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All-mail voting in Colorado increases turnout and reduces turnout inequality☆

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A B S T R A C T

The COVID-19 crisis has generated interest in all-mail voting (AMV) as a potential policy solution for avoiding in-person elections. However, the quality of AMV implementation has varied greatly across states, leading to mixed results in previous research. We exploit the understudied 2014 implementation of AMV in Colorado to estimate the effect on turnout for all registered voters, along with age, racial, education, income and wealth, and occupational subgroups. Using large voter file data and a difference-in-differences design within individuals, we find a positive overall turnout effect of approximately 8 percentage points—translating into an additional 900,000 ballots being cast between 2014 and 2018. Effects are significantly larger among lower-propensity voting groups, such as young people, blue-collar workers, voters with less educational attainment, and voters of color. The results suggest that researchers and policymakers should look to Colorado's AMV approach as an effective model for boosting aggregate turnout and reducing voting disparities across subgroups.

> *"We have really figured out a solution that encourages engagement, encourages turnout, encourages voting."* — Former Denver, CO, Director of Elections Amber McReynolds

The COVID-19 public health crisis presented a significant challenge for election officials across the country in advance of the 2020 presidential election (Elections, 2020). Recognizing the need to ensure both voter safety and access to the ballot, advocates and election officials turned to all-mail voting (AMV) systems, in which the state mails every registered voter a ballot to complete at home, as a potential policy solution. Of the more than a dozen states that opted to postpone their primary, special, and local elections in the wake of the coronavirus pandemic, most used the extra time to ramp up mail-voting processes (Corasaniti and Saul, 2020; Voting & COVID-19). But beyond providing a temporary solution amidst an unprecedented pandemic, can all-mail voting help overcome another problem that ails us, one that threatens to further undermine the health of American democracy: turnout inequality? That is, can all-mail voting help close turnout gaps that persist between older and younger Americans, between wealthier and poorer Americans, between white Americans and Americans of color, and between working class and white-collar Americans?

In this paper, we endeavor to answer this question by investigating the turnout effects of Colorado's switch to AMV. Despite the substantial literature on mail voting, there has been, to the best of our knowledge, no systematic analysis of AMV in Colorado. This is a critical gap. Colorado currently boasts one of the highest voter turnout rates in the nation (Murray, 2018), and many policy experts consider Colorado's AMV policy to be a gold standard for states considering adopting similar reforms (e.g., Chapman et al., 2019; Kondracke, 2020). In fact, in the wake of the coronavirus pandemic, a third of states reportedly contacted Colorado's secretary of state for support building or expanding their own mail voting systems in advance of the general election (Carman, 2020).

Using a large voter file, we use a difference-in-differences design to estimate within-subject effects of AMV in Colorado. The effects we estimate are substantial. All-mail voting in Colorado increased voter turnout by about 8 percentage points overall.[1] Effects are disproportionately large among young people 10.1 percentage points for individuals 30 years old and younger. Similarly impressive effects are observed among blue-collar workers, voters with less educational

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[1] By percentage point, we refer to the simple difference in turnout rate. Alternatively, this amount could be expressed in percentage growth of the electorate, in which all-mail voting expanded the Colorado electorate by about 11 percent.

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attainment, voters with less wealth, and voters of color.

The findings underscore the positive turnout effects of AMV. Perhaps more importantly, our analysis highlights Colorado as a policy example to be emulated by other states as they consider adopting or expanding mail voting.

1. What do we know about all-mail voting?

Voting by mail has a long and successful history in the United States that stretches back to soldiers' absentee voting in the 18th century (Dubin and Kalsow, 1996). Its use has expanded greatly in recent decades, with ballots cast by mail constituting approximately one-fourth of all votes cast in the 2016 presidential election (Roberts, 2018). In the modern era, mail-in ballots, whether absentee ballots or ballots in AMV states, have shown near-zero evidence of vulnerability to fraud (in absolute terms or relative to traditional ballots), and the very few documented cases of attempted fraud have been quickly detected (Minnite, 2010). The risk of human and technological error is also no more prevalent than with traditional ballots. And before the wave of public criticisms from Republican officials in advance of the 2020 election, support for AMV transcended partisanship among the American public. A Reuters/Ipsos poll in April 2020 found that 79 percent of Democrats and 65 percent of Republicans support providing all voters with a mail-in ballot in the 2020 general election (Kahn, 2020; see also Talev and Treene, 2020). More than that, universal expansion of AMV is not inherently partisan, and recent work demonstrates that AMV does little to advantage either political party (Barber and Holbein, 2020; Thompson et al., 2020).

What can we learn from states with existing AMV regimes about the policy's effect on turnout? Proponents claim that AMV should lead to higher turnout by saving voters time, making voting more convenient for those without easy access to transportation, and mitigating the effects of Election-Day obstacles like bad weather (e.g., Thompson et al., 2020). Wait times at traditional polling places, for example, are substantial: in 2012, over 3.5 million Americans waited over 1 hour in line to vote, and average wait times are longer in precincts with higher concentrations of racial minorities (Pettigrew, 2017). Past research on the effectiveness of AMV to overcome these issues, however, has found mixed results. Variation in estimates of AMV's turnout effect may reflect random noise, but we argue that they likely reflect differences in how states construct and implement AMV laws.

Much of the past research on the effects of AMV was conducted in the first decade of the 2000s, when Oregon was the sole state with an AMV system. Studies of Oregon's mail-voting regime find a positive effect on overall turnout (Gronke et al., 2007; Richey, 2008; Southwell, 2009, 2010; Southwell and Burchett, 2000). Some earlier studies find, however, that AMV appears to primarily turn out those already predisposed to vote, rather than mobilizing unlikely voters into the electorate (Berinsky et al., 2001; Karp and Banducci, 2000).

Additional studies investigate AMV's turnout effect by exploiting a California state law that allows election administrators in small precincts to mandate that all voting be conducted via mail. The results of this research are less sanguine: multiple studies conclude that AMV may *depress* turnout in general elections (Bergman and Yates, 2011; Elul et al., 2017; Kousser and Mullin, 2007). The negative effects detected in California may reflect the concentration of AMV in small, rural precincts, and minimal state investment in the transition to mail ballots in these areas.

In recent years, AMV has expanded to several additional states (see Appendix Table A1). In 2011, Washington became the second state to mandate that all elections be conducted by mail. Colorado adopted AMV in 2013, followed by Hawaii in 2019. The Utah legislature passed a law in 2012 permitting jurisdictions to opt into all-mail elections; in 2019, every jurisdiction in the state had adopted the policy. A 2016 California law permitted counties to opt into conducting elections by mail, and five did so in the 2018 primary and general elections (Elections, 2020). In 2020, California Governor Gavin Newsom announced an executive order to conduct the November election entirely by mail.

This expansion of AMV offers researchers new opportunities to study the effects of mail voting on turnout. Exploiting variation in the timing of policy adoption across Washington counties, Gerber, Huber, and Hill (Gerber et al., 2013) estimate that AMV increased turnout by between 2 and 4 percentage points, and that gains were higher for infrequent voters. Similarly, an analysis of AMV in Utah finds that the policy boosted turnout by 5–7 percentage points, with young people and other low-propensity voters showing the largest turnout gains (Showalter et al., 2018). A separate analysis finds that the five California counties that adopted AMV in 2018 saw steeper turnout growth than the rest of the state, controlling for historical turnout trends and electoral competition. Voting rates for young, Latinx, and Asian American voters also rose more sharply in AMV counties than in other counties (McGhee et al., 2019).

2. Colorado's all-mail voting policy

Colorado's AMV policy centers around proactively mailing ballots to all registered voters, rather than requiring voters to request an absentee ballot before the election. Any voter who registers at least eight days before the election receives a ballot by mail. Voters may choose to mail back their completed ballot, drop it in one of many secure collection boxes, or bring it to a vote center, where professional staff serve those who prefer to vote in person; in 2014, the first year in which Colorado implemented AMV, nearly two-thirds of voters opted to return their ballots in person rather than by mail (Bosh, 2016). Regardless of which ballot return method a voter adopts, the ballot must be turned in or received by the county clerk by 7:00 p.m. on Election Day (as opposed to merely being postmarked by Election Day). Vote centers are open during an early voting period as well as Election Day; individuals who register in the week leading up to the election can still cast their ballot in-person at a vote center. This is an important distinction between the election regime of Oregon, the focus of most past AMV research, and that of Colorado. In Oregon, individuals must register to vote no later than 21 days before Election Day to receive a mail-in ballot and participate in the election. Again, and by contrast, Colorado allows individuals to register through Election Day itself. Colorado also proactively updates voter addresses using the U.S. Postal Service's National Change of Address database and, as of 2017, provides for automatic voter registration throughout the state.

Notably, the AMV policy was implemented statewide in a single election, rather than staggered by county (as in Washington) or confined to certain small and rural precincts (as in California until 2016). In some ways, the temporal and geographic variation in implementing AMV within California and Washington are helpful in identifying causal effects. However, such a focus neglects potentially important lessons from Colorado's AMV law, which was adopted statewide after the state looked to save money by changing to an AMV system (NVAHI, 2019). The switch to AMV occurred with robust and coordinated investment from state and county administrators: the initial idea was championed by a "broad coalition of election administrators, voting rights advocates, good government reform groups, [and] accessibility advocates," and the final AMV bill was largely drafted by election administrators (Chapman et al., 2019). Furthermore, because it is not always feasible for states to stagger implementation by county, it is all the more important to estimate the effects of statewide AMV implementation.

3. Data and estimation strategy

Our main analyses use data from the national L2 Voter File. The data contain the complete voting records of registered voters in the five election cycles from 2010 through 2018. These data also include a range of individual-level covariates. Some of these covariates, such as age, are derived from entries on voter registration forms. Others are based on predictions from commercial databases, which draw upon aggregate demographic data (e.g., median income in a Census block) and proprietary individual level data (e.g., based on smartphone activity). The use of our chosen covariates from the L2 Voter File, including age, race-ethnicity, education, income, wealth, and occupation, is well supported by existing research (e.g., Enamorado and Imai, 2019; Imai and Khanna, 2016). Using the L2 Voter File, we construct a balanced panel of all individuals who had registered in their respective states *before* the 2010 elections, allowing us to track their voting records for multiple election cycles before and after implementation of AMV.[2]

Restricting our main analysis to only those voters registered years in advance of the adoption of AMV helps us avoid picking up the turnout effect of Colorado's same-day registration (SDR) reform, which was passed simultaneously to AMV in 2013. SDR's primary turnout-boosting mechanism involves lowering registration and voting costs for *unregistered* individuals; as such, we do not expect it to meaningfully affect the turnout of the already-registered voters we study in this paper. However, Burden et al. (2014) suggest that SDR may also increase the salience and social importance of Election Day itself, thereby affecting overall turnout. We discuss this possibility in the concluding section of this paper.

Our principal estimation strategy is a difference-in-differences analysis with matching, which exactly matches Colorado registrants to registrants of other states based on birth year and 2010 and 2012 turnout. We then use individual fixed effects (and standard errors clustered by state) to precisely estimate a within-individual treatment effect. This strategy allows us to measure changes in turnout over time for each individual, eliminating all time-invariant differences *across* individuals that may influence their propensity to vote. Critically, exact matching on individuals' pre-treatment turnout makes the 'pre-trends' identical for control and treated units. Another way of thinking about this design is that it constructs a control state with a population that is identical to Colorado's with respect to age and voting history. We additionally adjust for electoral competitiveness with covariates for logged campaign spending in the state's U.S. House and Senate races, as well as gubernatorial election schedules.

We also estimate the subgroup effects of AMV. In particular, we are interested in potentially heterogeneous effects of implementing AMV by age, race-ethnicity, income, wealth, occupation, and education. The large size of the voter file data makes it possible to precisely estimate the effect of AMV effects for each of these subgroups, when we stratify regressions by demographic characteristics such as birth-year cohort. For the subgroup analyses, we use the same differences-in-differences with exact matching design.

Second, to complement our main model, we estimate two additional models. First, we compare the change in turnout among individual Colorado residents following the implementation of AMV to the change in turnout among residents of nearby 'control' states without AMV regimes. These analyses use the states of Arizona, Nevada, and New Mexico as control states. In addition to being regionally similar to Colorado, each of these states has similar political cultures and trajectories: all are presidential swing states, with competitive races between Demoratic and Republican candidates; all saw a significant increase in independent voters in 2012 and, especially, 2016; and each had, on average, similar turnout levels to Colorado in 2010, the last midterm election year before Colorado adopted AVR in 2013 (Figure A2). Moreover, each control state has no-fault absentee voting—the same policy Colorado had in place before adopting AMV—and none made significant changes to electoral policy during the time of our study.

Third, we estimate a model using the Current Population Survey (CPS) Voter Supplement. The CPS is a biannual survey of approximately 60,000 individuals. Because it relies on respondents' self-reported voting histories, it suffers from overreporting of voter turnout. However, unlike our voter file data, the CPS includes unregistered voters. We run a main CPS model subsetted to registered voters and provide additional specifications using all respondents in the Appendix (Tables A9-A10). Because the CPS data are repeated cross-sectional samples of states' residents, our CPS analyses use a within-state (but, unlike our L2 analyses, not within-individual) design.

Finally, we supplement our analysis by assessing whether the observed increase in turnout is driven by retaining existing voters or by mobilizing new voters (i.e., registered non-voters and recent registrants) to vote. We find that new voters primarily account for the increase in turnout following Colorado's election reforms (Appendix Table A2). We additionally account for voters who had been voting via absentee ballot in Colorado prior to the transition to AMV. We find that the increase in turnout is almost entirely concentrated among voters who had not voted by absentee ballot during the pre-treatment period (Appendix Table A3).

4. Results

Table 1 displays the overall effects of AMV in Colorado. Estimates from all three models indicate a sizable effect on turnout. The results suggest that AMV causes an overall turnout increase of 5.8–8.2 percentage points among registered voters. This is a large effect. The main model, the difference-in-differences with exact matching, shows an effect size of 8.1 percentage points. The CPS results show a 5.8 percentage-point effect. To the best of our knowledge, rarely, if ever, do we observe within-individual (or even within-state) turnout effects of this magnitude from changes in election law. Although the results may be surprising, the consistently large effects shown across three distinct research designs strengthens our confidence in this result.

Table 1
Estimated effect of all-mail voting

	L2: Exact Matching (All States)	L2: Control States (NM, NV, AZ)	CPS (All States)
All-Mail Voting	0.0806	0.0823	0.0573
	(0.0057)	(0.0018)	(0.0039)
Ln(Senate Spending)	0.0013	0.0013	0.0006
	(0.0004)	(0.0005)	(0.0002)
Ln(House Spending)	0.0024	0.0137	
	(0.0020)	(0.0029)	
Gubernatorial Contest	0.0253		0.0112
	(0.0076)		(0.0063)
Individual Fixed Effects	Yes	Yes	No
State Fixed Effects	No	No	Yes
Cycle Fixed Effects	Yes	Yes	Yes
Cluster	State	State	State
R^2	0.433	0.479	0.170
R^2-within	0.007	0.008	
N. of cases	20,164,430	27,496,488	951,524

OLS estimation with individual and cycle fixed effects, standard errors clustered on state.

[2] The youngest voters in the panel were 18 years old in 2010 and 26 years old in 2018. For more on the consequences of excluding those who were unregistered before the 2010 elections, see the discussion at the beginning of the Appendix.

4.1. Turnout by age groups

Next, our attention turns to the differential effects of Colorado's AMV policy on turnout by various subgroups. (Full regression results for income, wealth, occupation, education, and race-ethnicity subgroups can be found in Appendix Tables A4-A8.) We look first at changes in turnout by age group, relative to the initial baseline. This is an especially important analysis because age is a key predictor of turnout in US elections, with younger voters almost always turning out at much lower rates than older voters (Holbein and Hillygus, 2020). For this analysis, we estimate the main ("L2: Exact Matching") model from Table 1 separately for each birth year cohort. This directly compares individuals born in the same year across states. Fig. 1 plots the estimated effect on turnout of Colorado's implementation of AMV for each cohort. The effects are very precisely estimated, as shown by the error bars.

All age groups see significantly increased turnout after the introduction of AMV. The effects are largest for the youngest cohorts included in the panel, trend smoothly down for those born between 1980 and 1945, and rebound slightly among the oldest cohorts. The estimated 10.1 percentage point increase for the youngest cohorts (those born after 1980) translates into a relative increase of 26 percent over turnout levels observed in 2010. These results comport with claims made by vote-at-home reform advocates that mailing ballots should benefit voters who face time constraints caused by scheduling conflicts with work and school. According to the CPS, non-voters under the age of 40 are disproportionately likely to cite time constraints as a reason for not voting, with 38 percent of younger non-voters citing time constraints, compared with just 7 percent of those 65 and older (Appendix Figure A3).

4.2. Turnout by income and wealth

We next analyze turnout differences between income and wealth groups relative to the baseline. While turnout increases substantially for all income groups, low-income registered voters experience the largest turnout boost of approximately 8.4 percentage points (Appendix Figure A1).[3] More striking differences emerge when we examine differences in turnout boosts for Coloradans at either end of the wealth distribution. Here, we observe a turnout boost of about 10 percentage points for individuals who have the least amount of wealth. Fig. 2 shows that the turnout boost remains large, but declines steadily as one moves across the distribution, with the wealthiest Coloradans benefitting the least from the implementation of AMV. We note, however, that even among this well-resourced class of voters, turnout increases by more than 5 percentage points post-implementation. In line with a resource model of citizen participation, wealthier individuals typically turn out at higher rates than their less wealthy counterparts (Nadeau et al., 2019). The turnout boost observed among the least wealthy suggests that AMV has the potential to help close this persistent gap.

4.3. Turnout by occupational categories

Looking at effects among different occupational groups, we observe turnout boosts among individuals in each category (Fig. 3). Notably, among blue-collar workers, there is an 8.3 percentage-point increase in turnout relative to baseline, larger than the turnout increases for the professional and management classes. These findings are compatible with the argument that those less able to take time off from work may benefit most from an AMV system.

[3] Because L2 Voter File data is more reliable for household net worth than for individual income, we focus here on net worth and provide full results for our income regressions in the Appendix.

4.4. Turnout by educational attainment

While individuals across levels of educational attainment see a turnout boost from AMV, the largest increase is observed among the least-educated individuals (Fig. 4). Among those without a high school diploma, turnout increases by 8.5 percentage points. At the other end of the education distribution, those with a graduate degree experience a 5.9 percentage-point increase in turnout—large, but noticeably lower than the increase observed for every other education category.

4.5. Turnout by race

All racial and ethnic groups see a turnout boost under Colorado's AMV system, as shown in Fig. 5. We observe the most substantial turnout effects for Asian American and African American voters, who experience turnout boosts of 10.0 and 9.3 percentage points, respectively. A similarly striking effect is observed among Latinx individuals, whose turnout rate increases by 8.9 percentage points.

4.6. Turnout by party

We also estimate the effect of AMV by party registration. In contrast to other research that examines the partisan effects of AMV on aggregate election outcomes (Barber and Holbein, 2020; Thompson et al., 2020), we only have information on individual party registration (which is strongly associated with but not identical to partisan vote choice). Still, consistent with these other studies, we find little evidence that AMV disproportionately benefits Republican or Democratic Party registrants. The turnout effect for registered Republicans in Colorado is approximately 6.8 percentage points, while the effect for registered Democrats is approximately 7.8 percentage points. Independents, by contrast, see a turnout boost of 9.5 percentage points.

5. Conclusion

This paper finds that Colorado's AMV policy increased turnout both overall and across all major demographic groups. All-mail voting is not only safer than in-person voting during a global pandemic but also better for democratic representation, with all age, income, race, occupational, and education groups benefiting from its introduction. We believe Colorado should serve as a model for states adopting or expanding mail voting.

The COVID-19 crisis highlighted what advocates of electoral reform have long known: in much of the country, the status quo of voting policy is incompatible with principles of democracy that hold as sacrosanct citizen involvement in the electoral process. Out of a concern for public health, states moved to expand mail voting in advance of the November 2020 election. Out of a concern for core principles of democracy, states should hold onto mail voting long after this particular crisis ends.

Regarding our results, we recommend exercising caution when generalizing from the subgroup findings. Although there is sufficient data to estimate precise subgroup effects of AMV in Colorado, treatment effects may vary for certain subgroups in other states, if those subgroups are systematically different from their Colorado counterparts (for example, while 4.6 percent of Colorado residents are Black or African American according to the U.S. Census, median Black income is relatively high in Colorado compared to other states). The effects of AMV on subgroups may also vary geographically.

We also note that Colorado passed its AMV policy alongside an implementation of same-day registration (SDR), a reform that makes it possible for voting-eligible individuals to register to vote on Election Day. Importantly, our estimation strategy restricts our analyses to those individuals who were registered to vote several years prior to the passage of AMV, which allays some concerns that we are capturing effects of SDR and not effects of AMV. We recognize, however, that although SDR should not directly increase the likelihood of turning out for those

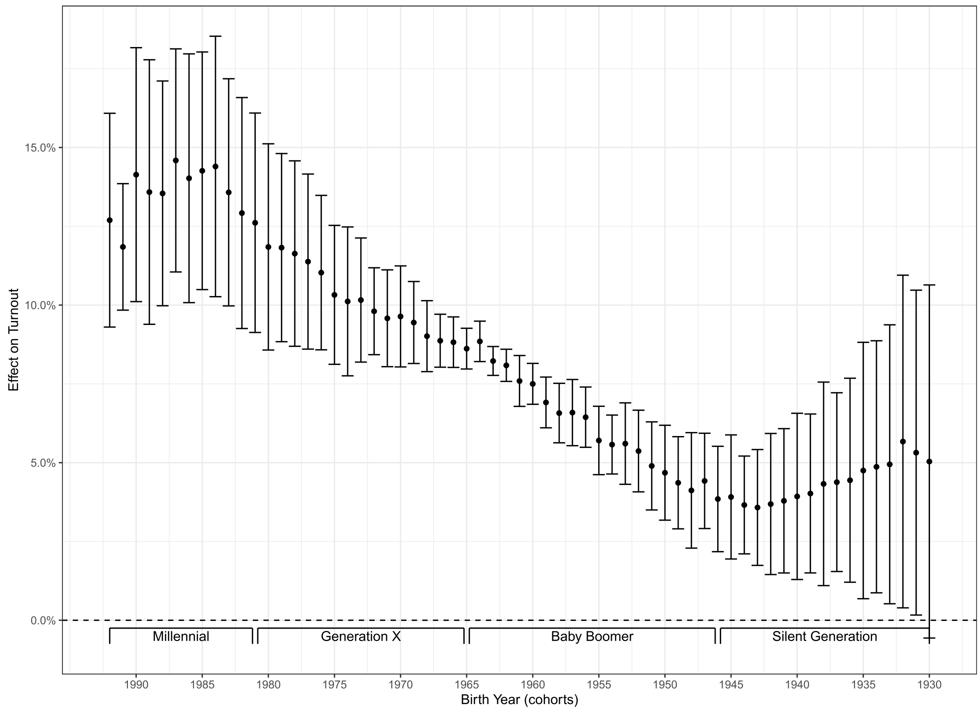


Fig. 1. Estimated Effect on Turnout by Birth-Year Cohorts
Note: Estimates and 95% confidence intervals are from a stratified regression by age cohort (birth year). Models include individual and cycle fixed effects. Standard errors are clustered on state.

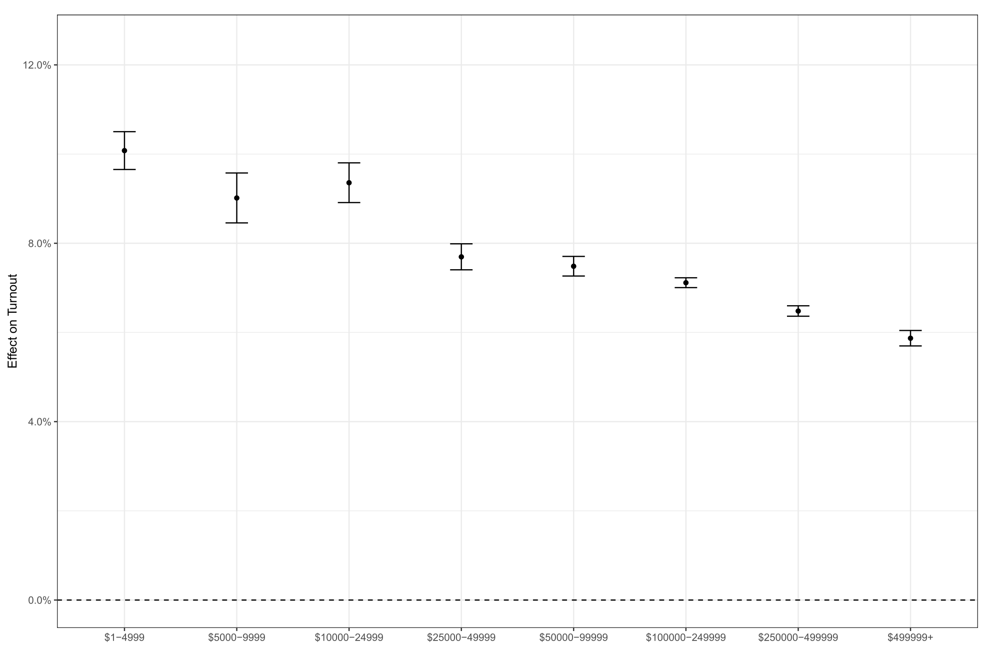


Fig. 2. Estimated Effect on Turnout by Household Net Worth
Note: Estimates and 95% confidence intervals are from a stratified regression by household net worth. Models include individual and cycle fixed effects. Standard errors are clustered on state.

already registered to vote, it may offer some small, indirect turnout boost by increasing the normative importance of, or the social pressure associated with, Election Day (Burden et al., 2014). As such, policymakers hoping to emulate Colorado's success at increasing both aggregate and subgroup turnout should consider adopting SDR in conjunction with AMV.

To be sure, there are challenges to implementing mail voting at scale. Successful implementation of mail voting will require political leaders from both major parties to set aside questions of partisan advantage and prioritize public safety and key principles of democracy, chief among them citizen engagement in the electoral process. Secretaries of state and local elections administrators must rapidly scale their mail-voting

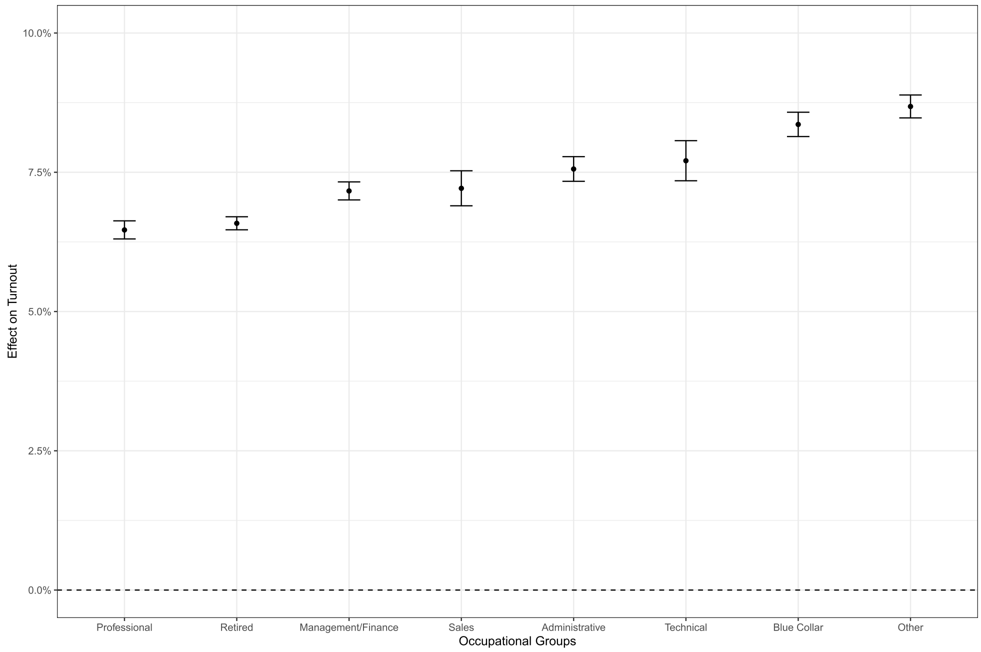


Fig. 3. Estimated Effect on Turnout by Occupational Groups
Note: Estimates and 95% confidence intervals are from a stratified regression by occupational group. Models include individual and cycle fixed effects. Standard errors are clustered on state.

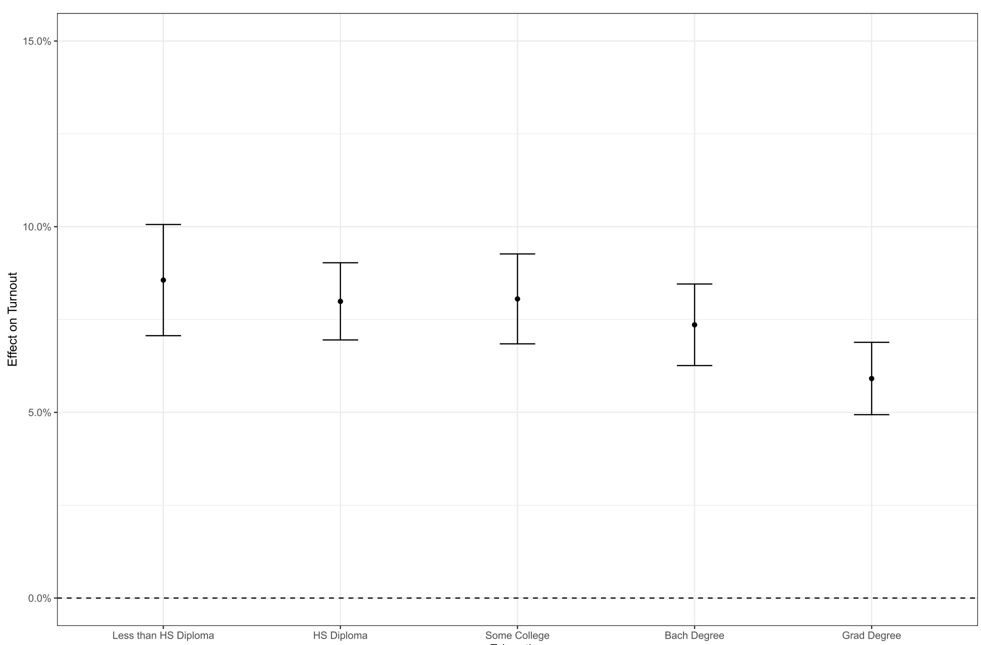


Fig. 4. Estimated Effect on Turnout by Educational Attainment
Note: Estimates and 95% confidence intervals are from a stratified regression by level of educational attainment. Models include individual and cycle fixed effects. Standard errors are clustered on state.

infrastructure in order to serve greatly increased numbers of mail voters. And, as is the case in Colorado, in-person voting options should be maintained (with added safety precautions) so that those who miss the window to receive an absentee ballot by mail can still vote. The federal government should aid in these efforts, and help ensure that states have the resources—both financial and technical—to move forward with AMV.

For those hoping to protect public health while ensuring high levels of citizen engagement in U.S. elections, AMV provides a clear and effective solution. The outstanding question is whether policymakers can marshal the political will and resources to adopt it.

Data availability

The authors do not have permission to share data.

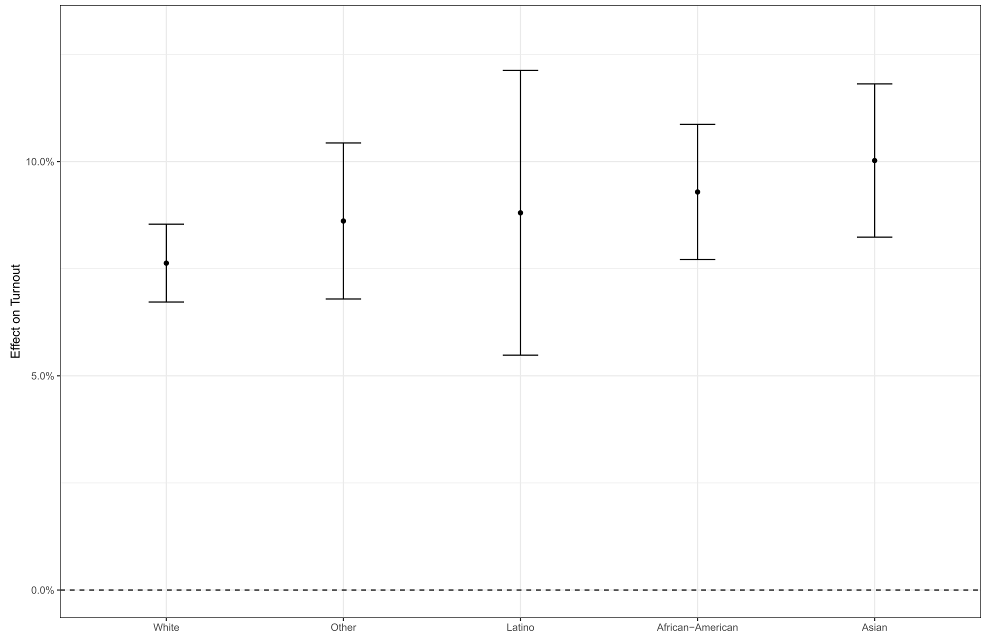


Fig. 5. Estimated Effect on Turnout by Race
Note: Estimates and 95% confidence intervals are from a stratified regression by race and ethnicity. Models include individual and cycle fixed effects. Standard errors are clustered on state.

Appendix A

State Adoption of All-Mail Voting

Table A1
States with All-Mail Elections (Pre-COVID)

State	Year Enacted	Year Implemented
Colorado	2013	2014
Hawaii	2019	2020
Oregon	1998	2000
Utah	2012 (permitted counties to conduct elections by mail)	2019 (first year all counties conducted elections by mail)
Washington	2011	2012

Source: National Conference of State Legislatures

Does AMV bring in registered non-voters or retain existing voters?

Our main results show large increases in turnout as a result of Colorado's AMV policy. But does this increase stem from greater participation by registrants with a track record of not voting, or from greater retention of existing voters? We investigate this question by observing the 2014 voting behavior of individuals who were registered but did not vote in 2010 ("registered non-voters"). In total, 43 percent of 2010 registered non-voters in Colorado turned out in 2014, the state's first year with AMV. This compares with just 18 percent in the control states of Arizona, New Mexico, and Nevada. We then turn to the retention rates of those who *did* vote in 2010. In Colorado, 89 percent of these voters remained in the electorate in 2014, compared with 69 percent in the control states. This first descriptive analysis is consistent with most of the AMV effect coming from the incorporation of new voters.

Table A2
Turnout rates in 2014 by year of registration, state

Registration Year	2014 Colorado Turnout	2014 Control State Turnout	2014 All States Turnout (Excluding CO)
2011	56.50	28.72	26.14
2012	48.01	25.14	26.48
2013	55.06	29.51	23.79
2014	54.92	29.43	32.62

Our research design excludes voters who registered after 2010 from our main analyses. This excludes from our main analyses younger voters who turned 18 after 2010 as well as voters relocating from other states, two groups that stand to benefit more from the adoption of all mail voting. Table A2 shows the average 2014 voter turnout of Coloradans who registered to vote in the year 2011, 2012, 2013, and 2014, respectively, compared to 2014 turnout in the control states and all other states. Newly registered voters in Colorado turned out to vote at about twice the rate of newly registered people in the control states. The results are similar when using all other states as the comparison group.

The increase in turnout came from voters who were not already voting absentee

Prior to its adoption of AMV, Colorado allowed no-fault absentee voting. A sizable percentage of Coloradans were already voting by mail before 2014. (Arizona, Nevada and New Mexico similarly allow no-fault absentee voting.) If the observed increase in turnout in Colorado is being driven by the expansion of mail voting, this effect should be concentrated among registered voters who were not already receiving their ballot by mail.

Fortunately, the voter file includes data on ballot type, which allows us to disaggregate voters who voted by mail before the adoption of AMV. To assess the source of the increase, we first subset on voters in Colorado and the control states who had voted absentee in 2010 and then did the same for those who had not voted absentee. We then ran separate regression models for each group. The estimated effect for absentee voters is 0.029 versus 0.175 for everyone else (Table A3). This suggests that 93.6% of the observed increase in Colorado was from non-absentee voters. An implication of this is that the increase in turnout associated with AMV would potentially be much larger in states that currently do not allow no-fault absentee voting.

Table A3
Estimated Effect of All-Mail Voting By Ballot Type in 2010

	Voted Absentee in 2010	Did Not Vote Absentee in 2010
All-Mail Voting	0.0294	0.1754
	(0.0141)	(0.0105)
Senate Contest	0.0179	−0.0024
	(0.0086)	(0.0225)
Individual Fixed Effects	Yes	Yes
Cycle Fixed Effects	Yes	Yes
Cluster	State	State
R^2	0.22696	0.47015
R^2-Within	0.00385	0.01513
N. of cases	8,167,895	19,745,230

Note: OLS estimation with individual and cycle fixed effects, standard errors clustered on state.

Figures for Subgroup Analyses

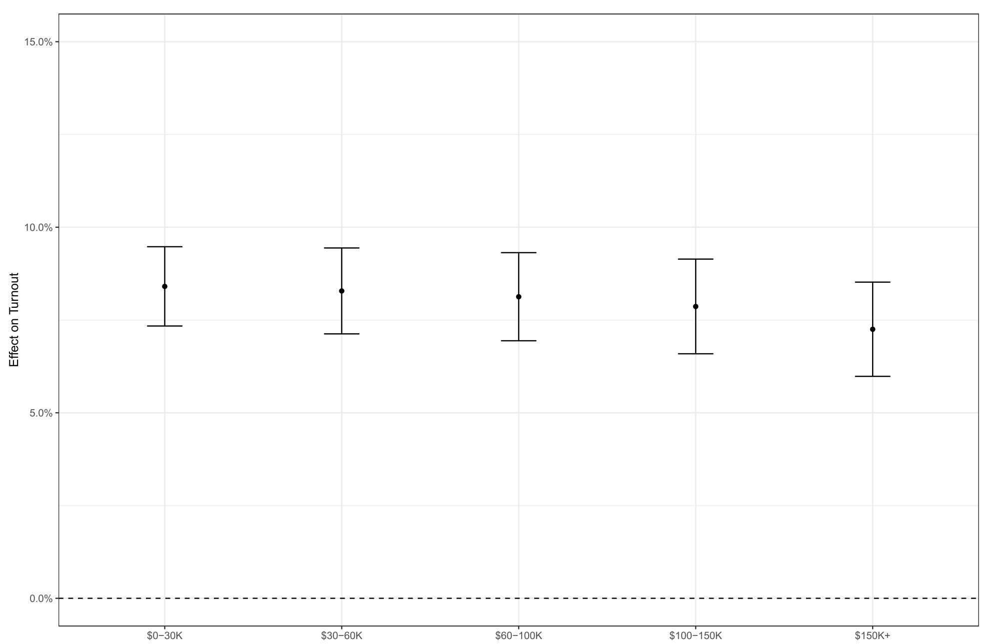


Fig. A1. Estimated Effect on Turnout by Income
Note: Estimates and 95% confidence intervals are from a stratified regression by income group. Models include individual and cycle fixed effects. Standard errors are clustered on state.

While turnout increases substantially for all income groups, low-income registered voters experience the largest turnout boost of approximately 8.4 percentage points. Of note, there is not much observed difference in the turnout increase among those who make less than $100,000 per year. The boost in turnout among these earners is slightly larger than that experienced by individuals toward the top of the income distribution.

Regression tables for subgroup analyses

Table A4
Estimated Effect of All-Mail Voting By Income

	$0–30 K	$30–60 K	$60–100 K	$100–150 K	$150 K+
All-Mail Voting	0.0839	0.083	0.0816	0.0784	0.0721
	(0.0055)	(0.006)	(0.006)	(0.0064)	(0.0065)
Senate Spending	0.0196	0.0176	0.0193	0.0233	0.0271
	(0.0053)	(0.0053)	(0.0061)	(0.0073)	(0.0075)
House Spending	0.001	0.0019	0.0026	0.003	0.0023
	(0.0024)	(0.002)	(0.002)	(0.0019)	(0.002)
Gov. Election	0.0222	0.0196	0.0223	0.0349	0.0427
	(0.0078)	(0.0068)	(0.0064)	(0.0102)	(0.0141)
Individual Fixed Effects	Yes	Yes	Yes	Yes	Yes
Cycle Fixed Effects	Yes	Yes	Yes	Yes	Yes
Cluster	State	State	State	State	State
R^2	0.4415	0.4568	0.4342	0.4085	0.3945
R^2-Within	0.0072	0.0067	0.0069	0.0076	0.0081
N. of cases	1973092	4208474	6709740	4247661	2665129

Note: OLS estimation with individual and cycle fixed effects, standard errors clustered on state.

Table A5
Estimated Effect of All-Mail Voting By Net Worth

	$1–4999	$5000–9999	$10,000–24,999	$25,000–49,999	$50000-99999	$100,000–249,999	$250,000–499,999	$499,999+
All-Mail Voting	0.0998	0.0893	0.0931	0.0765	0.0745	0.0703	0.0645	0.0582
	(0.0074)	(0.0058)	(0.0069)	(0.0058)	(0.0044)	(0.0063)	(0.0051)	(0.0054)
Senate Spending	0.0255	0.0254	0.0219	0.0236	0.0172	0.0224	0.0217	0.0227
	(0.0088)	(0.0068)	(0.006)	(0.0059)	(0.0051)	(0.0065)	(0.0072)	(0.0074)
House Spending	0.0031	0.0022	0.0025	0.0024	0.0021	0.0035	0.0034	0.0027
	(0.0032)	(0.0027)	(0.0033)	(0.0024)	(0.0022)	(0.0017)	(0.0016)	(0.0014)
Gov. Election	0.0139	0.0117	0.0171	0.0192	0.0129	0.0274	0.0301	0.0297
	(0.0091)	(0.0102)	(0.0093)	(0.0082)	(0.0064)	(0.0071)	(0.0086)	(0.0081)
Individual Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cycle Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cluster	State	State	State	State	State	State	State	State
R^2	0.4094	0.4161	0.4093	0.4073	0.4123	0.3889	0.3625	0.3469
R^2-Within	0.0082	0.0066	0.0072	0.0051	0.005	0.0066	0.007	0.0066
N. of cases	459805	277289	409404	1141236	1636364	5011032	3604861	1512386

Note: OLS estimation with individual and cycle fixed effects, standard errors clustered on state.

Table A6
Estimated Effect of All-Mail Voting By Occupational Group

	Retired	Professional	Management/Finance	Administrative	Sales	Technical	Blue Collar	Other
All-Mail Voting	0.0658	0.0641	0.0717	0.0757	0.0765	0.0767	0.0834	0.0854
	(0.0038)	(0.0051)	(0.0057)	(0.0063)	(0.0062)	(0.0072)	(0.0064)	(0.007)
Senate Spending	0.0009	0.0018	0.0015	0.0017	0.0014	0.0016	0.0011	0.0016
	(0.0002)	(0.0004)	(0.0004)	(0.0004)	(0.0005)	(0.0005)	(0.0004)	(0.0004)
House Spending	0.0025	0.0023	0.0025	0.0032	0.002	0.0025	0.0022	0.0024
	(0.0013)	(0.0019)	(0.0019)	(0.0022)	(0.002)	(0.0017)	(0.0023)	(0.0022)
Gov. Election	0.0209	0.0298	0.0294	0.0284	0.0213	0.0356	0.0196	0.0258
	(0.006)	(0.0096)	(0.0084)	(0.0097)	(0.0074)	(0.0112)	(0.0073)	(0.0088)
Individual Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cycle Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cluster	State	State	State	State	State	State	State	State
R^2	0.369	0.3833	0.3813	0.3973	0.4098	0.3988	0.4321	0.414
R^2-Within	0.0081	0.0074	0.0077	0.0081	0.007	0.0072	0.0062	0.0075
N. of cases	2702719	2248048	2165219	1316489	695309	552069	1573789	1789361

Note: OLS estimation with individual and cycle fixed effects, standard errors clustered on state.

Table A7
Estimated Effect of All-Mail Voting By Education

	Less than HS Diploma	HS Diploma	Some College	Bach Degree	Grad Degree
All-Mail Voting	0.0853	0.0801	0.0803	0.0736	0.0588
	(0.0075)	(0.0053)	(0.0062)	(0.0056)	(0.005)
Senate Spending	0.0013	0.0013	0.0014	0.0014	0.0015
	(0.0005)	(0.0004)	(0.0004)	(0.0004)	(0.0004)
House Spending	0.0018	0.0024	0.0034	0.0024	0.0021

(*continued on next page*)

Table A7 (*continued*)

	Less than HS Diploma	HS Diploma	Some College	Bach Degree	Grad Degree
	(0.0022)	(0.0022)	(0.0017)	(0.0018)	(0.0017)
Gov. Election	0.0071	0.0213	0.0247	0.0282	0.0308
	(0.0092)	(0.0073)	(0.0076)	(0.0083)	(0.0098)
Individual FEs	Yes	Yes	Yes	Yes	Yes
Cycle FEs	Yes	Yes	Yes	Yes	Yes
Cluster	State	State	State	State	State
R^2	0.4336	0.4245	0.4035	0.3871	0.3787
-WitR^2hin	0.0059	0.0074	0.0073	0.0077	0.0073
N. of cases	476980	3843427	2766493	4941088	2915740

Note: OLS estimation with individual and cycle fixed effects, standard errors clustered on state.

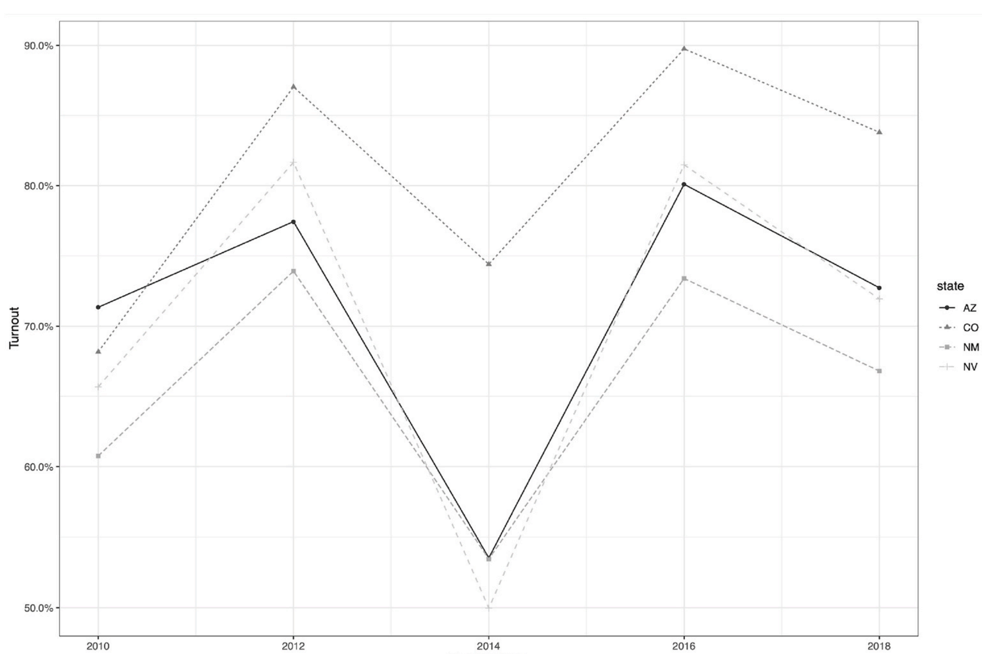
Table A8
Estimated Effect of All-Mail Voting By Race

	White	Other	Latino	Asian	African-American
All-Mail Voting	0.0764	0.0857	0.0883	0.1004	0.0927
	(0.0047)	(0.0095)	(0.0168)	(0.0091)	(0.0082)
Senate Spending	0.0011	0.002	0.0017	0.0017	0.0012
	(0.0003)	(0.0005)	(0.0006)	(0.0004)	(0.0005)
House Spending	0.002	0.0045	0.0044	0.0065	0.0046
	(0.0017)	(0.0031)	(0.0027)	(0.0038)	(0.004)
Gov. Election	0.0277	0.0371	0.041	0.0572	0.0109
	(0.0067)	(0.0148)	(0.0147)	(0.0198)	(0.0057)
Individual FEs	Yes	Yes	Yes	Yes	Yes
Cycle FEs	Yes	Yes	Yes	Yes	Yes
Cluster	State	State	State	State	State
R^2	0.4187	0.4427	0.4519	0.4598	0.4479
R^2-Within	0.0069	0.0094	0.0075	0.0104	0.0042
N. of cases	14514987	351161	2002101	419413	1266309

Note: OLS estimation with individual and cycle fixed effects, standard errors clustered on state.

Turnout rates for registered voters by state and cycle

As Arizona, New Mexico, and Nevada saw a turnout decrease of 13.8 percentage points in 2014 relative to 2010, turnout *increased* in Colorado by 6.3 percentage points. The increase in Colorado was three percentage points larger (9.4 percentage points) for young voters born after 1980. Figure A2 presents average turnout of registered voters by state from 2010 through 2018.



Note: Turnout of registered voters by state, 2010-2018, using data from the L2 Voter File.

Fig. A2. Comparing Turnout in Colorado and Control States
Note: Turnout of registered voters by state, 2010–2018, using data from the L2 Voter File.

Replication with CPS data

We replicate our study using data from the Census Current Population Survey (CPS) Voter Supplement (Table A9). The CPS Voter Supplement is a biennial survey of over 60,000 households, which asks respondents for self-reports of voter turnout. Self-reported voter turnout suffers from significant overreporting, but the data provide a helpful robustness check for our main analyses. We also note that the CPS samples all Americans, not just registrants (as in a voter file), so the quantity of interest is distinct. Because the CPS data cover a long time period, in Models 1 and 2 we include all states that adopt AMV (Colorado, Oregon, and Washington) as treatment units and all other states as control units. In Models 3 and 4, we more directly replicate our analysis, comparing the effect of Colorado's adoption of AMV to control states that never adopt AMV.

Table A9
Replication with CPS Voter Supplement Data

	All AMV States	All AMV States	Colorado Only	Colorado Only
	Elections (2020)	Corasaniti and Saul (2020)	Voting & COVID-19	Murray (2018)
All-Mail Voting	0.0292	0.0284	0.0545	0.0573
	(0.0124)	(0.0143)	(0.0043)	(0.0038)
Demographic Covariates	No	Yes	No	Yes
Senate Spending FE	Yes	Yes	Yes	Yes
Governor Election FE	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes
Cycle Fixed Effects	Yes	Yes	Yes	Yes
Cluster	State	State	State	State
R^2	0.031	0.171	0.032	0.170
N. of cases	1,085,827	983,179	1,051,590	951,524

Note: Demographic covariates include respondent age, education, gender, income, and race. OLS estimation with state and cycle fixed effects. Standard errors clustered on state.

In this robustness check, we estimate overall turnout effects of about 2.9 percentage points in Models 1 and 2. While these estimates are smaller in magnitude than our main results, the effects are still substantial in magnitude and statistically significant. Given that this replication explores the effect of a range of all-mail-voting regimes on a different dependent variable (self-reported turnout) and covers different states and election cycles, this replication strengthens our confidence in the paper's broad conclusion that AMV increases voter turnout. Models 3 and 4, which exclude other AMV states, show effect estimates of 5.5 and 5.7 percentage points. The AMV coefficients in Models 3 and 4 are significantly larger than those in Models 1 and 2 at the $p < 0.05$ level, again consistent with strong assessments of Colorado's policy implementation.

In Table A10, we run the same model specifications, but this time subsetting the sample to registered voters only. The results for all AMV states show positive effects of 2.4 and 2.6 percentage points for all AMV states in the bivariate and demographic controls specifications, respectively. The corresponding models focusing on Colorado AMV show 6.3 and 6.5 percentage point effects.

Table A10
Replication with CPS Voter Supplement Data, Registrants Only

	All AMV States	All AMV States	Colorado Only	Colorado Only
	Elections (2020)	Corasaniti and Saul (2020)		Murray (2018)
All-Mail Voting	0.0225	0.0251	0.0626	0.0648
	(0.0217)	(0.0230)	(0.0046)	(0.0043)
Demographic Covariates	No	Yes	No	Yes
Senate Spending FE	Yes	Yes	Yes	Yes
Governor Election FE	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes
Cycle Fixed Effects	Yes	Yes	Yes	Yes
Cluster	State	State	State	State
R^2	0.065	0.128	0.065	0.127
N. of cases	569,280	536,018	551,329	518,811

Note: Demographic covariates include respondent age, education, gender, income, and race. OLS estimation with state and cycle fixed effects. Standard errors clustered on state.

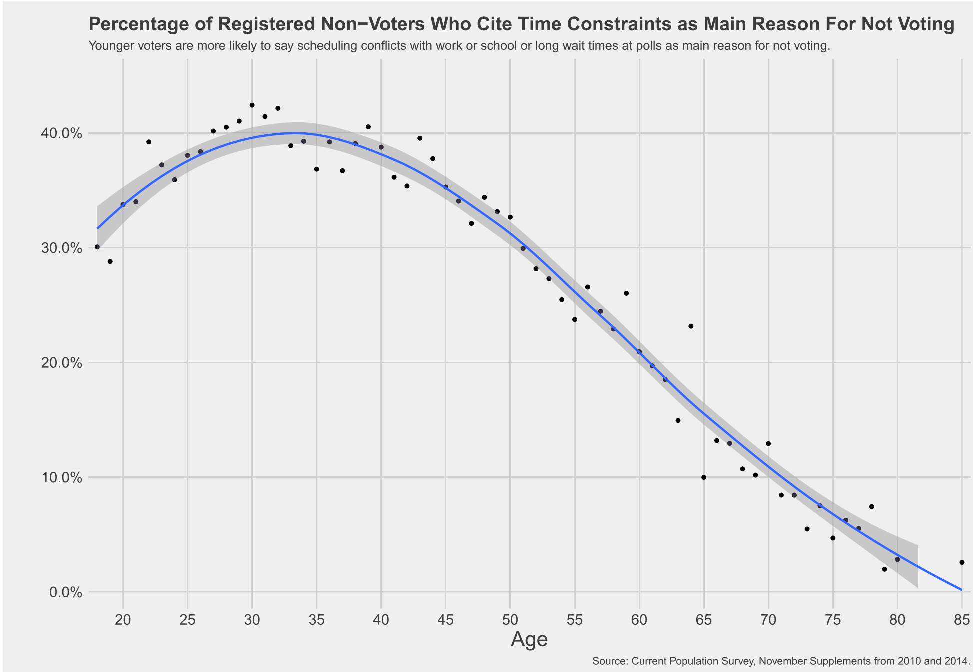


Fig. A3. Percentage of Registered Voters Citing Time Constraints as Main Reason for Not Voting
Note: The CPS includes an item asking non-voters their reason for not voting, which we used to calculate the proportions by age of respondents indicating scheduling conflicts with work or school or long wait times at the polls as reasons.

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