

MODELING VOTING SERVICE TIMES WITH MACHINE LOGS

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MIT ELECTION DATA
+ SCIENCE LAB

MEASURING POLLING PLACE SERVICE TIMES

BACKGROUND AND MOTIVATION

- + Long lines serious issue in American election administration
- + Dominant theory on wait times suggests that the rate at which voters arrive, the number of machines in a precinct, and the rate at which voters vote determine line formation at a polling location

DATA

- + South Carolina uses ES&S iVotronic DRE machines in all precincts
- + Machines automatically create “machine-log” files that monitor election day events as audit trail
 - Logs only mark cast times
- + Additional files include “ballot images” of cast votes

DATA (EL155, BALLOT IMAGES)

RUN DATE:11/08/16 09:56 PM

PRECINCT 1 - Abbeville No. 1

VOTR.	B/I	CANDIDATES RECEIVING A VOTE	
5120096	4 *	10 Hillary Rodham Clinton	President and Vice President
5120096	4	19 Thomas Dixon	U S Senate
5120096	4	27 Hosea Cleveland	CONG003 President District 3
5120096	4	31 Floyd Nicholson	SEN0010 State Senate District 10
5120096	4	35 Craig Gagnon	HOUS011 State House of Representatives D
5120096	4	38 David Stumbo	Solicitor District 8
5120096	4	42 W/I CALLAHAN	Sheriff
5120096	4	44 Emily Yeargin McMahan	Clerk of Court
5120096	4	47 Ronnie Ashley	Coroner
5120096	4	50 Charles H Goodwin	CNCL003 County Council District 3
5120096	4	65 Susie K New	Soil and Water District Commission
5120096	4	71 Harold McNeill	MUNABBE Mayor
5120096	4	79 Jim Grant	CTY0008 City Council District 8
5120096	4	82 Yes	Sales and Use Tax Referendum
5120096	5 *	14 Donald J Trump	President and Vice President
5120096	5	22 Tim Scott	U S Senate
5120096	5	28 Jeff Duncan	CONG003 President District 3
5120096	5	32 J Bryan Hope	SEN0010 State Senate District 10
5120096	5	35 Craig Gagnon	HOUS011 State House of Representatives D
5120096	5	38 David Stumbo	Solicitor District 8
5120096	5	41 Ray Watson	Sheriff
5120096	5	44 Emily Yeargin McMahan	Clerk of Court
5120096	5	47 Ronnie Ashley	Coroner
5120096	5	53 Billy Norris	CNCL004 County Council District 4
5120096	5	65 Susie K New	Soil and Water District Commission
5120096	5	71 Harold McNeill	MUNABBE Mayor
5120096	5	76 Joshua Bryan Baughman	CTY0007 City Council District 7
5120096	5	83 No	Sales and Use Tax Referendum

DATA (EL152, MACHINE-LOGS)

5101642	117461	SUP	11/08/2016	07:13:32	0002400	PEB access failed
		SUP	11/08/2016	07:13:32	0000706	Failed to retrieve EQC from PEB
		SUP	11/08/2016	07:13:32	0001635	Terminal shutdown - IPS exit
		SUP	11/08/2016	07:23:52	0001633	Terminal shutdown
	139456	SUP	11/08/2016	07:27:00	0001510	Vote cast by voter
		SUP	11/08/2016	07:30:39	0001510	Vote cast by voter
	0	UNK	11/08/2016	07:30:47	0002400	PEB access failed
		UNK	11/08/2016	07:30:47	0002400	PEB access failed
		UNK	11/08/2016	07:30:59	0002400	PEB access failed
		UNK	11/08/2016	07:30:59	0000706	Failed to retrieve EQC from PEB
		UNK	11/08/2016	07:30:59	0001635	Terminal shutdown - IPS exit
	139456	SUP	11/08/2016	07:35:52	0001510	Vote cast by voter
		SUP	11/08/2016	07:38:25	0001510	Vote cast by voter
		SUP	11/08/2016	07:41:17	0001510	Vote cast by voter
		SUP	11/08/2016	07:44:35	0001510	Vote cast by voter
		SUP	11/08/2016	07:48:33	0001510	Vote cast by voter
		SUP	11/08/2016	07:52:46	0001510	Vote cast by voter

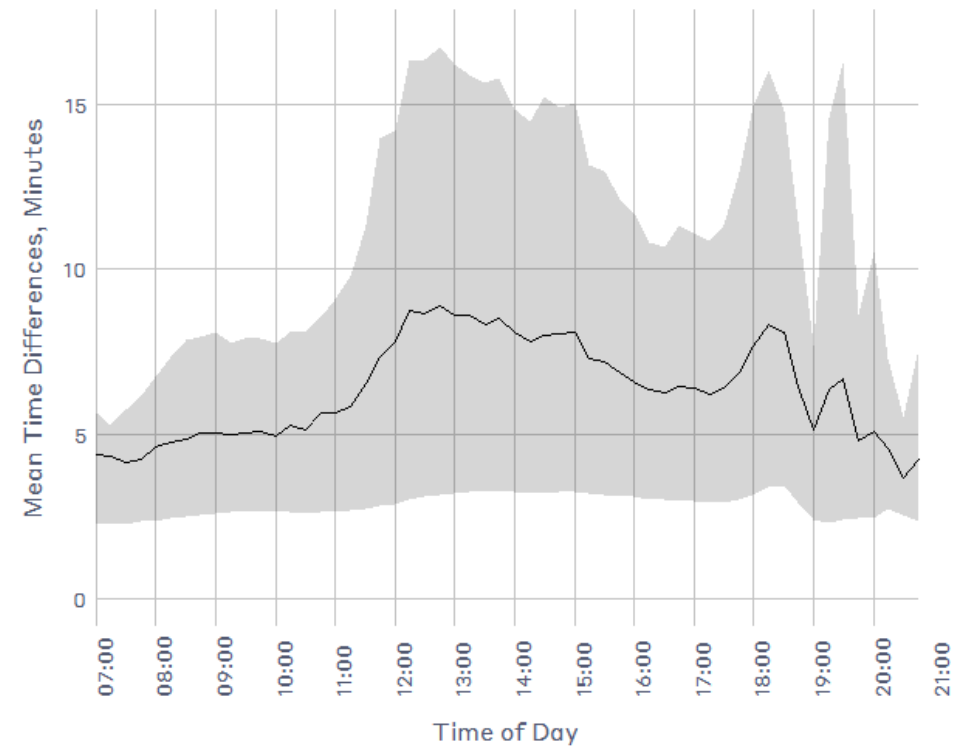
BALLOT MARKING TIMES

- + Times between consecutive ballot events can be thought of as occupied time – but only when at capacity
 - Think of time between votes as slack time + walk time + ballot marking time + time standing at booth
- + To minimize slack time, we restrict the voting machines that enter the dataset

MACHINE RESTRICTION (TIME OF DAY)

+ Look at 7:15-7:30 time slot

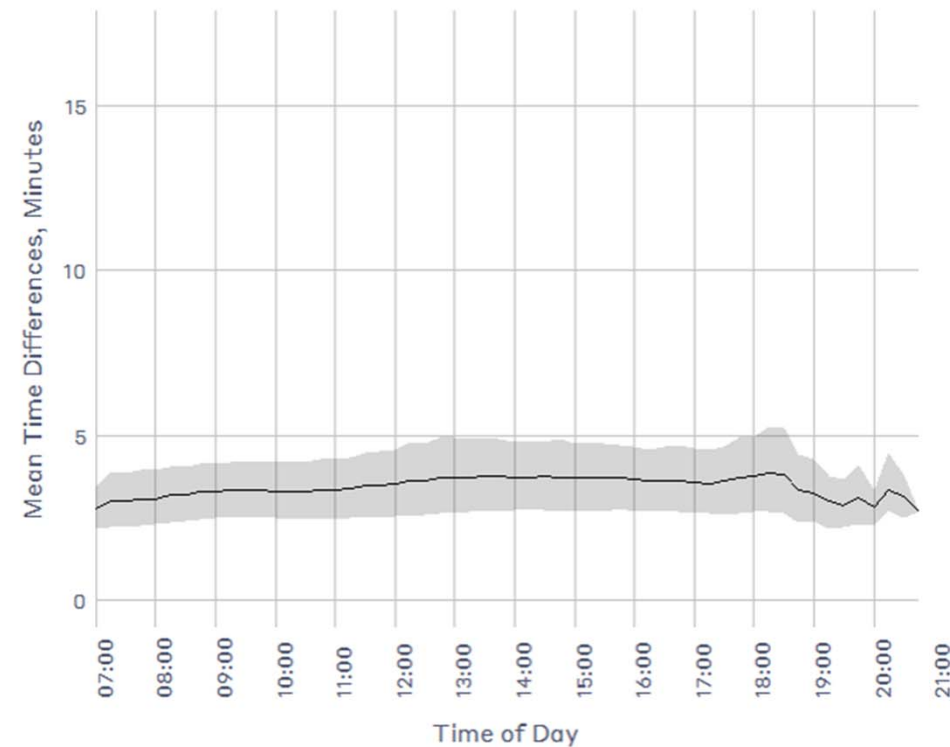
Difference in vote events, no restriction



MACHINE RESTRICTION (USES PER 15)

- + Look at machines used 4
- + times in the 15 minute period

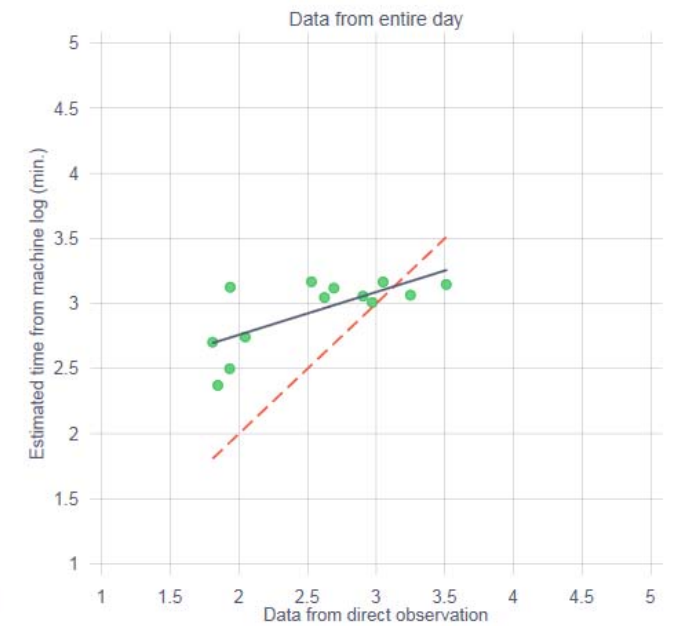
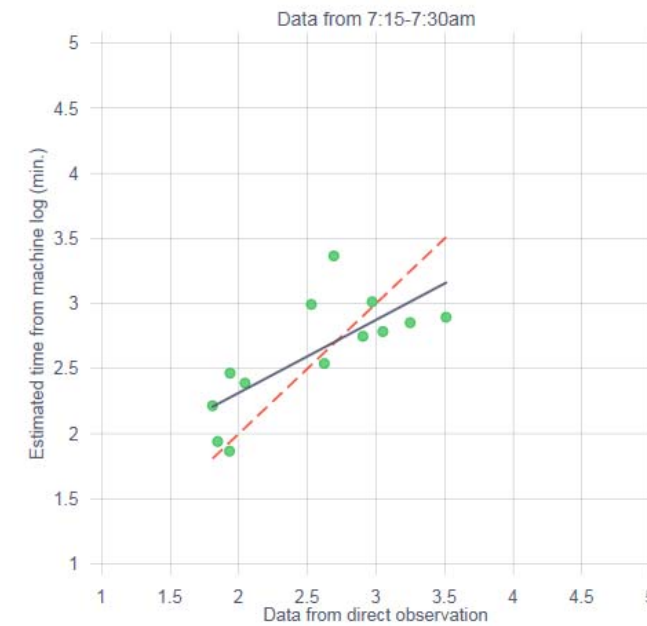
Difference in vote events, 7:15-7:30, 4 machines



CORRELATION WITH OBSERVED

- + Look at precinct observation
- + project data collected in 2016
- + (13 observations)

Difference of observed v imputed,
Richland County limited observations



PREDICTING MARKING TIMES

Variables	Data source
Length of ballot	CVR
Voter behavior	CVR
Demographics	State demographic data @ precinct level

Time period of timing	7:15-7:30am	All day
Pct. pop. > 65	0.0471 (0.113)	0.100* (0.0468)
Pct. pop. non-white	0.485*** (0.0706)	0.409*** (0.0382)
Thousand voters/machine	-0.891* (0.339)	-1.802*** (0.221)
Undervote pct.	-0.162 (0.210)	-0.0775 (0.124)
Straight-ticket pct.	-0.234 (0.143)	-0.531*** (0.150)
Offices on ballot	0.0279* (0.0129)	0.0218*** (0.00612)
Candidates on ballot	0.0208*** (0.00480)	0.0118*** (0.00171)
Constant	1.933*** (0.165)	2.838*** (0.114)
Observations	1432	1552
R^2	0.251	0.536
rmse	0.357	0.167

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

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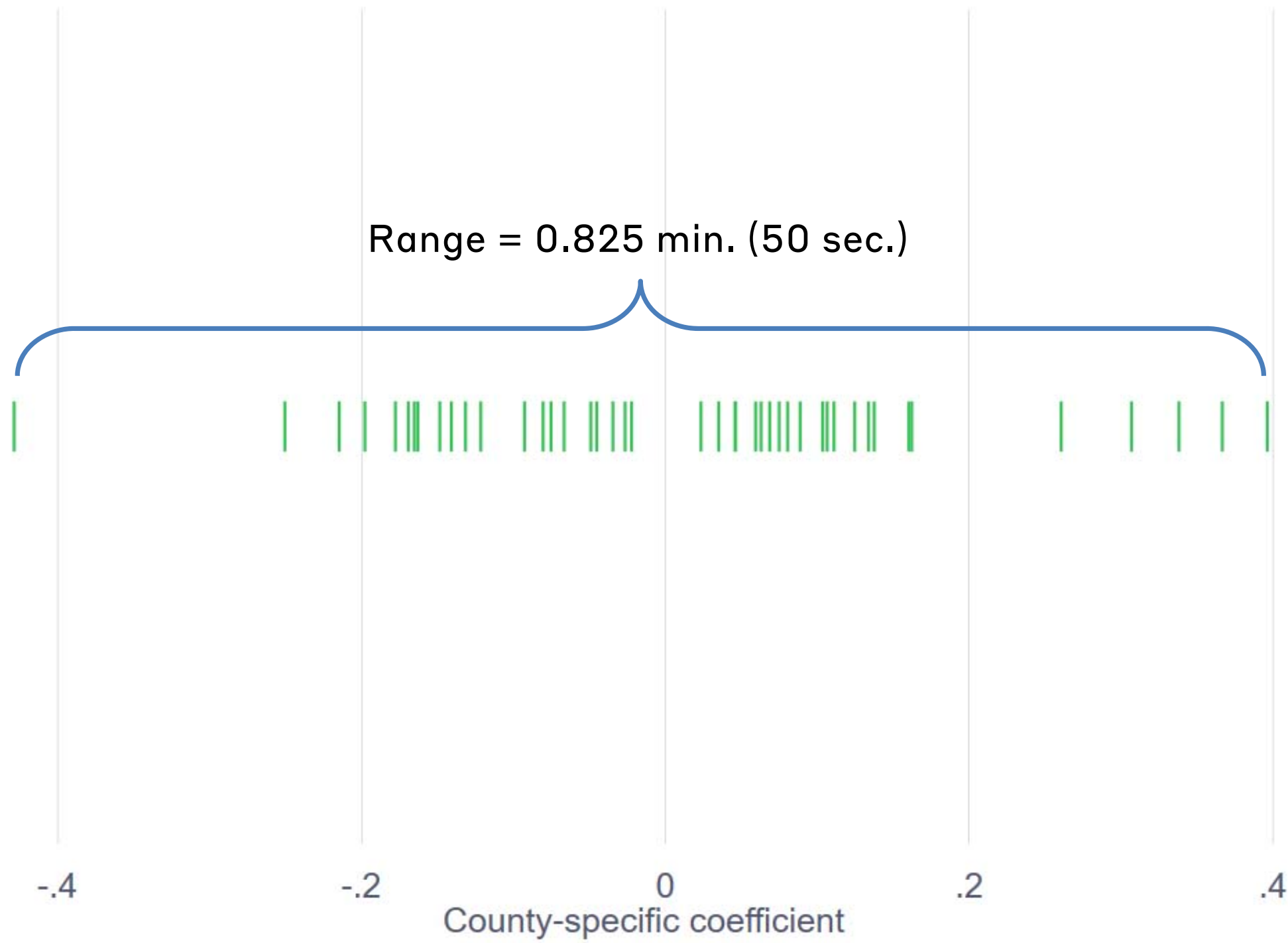
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DISCUSSION AND QUESTIONS

TIME OF DAY PARAMETERS

Comparison of multivariate regression results for different datasets

Time period	7-7:15am	7-7:15am	7-7:15am	7:15-7:30am	7:15-7:30am	7-7:30am	7-7:30am	7-7:30am	All day	All day
Trimming cut-off (min.)	5	10	30	10	30	5	10	30	10	30
Pct. pop. > 65	0.161 (0.143)	0.220 (0.133)	0.248 (0.127)	0.125 (0.135)	0.299 (0.221)	0.0709 (0.110)	0.114 (0.124)	0.236 (0.154)	0.143* (0.0546)	0.233** (0.0836)
Pct. pop. non-white	0.293*** (0.0766)	0.330*** (0.0919)	0.339** (0.0984)	0.630*** (0.0815)	0.773*** (0.0944)	0.435*** (0.0629)	0.555*** (0.0709)	0.651*** (0.0777)	0.527*** (0.0357)	0.691*** (0.0491)
Thou. voters/machine	-0.962** (0.348)	-1.415*** (0.362)	-1.526*** (0.395)	-1.008* (0.439)	-1.458** (0.511)	-0.845* (0.344)	-1.053* (0.425)	-1.472** (0.498)	-2.345*** (0.253)	-3.494*** (0.291)
Undervote pct.	0.120 (0.209)	0.107 (0.219)	0.0824 (0.235)	-0.239 (0.234)	-0.230 (0.260)	-0.0430 (0.193)	-0.0981 (0.201)	-0.0885 (0.229)	-0.0678 (0.116)	-0.0982 (0.119)
Straight-ticket pct.	-0.348** (0.118)	-0.314* (0.129)	-0.384** (0.138)	-0.224 (0.172)	-0.467* (0.226)	-0.245* (0.119)	-0.195 (0.143)	-0.386* (0.178)	-0.622*** (0.168)	-0.788*** (0.184)
Offices on ballot	0.0174 (0.0106)	0.0236* (0.00983)	0.0249* (0.00942)	0.0283 (0.0173)	0.0229 (0.0204)	0.0243* (0.0107)	0.0251 (0.0134)	0.0217 (0.0152)	0.0241** (0.00702)	0.0347*** (0.00722)
Candidates on ballot	0.0215* (0.00829)	0.0220** (0.00768)	0.0207* (0.00897)	0.0228*** (0.00628)	0.0212** (0.00674)	0.0196*** (0.00493)	0.0213*** (0.00586)	0.0191** (0.00665)	0.0106*** (0.00177)	0.00243 (0.00300)
Constant	1.969*** (0.227)	1.974*** (0.247)	2.054*** (0.262)	1.926*** (0.203)	2.179*** (0.248)	1.976*** (0.153)	1.981*** (0.180)	2.223*** (0.215)	3.098*** (0.121)	3.546*** (0.151)
Observations	1144	1144	1144	1432	1432	1474	1474	1474	1552	1552
R ²	0.221	0.213	0.200	0.249	0.231	0.282	0.284	0.252	0.568	0.599
rmse	0.340	0.381	0.408	0.413	0.476	0.317	0.362	0.414	0.192	0.234

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

MACHINE REQUIREMENTS PARAMETERS

Time period	7:15-7:30am	7:15-7:30am	All day	All day
Machine cut-off	3	5	3	5
Pct. pop. > 65	0.045 (0.165)	0.002 (0.104)	0.245** (0.107)	0.071* (0.037)
Pct. pop. non-white	0.866*** (0.096)	0.416*** (0.090)	0.832*** (0.039)	0.316*** (0.034)
Thou. voters/machine	-1.569*** (0.507)	-0.617** (0.267)	-4.069*** (0.314)	-1.074*** (0.185)
Undervote	-0.385 (0.237)	-0.260 (0.222)	0.063 (0.150)	-0.037 (0.077)
Straight-ticket pct.	-0.469** (0.226)	-0.179 (0.171)	-1.233*** (0.213)	-0.339*** (0.118)
Offices on ballot	0.030** (0.014)	0.024*** (0.009)	0.022*** (0.008)	0.013*** (0.004)
Candidates on ballot	0.028*** (0.006)	0.019*** (0.007)	0.011*** (0.003)	0.012*** (0.002)
Constant	2.182*** (0.191)	2.037*** (0.174)	3.964*** (0.135)	2.642*** (0.074)
Observations	1,483	1,306	1,557	1,510
R ²	0.279	0.225	0.661	0.435
Adjusted R ²	0.254	0.194	0.650	0.415
Residual Std. Error	16.381 (df = 1432)	9.940 (df = 1255)	7.361 (df = 1506)	5.015 (df = 1459)

Note:

*p<0.1; **p<0.05; ***p<0.01