Vote-by-Mail and Voter Turnout in the Pandemic Election

Technical Appendix

CONTENTS

Eric McGhee, Jennifer Paluch, and Mindy Romero

Appendix A. Full Model Results and Alternative Specifications

Understanding the turnout consequences of policy decisions about voting by mail requires accounting for many variables in motion in the 2020 election. States changed more than just their policies on voting by mail; a number of them also used registration reforms like automatic voter registration for the first time in a presidential election. The coronavirus itself might have been a factor in turnout by discouraging voters from participating where caseloads were high. And there were the normal dynamics of a presidential election, where battleground states likely had higher turnout than others. Even beyond all these visible forces there were likely invisible ones that drove higher or lower turnout in certain areas of the country for reasons that are not easy to identify.

The tremendous diversity in election policies and other dynamics across the country's more than 3000 counties can help us isolate the effect of the vote-by-mail policies themselves. This can give us perspective on the consequence of mailing ballots in states like California, where the universality of the policy would otherwise make it difficult to understand its effects. A similar comparison of counties within California can estimate the effect of the in-person voting options. This appendix contains the results of difference-in-differences models run on county-level data from 1992 through 2020 that leverage this variation.

We ran nine national models, each with county and year mean centered data to estimate a full difference-in-differences model:

- **Model 1** included an interaction between all-mail balloting and the share of ballots cast by mail the last election before the reform was adopted (as a way of estimating the effect on in-person voters); county-specific linear trends; controls for average COVID cases in the last month before the election, the state's absolute presidential vote margin, a dummy for counties where the denominator was active registrants only, election reforms other than all vote-by-mail, and interactions with the 2020 election year. Because no state or county adopted election-day registration or early voting in 2020, we did not interact those two reforms with the 2020 dummy.
- **Model 2** was identical to Model 1 and also included an interaction between a California dummy and the 2020 election year, to explore California's unique experience under the pandemic.
- **Model 3** was identical to Model 1 but did not include the interaction with the VBM rate in the last election before all-mail balloting.
- **Model 4** was identical to Model 3 but without the county-specific linear trends.
- **Model 5** was identical to Model 4 but without the 2020 interactions, and with county-by-decade fixed effects to test for non-linear changes over time.
- **Model 6** used the natural log of raw county turnout as the outcome variable, to test the consequences of total registration as the denominator. The model omitted the interactions with the 2020 election year, but did include the county-specific linear trends.
- **Model 7** was identical to Model 4 but without the interactions with the 2020 election year.
- **Model 8** was identical to Model 4 but included only the all mail ballot reform to explore the possibility that its estimate was drawn from too limited a number of states.
- **Model 9** was an event study design to explore the possibility of pre- and post-treatment trends in all-mail ballot counties.

The models with county-specific linear trends test the parallel trends assumption of the difference-in-differences model. Because the point estimate for all vote-by-mail is largely the same, we choose to report the estimates from these more complete specifications in the main text. The other models test the robustness of the significant all-vote-by-mail effect. All of these results are reported in Table A1. We also tested models that used the total

number of COVID cases in the month before the election and the linear case trend in the month before the election. The results were substantively identical.

Table A2 contains the estimates of the effect of in-person options in California. Here we ran four models: one with linear time trends, one without, and a version of each with controls for the number of drop boxes and in-person staffed voting locations in the county.

Model results—all U.S. counties in presidential elections, 1992-2020

	Model 1 (main)	Model 2	Model 3 (main alternate)	Model 4	Model 5	Model 6 (outcome= ln(turnout))	Model 7	Model 8	Model 9 (event study)
Mail ballots to all	0.096	0.097	0.039	0.046	0.040	0.029	0.041	0.047	--
	(0.012)	(0.012)	(0.005)	(0.005)	(0.004)	(0.005)	(0.004)	(0.004)	
Mail ballots to all X last VBM %	-0.122	-0.126	--	--	--	--	--	--	--
	(0.020)	(0.021)							
No-excuse VBM	0.010	0.010	0.009	0.009	-0.006	0.004	0.007	--	0.008
	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)	(0.001)		(0.001)
VBM applications to all	0.008	0.008	0.007	0.032	-0.003	-0.005	-0.005	--	-0.007
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.003)	(0.002)		(0.002)
Automatic voter registration	0.028	0.028	0.030	0.034	-0.012	-0.003	-0.014	--	-0.015
	(0.005)	(0.005)	(0.005)	(0.004)	(0.002)	(0.004)	(0.002)		(0.002)
State presidential vote margin	-0.021	-0.021	-0.026	-0.022	-0.038	-0.111	-0.033	-0.023	-0.035
	(0.008)	(0.008)	(0.008)	(0.008)	(0.007)	(0.009)	(0.008)	(0.008)	(0.008)
Permanent vote-by-mail	-0.018	-0.018	-0.012	-0.005	-0.020	--	-0.003	--	-0.010
	(0.005)	(0.005)	(0.005)	(0.004)	(0.005)		(0.004)		(0.004)
Election-day registration	-0.004	-0.005	-0.016	0.013	-0.004	-0.001	0.011	--	0.012
	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)	(0.004)	(0.003)		(0.003)
Early voting	-0.006	-0.006	-0.006	0.002	-0.001	0.012	0.002	--	0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)		(0.002)
Active registrants as denominator	0.001	0.001	0.000	0.002	-0.023	-0.002	-0.006	-0.011	-0.006
	(0.005)	(0.005)	(0.005)	(0.004)	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)
Mail ballots to all X 2020	0.010	0.011	0.007	0.009	--	--	--	-0.018	--
	(0.014)	(0.014)	(0.005)	(0.004)				(0.004)	
Mail ballots to all X last VBM % X 2020	-0.013	-0.017	--	--	--	--	--	--	--
	(0.022)	(0.022)							
No-excuse VBM X 2020	-0.037	-0.037	-0.037	-0.008	--	--	--	--	--
	(0.003)	(0.003)	(0.003)	(0.003)					
VBM applications to all X 2020	0.009	0.009	0.009	-0.035	--	--	--	--	--
	(0.002)	(0.002)	(0.002)	(0.003)					

	Model 1 (main)	Model 2	Model 3 (main alternate)	Model 4	Model 5	Model 6 (outcome= ln(turnout))	Model 7	Model 8	Model 9 (event study)
Automatic voter registration X 2020	-0.060	-0.060	-0.059	-0.067	--	--	--	--	--
	(0.005)	(0.005)	(0.005)	(0.004)					
Average COVID cases last month X 2020	0.000	0.000	0.000	0.000	0.000	0.000	--	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)
State presidential vote margin X 2020	-0.022	-0.025	-0.023	-0.045	--	--	--	-0.030	--
	(0.013)	(0.013)	(0.012)	(0.011)				(0.010)	
California X 2020	--	0.013	--	--	--	--	--	--	--
		(0.008)							
Treatment lag -3 or more	--	--	--	--	--	--	--	--	-0.013
									(0.003)
Treatment lag -2	--	--	--	--	--	--	--	--	-0.002
									(0.002)
Treatment year	--	--	--	--	--	--	--	--	0.031
									(0.004)
Treatment lead +1	--	--	--	--	--	--	--	--	0.047
									(0.006)
Treatment lead +2	--	--	--	--	--	--	--	--	0.050
									(0.005)
County mean centering	X	X	X	X		X	X	X	X
Year mean centering	X	X	X	X	X	X	X	X	X
County trends	X	X	X			X			
Decade X county mean centering					X				
RMSE	0.038	0.038	0.038	0.046	0.037	0.051	0.047	0.047	0.046
N	23037	23037	23044	23044	23044	23044	23044	23044	23044

SOURCES: David Leip's Atlas of U.S. Presidential Elections (county turnout and registration); Pew Research Center Non-Precinct Place Voting Study (election policies); National Conference of State Legislatures (election policies); Election Administration and Voting Survey (election policies); Thompson, et al. (2020) replication file (early Washington vote-by-mail numbers); New York Times COVID-19 database.

NOTES: Cell entries are ordinary least squares coefficients with clustered standard errors. Treatment lags for the event study model are defined in relation to the adoption of all-mail balloting; one-election lag is omitted to identify the model. Lagged vote-by-mail rate (from 2016) was not available for Vermont, so for that state only we used the vote-by-mail rate from the following midterm election (2018).

TABLE A2
Model results: California counties in presidential elections, 1992–2020.

	Model 1	Model 2	Model 3	Model 4
Consolidated precincts available to anyone in county	0.014	0.024	0.023	0.004
	(0.010)	(0.010)	(0.013)	(0.015)
Voter's Choice Act	0.015	0.021	0.021	0.003
	(0.011)	(0.009)	(0.013)	(0.016)
Consolidated precincts available to neighborhood	-0.008	0.011	0.015	-0.021
	(0.013)	(0.012)	(0.013)	(0.015)
All-mail (no in-person)	0.008	-0.008	-0.009	0.006
	(0.023)	(0.006)	(0.006)	(0.023)
Drop boxes per 10,000 voting-eligible residents	--	--	-0.004	0.004
			(0.003)	(0.002)
Staffed voting locations per 10,000 voting-eligible residents	--	--	-0.001	-0.002
			(0.003)	(0.002)
County mean centering	X	X	X	X
Year mean centering	X	X	X	X
County trends	X			X
RMSE	0.025	0.029	0.029	0.025
N	464	464	464	464

SOURCES: California Secretary of State.

NOTES: Cell entries are ordinary least squares coefficients with clustered standard errors.

TABLE A3
Data balance: number of counties using each reform by year

	1992	1996	2000	2004	2008	2012	2016	2020
No-excuse VBM	540	750	1113	1179	1447	1574	1661	2405
Mail ballots to all	0	2	38	43	75	78	162	327
VBM applications to all	0	0	0	0	0	0	1	719
Automatic voter registration	0	0	0	0	3	3	198	677
Election-day registration	147	311	311	311	466	466	530	588
Early voting	749	881	1349	1798	1900	1964	1978	1978

SOURCES: David Leip's Atlas of U.S. Presidential Elections (county turnout and registration); Pew Research Center Non-Precinct Place Voting Study (election policies); National Conference of State Legislatures (election policies); Election Administration and Voting Survey (election policies); Thompson, et al. (2020) replication (early Washington vote-by-mail numbers); New York Times COVID-19 database.

NOTES: Cell entries are the total number of counties that used each reform in each year.

TABLE A4
Data balance: counties newly adopting only the specified reform in each year

	1992	1996	2000	2004	2008	2012	2016	2020
No-excuse VBM	212	173	82	0	268	102	87	631
Mail ballots to all	0	1	36	5	32	1	20	49
VBM applications to all	0	0	0	0	0	0	1	582
Automatic voter registration	0	0	0	0	3	0	195	227
Election-day registration	146	164	0	0	155	0	0	0
Early voting	420	95	187	383	102	37	14	0

SOURCES: David Leip's Atlas of U.S. Presidential Elections (county turnout and registration); Pew Research Center Non-Precinct Place Voting Study (election policies); National Conference of State Legislatures (election policies); Election Administration and Voting Survey (election policies); Thompson, et al. (2020) replication file (early Washington vote-by-mail numbers); New York Times COVID-19 database.

NOTES: Cell entries are the total number of counties that added that reform—and only that reform—for the first time that year. For example, a county that added only two reforms—Election Day registration in 2012 and automatic voter registration in 2016—would be counted with each reform in the corresponding year but not in any other cell. By contrast, a county that added the same two reforms in the same year would be counted nowhere, because it had never adopted a reform by itself.

TABLE A5
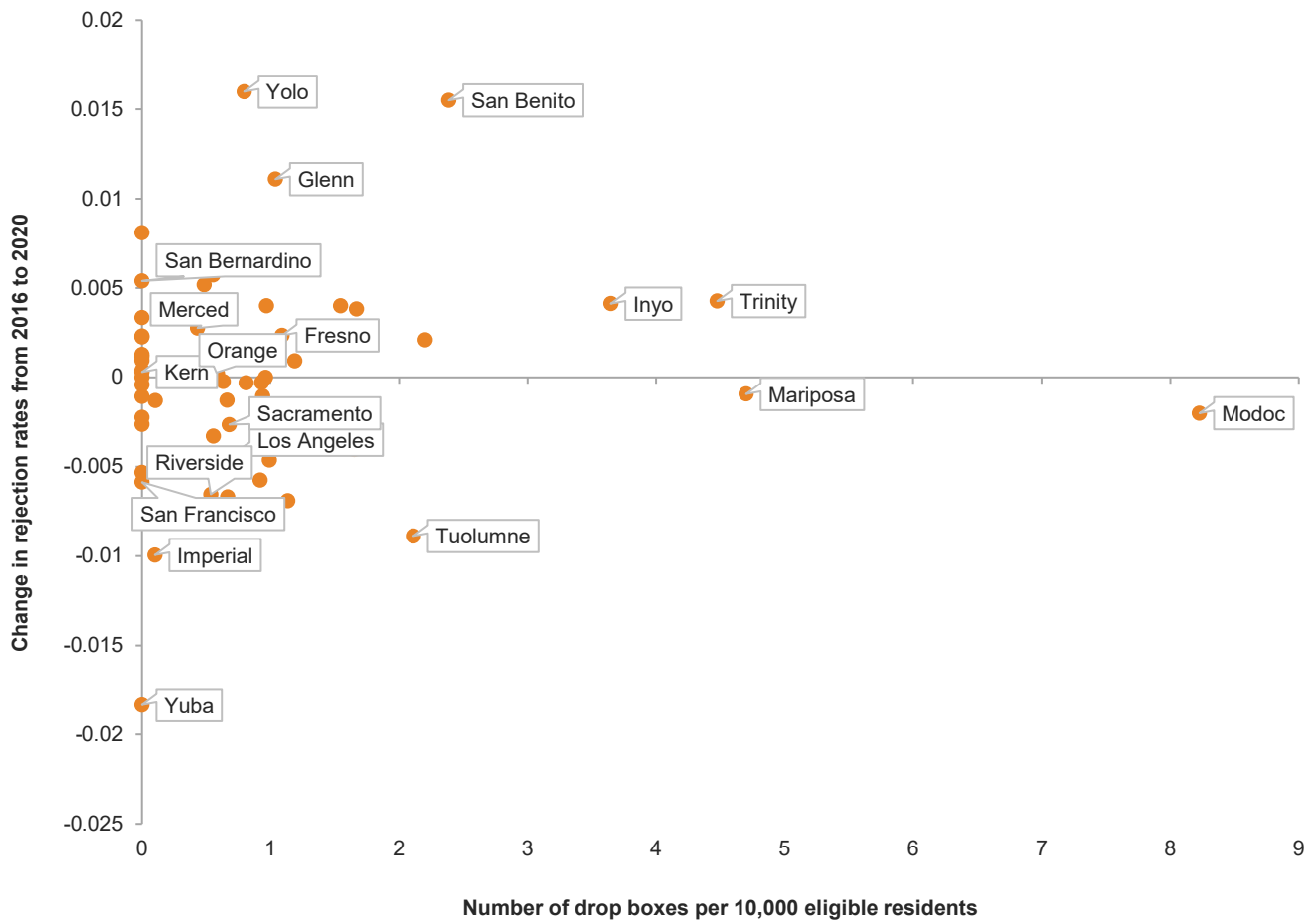Vote-by-mail ballot rejection rates by county, 2016 and 2020

	2016	2020	Change (2020 – 2016)		2016	2020	Change (2020 – 2016)
Alameda	0.44%	0.50%	0.06%	Orange	0.39%	0.42%	0.03%
Alpine	0.80%	0.27%	-0.53%	Placer	0.48%	0.37%	-0.11%
Amador	0.20%	0.41%	0.21%	Plumas	0.01%	0.24%	0.23%
Butte	0.95%	0.49%	-0.46%	Riverside	1.28%	0.62%	-0.65%
Calaveras	0.34%	0.73%	0.38%	Sacramento	0.52%	0.26%	-0.26%
Colusa	0.54%	1.35%	0.81%	San Benito	0.65%	2.20%	1.55%
Contra Costa	0.41%	0.36%	-0.04%	San Bernardino	0.49%	1.03%	0.54%
Del Norte	1.93%	1.71%	-0.22%	San Diego	0.44%	0.49%	0.06%
El Dorado	N/A	0.37%	N/A	San Francisco	0.82%	0.23%	-0.59%
Fresno	1.13%	1.37%	0.23%	San Joaquin	0.69%	0.36%	-0.33%
Glenn	0.35%	1.46%	1.11%	San Luis Obispo	1.18%	0.60%	-0.58%
Humboldt	0.43%	0.83%	0.40%	San Mateo	0.42%	0.39%	-0.03%
Imperial	2.04%	1.04%	-1.00%	Santa Barbara	0.72%	0.59%	-0.13%
Inyo	0.45%	0.86%	0.41%	Santa Clara	0.70%	0.20%	-0.50%
Kern	0.82%	0.85%	0.03%	Santa Cruz	0.38%	0.35%	-0.03%
Kings	0.20%	0.37%	0.16%	Shasta	0.41%	0.30%	-0.11%
Lake	0.87%	0.97%	0.09%	Sierra	0.37%	0.41%	0.04%
Lassen	0.20%	0.29%	0.09%	Siskiyou	0.41%	0.75%	0.33%
Los Angeles	1.07%	0.62%	-0.45%	Solano	0.29%	0.52%	0.23%
Madera	0.49%	1.06%	0.57%	Sonoma	0.49%	0.51%	0.02%
Marin	1.03%	0.36%	-0.67%	Stanislaus	0.89%	0.76%	-0.13%
Mariposa	0.71%	0.62%	-0.09%	Sutter	1.04%	0.35%	-0.69%
Mendocino	N/A	0.22%	N/A	Tehama	0.53%	0.65%	0.13%
Merced	0.77%	1.04%	0.28%	Trinity	0.61%	1.04%	0.43%
Modoc	1.21%	1.01%	-0.20%	Tulare	0.92%	1.44%	0.52%
Mono	0.65%	0.77%	0.12%	Tuolumne	1.07%	0.18%	-0.89%
Monterey	0.69%	0.42%	-0.26%	Ventura	0.48%	0.46%	-0.02%
Napa	0.71%	0.31%	-0.40%	Yolo	0.18%	1.78%	1.60%
Nevada	0.06%	0.46%	0.40%	Yuba	2.79%	0.95%	-1.84%

SOURCES: California Secretary of State.

NOTES: Rejection rates are rejected ballots as a share of all vote-by-mail ballots returned. Missing data indicates nonreporting counties.
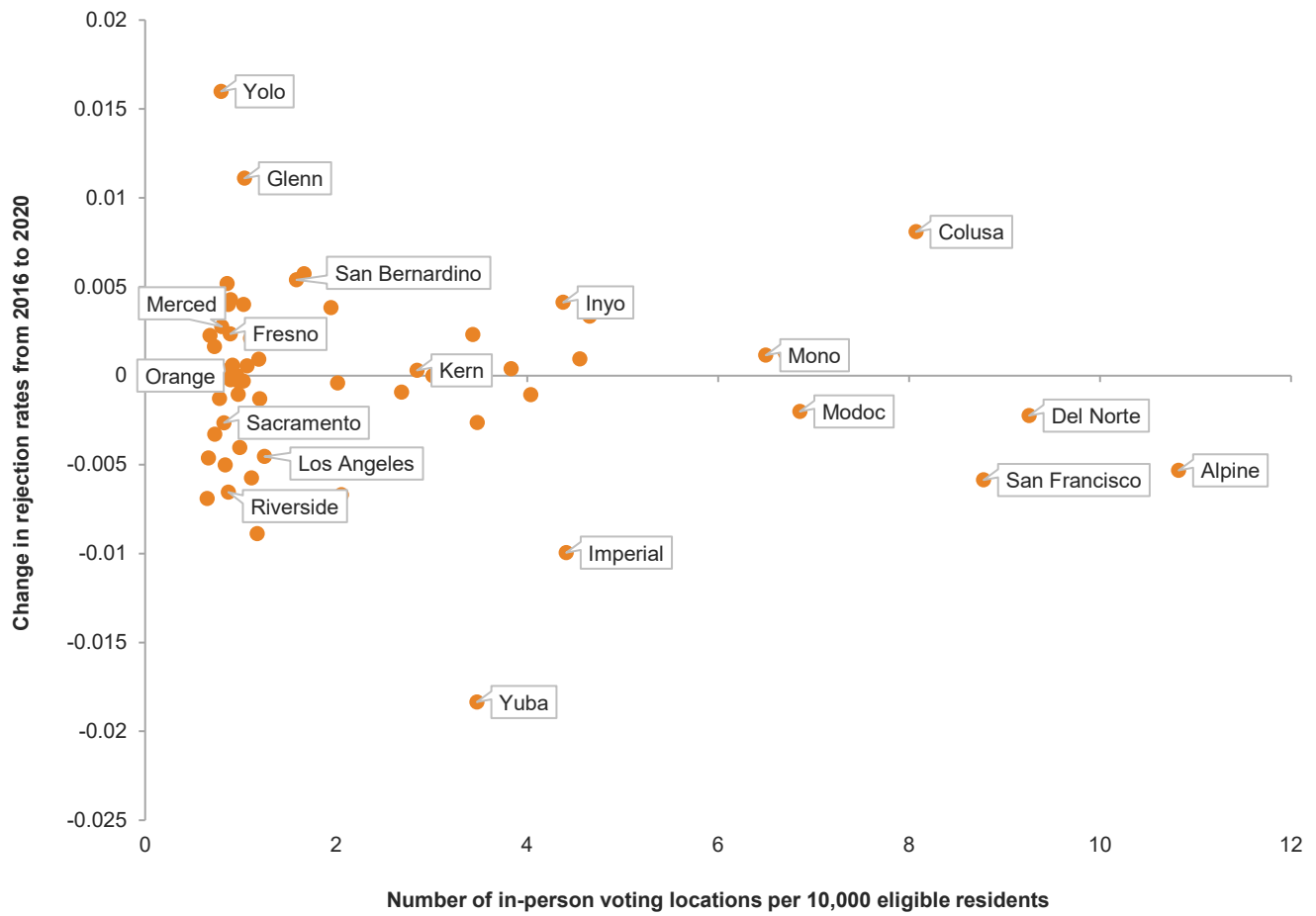
Change in county vote-by-mail rejection rates by number of drop boxes

SOURCE: California Secretary of State.

Change in county vote-by-mail rejection rates by number of in-person voting locations

SOURCE: California Secretary of State.