Voting Technologies, Recount Methods and Votes in Wisconsin and Michigan in 2016*

Walter R. Mebane, Jr.[1] and Matthew Bernhard[2]

[1] Professor, Department of Political Science and Department of Statistics, University of Michigan, Haven Hall, Ann Arbor, MI 48109-1045 (E-mail: wmebane@umich.edu)
[2] Department of Computer Science and Engineering, University of Michigan, Bob and Betty Beyster Building, 2260 Hayward Street, Ann Arbor, MI 48109-2121 (E-mail: matber@umich.edu)

Abstract. We present data from the 2016 presidential election recounts done in Wisconsin and Michigan and information about the voting technologies that were used there to explain why it is challenging to show that the voting technologies treated candidates Trump and Clinton symmetrically. Lack of clarity about which type of technology was used to record vote counts, a mix of mostly small but sparse large counted differences between original and recounted vote totals, features that relate to voters, technologies and recount methods, and selectivity concerns are among the obstacles.

1 Introduction

Were the outcomes in Wisconsin and Michigan in the 2016 presidential election correct? Candidate Trump won both states—by margins over Clinton of 22,748[3] and 10,702[4], respectively—but the results are controversial. One concern is whether the vote tabulation technologies were hacked, as much of the equipment used to tabulate votes in 2016 has been shown to be particularly vulnerable.[5] Russian hacking had already taken place during the campaign, as acknowledged by [24], and it seems reasonable that in their efforts to influence the election vote manipulation may have been attempted. Recounts were prompted in both states by the Stein campaign [13, 14, 10].

We describe data from the recounts about the distribution of voting technologies and the ways votes changed during the recount. These data might be used as evidence about whether the voting technology treated candidates Trump and Clinton symmetrically in places in these states that had votes recounted. Presumably, a hack intended to benefit or harm one candidate more than the other would cause asymmetric treatment.

* Prepared for presentation at the 3rd Workshop on Advances in Secure Electronic Voting at Financial Cryptography and Data Security 2018. Thanks to Preston Due, Joseph Hansel and Barry Snyder for assistance. Thanks to Philip Stark for suggestions and to Alex Halderman and Dan Wallach for discussions.

[3] Wisconsin margin computed using recounted vote values in [29].
[4] Michigan margin computed using official values in [16].
[5] See California's Top-to-Bottom review [5] and Ohio's Project EVEREST [20].

2 Recount Data

It is useful to look at raw numbers from the recounts both to show one of the difficulties in the way of estimating the number of affected votes. The following issues with the numerical distributions are by no means the most serious challenge to performing an analysis in terms of exact vote counts, but it's not clear how to resolve them.

The problem with the exact vote counts is that they are mostly small but there are a few relatively large values. We focus on the differences between the recounted vote counts for each candidate and the original vote counts: the original vote count in each ward (Wisconsin) or precinct (Michigan) is subtracted from the recounted vote count. Tables 1 and 2 enumerate the distribution of differences by major party candidate in Wisconsin, separately for each recount method, and Tables 3 and 4 enumerate the distribution of differences by candidate in Michigan, separately for each vote-casting method.[6] In all four cases the most frequent difference is zero, meaning the count of votes for the candidate did not change in the recount from the original count. The next most frequent differences are small decreases or increases.

	-25	-18	-16	-11	-10	-9	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10
Hand	1	1	0	0	1	1	2	2	5	9	15	43	167	1457	199	57	39	11	7	4	3	2	1	1
Machine	0	0	1	1	0	0	2	1	2	4	9	18	58	810	100	27	7	7	3	2	2	0	1	2
Mixed	0	0	0	0	0	0	0	0	0	2	3	3	21	199	31	8	3	1	2	0	0	1	0	0

	11	14	23	29	31	32	39	50	65	246
Hand	1	2	1	2	0	1	1	1	1	0
Machine	0	1	0	0	1	0	0	0	0	1
Mixed	0	0	0	0	0	0	0	0	0	0

Table 1. Trump: recounted votes minus original votes, Wisconsin

	-30	-18	-17	-14	-12	-10	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9
Hand	1	0	1	0	1	0	0	1	0	5	6	17	52	161	1457	187	79	22	10	9	5	8	4	0
Machine	0	1	0	1	0	1	2	2	1	4	6	8	15	82	734	126	31	18	6	4	6	5	2	1
Mixed	0	0	0	0	0	0	0	0	1	0	1	4	6	25	199	23	6	1	3	3	1	0	0	1

	10	11	13	14	15	17	19	22	24	33	68	79
Hand	2	1	1	1	1	1	1	1	1	0	1	1
Machine	0	0	0	1	0	1	1	0	0	1	0	0
Mixed	0	0	0	0	0	0	0	0	0	0	0	0

Table 2. Clinton: recounted votes minus original votes, Wisconsin

	-209	-25	-19	-10	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	10	11	15	16	24	26
PCT	0	1	2	1	1	1	2	1	4	12	25	119	1306	370	111	34	11	4	2	2	0	1	1	1	1	1	1
AV	1	0	0	1	0	0	0	0	0	2	10	45	810	123	29	8	2	0	2	0	1	2	0	0	0	0	0

Table 3. Trump: recounted votes minus original votes, Michigan

	-287	-41	-29	-24	-20	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	10	16	20	23	25	26
PCT	0	1	1	1	1	0	1	1	4	2	8	35	139	1182	418	121	58	23	6	5	1	2	1	1	1	1	1
AV	1	0	0	0	0	1	0	1	1	4	6	13	78	757	119	41	9	0	3	0	2	0	0	0	0	0	0

Table 4. Clinton: recounted votes minus original votes, Michigan

The problem is the sporadic double-digit and even a few triple-digit differences: in Wisconsin Trump gains 246 votes in one machine-recounted ward; in Michigan Trump loses 209 votes and Clinton loses 287 votes in absentee (AV) precincts. The large differences are probably produced by different processes than the smaller differences, but it is not obvious how to distinguish the processes.

[6] All recounting in Michigan was manual.

Simply declaring the larger values "outliers" [25, 21] seems incurious about what produced them; specifying a mixture model is challenging given the complexities of technologies and procedures in the states, which we do not elaborate here.[7]

At least in Wisconsin we observe that larger differences tend to be associated with particular reasons cited to explain recount changes in official "minutes" documents [31, 36]. As Table 5 shows, in Wisconsin the largest average differences (in magnitude) occur when the reasons cited are "nonstandard pens or ballots" (mentioned four times) or "voting machine/tabulator error" (mentioned 13 times).[8] Both of these reasons concern features of the voting technologies and so may be worrisome. Many nonzero changes occur ($N = 759$) that lack explanation.

Reason	N^a	Trump	Clinton
Ballots rejected during recount	316	−.199	.0158
Ballots found during recount	72	1.38	3.38
Nonstandard pens or ballots	4	13.8	16.9
Ballots marked incorrectly	296	.993	1.17
Lost ballots	23	−1.43	−1.17
Human counting error	37	.0213	−1.23
Paper jam	21	−.870	−.696
Ballots wrongfully rejected	73	1.09	1.82
Voting machine error	13	7.56	7.83
No explanation	759	.680	.389

Note: mean of nonzero differences between the recounted and original vote count in Wisconsin wards. [a] Number of occurrences of each reason. Multiple reasons are cited for some wards.

Table 5. Recounted Votes Minus Original Votes, Mean by Reason, Wisconsin

3 Technologies and Covariates

Another challenge in the way of determining whether technologies treated the candidates symmetrically is that neither voters nor technologies are randomly

[7] But see the discussion of DRE usage on page 5.

[8] In Table 1 the biggest increase (from CITY OF MILWAUKEE Ward 34) is not explained but the recounted vote count in [29] matches the count reported in minutes [22, 17–18], the second biggest (from CITY OF MARINETTE Wards 1,3,5) is explained by "nonstandard pens or ballots" and "voting machine/tabulator error," and the third biggest (from CITY OF MARINETTE Wards 2,4,6) is explained by "nonstandard pens or ballots," "ballots found during recount" and "ballots rejected during recount." In Table 2 the biggest increase (from CITY OF MARINETTE Wards 1,3,5) is explained by "nonstandard pens or ballots" and "voting machine/tabulator error," and the second biggest (from CITY OF MARINETTE Wards 2,4,6) is explained by "nonstandard pens or ballots," "ballots found during recount" and "ballots rejected during recount." The Marinette wards used Eagle opscan machines (vendor Command Central), and minutes mention problems with "improper pens," "Problems with the voting machine rejecting ballots on election night" and "Machine parts were obtained [...] and installed per instructions from Command Central, voting equipment vendor" [19, 43–44].

assigned to votes, so that many unknown attributes may relate to both and different kinds of voters used each type of technology. Some voters and some technologies make or induce more mistakes than others, even if there is no malfeasance [15]. Whether voters or technologies act independently of one another is also unknown, although given conditioning on appropriate manifest covariates independence may be plausible as a null hypothesis. Observationally we also face a problem in that it is not clear what technology was used to produce each vote: in some cases the original voting technology is unknown and sometimes the recounting method is unclear. We detail some of these complications for each state.

3.1 Wisconsin

Figure 1 shows the different voting technologies in Wisconsin municipalities. The number of recounted votes across all presidential candidates is positive for $n = 3,500$ Wisconsin wards.[9] Table 6 shows the frequency distribution of voting technology and recount method types across all Wisconsin wards for which the total number of recounted votes across all presidential candidates is positive ($n = 3,500$). Each municipality has its own technology.[10]

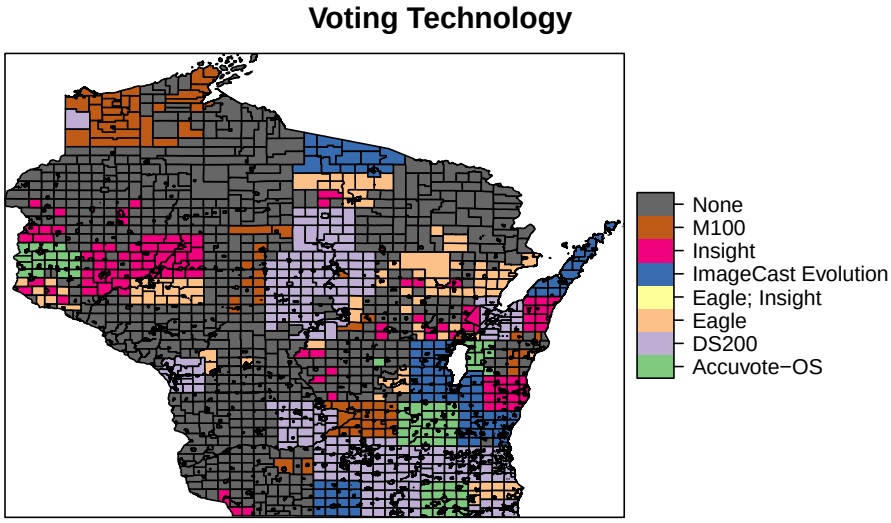

Fig. 1. Wisconsin Technologies by Municipality

In addition to the types of systems listed as Voting Technology all wards also have "accessibility technology" [33], shown in Figure 2 . Table 7 shows the pattern in which Voting Technology overlaps in wards with Accessibility Technology. Voters can choose which mode to use to vote. While all the voting technologies

[9] Recount methods distribution: hand, 2,126; machine, 1.066; mixed, 286; other, 22.

[10] Category "Other" in Figure 2 contains the technologies Populex 2.3, Vote-Pad and "Edge; Automark." "None" indicates that votes are tabulated by hand or technology is not reported.

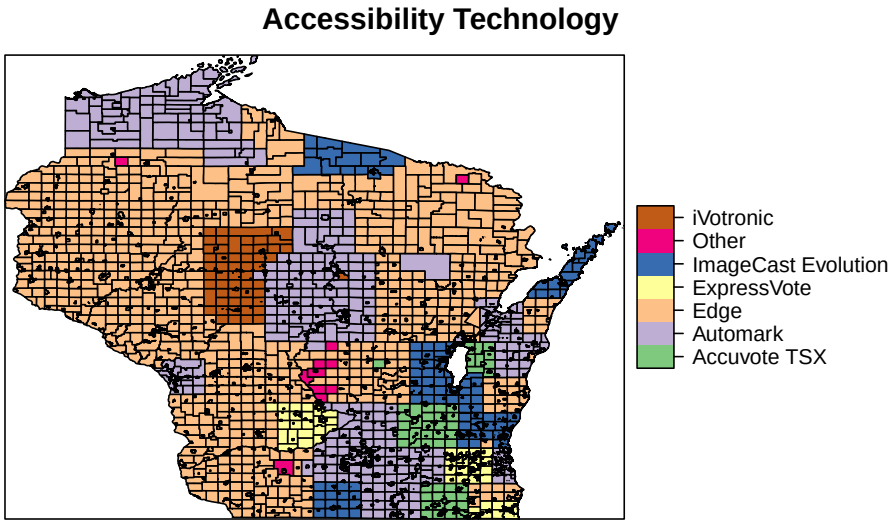

Fig. 2. Wisconsin Accessibility Technologies by Municipality

except "None" are opscan systems, several of the accessibility systems are Direct Record Electronic (DRE) systems (Accuvote TSX, Edge and iVotronic; Automark and ExpressVote are ballot marking devices, ImageCast Evolution and Populex 2.3 are accessible ballot marking and scanning devices).[11] As Table 8 shows many wards have some votes cast using DRE systems.

A challenge to estimating the association between Voting Technology and votes is that we rarely know precisely which mode was used to record each vote.

[11] Problems that required "programmer" or vendor Command Central help to resolve or that may suggest there was some kind of software error are reported for the Edge machine in several county minute files. In at least seven wards a programmer or Command Central had to help to retrieve ballots (TOWN OF ARLAND Ward 1 and TOWN OF CUMBERLAND Ward 1 [1, 11–12]; TOWN OF GILMANTON Ward 1 [8, 14]; TOWN OF RUSK Ward 1 and VILLAGE OF WEBSTER Wards 1-2 [4, 15, 27]; TOWN OF HARRISON Ward 1 [11, 22]; TOWN OF OCONTO FALLS Ward 1-2 [23, 46]). in at least nine wards the machine count was wrong (TOWN OF RED CEDAR Ward 1-3, TOWN OF WILSON Ward 1 and CITY OF MENOMONIE Wards 5,7 [9, 13, 23, 34]; TOWN OF BEETOWN Ward 1, TOWN OF BLOOMINGTON Ward 1, TOWN OF BOSCOBEL Wards 1-2 [11, 10, 12–13]; TOWN OF CHASE Wards 1-5 [23, 22]; TOWN OF HELVETIA Wards 1-2 [26, 8]; TOWN OF WAUTOMA Ward 1-3 [27, 20]). In at least four wards ballots did not print out or needed to be reprinted (TOWN OF STANFOLD Ward 1 [1, 22]; TOWN OF COLBURN Ward 1 and TOWN OF GOETZ Wards 1-2 [7, 13, 20]; CITY OF BERLIN Ward 1-6 [12, 2]). Overall the minutes report 41 wards with explicitly described problems with their Edge machines, and 1270 wards with Edge machines but nothing reported regarding them. Problem reports are not always associated with nonzero changes in vote counts.

Voting Technology		Recount Method	
None	850	Hand	2126
Accuvote-OS	154	Machine	1066
DS200	1475	Mixed	286
Eagle	294	other	22
Eagle; Insight	4		
ImageCast Evolution	287		
Insight	229		
M100	205		

Note: number of wards using each type of Voting Technology or recount method. Voting technology taken from [35]. Recount methods gleaned from [30] and from county minutes at [32].

Table 6. Wisconsin Ward Voting Technologies and Recount Methods

	Accessibility Technology								
Voting Technology	Accuvote TSX	Auto-mark	Edge	Edge; Automark	Express-Vote	ImageCast Evolution	Populex 2.3	Vote Pad	iVotronic
None	1	64	727	0	0	0	2	9	47
Accuvote-OS	120	0	34	0	0	0	0	0	0
DS200	0	1141	0	0	333	0	0	0	1
Eagle	0	8	286	0	0	0	0	0	0
Eagle; Insight	0	0	4	0	0	0	0	0	0
ImageCast Evolution	0	0	0	0	0	287	0	0	0
Insight	0	0	229	0	0	0	0	0	0
M100	0	183	1	1	0	0	0	0	20

Note: number of wards using each type of Voting Technology and Accessibility Technology by Vendor. Technologies taken from [35].

Table 7. Wisconsin Ward Voting and Accessibility Technologies

Votes cast using DRE systems were not changed in the recount, but only rarely are all ballots reported as having been cast using DREs.[12] This is especially important to note because if DRE machines were corrupted, the paper audit trail generated by the machines would likely reflect the manipulated votes. If voters fail to verify that their vote has been correctly recorded by the machine (which may occur, see [6]), then neither the paper trail nor analysis of recount data would detect manipulation. If a sufficient fraction of voters successfully verify their vote as recorded on the paper, this is in principle enough to detect manipulation—but we have no data regarding such verifications, and prior work suggests that voters don't verify their votes [6]. However, no incidences of incorrect votes recorded on the paper audit trail were reported in Wisconsin; while this does not rule out DRE tampering, it does narrow the likelihood that it occurred. Some ballots in each case may be produced using accessibility technology.

Several variables relate to Voting Technology and Recount Method: Clinton (HRC) vote proportion, a ratio of two different estimates of the number

[12] In [28] only 21 wards report a positive number of DRE votes and zero votes cast using other modes, which are `Paper Ballots`, `Optical Scan Ballots`, and `Auto-Mark`.

	Some DRE Votes?		Vendor				
				Command			
Voting Technology	No	Yes	None	Central	Dominion	ES&S	Optech
None	83	765	850	0	0	0	0
Accuvote-OS	119	35	0	33	121	0	0
DS200	1458	16	0	0	0	1475	0
Eagle	87	205	0	281	0	0	13
Eagle; Insight	4	0	0	4	0	0	0
ImageCast Evolution	282	5	0	0	287	0	0
Insight	21	208	0	218	11	0	0
M100	186	19	0	0	0	205	0

	Vendor				
		Command			
Accessibility Technology	None	Central	Dominion	ES&S	Optech
Accuvote TSX	1	0	120	0	0
Automark	64	2	0	1324	6
Edge	727	534	12	1	7
Edge; Automark	0	0	0	1	0
ExpressVote	0	0	0	333	0
ImageCast Evolution	0	0	287	0	0
Populex 2.3	2	0	0	0	0
Vote Pad	9	0	0	0	0
iVotronic	47	0	0	21	0

Note: number of wards using each type of Voting Technology or Accessibility Technology by Vendor. Technologies and Vendors taken from [35].

Table 8. Wisconsin Ward Voting Technologies by Vendor

of registered voters,[13] the proportion of DRE votes, the absentee proportion,[14] turnout[15] and county total votes. Different types of voters use different types of technologies and cast ballots that were subject to varying kinds of vetting.

A specific suspicion in the election is that some vendors may have corrupted votes using the software they installed in voting technology. Figures 3 and 4 shows how the vendors are distributed across municipalities. As the top part of Table 8 shows, several opscan system vendors provided several different types of voting technology. As the bottom part of the table shows, various kinds of accessibility technology are collocated in wards with the vendors' opscan systems.

[13] The ratio is the number of registered voters from [34], over the number of registered voters from [28].

[14] The "proportion" is the ratio of `Absentee Issued` to `Total Voters`, both from [28]. In one ward the ratio is greater than 1: in "VILLAGE OF FOOTVILLE Ward 1" the ratio is 556/410.

[15] Turnout is computed using the ratio of the recounted `Total Votes` from [29] over the number of registered voters from [34].

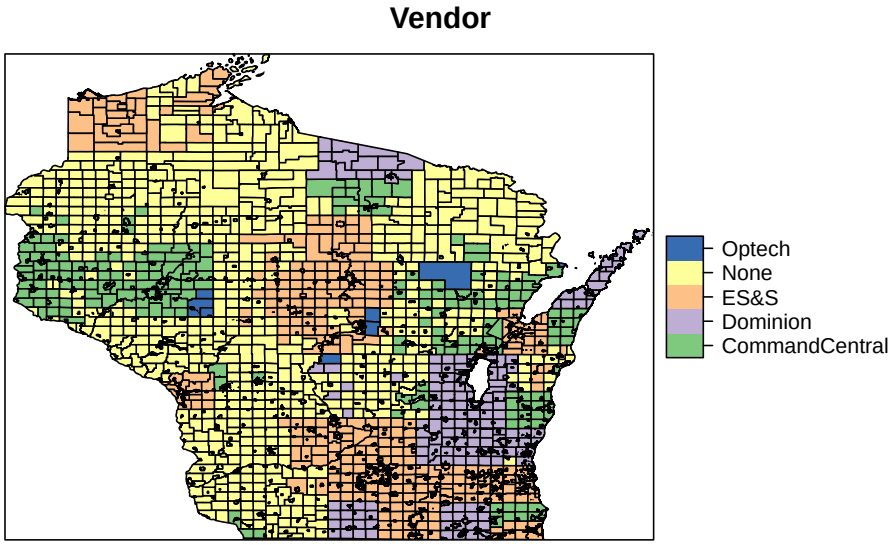

Fig. 3. Wisconsin Vendors by Municipality

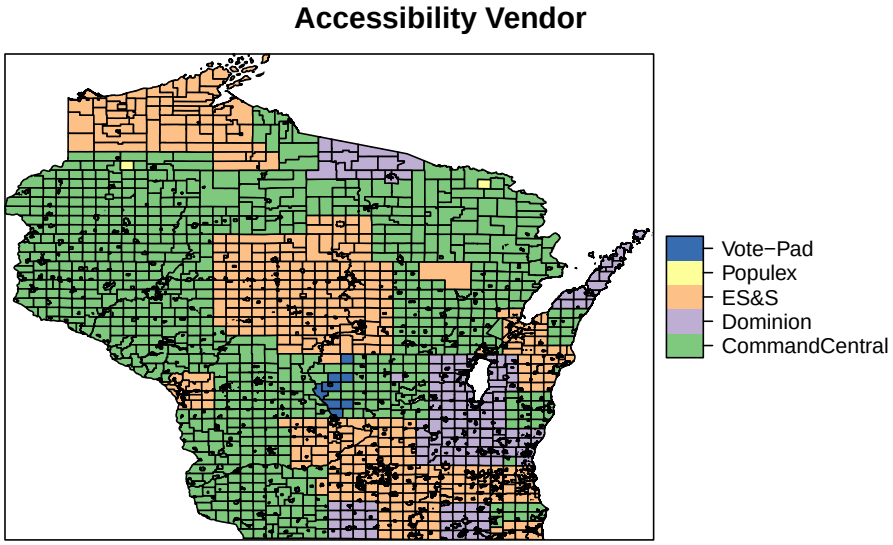

Fig. 4. Wisconsin Accessibility Vendors by Municipality

3.2 Michigan

The number of recounted votes across all presidential candidates is positive in $n = 3,051$ Michigan precincts. Each city or township has its own technology. Figure 5 shows how the technologies are distributed across townships. Table 9

shows the frequency distribution of types of voting technology both across all Michigan precincts and across the precincts that were recounted.

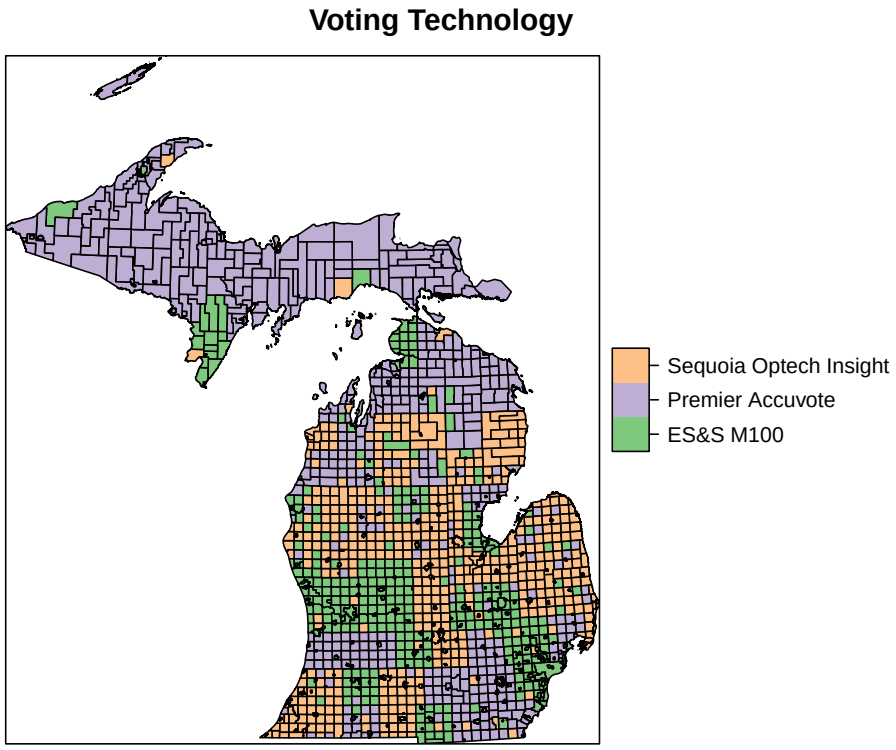

Fig. 5. Michigan Technologies by City and Township

Several variables relate to Voting Technology: Clinton (HRC) vote proportion,[16] turnout,[17] active voter proportion[18] and county vote population. Different types of voters use different types of technologies.

4 Conclusion

Analysis of these data can address only Wisconsin wards and Michigan precincts for which recounts occurred and for which we have data from official sources. While the recount in Wisconsin covered the whole state, the recount in Michigan did not. We would have nothing to say about Michigan precincts that were not recounted, apart from noting that severe problems have been documented in Detroit [17].

[16] HRC vote proportion is computed using recounted vote counts in [2].

[17] Turnout is the ratio of the precinct total of votes cast for president in the recount data [2] over the total number of registered voters in the town the precinct is in [3]

[18] The active voter proportion is the ratio of `ActiveVoters` over `RegisteredVoters`, both town-level variables from [3]

	Precincts			
	All		Recounted	
Technology	PCT	AV	PCT	AV
ES&S M100	2490	2021	1362	768
Premier Accuvote	579	492	348	132
Sequoia Optech Insight	323	151	298	126

Note: number of precincts using each type of Voting Technology or recount method. "PCT" denotes in-person precincts and "AV" denotes absentee precincts. Voting technology taken from [3]. Precinct type and recounted status from [2].

Table 9. Michigan Precinct Voting Technologies

Likewise analysis might depend on assuming that hand recounted ballots that were originally cast manually on paper provide "true" tabulations, but in Wisconsin about half of the votes were recounted by machine. If the same machines—or different machines—were used to recount as to originally tabulate votes, and these machines were corrupted, then the recount data provides no veneration of those results.

For both states we think the prospects are not good for using the kinds of data we have assembled to produce exact statistical estimates—using the exact vote counts—of the effects voting technologies (and recount methodologies) may have had. In Wisconsin the profound problem is that we cannot be sure which technology was used to produce the record of each vote, and cases of machine recounting do not meet sufficiently rigorous standards to establish the correct outcome. In Michigan the decision to recount in each county were based on vastly more information than we have as analysts, and there is no reason to believe these decisions are unrelated to features associated with both voting technologies and potential distortions in votes. In fact, such a self-selection concern affects all the data we have, given that someone chose which voting technologies to implement in each jurisdiction and then someone chose which modality to use to cast, count and record each vote: self-selections qualify as well any analysis we might do.

The best way to get evidence about whether the vote counts are correct is to perform either a risk-limiting audit [18] or a full manual retabulation. Such evidence about the accuracy of the vote counts would still leave the problem of determining whether voting technologies—or something else—distorted votes. Forensic analysis might also provide significant insight into the correctness of the election, but given advanced intrusion such analysis may not provide useful evidence.

References

1. Barron County Board of Canvass. Minutes. URL `http://elections.wi.gov/sites/default/files/recount_2016/barron_county_unapproved_recount_minutes_pdf_15035.pdf`, 2016.
2. Bureau of Elections. file `byprecinct.xlsx`, obtained via Freedom of Information Act request from Melissa Malerman (MDOS), MI Bureau of Elections, March 31, 2017.
3. Bureau of Elections. 2016 bienniel precinct report. file `BiennialPrecinct2016_531265_7.pdf`, URL `http://www.michigan.gov/documents/sos/BiennialPrecinct2016_531265_7.pdf`, Michigan Deparment of State, March 31, 2017.
4. Burnett County Board of Canvassers. Recount minutes. URL `http://elections.wi.gov/sites/default/files/recount_2016/burnett_county_recount_minutes_pdf_11690.pdf`, 2016.

5. California Secretary of State's Office. Top-to-bottom review of electronic voting systems, 2007. http://wwws.os.ca.gov/elections/voting-systems/oversight/top-bottom-review/.
6. B. A. Campbell and M. D. Byrne. Now Do Voters Notice Review Screen Anomalies? A Look at Voting System Usability. In *EVT/WOTE*, 2009.
7. Chippewa County Board of Canvass. Board of canvass minutes. URL http://elections.wi.gov/sites/default/files/recount_2016/chippewa_county_recount_minutes_pdf_11482.pdf, 2016.
8. County of Buffalo. Date of recount: 12/1/2016. URL http://elections.wi.gov/sites/default/files/recount_2016/buffalo_county_recount_minutes_pdf_15905.pdf, 2016.
9. Dunn County. Recount minutes. URL http://elections.wi.gov/sites/default/files/recount_2016/dunn_county_recount_minutes_pdf_10781.pdf, 2016.
10. S. Friess. *Inside the Recount*. The New Republic, Feb. 2017. URL https://newrepublic.com/article/140254/inside-story-trump-clinton-stein-presidential-election-recount.
11. Grant County. Recount minutes. URL http://elections.wi.gov/sites/default/files/recount_2016/grant_county_recount_minutes_pdf_17421.pdf, 2016.
12. Green Lake County Board of Canvassers. Recount minutes. URL http://elections.wi.gov/sites/default/files/recount_2016/green_lake_county_recount_minutes_pdf_60039.pdf, 2016.
13. P. Gupta. *Jill Stein on What's Next With the Recount Effort in Wisconsin, Michigan, and Pennsylvania*. Cosmopolitan Magazine, Dec. 2016. URL http://www.cosmopolitan.com/politics/a8467128/jill-stein-voter-recount-wisconsin-michigan-pennsylvania/.
14. J. A. Halderman and M. Bernhard. *Recount 2016: An Uninvited Security Audit of the U.S. Presidential Election*. Chaos Communications Congress, Dec. 2016. URL https://www.youtube.com/watch?v=E7Wo55F08-Y.
15. P. S. Herrnson, R. G. Niemi, M. J. Hanmer, B. B. Bederson, F. G. Conrad, and M. W. Traugott. *Voting Technology: The Not-So-Simple Act of Casting a Ballot*. Brookings, Washington, D.C., 2008.
16. R. Johnson. Election precinct results search. file 2016GEN.zip, URL http://miboecfr.nictusa.com/cgi-bin/cfr/precinct_srch.cgi?elect_year_type=2016GEN&county_code=00&Submit=Search, Secretary of State, downloaded March 28, 2017.
17. R. Johnson. Executive Summary of Audits Conducted in Detroit and Statewide in Relation to the November 8, 2016 General Election. URL http://www.michigan.gov/documents/sos/Combined_Detroit_Audit_Exec_summary_551188_7.pdf, February 9, 2017, Secretary of State.
18. M. Lindeman and P. B. Stark. A gentle introduction to risk-limiting audits. *IEEE Security and Privacy*, 10, 2012.
19. Marinette County. Date of recount: December 1, 2016 – agenda exhibit a. URL http://elections.wi.gov/sites/default/files/recount_2016/marinette_county_unapproved_recount_minutes_pdf_85823.pdf, 2016.
20. P. McDaniel et al. EVEREST: Evaluation and validation of election-related equipment, standards and testing. http://www.patrickmcdaniel.org/pubs/everest.pdf, Dec. 2007.
21. W. R. Mebane, Jr. and J. S. Sekhon. Robust Estimation and Outlier Detection for Overdispersed Multinomial Models of Count Data. *American Journal of Political Science*, 48, Apr. 2004.
22. Milwaukee County. Milwaukee county city of milwaukee canvass statement, recount election. URL http://elections.wi.gov/sites/default/files/recount_2016/city_of_milwaukee_wards_26_50_minutes_pdf_18183.pdf, 2016.
23. Oconto County Board of Canvass. Recount minutes. URL http://elections.wi.gov/sites/default/files/recount_2016/oconto_county_recount_minutes_pdf_86884.pdf, 2016.
24. ODNI. *Assessing Russian Activities and Intentions in Recent US Elections*. Office of the Director of National Intelligence, Jan. 2017. URL https://www.dni.gov/files/documents/ICA_2017_01.pdf.
25. J. Wand, K. Shotts, J. S. Sekhon, W. R. Mebane, Jr., M. Herron, and H. E. Brady. The butterfly did it: The aberrant vote for buchanan in palm beach county, florida. *American Political Science Review*, 95, Dec. 2001.
26. Waupaca County. Waupaca county recount minutes part 2. URL http://elections.wi.gov/sites/default/files/recount_2016/waupaca_county_recount_minutes_part_2_pdf_16707.pdf, 2016.
27. Waushara County Board of Canvassers. Recount of presidential race. URL http://elections.wi.gov/sites/default/files/recount_2016/waushara_county_recount_minutes_pdf_60143.pdf, 2016.
28. Wisconsin Elections Commission. 2016 general election el-190f: Election voting and registration statistics report. file 2016_presidential_and_general_election_el_190_2017_18402.xlsx, URL http://elections.wi.gov/node/4952, downloaded May 10, 2017.
29. Wisconsin Elections Commission. 2016 presidential recount. file Ward by Ward Original and Recount President of the United States.xlsx, URL http://elections.wi.gov/elections-voting/recount/2016-presidential, downloaded February 4, 2017.
30. Wisconsin Elections Commission. 2016 presidential recount county cost estimates and counting methods. URL http://elections.wi.gov/sites/default/files/story/presidential_recount_county_cost_estimate_and_reco_16238.pdf, as of May 19, 2017.
31. Wisconsin Elections Commission. 2016 presidential recount results, county by county. URL http://elections.wi.gov/elections-voting/recount/2016-presidential/county-by-county, as of May 19, 2017.

32. Wisconsin Elections Commission. 2016 presidential recount results, county by county. files downloaded from URL http://elections.wi.gov/elections-voting/recount/2016-presidential/county-by-county, on February 3, 2017.
33. Wisconsin Elections Commission. Accessible voting equipment. URL http://elections.wi.gov/voters/accessibility/accessible-voting-equipment, as of May 24, 2017.
34. Wisconsin Elections Commission. February 1, 2017 voter registration statistics. file registeredvotersbywards_xlsx_48154.csv, URL http://elections.wi.gov/publications/statistics/registered-voters-2017-february-1, downloaded February 4, 2017.
35. Wisconsin Elections Commission. Voting equipment use by Wisconsin municipalities. file voting_equipment_by_municipality_09_2016_xlsx_78114.xlsx, URL http://elections.wi.gov/elections-voting/voting-equipment/voting-equipment-use, downloaded November 25, 2016.
36. Wisconsin Elections Commission. Wisconsin recount results update – day 11. file explanation_of_changes_per_reporting_unit_12_11_16_10043.pdf, URL http://elections.wi.gov/publications/statistics/recount/2016/12-11-spreadsheet, downloaded on May 10, 2017.