



## **CALTECH/MIT VOTING TECHNOLOGY PROJECT**

A multi-disciplinary, collaborative project of the California Institute of Technology – Pasadena, California 91125 and the Massachusetts Institute of Technology – Cambridge, Massachusetts 02139

**TITLE**      **Voting Technology: Vote-by-Mail, and Residual Votes in California, 1990-2010**

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Supplemental Appendix

To test the supposition that the lost votes recovered by California through the modernization of voting technologies may be being undone by the trend toward more voting by mail, Table A1 attempts to quantify changes in the residual vote rate in each county from the presidential elections of 1992 to 2008 due to changes in voting technologies, and due to the growth in voting by mail. The table starts by reporting turnout in the 1992 and 2008 presidential elections; the percentage of ballots cast by mail in 1992 and 2008, along with the change across the two years; the type of voting equipment used in 1992 and 2008; and the estimated change in the residual vote rate from 1992 and 2008 based on changes in voting technology, using the coefficients from Table 4 in the text. It then calculates the estimated number of votes represented by this coefficient by multiplying it by turnout for 2008. Negative values indicate an estimated reduction in the residual vote in 2008 due to technology changes since 1992. For instance, for Alameda County, we estimate that the change from punch cards in 1992 to precinct-count optical scanning in 2008 resulted in a reduction in the number of residual votes in 2008 by 5,343 ( $\approx -0.85\% \times 628,545$ ).

[Table A1 about here]

We then estimate the number of residual votes due to changes in the vote-by-mail rate in presidential elections by multiplying the relevant coefficient in Table 4 by the change in the vote-by-mail rate *and* the turnout for 2008. For instance, for Alameda County, we estimate that the growth in the vote-by-mail rate from 12.7% in 1992 to 48.3% in 2008 resulted in an increase in the number of residual votes in 2008 by 4,925 ( $\approx .022 \times [48.3\% - 12.7\%] \times 628,545$ ).

Table A1. Calculation of net change in residual vote rate from 1992 to 2010, combining effects of voting technology and vote-by-mail.

County	Turnout		Vote-by-Mail Pct.			Voting equipment type		Voting technology effect		Vote-by-Mail Effect	Combined effect
	1992	2008	1992	2008	Change	1992	2008	Net rv change pct	Net votes	Net votes	Net votes
Alameda	541,928	628,545	12.7%	48.3%	35.6%	Punch	Opscan-P	-0.85%	-5,343	4,925	-418
Alpine	638	697	22.1%	100.0%	77.9%	Punch	Opscan-C	-0.68%	-5	12	7
Amador	15,692	19,006	16.5%	51.8%	35.4%	Opscan-C	Opscan-P	-0.17%	-32	148	116
Butte	88,446	99,392	18.0%	49.4%	31.5%	Punch	Opscan-C	-0.68%	-676	688	12
Calaveras	17,516	23,588	24.7%	58.5%	33.8%	Punch	Opscan-P	-0.85%	-200	176	-25
Colusa	5,860	6,532	19.7%	49.3%	29.6%	Punch	Opscan-P	-0.85%	-56	43	-13
Contra Costa	389,391	456,876	19.7%	47.6%	27.9%	Opscan-C	Opscan-P	-0.17%	-777	2,805	2,028
Del Norte	9,687	9,684	27.5%	48.4%	20.9%	Punch	Opscan-C	-0.68%	-66	45	-21
El Dorado	66,949	93,890	19.8%	54.7%	34.9%	Punch	Opscan-P	-0.85%	-798	722	-76
Fresno	224,241	275,554	18.6%	45.3%	26.7%	Punch	Opscan-P	-0.85%	-2,342	1,618	-724
Glenn	9,143	10,053	14.5%	36.8%	22.2%	Punch	Opscan-C	-0.68%	-68	49	-19
Humboldt	61,030	64,358	17.2%	40.6%	23.5%	Punch	Opscan-P	-0.85%	-547	332	-215
Imperial	27,597	39,823	12.0%	32.3%	20.2%	Punch	Opscan-C	-0.68%	-271	177	-94
Inyo	8,588	8,625	18.7%	43.2%	24.5%	Punch	Opscan-C	-0.68%	-59	47	-12
Kern	185,781	235,854	14.1%	41.2%	27.1%	Punch	Opscan-C	-0.68%	-1,604	1,405	-199
Kings	26,326	35,775	15.7%	64.2%	48.6%	Punch	Opscan-C	-0.68%	-243	382	139
Lake	24,035	25,863	20.5%	53.3%	32.8%	Opscan-C	Opscan-C	0.00%	0	186	186
Lassen	10,510	11,510	15.6%	44.2%	28.6%	Punch	Opscan-P	-0.85%	-98	72	-25
Los Angeles	2,831,077	3,368,057	13.7%	24.1%	10.3%	Punch	InkaVote	-0.89%	-29,976	7,652	-22,324
Madera	31,222	43,032	18.4%	54.0%	35.6%	Opscan-C	Opscan-C	0.00%	0	337	337
Marin	132,422	141,321	19.2%	58.7%	39.5%	Punch	Opscan-P	-0.85%	-1,201	1,228	27
Mariposa	8,469	9,756	24.8%	55.3%	30.4%	Opscan-C	Opscan-C	0.00%	0	65	65
Mendocino	37,658	40,580	15.2%	22.2%	7.0%	Punch	Opscan-C	-0.68%	-276	62	-213
Merced	49,958	64,688	16.0%	40.3%	24.3%	Mechanical	Opscan-P	0.06%	39	346	385
Modoc	4,702	4,505	18.2%	31.8%	13.6%	Punch	Opscan-P	-0.85%	-38	14	-25
Mono	4,499	5,621	17.7%	33.7%	16.0%	Punch	Opscan-P	-0.85%	-48	20	-28
Monterey	118,303	131,381	24.9%	58.8%	33.9%	Punch	Opscan-C	-0.68%	-893	980	86
Napa	55,090	60,366	17.2%	27.5%	10.3%	Punch	Opscan-C	-0.68%	-410	137	-273
Nevada	45,414	56,177	23.6%	69.5%	45.9%	Opscan-C	Opscan-P	-0.17%	-96	567	471
Orange	979,024	1,167,657	15.4%	46.5%	31.1%	Punch	DRE	-0.47%	-5,488	7,989	2,501
Placer	93,438	175,215	23.4%	55.6%	32.2%	Punch	Opscan-P	-0.85%	-1,489	1,239	-250
Plumas	10,521	11,169	23.0%	58.7%	35.8%	Punch	Opscan-P	-0.85%	-95	88	-7
Riverside	434,316	657,005	18.1%	41.5%	23.5%	Opscan-C	Opscan-C	0.00%	0	3,392	3,392
Sacramento	461,887	546,660	14.6%	44.2%	29.6%	Punch	Opscan-P	-0.85%	-4,647	3,560	-1,087
San Benito	13,207	19,982	19.1%	43.3%	24.2%	Punch	Opscan-C	-0.68%	-136	106	-29

County	Turnout		Vote-by-Mail Pct.			Voting equipment type		Voting technology effect		Vote-by-Mail Effect	Combined effect
	1992	2008	1992	2008	Change	1992	2008	Net rv change pct	Net votes	Net votes	Net votes
San Bernardino	482,162	616,320	14.8%	37.2%	22.4%	Punch	Opscan-C	-0.68%	-4,191	3,042	-1,149
San Diego	1,002,914	1,245,947	24.4%	46.0%	21.6%	Punch	Opscan-C	-0.68%	-8,472	5,926	-2,546
San Francisco	329,695	388,112	22.6%	46.0%	23.4%	Punch	Opscan-P	-0.85%	-3,299	1,996	-1,303
San Joaquin	165,909	212,214	18.4%	48.0%	29.6%	Opscan-C	Opscan-C	0.00%	0	1,381	1,381
San Luis Obispo	107,144	134,061	23.9%	51.0%	27.1%	Punch	Opscan-P	-0.85%	-1,140	800	-339
San Mateo	281,791	307,350	20.2%	48.1%	27.8%	Opscan-C	DRE	0.21%	645	1,883	2,529
Santa Barbara	164,705	176,562	22.2%	52.2%	30.0%	Opscan-C	Opscan-P	-0.17%	-300	1,164	864
Santa Clara	610,002	678,033	13.5%	57.3%	43.8%	Punch	Opscan-C	-0.68%	-4,611	6,534	1,923
Santa Cruz	116,527	128,555	20.3%	47.1%	26.8%	Punch	Opscan-P	-0.85%	-1,093	757	-336
Shasta	69,223	81,378	15.0%	51.8%	36.8%	Punch	Opscan-C	-0.68%	-553	659	106
Sierra	1,918	2,012	21.3%	100.0%	78.7%	Punch	Opscan-C	-0.68%	-14	35	21
Siskiyou	21,428	21,723	18.1%	61.3%	43.2%	Punch	Opscan-P	-0.85%	-185	206	22
Solano	134,444	162,638	16.1%	51.1%	35.0%	Punch	Opscan-P	-0.85%	-1,382	1,253	-130
Sonoma	201,499	231,817	20.1%	59.4%	39.3%	Opscan-C	Opscan-C	0.00%	0	2,005	2,005
Stanislaus	131,398	162,941	31.1%	52.9%	21.8%	Punch	Opscan-P	-0.85%	-1,385	782	-603
Sutter	26,456	33,337	23.9%	68.3%	44.4%	Opscan-C	Opscan-C	0.00%	0	326	326
Tehama	22,071	24,803	14.7%	54.8%	40.2%	Punch	Opscan-C	-0.68%	-169	219	50
Trinity	6,806	6,482	30.6%	36.6%	6.0%	Punch	Opscan-P	-0.85%	-55	9	-47
Tulare	91,659	106,551	13.0%	36.8%	23.8%	Opscan-C	Opscan-P	-0.17%	-181	558	377
Tuolumne	24,526	27,499	22.6%	51.6%	29.0%	Punch	Opscan-P	-0.85%	-234	175	-59
Ventura	276,404	343,690	19.1%	43.5%	24.4%	Punch	Opscan-P	-0.85%	-2,921	1,846	-1,075
Yolo	63,394	80,674	15.0%	47.1%	32.1%	Punch	Opscan-C	-0.68%	-549	570	21
Yuba	17,925	21,681	21.0%	48.0%	27.0%	Punch	Opscan-C	-0.68%	-147	129	-19

Note: Some sums do not add up due to rounding error.

Table A2. Pre-2000 studies on ballot roll-off

Citation	Geographic coverage	Offices studied	Year(s)	Baseline for turnout	Finding
White (1960)	Michigan	Referendum	1958	Vote for governor	Lever machines had higher roll-off
Mather (1964)	Iowa	Top vote-getter; Referenda	1920-1960	Eligible electorate; votes cast for election with most total votes	Paper-ballot counties had higher turnout; Lever machines had higher roll-off
Thomas (1968)	Michigan	Referenda	1958-1963	Total votes for partisan office receiving the most total votes on ballot	Lever machines had higher roll-off
Asher, Schussler, and Rosenfield (1982)	Ohio	Governor (primarily) and other down-ballot state elections	1974-1980	Turnout	Punch cards cause more lost votes at top of ballot, but many fewer down-ballot
Montgomery (1982)*	Michigan	Special elections	Unknown	Unknown	Punch cards experience more “vote loss”
Fraser (1985)	Ohio	All statewide contests	1974-1982	Turnout	Punch card have higher roll-off for governor; machines have higher roll-off down-ballot, including referenda
Mather (1986)	Iowa	Top vote-getter; Referenda	1920-1984	Eligible electorate; votes cast for election with most total votes	Paper-ballot counties had higher turnout; Lever machines had higher roll-off
Darcy and Schneider (1989)	Oklahoma	All statewide contests	1986	Presumably turnout	OpSCAN ballots with “confusing” layouts experience more roll-off; otherwise, opSCAN ballots have less roll-off
Nichols and Strikek (1995)	Columbus, Ohio	Federal, state, & county offices	1992	Votes cast for president	Electronic voting machines produce less roll-off, except for U.S. Senate
Nichols (1998)	Kentucky	Constitutional referenda	1992, 1996	Votes cast in “major partisan office”	Electronic voting machines produce less roll-off in referenda

\*Cited in Shocket, Heighberger, and Brown (1992).

Table A3. Use of voting technologies in California, by number of voters and number of counties, 1992–2010

Year	Mechanical lever		Punch, Votomatic		Punch, Datavote		Optical scan, central count		Optical scan, precinct count		DRE		InkaVote	
	Voters	Cnty	Voters	Cnty	Voters	Cnty	Voters	Cnty	Voters	Cnty	Voters	Cnty	Voters	Cnty
1990	34,669	1	4,891,264	17	1,963,447	31	1,009,751	9	0	0	0	0	0	0
1992	49,958	1	6,951,797	15	2,492,252	29	1,583,075	11	297,483	2	0	0	0	0
1994	0	0	5,313,966	13	1,941,102	28	1,411,849	15	233,715	2	0	0	0	0
1996	0	0	6,112,148	12	2,117,080	28	1,708,631	15	325,653	3	0	0	0	0
1998	0	0	5,092,521	12	1,786,994	28	1,466,862	15	271,272	3	0	0	0	0
2000	0	0	5,947,871	9	2,033,175	21	1,150,538	11	1,556,182	16	455,077	1	0	0
2002	0	0	3,636,190	8	1,441,440	20	858,540	11	1,138,167	16	664,484	3	0	0
2004	0	0	0	0	601,657	12	2,547,851	11	2,763,319	24	3,592,454	10	3,085,582	1
2006	0	0	0	0	0	0	387,481	8	2,893,092	27	3,585,367	22	2,033,119	1
2008	0	0	0	0	0	0	6,131,091	29	4,244,029	28	1,475,007	2	3,368,057	1
2010	0	0	0	0	0	0	3,645,053	28	3,155,702	27	1,124,464	2	2,377,105	1

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