24,334.19
Observations	250	250	250	250	250	250

B: Effect on 2022 Cumulative COVID-19 Death Rate Per 100,000						
	Gender		Age			
	(1) Female	(2) Male	(3) 0-24	(4) 25-64	(5) 65-74	(6) 75+
Cumulative Effect of an	-20.98***	-30.82***	-0.64***	-19.39***	-88.57***	-142.55***
Additional Representative	(4.78)	(5.84)	(0.14)	(4.36)	(17.14)	(38.60)
Dep. Var. Mean in 2022	249.21	316.83	2.78	132.11	662.15	2,126.02
Observations	200	200	200	200	200	200

Notes: This table shows the effect of an additional congressional representative on the mortality from all causes (panel A) and COVID-19 (panel B) per 100,000 state residents by gender in columns 1 and 2 and age in columns 3 through 6. The data for deaths are from the CDC Wonder database for years 2018 to 2022. The outcome underlying the presented coefficients is the group specific contemporaneous death rate which is deaths in the year divided by the group's population in the state in 2019 and multiplied by 100,000. For each outcome, we derive the 2022 cumulative coefficients presented in the table by first estimating the ρ_t from equation 1 which represent the contemporaneous effect of an additional representative in the year t using 2019 as the reference period, and then adding the contemporaneous effects for years 2020 to 2022. The baseline event-study specification used to estimate the presented coefficients incorporates controls for the state's vote share for Donald Trump in the 2016 presidential election and the state's 2019 population density, state and year fixed effects, and standard errors clustered at the state level.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 6: Heterogeneity by Race in the Reduced Form Effect of An Additional Representative on Mortality Using Our Age Adjustment (Two Age Groups)

	A: Effect on 2022 Cumulative All-Cause Death Rate Per 100,000							
	All Races		Hispanic		Non-Hispanic Black		Non-Hispanic White	
	(1) Crude	(2) Age-Adjusted	(3) Crude	(4) Age-Adjusted	(5) Crude	(6) Age-Adjusted	(7) Crude	(8) Age-Adjusted
Cumulative Effect of an Additional Representative	-38.04**	-38.27***	-38.46*	-66.54**	-101.50***	-58.00***	-44.04**	-32.42*
	(17.44)	(14.18)	(20.98)	(28.79)	(25.80)	(18.42)	(22.10)	(16.78)
Dep. Var. Mean in 2022	3,217.16	2,659.32	1,131.38	1,722.66	2,748.15	3,057.06	3,745.28	2,713.2
Observations	250	250	250	250	250	250	250	250
	B: Effect on 2022 Cumulative COVID-19 Death Rate Per 100,000							
	All Races		Hispanic		Non-Hispanic Black		Non-Hispanic White	
	(1) Crude	(2) Age-Adjusted	(3) Crude	(4) Age-Adjusted	(5) Crude	(6) Age-Adjusted	(7) Crude	(8) Age-Adjusted
Cumulative Effect of an Additional Representative	-25.59***	-25.20***	-26.56*	-35.72**	-71.88***	-55.14***	-31.42***	-22.84***
	(5.12)	(4.18)	(14.88)	(17.06)	(10.76)	(6.98)	(6.81)	(4.51)
Dep. Var. Mean in 2022	282.66	232.47	171.17	267.96	257.5	291.87	300.86	213.61
Observations	200	200	200	200	200	200	200	200

Notes: This table shows the effect of an additional congressional representative on the mortality from all causes (panel A) and COVID-19 (panel B) by race. Columns 1 and 2 show estimates for the full population, columns 3 and 4 show estimates for the Hispanic group, columns 5 and 6 show estimates for the non-Hispanic black group and columns 7 and 8 show estimates for the non-Hispanic white group. For each group, the left column depicts the effect of an additional representative on the crude death rate which is constructed as the the number of deaths within a group divided by the group's population in the state in 2019 and multiplied by 100,000. The right column depicts the effect on the group's age-adjusted death rate. Age adjustment is done on the basis of two broad age groups, 0 to 64 years, and 65 years and above. The age-adjusted death rate is constructed by first computing the crude age-specific death rate within a race-age group (ex. the death rate for Hispanics ages 0 to 64 years). Each age-specific death rate is then multiplied by the proportion of the 2000 U.S. standard population in that age group. This proportion was 0.873613 for ages 0 to 64 and 0.126387 for ages 65 and above. These products are then summed to get the final age-adjusted death rate. For each outcome, we derive the 2022 cumulative coefficients presented in the table by first estimating the ρ_t from equation 1 which represent the contemporaneous effect of an additional representative in the year t using 2019 as the reference period. We then derive the cumulative effect of an additional representative up to the year 2022 by adding the contemporaneous effects for years 2020 to 2022. The baseline event-study specification used to estimate the presented coefficients incorporates controls for the state's vote share for Donald Trump in the 2016 presidential election and the state's 2019 population density, state and year fixed effects, and standard errors clustered at the state level.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 7: The Reduced Form Effect of An Additional Representative on Hospitalization, Emergency Department Visits and COVID-19 Cases

	(1) All Cause Hospital Admissions	(2) All Cause ED Visits	(3) COVID-19 (Confirmed) Hospital Admissions	(4) COVID-19 (Confirmed or Suspected) Hospital Admissions	(5) COVID-19 (Confirmed or Suspected) ED Visits	(6) COVID-19 Cases
Cumulative Effect of an Additional Representative up to 2022	122.05	-116.37	-213.70***	-357.75***	-1170.44***	899.02
	(112.46)	(1973.02)	(43.86)	(125.46)	(445.14)	(798.09)
Dep. Var. Mean in 2022	28,539.56	122,191.78	1,540.37	2,815.81	13,117.64	30,412.64
Observations	350	350	200	200	200	200

Notes: This table shows the effect of an additional congressional representative on a number of outcomes. The outcome in column 1 is a state's total yearly hospital admissions for all causes. The outcome in column 2 is a state's total yearly emergency department visits for all causes. In column 3, the outcome is yearly hospital admissions for patients confirmed to be suffering from COVID-19. In column 4, it is hospital admissions for for patients confirmed or suspected to be suffering from COVID-19. In column 5, the outcome is yearly emergency department visits for patients confirmed or suspected to be suffering from COVID-19. In column 6 we show the effect on total yearly COVID-19 cases. All outcomes are scaled to be per 100,000 of a state's residents in December 2019, just prior to the COVID-19 pandemic. Outcomes in columns 1 and 2 use yearly data from the Kaiser Family Foundation. Outcomes in columns 3 to 5 use facility-level data from the Health and Human Services' COVID-19 Reported Patient Impact and Hospital Capacity dataset, aggregated to the state and year level. Due to the HHS' data collection timeline, the year 2020 in our analyses represents data from June to December 2020, while the years 2021 and 2022 include all months of the year. The outcome in column 6 uses data from the Hopkins CSSE. To derive the coefficients presented in the table, we first estimate the ρ_t from equation 1 which represent the contemporaneous effect of an additional representative in the year t using 2019 as the reference period. We then derive the cumulative effect of an additional representative up to the year 2022 by adding the contemporaneous effects for years 2020 to 2022. The baseline event-study specification used to estimate each of the effects incorporates controls for the state's vote share for Donald Trump in the 2016 presidential election and the state's 2019 population density, state and year fixed effects, and standard errors clustered at the state level.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 8: The Reduced Form Effect of An Additional Representative on COVID-19 Vaccination, Testing Volume and the Ratio of Covid-19 Cases to Tests

	(1) COVID-19 Vaccinations	(2) COVID-19 Test Volume	(3) Ratio of COVID-19 Cases to Tests	(4) Hospital Beds	(5) Medicaid Enrollment
Cumulative Effect of an Additional Representative up to 2022	7,755.40***	83,228.33***	-0.018***		
	(2591.85)	(22429.24)	(0.005)		
Average Contemporaneous Effect of an Additional Representative From 2020 to 2022				0.72	-212.29
				(1.45)	(185.83)
Dep. Var. Mean in 2022	197,025.54	328,478.13	0.114	257.42	25,796.90
Observations	200	186	186	350	350

Notes: This table shows the effect of an additional congressional representative on the yearly number of COVID-19 vaccine doses administered in column 1, number of COVID-19 tests administered in column 2, the ratio of COVID-19 cases to tests in column 3, the number of hospital beds in column 4, and total Medicaid and CHIP enrollment in column 5. The outcome in column 2 and the denominator of the outcome in column 3 includes total viral and antigen tests administered in 89% of state-years and only viral tests in 2% of the state-years, with no data available for the remaining 9% of state-years. The data for vaccinations are obtained from the CDC while data for tests and cases are obtained from Hopkins CSSE. Data for hospital beds are obtained from the Kaiser Family Foundation. Data for Medicaid enrollment are from the Centers for Medicare and Medicaid Services and represent the total Medicaid and CHIP enrollment in the state as of December in a calendar year. Each outcome other than the ratio of cases to tests is scaled per 100,000 of a state's residents in December 2019, just prior to the COVID-19 pandemic. To derive the coefficients presented in the table, we first estimate the ρ_t from equation 1 which represent the contemporaneous effect of an additional representative in the year t using 2019 as the reference period. We then derive the cumulative effect of an additional representative up to the year 2022 in columns 1 and 2 by adding the contemporaneous effects for years 2020 to 2022. In column 3, the cumulative effect is estimated by first explicitly constructing the cumulative ratio in each year equal to the cumulative cases divided by the cumulative tests in that year, and then estimating equation 1 with this cumulative ratio as the outcome. In columns 4 and 5, we present the average of contemporaneous effects in years 2020, 2021 and 2022. The baseline event-study specification used to estimate each of the effects incorporates controls for the state's vote share for Donald Trump in the 2016 presidential election and the state's 2019 population density, state and year fixed effects, and standard errors clustered at the state level.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

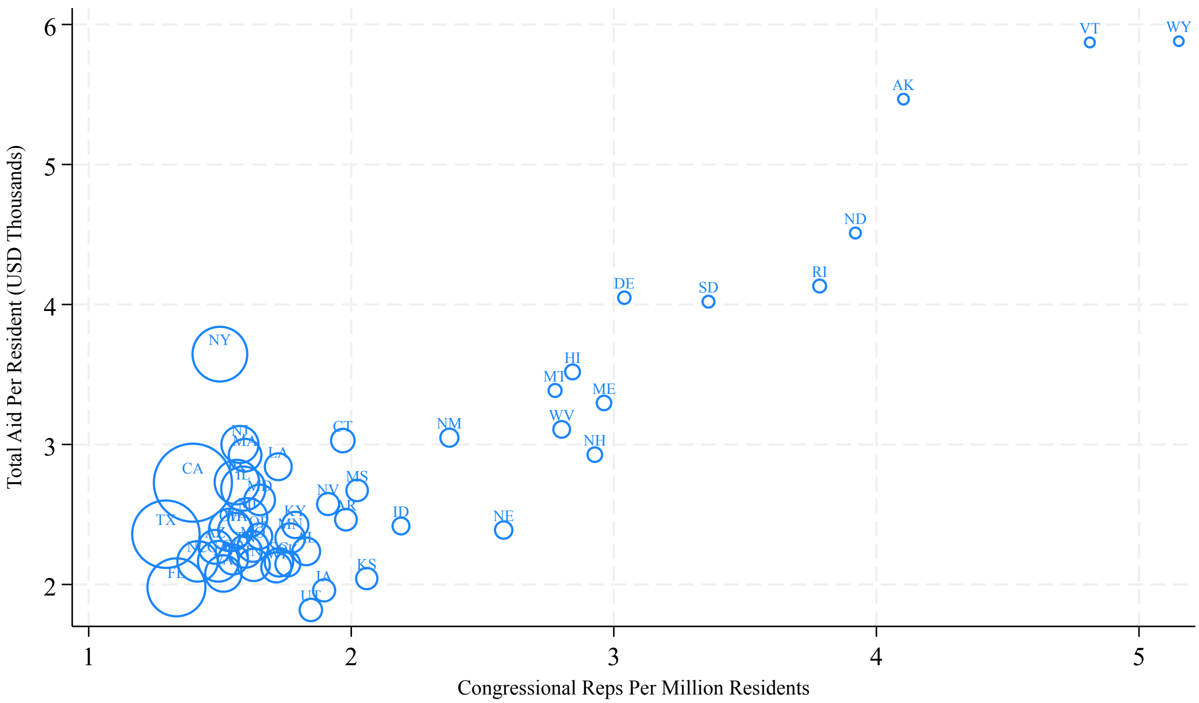
Table 9: Estimates of the Benefits of an Additional 100 Million USD in Fiscal Aid

Inputs				Estimates (Million $)		
Age Group	Estimated Number of Deaths Averted	Assumed Increase in Life Expectancy	Quality of Life Adjustment	**Estimated Value of Life Years Saved Per $100M in Fiscal Aid**		
				Value of Statistical Life (Million $)		
				Low	*Central*	*High*
				5.3	11.4	17.4
				Value of Statistical Life Year (Thousand $)		
				Low	*Central*	*High*
				130	278	423
A: Median Life Expectancy and No Quality Adjustment						
0 to 24	1.56	65.5	1.00	8.3	17.8	27.1
25 to 64	13.31	35.7	1.00	61.7	132.0	200.8
65 to 74	7.44	15.6	1.00	15.1	32.3	49.1
75 plus	16.48	5.3	1.00	11.3	24.1	36.6
Total	**38.79**			**96.3**	**206.1**	**313.7**
B: Downward-Adjusted Life Expectancy and No Quality Adjustment						
0 to 24	1.56	54.0	1.00	8.3	17.8	27.1
25 to 64	13.31	19.2	1.00	33.2	71.0	108.1
65 to 74	7.44	12.2	1.00	11.8	25.2	38.4
75 plus	16.48	2.0	1.00	4.3	9.2	13.9
Total	**38.79**			**57.6**	**123.2**	**187.6**
C: Median Life Expectancy with Quality Adjustment						
0 to 24	1.56	65.5	1.00	8.3	17.8	27.1
25 to 64	13.31	35.7	0.88	54.3	116.1	176.7
65 to 74	7.44	15.6	0.81	12.2	26.1	39.8
75 plus	16.48	5.3	0.76	8.6	18.3	27.8
Total	**38.79**			**83.4**	**178.4**	**271.5**
D: Downward-Adjusted Life Expectancy with Quality Adjustment						
0 to 24	1.56	54.0	1.00	8.3	17.8	27.1
25 to 64	13.31	19.2	0.88	29.2	62.5	95.1
65 to 74	7.44	12.2	0.81	9.6	20.4	31.1
75 plus	16.48	2.0	0.76	3.3	7.0	10.6
Total	**38.79**			**50.3**	**107.7**	**164.0**

Notes: In this table we provide our estimates for the benefits from an additional $100 million spending in fiscal aid. The estimates for benefits are obtained by first estimating the effects of fiscal aid on lives saved by age group, presented in Appendix Table B.11, then applying the CDC's estimates for life expectancy by age and quality-adjustment factors from Hanmer et al. (2006) to estimate the number of quality-adjusted life years saved by age group and finally multiplying these by the value of a statistical life year constructed from guidelines provided by the U.S. Department of Health and Human Services (2021). Further details about our cost-benefit analysis methodology are provided in Appendix D.

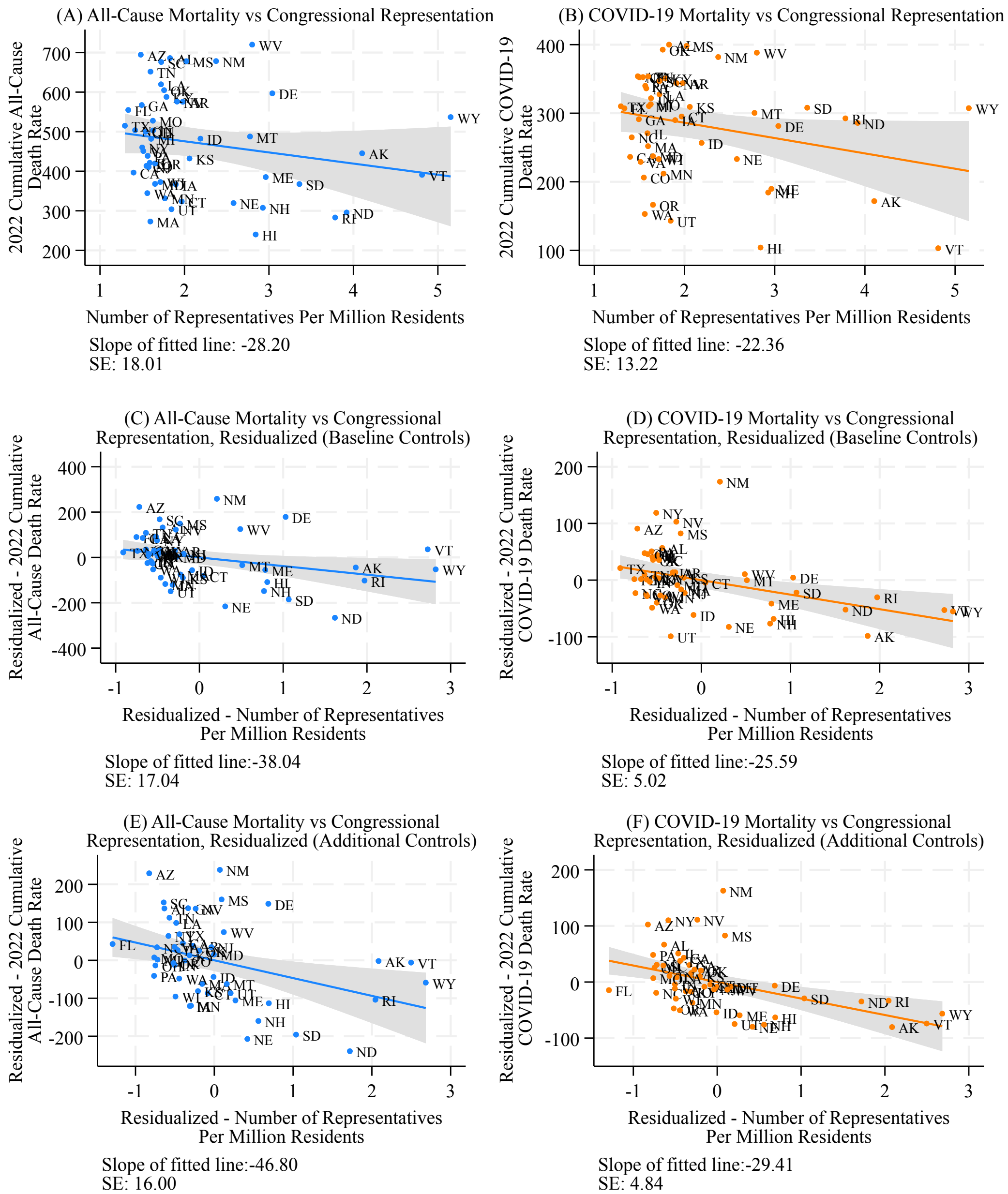
A Online Appendix Figures

Figure A.1: The Relationship Between Fiscal Aid and Congressional Representation



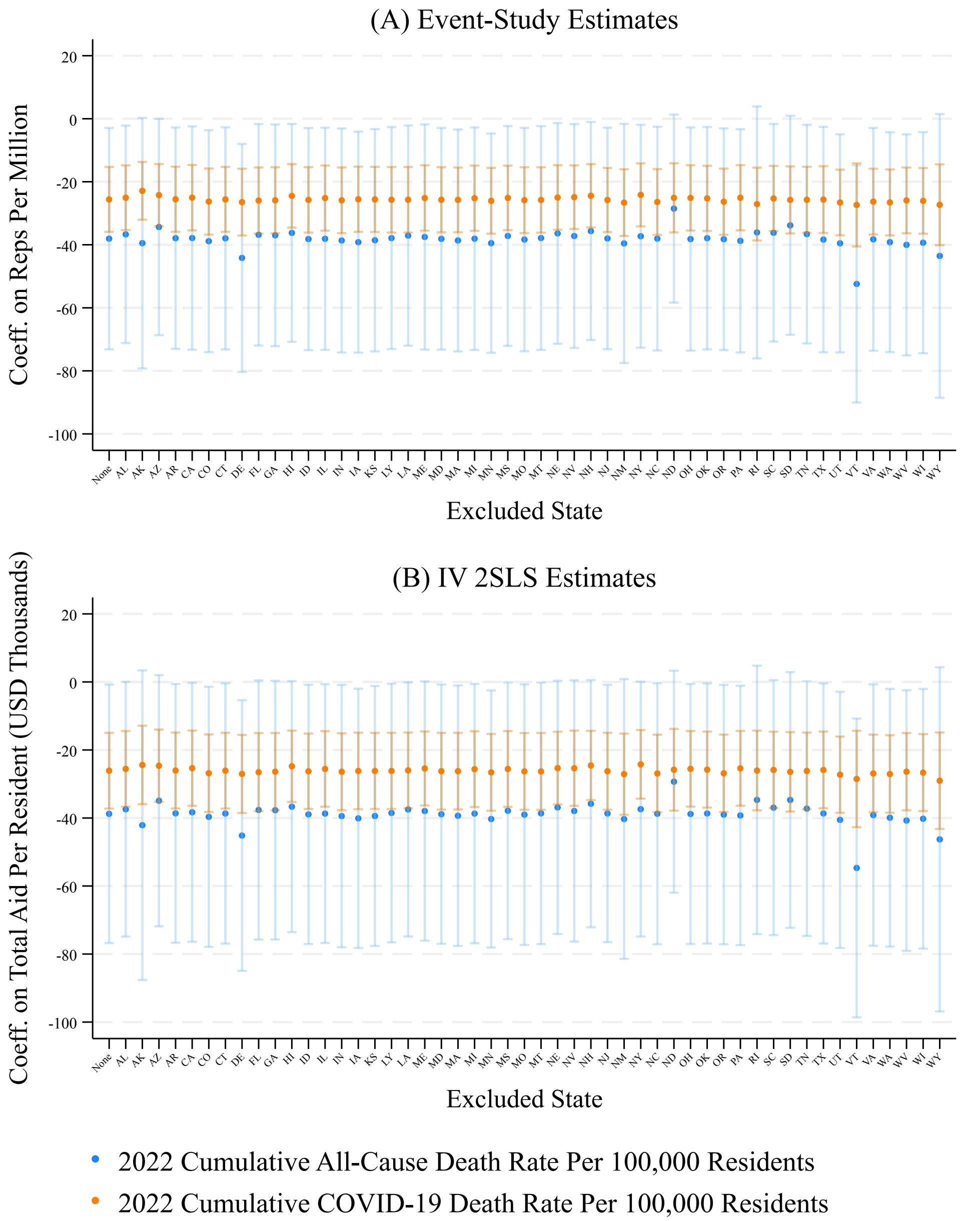
Notes: This figure plots Congressional representatives per million state residents on the x-axis and fiscal aid per capita in USD thousands on the y-axis. The hollow circles are annotated by the state which they represent and the size of the circle is proportional to the state's population in 2020.

Figure A.2: 2022 Cumulative Mortality and Congressional Representation



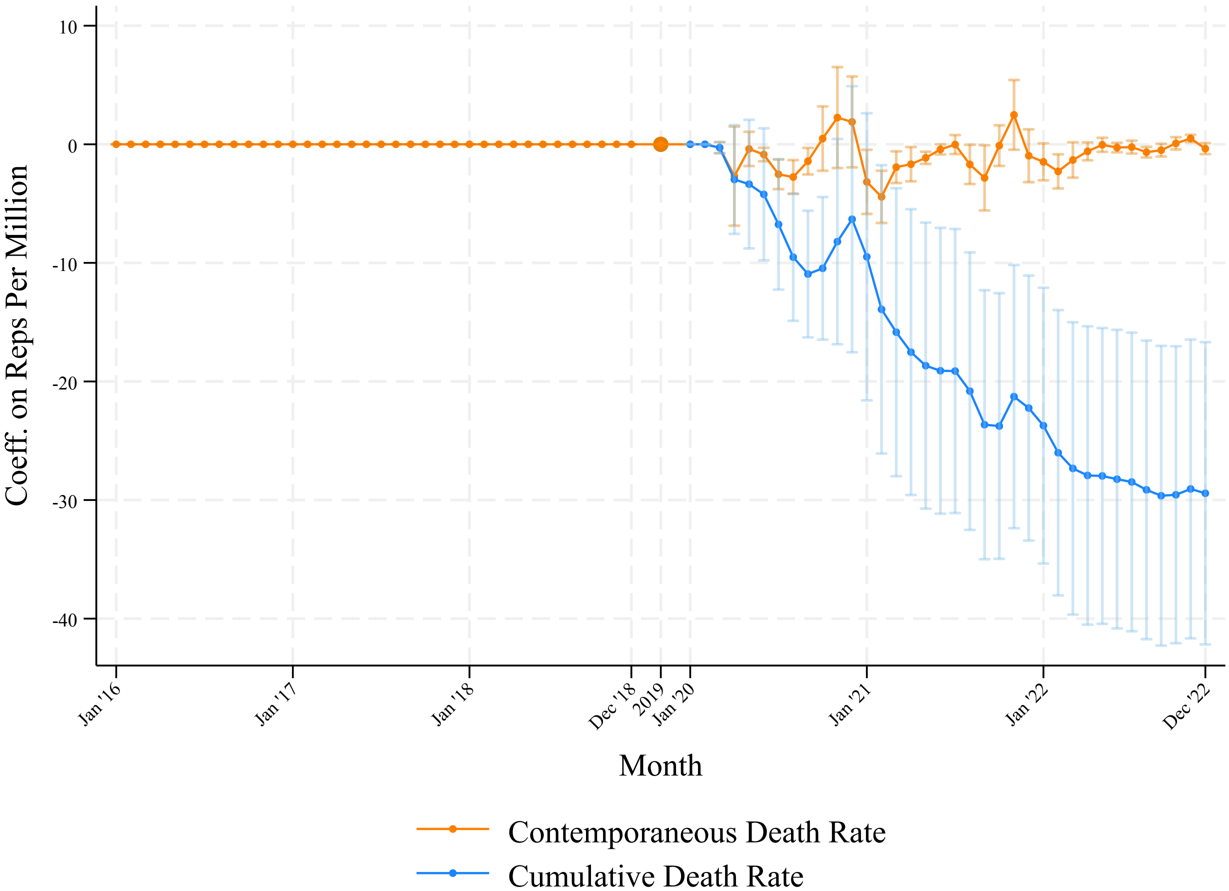
Notes: This figure plots a state's 2022 cumulative mortality as measured by the death rate per 100,000 state residents against Congressional representatives per million residents. Panels A and B plot the 2022 cumulative all-cause and COVID-19 mortality respectively against Congressional representation, mirroring results in column 4 of Table 3. Panels C and D plot the remaining variation in mortality and representation after controlling for our baseline controls which are the state's vote share for Donald Trump in the 2016 presidential election and the state's 2019 population density, mirroring results in column 1 of Table 3. Panels E and F plot the remaining variation in mortality and representation after controlling for our baseline controls as in panels C and D plus additional controls which are the state's chronic disease prevalence, the share of the state's population over age 65 in 2019 and the Oxford Stringency Index from March 2020, mirroring results in column 5 of Table 3. 2022 cumulative deaths are the sum of the contemporaneous deaths in years 2020, 2021 and 2022. To adjust for pre-existing differences in all-cause deaths among states receiving varying fiscal aid, we subtract three times the 2019 contemporaneous all-cause deaths from the raw cumulative value. The 2022 cumulative deaths are then scaled for the 2019 state population to get a measure of mortality per 100,000 state residents. Data for mortality are from the CDC Wonder database and data for Congressional representation are from various sources described in detail in Clemens et al. (2023).

Figure A.3: Sensitivity of Key Mortality Estimates to Exclusion of States from the Sample



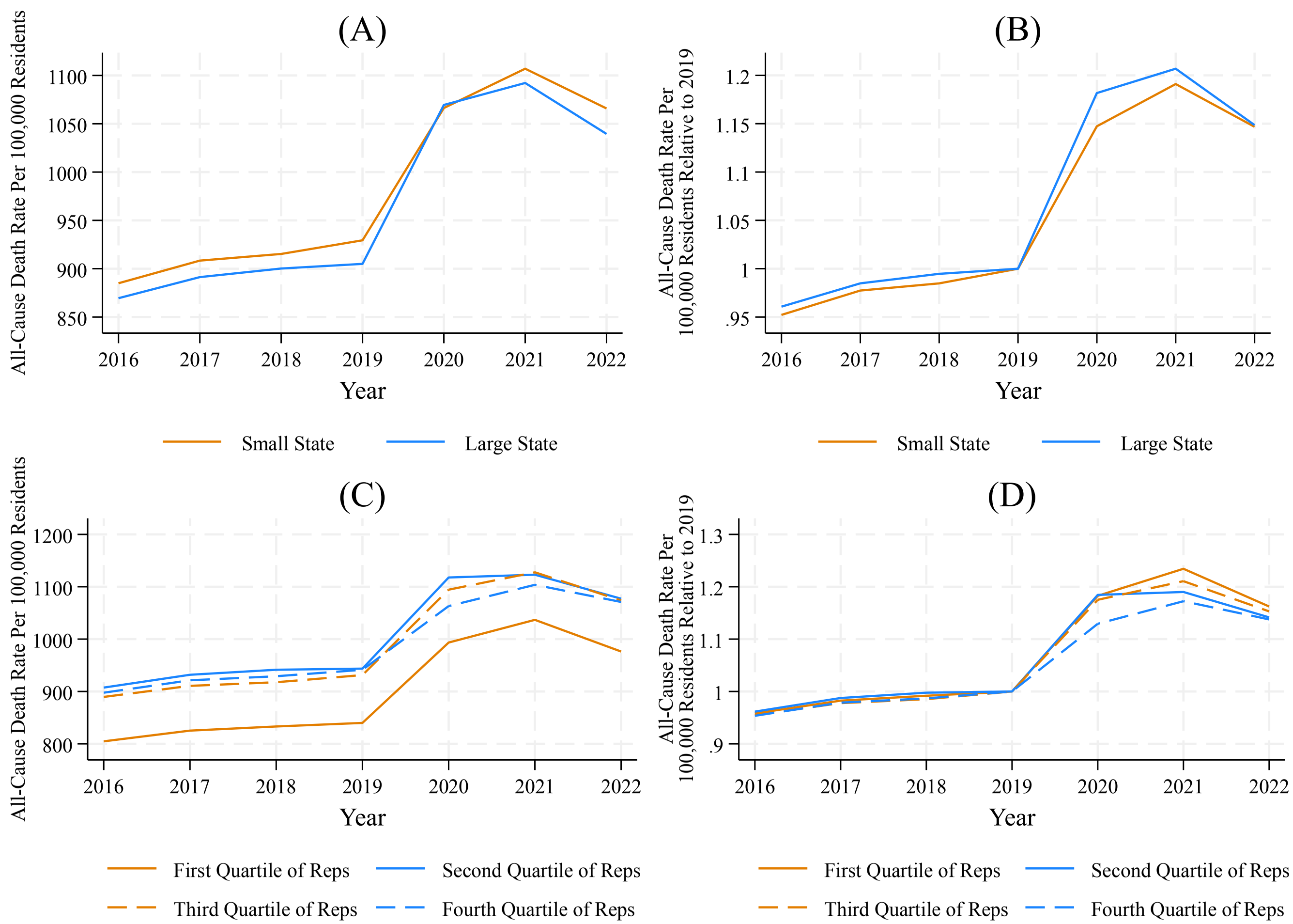
Notes: This figure displays estimates for the effects of fiscal aid on yearly mortality upon excluding one state at a time from the estimation sample. Data for all-cause and COVID-19 mortality are from the CDC Wonder database. Panel A displays the reduced form event-study estimates of the 2022 cumulative effect of an additional Congressional representative on mortality as in Table 3, with our baseline controls. Here, we first estimate the ρ_t from equation 1 which represent the contemporaneous effect on mortality per 100,000 residents of an additional representative in the year t using 2019 as the reference period. We then derive the cumulative effect of an additional representative up to the year 2022 by adding the contemporaneous effects for years 2020 to 2022. Panel B displays the second stage IV 2SLS estimates from equation 4 of the 2022 cumulative effect of total aid per resident (USD thousands) on mortality as in Table 4, with our baseline controls. Here, the 2022 cumulative deaths are calculated by summing the contemporaneous deaths from 2020 to 2022 in each state. To adjust for pre-existing differences in all-cause deaths among states receiving varying fiscal aid, we subtract three times the 2019 contemporaneous all-cause deaths from the raw cumulative value. We use these adjusted cumulative deaths for all causes and the raw cumulative deaths for COVID-19, scaled by state population, as outcomes in the 2SLS regression. The event-study specification clusters standard errors at the state level and the IV 2SLS specification accounts for standard error heteroskedasticity.

Figure A.4: The Reduced Form Effect of An Additional Representative on Monthly COVID-19 Mortality (Hopkins CSSE Data)



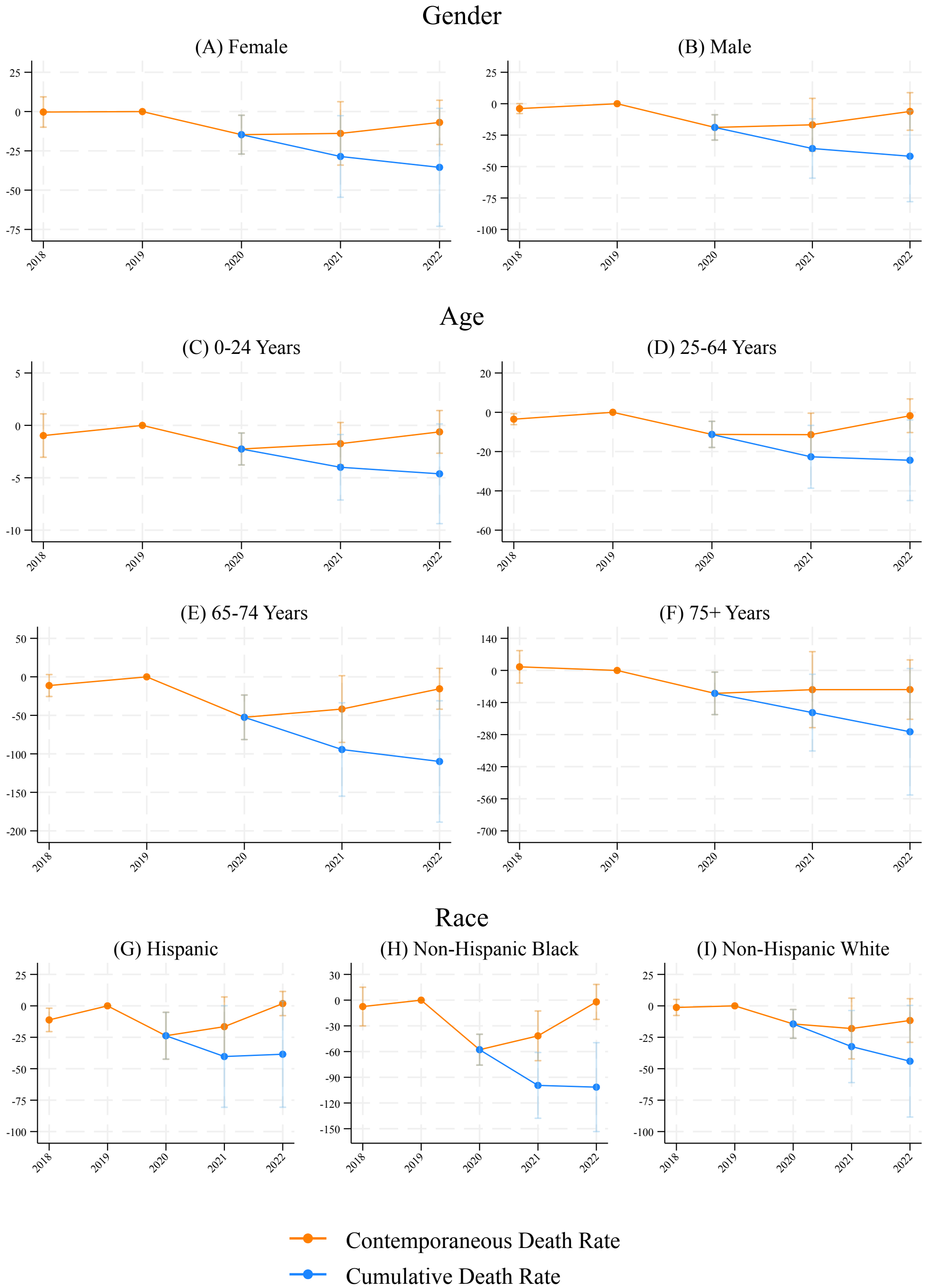
Notes: This figure shows the effect of an additional Congressional representative on the COVID-19 death rate per 100,000 state residents. Data for mortality are from the Hopkins CSSE. The x-axis marks the calendar month and the y-axis marks the coefficients derived as follows. The contemporaneous coefficients for month t presented in the figure are the estimates ρ_t from equation 1. We then derive the cumulative effect of an additional representative in each month t by adding the contemporaneous effects from January 2020 to t. The baseline event-study specification used to estimate each of the effects incorporates controls for the state's vote share for Donald Trump in the 2016 presidential election and the state's 2019 population density, state and year-month fixed effects, and standard errors clustered at the state level.

Figure A.5: Trends in Mean All-Cause Mortality By Year



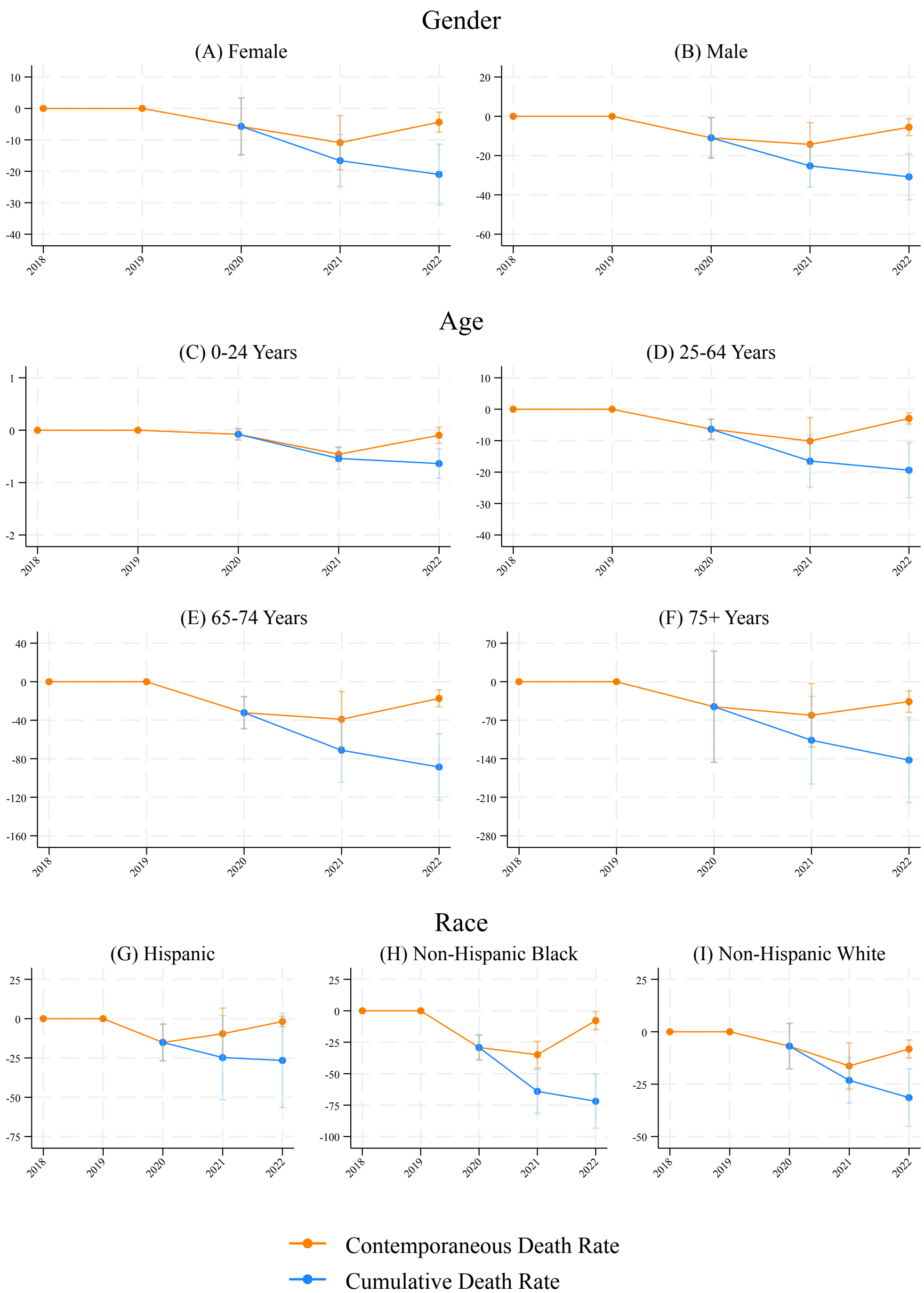
Notes: This figure displays the mean of the all-cause death rate per 100,000 state residents by year. In panels A and B states are categorized into two groups. Small states are those with more representatives per million residents and large states are those with fewer representatives per million residents, a categorization that is borrowed from Clemens and Veuger (2021). In panels C and D, states are categorized into four groups based on quartiles of representatives per million residents. Panels A and C plot the raw time series for the mean all-cause death rate and panels B and D plot the mean all-cause death rate relative to the 2019 value for each category.

Figure A.6: Heterogeneity in the Effect of an Additional Representative on All-Cause Mortality



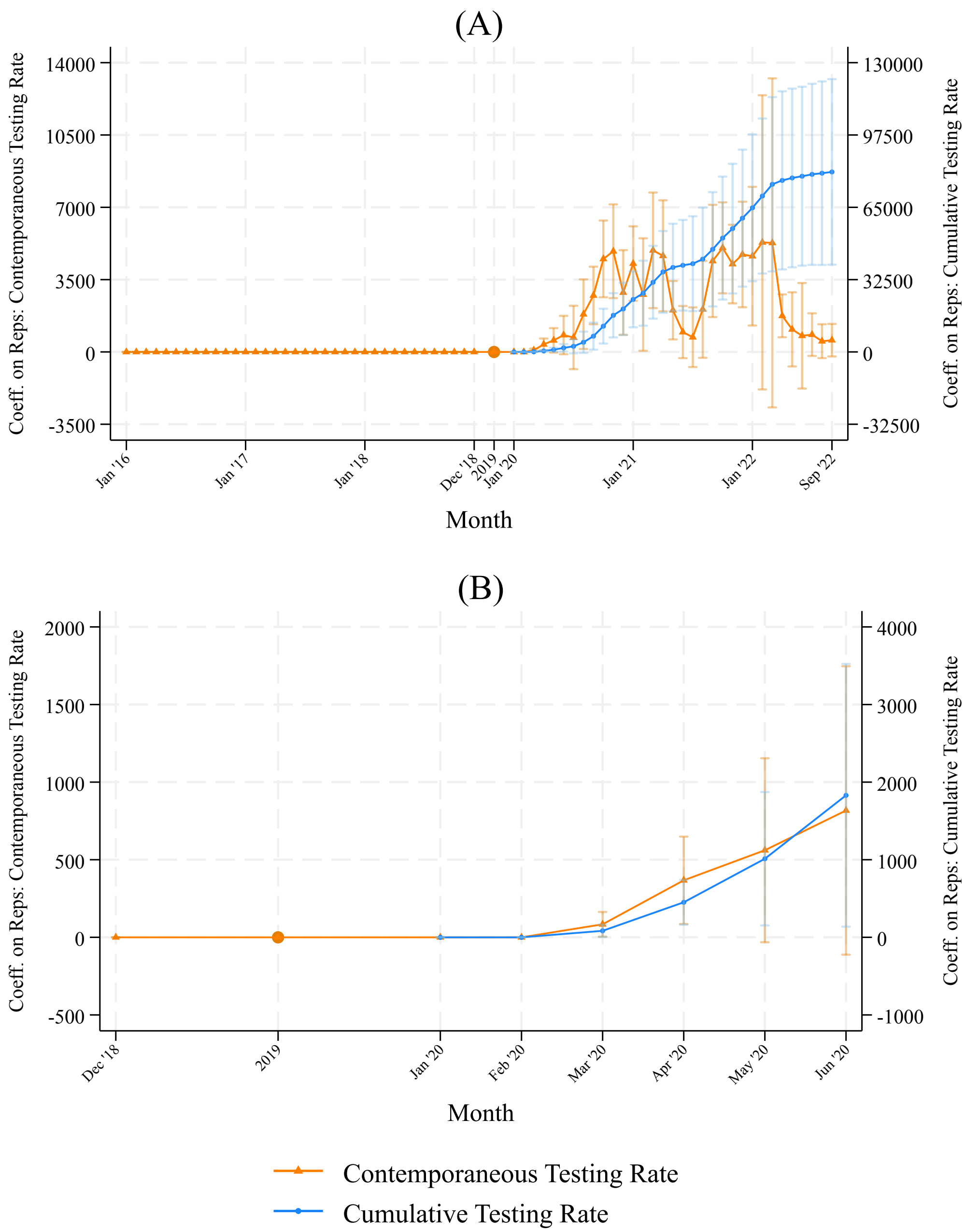
Notes: This figure shows the effect of an additional Congressional representative on the all-cause death rate per 100,000 state residents within various demographic segments. Data for mortality are from the CDC Wonder database. The x-axis marks the calendar year and the y-axis marks the coefficients derived as follows. The contemporaneous coefficients for year t presented in the figure are the estimates ρ_t from equation 1. We then derive the cumulative effect of an additional representative in each year t by adding the contemporaneous effects from year 2020 to t. The baseline event-study specification used to estimate each of the effects incorporates controls for the state's vote share for Donald Trump in the 2016 presidential election and the state's 2019 population density, state and year fixed effects, and standard errors clustered at the state level.

Figure A.7: Heterogeneity in the Effect of an Additional Representative on COVID-19 Mortality



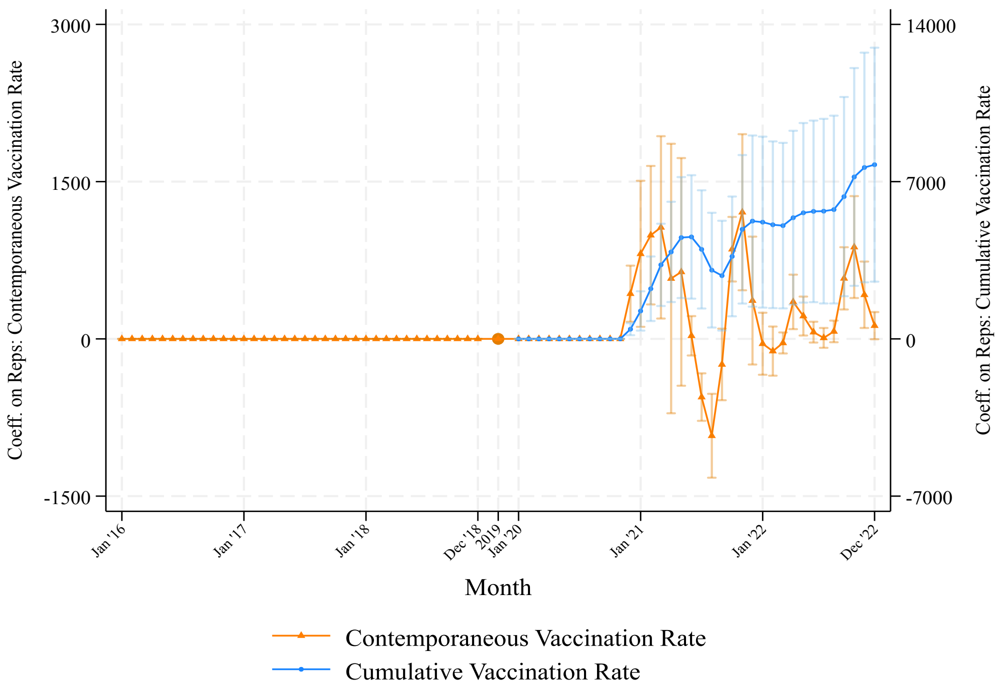
Notes: This figure shows the effect of an additional Congressional representative on the COVID-19 death rate per 100,000 state residents within within various demographic segments. Data for mortality are from the CDC Wonder database. The x-axis marks the calendar year and the y-axis marks the coefficients derived as follows. The contemporaneous coefficients for year t presented in the figure are the estimates ρ_t from equation 1. We then derive the cumulative effect of an additional representative in each year t by adding the contemporaneous effects from year 2020 to t. The baseline event-study specification used to estimate each of the effects incorporates controls for the state's vote share for Donald Trump in the 2016 presidential election and the state's 2019 population density, state and year fixed effects, and standard errors clustered at the state level.

Figure A.8: The Reduced Form Effect of an Additional Representative on Monthly COVID-19 Testing



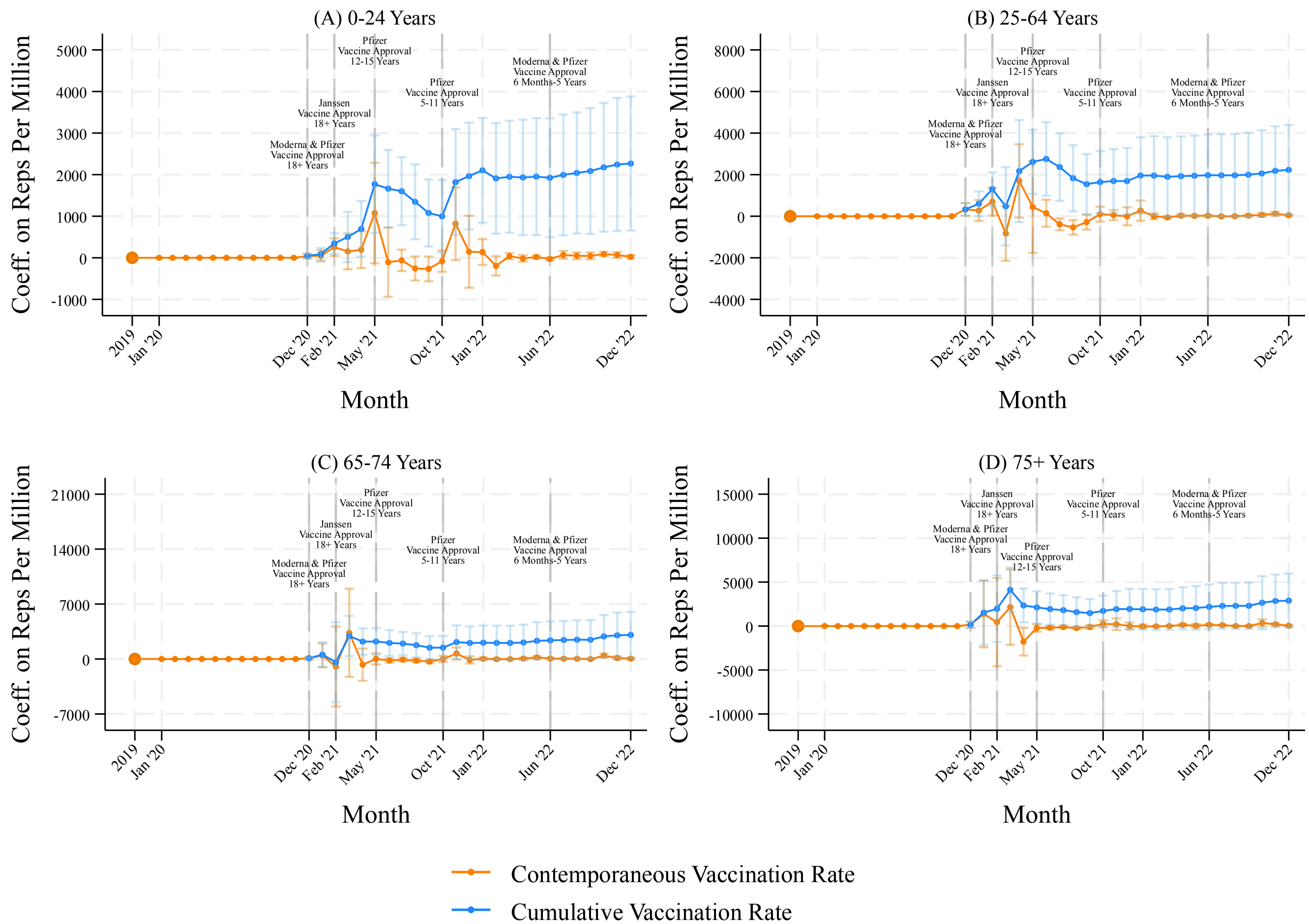
Notes: This figure shows the effect of an additional Congressional representative on a state's COVID-19 testing rate per 100,000 residents across different months. Testing data are from the Hopkins CSSE and are available for the months March 2020 to September 2022. Panel A depicts the effects across this entire period while panel B zooms into the months up to June 2020. The outcome is constructed using the total viral and antigen tests administered in a majority of state-months and only viral tests in some state-months, with no data available for approximately 5% of state-months. The coefficient for the contemporaneous testing rate in a month t is the ρ_t from equation 1. The coefficient for the cumulative testing rate for a month t is the sum of the coefficients for the contemporaneous testing rates for months 0 to t. In each panel, the left y-axis shows the effect of an additional Congressional representative on the contemporaneous outcome and the right y-axis show the effect on the cumulative. The specification incorporates controls for the state's vote share for Donald Trump in the 2016 presidential election and the state's 2019 population density. It includes state and year-month fixed effects, with standard errors clustered at the state level.

Figure A.9: The Reduced Form Effect of an Additional Representative on Monthly COVID-19 Vaccination



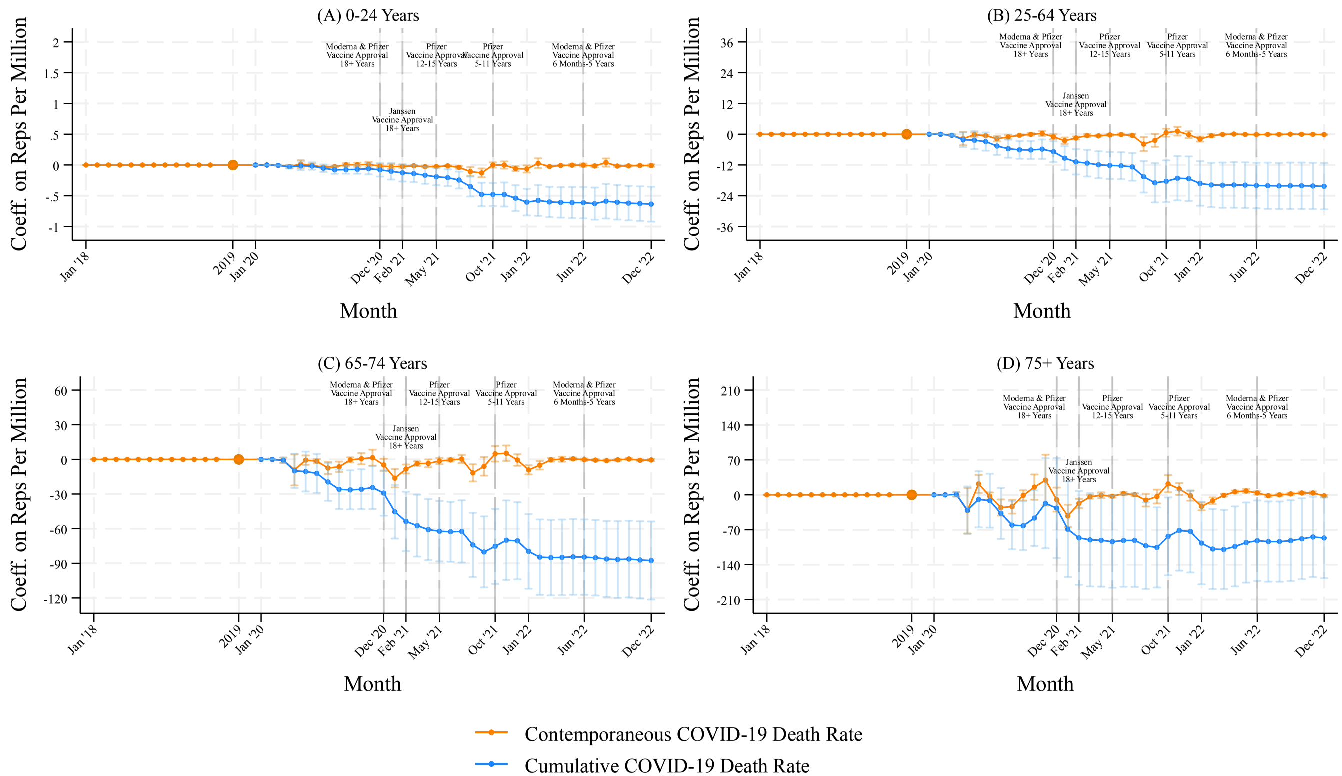
Notes: This figure shows the effect of an additional Congressional representative on a state's COVID-19 vaccination rate per 100,000 residents across different months. The data for vaccinations are obtained from the CDC and are available from December 2020 to December 2022 since December 2020 was when the earliest vaccines were available in the U.S. The coefficient for the contemporaneous vaccination rate in a month t is the ρ_t from equation 1. The coefficient for the cumulative vaccination rate for a month t is the sum of the coefficients for the contemporaneous vaccination rates for months 0 to t. The left y-axis shows the effect of an additional Congressional representative on the contemporaneous outcome and the right y-axis shows the effect on the cumulative. The specification incorporates controls for the state's vote share for Donald Trump in the 2016 presidential election and the state's 2019 population density. It includes state and year-month fixed effects, with standard errors clustered at the state level.

Figure A.10: The Reduced Form Effect of An Additional Representative on Monthly COVID-19 Vaccination by Age



Notes: This figure shows the effect of an additional Congressional representative on the COVID-19 vaccination by age. The outcome is the number of individuals with at least one dose of a COVID-19 vaccine rate per 100,000 state residents in that age group. Data are from the CDC. Vertical lines represent the timelines of FDA emergency approvals for vaccines which are obtained from the HHS (Health and Human Services 2024). The x-axis marks the calendar month and the y-axis marks the coefficients derived as follows. The contemporaneous coefficients for month t presented in the Figure are the estimates ρ_t from equation 1. We then derive the cumulative effect of an additional representative in each month t by adding the contemporaneous effects from January 2020 to t. The baseline event-study specification used to estimate each of the effects incorporates controls for the state's vote share for Donald Trump in the 2016 presidential election and the state's 2019 population density, state and year fixed effects, and standard errors clustered at the state level.

Figure A.11: The Reduced Form Effect of An Additional Representative on Monthly COVID-19 Mortality by Age



Notes: This figure shows the effect of an additional Congressional representative on the monthly COVID-19 death rate per 100,000 residents by age. The reference periods are all months in 2019. Data for death rates by age group from the CDC. 236 of the 3000 state-month values for COVID-19 deaths are censored in the CDC data and are consequently excluded from the analyses. Vertical lines represent the timelines of FDA emergency approvals for vaccines which are obtained from the HHS (Health and Human Services 2024). The x-axis marks the calendar month and the y-axis marks the coefficients derived as follows. The contemporaneous coefficients for month t presented in the Figure are the estimates ρ_t from equation 1. We then derive the cumulative effect of an additional representative in each month t by adding the contemporaneous effects from January 2020 to t. The baseline event-study specification used to estimate each of the effects incorporates controls for the state's vote share for Donald Trump in the 2016 presidential election and the state's 2019 population density, state and year-month fixed effects, and standard errors clustered at the state level.

B Online Appendix Tables

Table B.1: The Reduced Form Relationship Between An Additional Representative And 2019 Health Outcomes

	All-Cause Death Rate (2019)	Share of Pop. Above Age 65 (2019)	Death Rate for Diabetes (2019)
Effect of an	9.272	0.005	-0.059
Additional Representative	(20.39)	(0.004)	(2.275)
Dep. Var. Mean in 2019	915.26	0.17	72.68
Observations	50	50	50

Notes: This table presents the association between an additional congressional representative and health outcomes in 2019. The outcome in column 1 is the state's death rate from all causes in 2019 from the CDC Wonder. The outcome in column 2 is the share of the state's population ages 65 and above. The outcome in column 3 is the 2019 death rate from diabetes, a proxy for chronic disease burden, from the CDC Chronic Disease Indicator Tool. No other covariates are included and standard errors are robust to heteroskedasticity.

Table B.2: The Reduced Form Effect of An Additional Representative on COVID-19 Mortality

	Effect on 2022 Cumulative COVID-19 Death Rate Per 100,000				
	(1)	(2)	(3)	(4)	(5)
Cumulative Effect of an	-25.59***	-26.32***	-23.69***	-22.36*	-29.41***
Additional Representative	(5.12)	(8.81)	(7.25)	(13.28)	(5.06)
Covariates					
Trump Vote Share	640.48***	751.05***	690.53***		699.14***
	(176.67)	(99.40)	(165.81)		(182.68)
State Population Density	-0.04	-0.03			-0.06
	(0.05)	(0.04)			(0.05)
Pop. Weighted Density			0.0003		
			(0.004)		
Chronic Disease Prevalence					-0.06
					(0.86)
Population Share Over 65					1579.73**
					(729.59)
Oxford Stringency Index					170.78
					(161.44)
Population Weights	No	Yes	No	No	No
Dep. Var. Mean in 2022	282.66	282.66	282.66	282.66	282.66
Observations	200	200	200	200	200

Notes: This table shows the effect of an additional congressional representative on a state's yearly COVID-19 death rate per 100,000 residents cumulative up to 2022. To derive the coefficients presented in the table, we first estimate the ρ_t from equation 1 which represent the contemporaneous effect of an additional representative in the year t using 2019 as the reference period. We then derive the cumulative effect of an additional representative up to the year 2022 by adding the contemporaneous effects for years 2020 to 2022. The mortality data are from the CDC Wonder database. The baseline specification in column 1 includes controls for the state's vote share for Donald Trump in the 2016 Presidential election and the state's 2019 population density. In column 2, the baseline coefficients are weighted by the 2020 state population. In column 3, the state population density is replaced with the 2019 population-weighted average county population density in a state. In column 4, no control variables are incorporated. The specification in column 5 incorporates controls from the baseline specification as well as the state's chronic disease prevalence as measured by the diabetes death rate in 2019, the share of the state's population over age 65 in 2019 and the Oxford Stringency Index from March 2020. All specifications include state and year fixed effects, with standard errors clustered at the state level.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table B.3: Comparison of the OLS and IV 2SLS Estimates of the Effect of COVID-19 Fiscal Relief on Mortality

	(1)	(2)	(3)	(4)	(5)
A: OLS Effect on 2022 Cumulative All-Cause Death Rate Per 100,000					
Total Aid Per Resident	-18.07	-1.36	-18.37	-24.24	-24.80
(USD Thousands)	(15.84)	(24.02)	(16.29)	(16.15)	(15.22)
Dep. Var. Mean	471.39	471.39	471.39	471.39	471.39
B: IV Second Stage Effect on 2022 Cumulative All-Cause Death Rate Per 100,000					
Total Aid Per Resident	-38.78**	-71.88**	-36.19*	-29.75	-47.63**
(USD Thousands)	(18.89)	(28.67)	(18.74)	(19.54)	(18.74)
Dep. Var. Mean	471.39	471.39	471.39	471.39	471.39
C: OLS Effect on 2022 Cumulative COVID-19 Death Rate Per 100,000					
Total Aid Per Resident	-14.50**	27.96	-14.30*	-17.74	-17.77***
(USD Thousands)	(5.995)	(20.61)	(7.31)	(12.82)	(4.90)
Dep. Var. Mean	471.39	471.39	471.39	471.39	471.39
D: IV Second Stage Effect on 2022 Cumulative COVID-19 Death Rate Per 100,000					
Total Aid Per Resident	-26.09***	-33.56***	-23.21***	-23.59*	-29.93***
(USD Thousands)	(5.53)	(12.96)	(6.72)	(13.51)	(5.81)
Dep. Var. Mean	282.66	282.66	282.66	282.66	282.66
Covariates					
Trump Vote Share	Yes	Yes	Yes	No	Yes
State Population Density	Yes	Yes	No	No	Yes
Population Weighted Average County Population Density	No	No	Yes	No	No
Additional Controls	No	No	No	No	Yes
Population Weights	No	Yes	No	No	No
Observations	50	50	50	50	50

Notes: This table shows the effect of COVID-19 fiscal aid on the the cumulative 2022 death rate per 100,000 state residents using the OLS and instrumental variables 2SLS approaches separately. The mortality data are from the CDC Wonder database. The baseline specification in column 1 includes controls for the state's vote share for Donald Trump in the 2016 presidential election and the state's 2019 population density. In column 2, the baseline coefficients are weighted by the 2020 state population. In column 3, the state population density is replaced with the 2019 population-weighted average county population density in a state. In column 4, no control variables are incorporated. The specification in column 5 incorporates controls from the baseline specification as well as the state's chronic disease prevalence as measured by the diabetes death rate in 2019, the share of the state's population over age 65 in 2019 and the Oxford Stringency Index from March 2020. For each specification, in panels A and C we show the estimates from a regression of the 2022 cumulative all-cause death rate and 2022 cumulative COVID-19 death rate respectively on total aid per resident measured in thousands of USD. In panels B and D we show the IV 2SLS estimate from equation 4 of the effect of total aid per resident on the 2022 cumulative all-cause death rate and 2022 cumulative COVID-19 death rate respectively. The 2022 cumulative all-cause and COVID-19 deaths are calculated by summing the contemporaneous deaths from 2020 to 2022 in each state. To adjust for pre-existing differences in all-cause deaths among states receiving varying fiscal aid, we subtract three times the 2019 contemporaneous all-cause deaths from the raw cumulative value. We use these adjusted cumulative deaths for all causes and the raw cumulative deaths for COVID-19, scaled by state population, as outcomes in the regressions. Each regression contains 50 observations for states observed in the year 2022. Standard errors are robust to heteroskedasticity.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table B.4: Sensitivity of Key Mortality Estimates to the Exclusion of States With Reliance on Resource-Extraction and Tourism Related Industries

	A: Effect on 2022 Cumulative All-Cause Deaths Per 100,000							
	All States		Excluding Resource Intensive States		Excluding Tourism Intensive States		Excluding Resource and Tourism Intensive States	
	(1) Reduced Form	(2) IV 2SLS	(3) Reduced Form	(4) IV 2SLS	(5) Reduced Form	(6) IV 2SLS	(7) Reduced Form	(8) IV 2SLS
Cumulative Effect of an Additional Representative	-38.04**		-30.46		-34.24**		-25.38	
	(17.48)		(24.46)		(17.40)		(24.27)	
Total Aid Per Resident (USD Thousands)		-38.78**		-36.53		-34.79*		-30.47
		(18.89)		(31.73)		(18.57)		(31.11)
Dep. Var. Mean in 2022	3,217.16	471.39	3,242.46	474.29	3,226.69	472.31	3,254.36	475.47
First Stage F-Stat		171.40		65.25		166.79		61.61
Observations	350	50	329	47	329	47	308	44
	B: Effect on 2022 Cumulative COVID-19 Deaths Per 100,000							
	All States		Excluding Resource Intensive States		Excluding Tourism Intensive States		Excluding Resource and Tourism Intensive States	
	(1) Reduced Form	(2) IV 2SLS	(3) Reduced Form	(4) IV 2SLS	(5) Reduced Form	(6) IV 2SLS	(7) Reduced Form	(8) IV 2SLS
Cumulative Effect of an Additional Representative	-25.59***		-22.55***		-24.21***		-20.76***	
	(5.12)		(6.96)		(5.00)		(6.78)	
Total Aid Per Resident (USD Thousands)		-26.09***		-27.05***		-24.60***		-24.92***
		(5.53)		(10.05)		(5.33)		(9.68)
Dep. Var. Mean in 2022	282.66	282.66	284.42	284.42	284.64	284.64	286.66	286.66
First Stage F-Stat		171.40		65.25		166.79		61.61
Observations	200	50	188	47	188	47	176	44

Notes: This table represents the effect of federal aid on mortality upon excluding groups of states from the sample. Panel A shows the effect on the 2022 cumulative all-cause death rate per 100,000 and panel B shows the effect on the 2022 cumulative COVID-19 death rate per 100,000. Columns 1 and 2 include all states in the sample and mirror estimates in Tables 3 and 4 respectively. Columns 3 and 4 exclude resource-intensive states (Alaska, North Dakota, and Wyoming). Columns 5 and 6 exclude tourism-intensive states (Hawaii, Nevada, and Florida). Columns 7 and 8 exclude both of these categories of states, which were particularly impacted by the economic turmoil of the early pandemic. The reduced form effect of an additional representative on the outcome is constructed from equation 1, where contemporaneous effects for the years 2020, 2021 and 2022 are first estimated and then summed up to obtain the cumulative effect in 2022. The IV 2SLS estimate is the second stage estimate of the effect of total federal aid per resident from equation 4. To adjust for pre-existing differences in all-cause deaths among states receiving varying fiscal aid, we subtract three times the 2019 contemporaneous all-cause deaths from the raw cumulative value. We use these adjusted cumulative deaths for all causes and the raw cumulative deaths for COVID-19, scaled by state population, as outcomes in the 2SLS regression. Specifications used in all columns include our baseline controls for a state's vote share for Donald Trump in the 2016 presidential election and the state's 2019 population density, with standard errors clustered at the state level in the reduced form estimates and robust to heteroskedasticity in the IV 2SLS estimates.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table B.5: The Effect of a Categorical Instrument on Mortality

	IV First Stage	IV Second Stage		Event-Study Reduced Form	
	(1)	(2)	(3)	(4)	(5)
A:	Aid Per Capita	All-Cause Mortality	COVID-19 Mortality	All-Cause Mortality	COVID-19 Mortality
Cumulative Effect of Being a Small State	1.08***			-64.81*	-29.73*
	(0.25)			(34.93)	(16.50)
Total Aid Per Resident (USD Thousands)		-60.15*	-27.59*		
		(35.81)	(15.54)		
Dep. Var. Mean in 2022	2.85	471.39	282.66	3,217.16	282.66
First Stage F-Stat	18.13				
Observations	50	50	50	350	200
	(1)	(2)	(3)	(4)	(5)
B:	Aid Per Capita	All-Cause Mortality	COVID-19 Mortality	All-Cause Mortality	COVID-19 Mortality
Cumulative Effect of Being in a Higher Quartile of Representation	0.54***			-35.56***	-18.94***
	(0.11)			(13.62)	(5.84)
Total Aid Per Resident (USD Thousands)		-66.26**	-35.30***		
		(30.49)	(12.97)		
Dep. Var. Mean in 2022	2.85	471.39	282.66	3,217.16	282.66
First Stage F-Stat	23.62				
Observations	50	50	50	350	200

Notes: This table shows the effect of congressional representation on mortality using a categorical instrument. In panel A, the instrument is binary with a small state having a higher number of representatives per million residents and a large state having fewer representatives per million residents. The categorization of states as small or large is borrowed from Clemens and Veuger (2021). In panel B, the instrument takes the value 1, 2, 3 or 4 for the quartile in which a state's congressional representation falls. Column 1 shows the first stage effect from an IV 2SLS regression of fiscal aid on mortality. Columns 2 and 3 show the second stage effects of fiscal aid on all-cause and COVID-19 mortality respectively. Columns 4 and 5 show the reduced form effects of the instrument on all-cause and COVID-19 mortality respectively from our event-study specification. We report the first-stage F-statistic as a measure of the instrument's relevance. We perform a small-sample correction to obtain the relevant t-statistics for the second stage. In the IV regressions, the 2022 cumulative all-cause and COVID-19 deaths are calculated by summing the contemporaneous deaths from 2020 to 2022 in each state. To adjust for pre-existing differences in all-cause deaths among states receiving varying fiscal aid, we subtract three times the 2019 contemporaneous all-cause deaths from the raw cumulative value and use this as our outcome. Standard errors are clustered at the state level in columns 4 and 5 and robust to heteroskedasticity in columns 2 and 3.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table B.6: Heterogeneity by Race in the Reduced Form Effect of An Additional Representative on Mortality Using Our Age Adjustment (Three Age Groups)

	A: Effect on 2022 Cumulative All-Cause Death Rate Per 100,000							
	All Races		Hispanic		Non-Hispanic Black		Non-Hispanic White	
	(1) Crude	(2) Age-Adjusted	(3) Crude	(4) Age-Adjusted	(5) Crude	(6) Age-Adjusted	(7) Crude	(8) Age-Adjusted
Cumulative Effect of an Additional Representative	-38.04**	-37.96***	-38.46*	-67.66**	-101.50***	-55.00***	-44.04**	-30.81*
	(17.44)	(13.93)	(20.98)	(27.65)	(25.80)	(19.03)	(22.10)	(16.24)
Dep. Var. Mean in 2022	3,217.16	2,629.78	1,131.38	1,777.89	2,748.15	3,063.44	3,745.28	2,639.42
Observations	250	250	250	250	250	250	250	250
	B: Effect on 2022 Cumulative COVID-19 Death Rate Per 100,000							
	All Races		Hispanic		Non-Hispanic Black		Non-Hispanic White	
	(1) Crude	(2) Age-Adjusted	(3) Crude	(4) Age-Adjusted	(5) Crude	(6) Age-Adjusted	(7) Crude	(8) Age-Adjusted
Cumulative Effect of an Additional Representative	-25.59***	-24.83***	-26.56*	-37.28**	-71.88***	-54.72***	-31.42***	-21.80***
	(5.12)	(4.18)	(14.88)	(17.14)	(10.76)	(6.99)	(6.81)	(4.43)
Dep. Var. Mean in 2022	282.66	229.84	171.17	279.26	257.5	292.28	300.86	207.93
Observations	200	200	200	200	200	200	200	200

Notes: This table shows the effect of an additional congressional representative on the mortality from all causes (panel A) and COVID-19 (panel B) by race. Columns 1 and 2 show estimates for the full population, columns 3 and 4 show estimates for the Hispanic group, columns 5 and 6 show estimates for the non-Hispanic Black group and columns 7 and 8 show estimates for the non-Hispanic White group. For each group, the left column depicts the effect of an additional representative on the crude death rate which is constructed as the the number of deaths within a group divided by the group's population in the state in 2019 and multiplied by 100,000. The right column depicts the effect on the group's age-adjusted death rate. Age adjustment is done on the basis of three broad age groups, 0 to 24 years, 25 to 64 years and 65 years and above. The age-adjusted death rate is constructed by first computing the crude age-specific death rate within a race-age group (ex. the death rate for Hispanics aged 0 to 24 years). Each age-specific death rate is then multiplied by the proportion of the 2000 U.S. standard population in that age group. This proportion was 0.353346 for ages 0 to 24, 0.520267 for ages 25 to 64 and 0.126387 for ages 65 and above. These products within a racial group are then summed to get the final age-adjusted death rate. For each outcome, we derive the 2022 cumulative coefficients presented in the table by first estimating the ρ_t from equation 1 which represent the contemporaneous effect of an additional representative in the year t using 2019 as the reference period. We then derive the cumulative effect of an additional representative up to the year 2022 by adding the contemporaneous effects for years 2020 to 2022. The baseline event-study specification used to estimate the presented coefficients incorporates controls for the state's vote share for Donald Trump in the 2016 presidential election and the state's 2019 population density, state and year fixed effects, and standard errors clustered at the state level.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table B.7: Heterogeneity by Race in the Reduced Form Effect of An Additional Representative on Mortality Using CDC Crude and Age-Adjusted Rates But Anchoring Back to 2019 Population

	A: Effect on 2022 Cumulative All-Cause Death Rate Per 100,000							
	All Races		Hispanic		Non-Hispanic Black		Non-Hispanic White	
	(1) Crude	(2) Age-Adjusted	(3) Crude	(4) Age-Adjusted	(5) Crude	(6) Age-Adjusted	(7) Crude	(8) Age-Adjusted
Cumulative Effect of an	-38.06**	-38.55***	-38.45*	-68.69*	-101.49***	-105.38***	-44.05**	-30.84*
Additional Representative	(17.44)	(13.48)	(20.99)	(36.07)	(25.81)	(25.62)	(22.10)	(16.54)
Dep. Var. Mean in 2022	3,237.46	2,635.4	1,166.57	1,950.18	2,778.15	3,205.74	3,745.25	2,575.79
Observations	250	250	249	249	250	250	250	250
	B: Effect on 2022 Cumulative COVID-19 Death Rate Per 100,000							
	All Races		Hispanic		Non-Hispanic Black		Non-Hispanic White	
	(1) Crude	(2) Age-Adjusted	(3) Crude	(4) Age-Adjusted	(5) Crude	(6) Age-Adjusted	(7) Crude	(8) Age-Adjusted
Cumulative Effect of an	-25.60***	-24.60***	-16.02	-16.83	-46.68***	-35.15***	-31.43***	-20.36***
Additional Representative	(5.13)	(4.18)	(19.24)	(18.23)	(17.39)	(10.89)	(6.81)	(4.17)
Dep. Var. Mean in 2022	284.77	228.16	192.18	323.95	307.16	334.47	300.95	200.67
Observations	200	200	177	177	155	155	200	200

Notes: This table shows the effect of an additional congressional representative on the mortality from all causes (panel A) and COVID-19 (panel B) by race. Columns 1 and 2 show estimates for the full population, columns 3 and 4 show estimates for the Hispanic group, columns 5 and 6 show estimates for the non-Hispanic Black group and columns 7 and 8 show estimates for the non-Hispanic White group. For each group, the left column depicts the effect of an additional representative on the crude death rate. The right column depicts the effect on the group's age-adjusted death rate. We obtain the crude and age-adjusted death rates directly from the CDC Wonder, rather than constructing them ourselves from the death counts. Because the CDC's age adjustment makes use of very granular underlying age groups, it is subject to greater suppression of age-adjusted death rate values for data confidentiality reasons, which results in missing data in our estimation. Additionally, the CDC death rates are constructed using the contemporaneous state population within a race and age group as denominators. To make these more, even if not perfectly, comparable to our analyses in Tables 6 and B.6, we multiply the crude and age-adjusted rates obtained directly from the CDC by the contemporaneous state population within a race and divide by the 2019 state population within a race. For each outcome, we derive the 2022 cumulative coefficients presented in the table by first estimating the ρ_t from equation 1 which represent the contemporaneous effect of an additional representative in the year t using 2019 as the reference period. We then derive the cumulative effect of an additional representative up to the year 2022 by adding the contemporaneous effects for years 2020 to 2022. The baseline event-study specification used to estimate the presented coefficients incorporates controls for the state's vote share for Donald Trump in the 2016 presidential election and the state's 2019 population density, state and year fixed effects, and standard errors clustered at the state level.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table B.8: The Reduced Form Effect of An Additional Representative on Mortality from Other Causes Cumulative Up To 2022

	(1) External Causes	(2) Cancer	(3) Heart Attack	(4) Respiratory Diseases	(5) Hypertension	(6) Diabetes	(7) Mental Disorders
Cumulative Effect of an Additional Representative	-5.91	2.76	-1.72	-4.83*	-4.03*	1.18	1.72
	(4.69)	(3.13)	(1.15)	(2.70)	(2.41)	(0.84)	(2.70)
Dep. Var. Mean in 2022	627.7	1,338.09	242.25	619.0	227.48	203.39	337.13
Observations	350	350	350	350	350	350	350

Notes: This table shows the effect of an additional congressional representative on a state's yearly death rate per 100,000 residents cumulative up to 2022 from various underlying causes. To derive the coefficients presented in the table, we first estimate the ρ_t from equation 1 which represent the contemporaneous effect of an additional representative in the year t using 2019 as the reference period. We then derive the cumulative effect of an additional representative up to the year 2022 by adding the contemporaneous effects for years 2020 to 2022. All diseases shown are mutually exclusive categories and no category nests another. Data for deaths by cause for years 2016 to 2022 are from the CDC Wonder database. The specification used in all columns includes our baseline controls for a state's vote share for Donald Trump in the 2016 presidential election and the state's 2019 population density, with standard errors clustered at the state level.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table B.9: Robustness of the Reduced Form Effect of An Additional Representative on Vaccination and Testing to the Inclusion of Controls and Population Weights

A: Effect on 2022 Cumulative COVID-19 Vaccinations Per 100,000				
	(1)	(2)	(3)	(4)
Cumulative Effect of an	7,755.40***	12,049.63***	3,648.82	6,525.81***
Additional Representative	(2,591.85)	(3,150.10)	(7,747.90)	(1,820.97)
Baseline Controls	Yes	Yes	No	Yes
Additional Controls	No	No	No	Yes
Population Weights	No	Yes	No	No
Dep. Var. Mean in 2022	197,025.54	197,025.54	197,025.54	197,025.54
Observations	200	200	200	200

B: Effect on 2022 Cumulative COVID-19 Tests Per 100,000				
	(1)	(2)	(3)	(4)
Cumulative Effect of an	83,228.33***	70,815.59***	67,307.97**	85,456.88***
Additional Representative	(22,429.24)	(22,657.13)	(31,953.41)	(25,191.39)
Baseline Controls	Yes	Yes	No	Yes
Additional Controls	No	No	No	Yes
Population Weights	No	Yes	No	No
Dep. Var. Mean in 2022	328,478.13	328,478.13	328,478.13	328,478.13
Observations	186	186	186	186

Notes: This table shows the robustness of the reduced form effect of an additional congressional representative on a state's COVID-19 vaccination and testing to different specification choices. In all specifications, we first estimate the ρ_t from equation 1 which represent the contemporaneous effect of an additional representative in the year t using 2019 as the reference period. We then derive the cumulative effect of an additional representative up to the year 2022 by adding the contemporaneous effects for years 2020 to 2022. The outcome in panel A is the COVID-19 vaccine doses administered per 100,000 residents in a state. The outcome in panel B is the COVID-19 tests per 100,000 residents in a state. This includes total viral and antigen tests administered in 89% of state-years and only viral tests in 2% of the state-years, with no data available for the remaining 9% of state-years. The data for vaccinations are from the CDC and those for tests are from the Hopkins CSSE. The baseline specification in column 1 includes controls for the state's vote share for Donald Trump in the 2016 presidential election and the state's 2019 population density. In column 2, the baseline coefficients are weighted by the 2020 state population. In column 3, no control variables are incorporated. The specification in column 4 incorporates controls from the baseline specification as well as the state's chronic disease prevalence as measured by the diabetes death rate in 2019, the share of the state's population over age 65 in 2019 and the Oxford Stringency Index from March 2020. All specifications include state and year fixed effects, with standard errors clustered at the state level.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table B.10: Heterogeneity by Gender, Age and Race in the Reduced Form Effect of An Additional Representative on COVID-19 Vaccination

	All	Gender		Age			
	(1)	(2) Female	(3) Male	(4) 0 - 24 Years	(5) 25 - 64 Years	(6) 65 - 74 Years	(7) 75+ Years
Cumulative Effect of an Additional Representative	2,542.00**	2,455.68**	2,397.03**	2,275.73***	2,218.88**	3,082.04**	2,866.06*
	(1,048.73)	(1,106.43)	(936.66)	(806.96)	(1,078.00)	(1,469.50)	(1,535.84)
Mean Contemporaneous Vaccination Rate in 2020	1,936.12	2,445.86	1,271.57	309.65	3,017.98	1,610.11	1,854.78
Mean Contemporaneous Vaccination Rate in 2021	70,111.43	71,159.9	67,699.42	41,973.12	77,605.74	101,524.41	96,515.53
Mean Contemporaneous Vaccination Rate in 2022	7,086.05	7,186.81	6,889.07	9,311.38	5,924.09	6,441.7	6,458.97
Observations	200	200	200	200	200	200	200

	Race		
	(7) Hispanic	(8) Non-Hispanic Black	(9) Non-Hispanic White
Cumulative Effect of an Additional Representative	-0.01	0.01	0.02***
	(0.02)	(0.04)	(0.01)
Mean Contemporaneous Share Vaccinated in 2021	0.72	0.78	0.78
Mean Contemporaneous Share Vaccinated in 2022	0.12	0.1	0.09
Observations	112	95	150

Notes: This table shows the effect of an additional Congressional representative on COVID-19 vaccination by gender, age and race. The outcome in columns 1 through 6 uses administrative data from the CDC from 2020 through 2022 and is the number of individuals in a state who had received at least one dose of a COVID-19 vaccine by the end of the year. The outcome is scaled to be per 100,000 of the state's population belonging to the given gender or age in 2019. The outcome in columns 7 through 9 uses data from the National Immunization Survey for 2021 and 2022 and is the share of individuals belonging to a particular racial group that received at least one dose of a COVID-19 vaccine. Since the outcome in columns 7 through 9 is expressed as a share (ranging from 0 to 1), it is not scaled further for population, and one hundred times each coefficient denotes the effect of an additional representative on the percentage point change in the share of vaccinated individuals. The definitions of vaccination in this Table are different from the ones used in Table 8 where it is the total vaccine doses administered in the state. We derive the 2022 cumulative coefficients presented in the table by first estimating the ρ_t from equation 1 which represent the contemporaneous effect of an additional representative in the year t using 2019 as the reference period. We then derive the cumulative effect of an additional representative up to the year 2022 by adding the contemporaneous effects for years 2020 to 2022 for gender and age and years 2021 and 2022 for race. The baseline event-study specification used to estimate the presented coefficients incorporates controls for the state's vote share for Donald Trump in the 2016 presidential election and the state's 2019 population density, state and year fixed effects, and standard errors clustered at the state level. We provide means for the contemporaneous vaccination outcome in each of the years for which data is available. The addition of the means for all years will provide the cumulative vaccination mean in 2022 and the coefficient can thus be interpreted as a change relative to this metric.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table B.11: Decomposition of the Full Population Mortality Effects by Age

A: Reduced Form Effect on 2022 Cumulative All-Cause Death Rate Per 100,000					
	(1)	(2)	(3)	(4)	(5)
	All Ages	0 - 24 Years	25 - 64 Years	65 - 74 Years	75+ Years
Cumulative Effect of an Additional Representative	-38.04**	-1.53**	-13.06**	-7.30*	-16.17
	(17.44)	(0.73)	(5.36)	(4.27)	(9.89)
Dep. Var. Mean in 2022	3,217.16	63.48	789.91	662.86	1,700.82
Observations	250	250	250	250	250

B: Reduced Form Effect on 2022 Cumulative COVID-19 Death Rate Per 100,000					
	(1)	(2)	(3)	(4)	(5)
	All Ages	0 - 24 Years	25 - 64 Years	65 - 74 Years	75+ Years
Cumulative Effect of an Additional Representative	-25.59***	-0.20***	-10.23***	-7.21***	-7.96**
	(5.12)	(0.05)	(2.28)	(1.61)	(3.84)
Dep. Var. Mean in 2022	282.66	0.88	67.9	65.5	148.37
Observations	200	200	200	200	200

C: IV Second Stage Effect on 2022 Cumulative All-Cause Death Rate Per 100,000					
	(1)	(2)	(3)	(4)	(5)
	All Ages	0 - 24 Years	25 - 64 Years	65 - 74 Years	75+ Years
Total Aid Per Resident (USD Thousands)	-38.78**	-1.56**	-13.31**	-7.44*	-16.48
	(18.89)	(0.77)	(5.88)	(4.50)	(10.47)
Dep. Var. Mean in 2022	471.39	5.74	140.08	124.66	200.92
Observations	50	50	50	50	50

Notes: This table shows the reduced form effect of an additional congressional representative (equation 1) on all-cause (panel A) and COVID-19 (panel B) mortality, and the second stage from the IV 2SLS effect of fiscal aid per resident (USD thousands; equation 4) on all-cause mortality (panel C), by age. In all panels the coefficient reported is the effect on the 2022 cumulative death rate per 100,000 state residents. We derive the 2022 cumulative coefficients presented in panels A and B by first estimating the ρ_t from equation 1 which represent the contemporaneous effect of an additional representative in the year t using 2019 as the reference period. We then derive the cumulative effect of an additional representative up to the year 2022 by adding the contemporaneous effects for years 2020 to 2022. In panel C, we calculate the adjusted 2022 cumulative all-cause deaths by subtracting three times the 2019 contemporaneous all-cause deaths from the raw 2022 cumulative deaths. We then convert these adjusted deaths into the 2022 cumulative death rate by scaling for the state population. Our IV estimation takes this modified 2022 cumulative death rate as the outcome with the total aid per resident as the endogenous regressor and representatives per million residents as the instrument. The data for deaths are from the CDC Wonder database for years 2018 to 2022. The specification used in each panel and column incorporates controls for the state's vote share for Donald Trump in the 2016 presidential election and the state's 2019 population density, state and year fixed effects, and standard errors clustered at the state level in panels A and B and robust to heteroskedasticity in panel C.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

C Data Sources and Variable Construction

Table C.1 describes the construction, sources and period of availability of all variables used in our analyses. We provide some additional details about variable construction below.

All mortality data are from the CDC Wonder database. The database contains death counts by underlying cause of death from all death certificates registered in the United States and is a product of collaboration between federal and state statistical agencies. The underlying cause of death on a death certificate is the cause that leads to the chain of events that ultimately result in an individual's demise, even if it is not the immediate (i.e. final) cause of death. For causes other than COVID-19, we use mortality data from 2016 to 2022. For COVID-19, mortality from 2016 to 2019 is by construction zero. This is the reason why any coefficients for the effects on COVID-19 mortality are precise zeroes in years prior to 2020.

The CDC Wonder censors values of death between 0 and 9. We encounter this when our level of analysis is more granular, such as when studying monthly COVID-19 mortality or COVID-19 mortality by demographics. Where possible, we accurately calculate a censored value by subtracting the total of uncensored values from the provided value for a broader level of analysis. Where we can only infer the sum of a few censored values, we split that sum evenly across the censored observations. This results, in some cases, in non-integer values for deaths.

To obtain age-adjusted death rates by race, we first compute the crude age-specific death rate within a racial group for each of two broad age groups, 0 to 64, and 65 and above. Each age-specific death rate is then multiplied by the proportion of the 2000 U.S. standard population in that age group. This proportion was 0.87 for ages 0 to 64 and 0.13 for ages 65 and above. These proportion-weighted age-specific death rates within a racial group are then summed to get the final age-adjusted death rate.

For COVID-19 hospital admissions and ED visits, we aggregate facility-week level data to the state-year level for facilities that reported data for at least 127 of the 130 weeks, retaining 95.2% of the total facilities. When a missing value exists for a facility's reported outcome, the aggregation treats it as a zero unless all facilities in a state had missing values in the given year. For all-cause hospital admissions and ED visits, the KFF State Health Facts provide data points that are already scaled for the state's population as per the Census in that year. To maintain consistency of variable construction across our analyses, we use the census population figures to undo the original population scaling and rescale using the 2019 state population from the CDC. The Hopkins CSSE provides data on confirmed COVID-19 cases and deaths at the county level, which we aggregate to the state level.

Data on vaccination, representing the number of doses administered, in the main analyses are from the CDC and are collected from all vaccine disbursement facilities. Data on tests administered are from the Hopkins CSSE. We find some outliers in monthly testing growth in the months of March and June 2022. We handle these by smoothing the test counts between February and March 2022 and May and June 2022.[37] Additionally, we encounter two instances (state-months) of reductions in cumulative tests administered. We make a correction to the anomalous value that results in this reduction.[38] Neither of these two steps alters the yearly total of tests administered. Two other cases where we encounter declines in cumulative values are those of monthly COVID-19 deaths from the Hopkins data, which do not form the basis of our main mortality analyses, and yearly vaccination by race from the National Immunization Survey. We correct these using a similar procedure as in the case of tests.[39]

[37] In this procedure we allocate some tests from March and June 2022 to February and May 2022 respectively such that the new percentage change in tests from February to March and May to June would be at most at the 90th percentile of changes calculated from all states in that month (relative to the previous month) and at least at the 10th percentile of changes from all states in that month.

[38] In one instance we replace the current month's value with the previous month's, and in another instance we do the opposite.

[39] For monthly COVID-19 deaths, we correct 4 instances by replacing the previous month's value with the current month's. For vaccination by race we correct 14 instances by replacing the current year's value with the previous year's.

Table C.1: Data Sources and Variable Construction

Category	Variable	Construction	Numerator Source	Denominator Source	Level	Availability	Reference
Treatment	Fiscal Aid Per Resident (Thousands of USD)	Federal Aid to States and Local Governments Acts Authorized By the CARES, FFCRA, RRA and ARPA / 2020 State Population × 1000	Clemens et. al. (2023)	CDC Wonder	State	2016-2022	
Instrument	Congressional Representatives Per Million State Residents	State Representatives in the House of Representatives and Senate during the 116th and 117th Congress / 2020 State Population × 1,000,000	Lewis et. al. (2021)	CDC Wonder	State	2016-2022	
Outcomes	All-Cause Death Rate	All-Cause Deaths / 2019 State Population × 100,000	CDC Wonder	CDC Wonder	State - Year	2016-2022	Tab. 3, Tab. 4, Fig. 1, Fig. 2, Fig. A.3, Tab. B.4, Fig. A.5, Tab. B.3, Tab. B.1
		All-Cause Deaths / 2019 State Population × 100,000	CDC Wonder	CDC Wonder	State - Month	Jan 2016-Dec 2022	Fig. 2
		All-Cause Deaths / 2019 State Group Population × 100,000	CDC Wonder	CDC Wonder	State - Year - Group	2016-2022	Tab. 5, Fig. A.6
	COVID-19 Death Rate	COVID-19 Deaths / 2019 State Population × 100,000	CDC Wonder	CDC Wonder	State - Year	2020-2022	Tab. 3, Tab. 4, Fig. 1, Fig. 3, Fig. A.3, Tab. B.2, Tab. B.4, Tab. B.3
		COVID-19 Deaths / 2019 State Population × 100,000	CDC Wonder	CDC Wonder	State - Month	Jan 2020 - Dec 2022	Fig. 3
		COVID-19 Deaths / 2019 State Group Population × 100,000	CDC Wonder	CDC Wonder	State - Year - Group	2016-2022	Tab. 5, Fig. A.7
		COVID-19 Deaths / 2019 State Group Population × 100,000	CDC Wonder	CDC Wonder	State - Month - Group	Jan 2020 - Dec 2022	Fig. A.11
	Death Rate from External Causes, Cancer, Heart Attacks, etc.	Deaths From Reference Cause / 2019 State Population × 100,000	CDC Wonder	CDC Wonder	State - Year	2016-2022	Tab. B.8

Table C.1 (Cont.)

Category	Variable	Construction	Numerator Source	Denominator Source	Level	Availability	Reference
Outcomes	Hospital Admissions for All Causes	Hospital Admissions / 2019 State Population × 100,000	KFF State Health Facts	CDC Wonder	State - Year	2016-2022	Tab. 7, Fig. 4
	Emergency Department Visits for All Causes	ED Visits / 2019 State Population × 100,000	KFF State Health Facts	CDC Wonder	State - Year	2016-2022	Tab. 7, Fig. 4
	Hospital Admissions for COVID-19 (Confirmed or Suspected)	(Adult Hospital Admissions with Suspected COVID-19 + Pediatric Hospital Admissions with Suspected COVID-19 + Adult Hospital Admissions with Confirmed COVID-19 + Pediatric Hospital Admissions with Confirmed COVID-19) / 2019 State Population × 100,000	COVID-19 Reported Patient Impact and Hospital Capacity by Facility	CDC Wonder	State - Year	2020-2022	Tab. 7, Fig. 4
	Hospital Admissions for COVID-19 (Confirmed)	(Adult Hospital Admissions with Confirmed COVID-19 + Pediatric Hospital Admissions with Confirmed COVID-19) / 2019 State Population × 100,000	COVID-19 Reported Patient Impact and Hospital Capacity by Facility	CDC Wonder	State - Year	2020-2022	Tab. 7, Fig. 4

Table C.1 (Cont.)

Category	Variable	Construction	Numerator Source	Denominator Source	Level	Availability	Reference
Outcomes	Emergency Department Visits COVID-19	ED Visits with Suspected or Confirmed COVID-19 / 2019 State Population × 100,000	COVID-19 Reported Patient Impact and Hospital Capacity by Facility	CDC Wonder	State - Year	2020-2022	Tab. 7, Fig. 4
	COVID-19 Cases	COVID-19 Cases / 2019 State Population × 100,000	Hopkins CSSE	CDC Wonder	State - Year	2020-2022	Tab. 7, Fig. 4
	COVID-19 Vaccination	Doses administered / 2019 State Population × 100,000	COVID-19 Vaccination Trends in the United States, National and Jurisdictional	CDC Wonder	State - Year	2020-2022	Tab. 8, Fig. 5, Tab. B.9
		Doses administered / 2019 State Population × 100,000	COVID-19 Vaccination Trends in the United States, National and Jurisdictional	CDC Wonder	State - Month	Dec 2020-Dec 2022	Fig. A.9
		Individuals With At Least One COVID-19 Vaccine Dose / 2019 State Group Population × 100,000	COVID-19 Vaccination Trends in the United States, National and Jurisdictional	CDC Wonder	State - Year - Age Group	2020-2022	Tab. B.10

Table C.1 (Cont.)

Category	Variable	Construction	Numerator Source	Denominator Source	Level	Availability	Reference
Outcomes	COVID-19 Vaccination	Individuals With At Least One COVID-19 Vaccine Dose / 2019 State Group Population × 100,000	COVID-19 Vaccination Trends in the United States, National and Jurisdictional	CDC Wonder	State - Year - Gender	2020-2022	Tab. B.10
		Individuals In Racial Group Least One COVID-19 Vaccine Dose / Individuals In Racial Group	National Immunization Survey	CDC Wonder	State - Year - Race	2021-2022	Tab. B.10
		Individuals With At Least One COVID-19 Vaccine Dose / 2019 State Group Population × 100,000	National Immunization Survey	CDC Wonder	State - Month - Age Group	Dec 2020-Dec 2022	Fig. A.10
	COVID-19 Testing	COVID-19 Tests Administered * / 2019 State Population × 100,000 * Tests = Viral Tests + Antigen Tests for 88.6% of State-Years; Viral Tests only for 2% of State-Years; Missing for 9.3% of State-Years	Hopkins CSSE	CDC Wonder	State - Year	2020-2022	Tab. 8, Fig. 5, Tab. B.9
		COVID-19 Tests Administered* / 2019 State Population × 100,000 * Tests = Viral Tests + Antigen Tests for 92%	Hopkins CSSE	CDC Wonder	State - Month	Mar 2020-Dec 2022	Fig. A.8
	Ratio of COVID-19 Cases to Tests	COVID-19 Cases / COVID-19 Tests Administered* * Tests = Viral Tests + Antigen Tests for 88.6% of State-Years; Viral Tests only for 2% of State-Years; Missing for 9.3% of State-Years	Hopkins CSSE	Hopkins CSSE	State - Year	2020- 2022	Tab. 8, Fig. 5
	Hospital Beds	Hospital Beds / 2019 State Group Population × 100,000	KFF State Health Facts	CDC Wonder	State - Year	2020- 2022	Tab. 8, Fig. 5

Table C.1 (Cont.)

Category	Variable	Construction	Numerator Source	Denominator Source	Level	Availability	Reference
Outcomes	Medicaid Enrollment	Total Medicaid and CHIP Enrollment * / 2019 State Group Population × 100,000 *As of December of the Calendar Year	CMS Monthly Medicaid Enrollment Snapshots	CDC Wonder	State - Year	2016-2022	Tab. 8, Fig. 5
Covariates	Population Density	2019 State Population / State Land Area in Sq. Miles	CDC Wonder	2020 U.S. Gazetteer Files	State	2016-2022	
	Donald Trump Vote Share in the 2016 Presidential Election	Votes to Donald Trump / Total Votes	MIT Election Labs	MIT Election Labs	State	2016-2022	
	Diabetes Death Rate	Deaths from Diabetes in 2019 / 2019 State Population × 100,000	CDC's Chronic Disease Indicators	CDC's Chronic Disease Indicator	State	2016-2022	Tab. 3, Tab. 4, Tab. B.9, Tab. B.1
	Population share over the age of 65	State Population Aged 65 and above in 2019 / 2019 State Population × 100,000	CDC Wonder	CDC Wonder	State	2016-2022	Tab. 3, Tab. 4, Tab. B.9, Tab. B.1
	Oxford Stringency Index (March 2020)	Composite index between 0 to 100 of state's COVID-19 restrictions; rescaled by dividing by 100	Clemens et. al. (2023)		State	2016-2022	Tab. 3, Tab. B.9
Costs-Benefits	Value of Statistical Life in 2020 (2020 USD)		Health and Human Services' Guidelines for Regulatory Impact Analysis				Tab. 9
	Quality Adjustment Factor by Age		Hanmer et. al. (2006)				Tab. 9
Other	COVID-19 Vaccine Authorization Timeline		Health and Human Services' COVID-19 Vaccine Milestones				Fig. A.10

D Methodology for Cost-Benefit Analysis

Our point estimates from panel C of Appendix Table B.11 provide the estimates from our IV 2SLS framework of the effect of an additional $1000 per resident on the number cumulative all-cause deaths per 100,000 residents averted in various age groups by 2022. Unlike in the heterogeneity-by-age analyses elsewhere, here we decompose the total mortality effects across age groups by scaling each age group's deaths by the total 2019 state population. From this result we get that an additional $100 million in fiscal aid predicts 1.56 fewer deaths among residents ages 0 to 24 years, 13.31 fewer deaths among residents ages 25 to 64 years, 7.44 fewer deaths among residents ages 65 to 74 years and 16.48 fewer deaths among residents with age over 75.[40] To calculate life years saved by age group in panels A and C, we use the CDC's 2020 life tables (National Vital Statistics Reports 2022) and apply the value of the life expectancy of an individual of median age within each group.[41] These are our baseline estimates of number of life years saved per death averted in each group.

In panels B and D, we employ a more conservative assumption that each death averted in an age group is that of the oldest individual in that group, or alternatively, that each death is that of an individual with the health status of the oldest individual in their age group. Further, in panels A and B, we don't further adjust the number of life years saved by their quality. In panels C and D, we down-weight each estimated life year saved by a quality-adjustment factor that we obtain from Hanmer et al. (2006). The quality-adjustment factor is a utility-based score below 1 where 1 indicates full health and 0 indicates death.[42] Hanmer et. al.'s quality-adjustment factors are also used by the U.S. Department of Health

[40] Multiplying both the $1000 in aid per resident and the predicted deaths averted per 100,000 residents by 100,000 gives us the effect of $100 million on deaths averted.

[41] See Table 1 in the CDC's 2020 life tables (National Vital Statistics Reports 2022). The life tables provide life expectancy for one year age ranges, for example 12-13 and 13-14. When the median age in the age group in our estimation falls at one of the end-points of an age interval in the CDC table, we pick the CDC interval where the median age is the lower bound of the interval, for example the interval 12-13 when the median age is 12. For the last age group of 75 and over, we calculate a median age by assuming that the highest possible age is 100.

[42] Negative values are possible and indicate health states worse than death.

and Human Services (2021) in their derivations of quality-adjusted life years. The values we use are the average of the male and female factors in every age group in our estimation. In summary, multiplying the number of deaths averted by the implied increase in life expectancy and the quality-adjustment factor gives us the number of quality-adjusted life years saved per $100 million spent in fiscal aid.

Next, we turn to the U.S. Department of Health and Human Services (2016) to obtain the value of a statistical life (VSL). The HHS set regulatory guidelines by first reviewing the most reliable literature to identify VSL values. The review yielded a range of VSL values such that the HHS recommended conducting sensitivity analyses of policy benefits using the highest as well as lowest values of the range, and their mid-point. These are the high, low and central VSL values respectively (U.S. Department of Health and Human Services 2016).[43] We then back out a constant implied value of a statistical life year (VSLY) using the approach recommended by Millennium Challenge Corporation (2023).[44] The MCC guidelines recommend dividing the VSL by the life expectancy at the average U.S. adult age. The most reliable estimate for the adult population age distribution comes from the U.S. 2020 Census (U.S. Census Bureau 2023) and only provides the median adult age of 38.8 years. So we use this in our analysis and divide the VSL by 41.1 which is the life expectancy for 38 to 39 year-olds in the CDC 2020 life Table.[45] Our final estimates for the value of life years saved are obtained by multiplying the quality-adjusted life years saved by the VSLY derived from each of the low, central and high VSL values. For the 0 to 24 age group only, we assume that a death averted amounts to a full life saved and multiply the deaths averted directly by the VSL.

[43] See the 2020 estimate in Table D.1 of their updated guidelines (U.S. Department of Health and Human Services 2021).

[44] The Millennium Challenge Corporation (MCC) is a U.S. foreign aid agency established by the U.S. Congress and is required to conduct cost-benefit analyses for projects it implements.

[45] The constant-VSLY methodology is also common in the health literature as summarized in Hammitt (2023).