"fillable" PDF file, and to concerns about how the information in the survey might be used.[18] The survey was available on October 20, 2005; most responses were received in late 2005, though the final response was received on May 18, 2006. Respondents did come from a variety of backgrounds: academia, election administration, policymaking, and advocacy.[19]

Despite the low response rate to this elite survey, and the non-random method of respondent selection, we do feel that we there is interesting data that can help shed some light on elite perceptions of threats to the electoral process. The first set of threats we asked these subjects about were a wide variety of types of election fraud; we present the average ranking of the types of election fraud, for each dimensions we queried (the potential disruption it would cause, the likelihood in 2005, the likelihood in 2006, and the potential for mitigation) in Table 1.

[Table 1 about here]

When we examine the data in Table 1, it is clear that elite respondents see what might be called "denial of service" attacks on the electoral process (disruptions of early, absentee, or precinct voting) as ones likely to cause the greatest disruption --- and to be among some of the most difficult to mitigate. At the other end of the spectrum, our elite respondents saw illegal voting, the various types of double voting, and registration fraud as among the least disruptive types of election fraud. However, respondents perceived voting in multiple jurisdictions and registration fraud as difficult to mitigate. As to the relative likelihood of occurrence, in Table 1 it is clear that elite respondents see coercion as the most likely of the many types of election fraud to occur (both averaging 4.0 on the 1 to 10 scale we used), and disruptions of the process and voting in multiple precincts as the least likely to occur.

[18] We return to this point in the conclusion. We heard, third-hand, that there were concerns expressed in the community of election officials about how the data from this survey effort might be used.

[19] Unfortunately, due to the extremely limited response rate, confidentiality concerns prevent us from providing any detailed analysis of the profile of the respondents to this survey.

In the next section of Table 1, we provide information on the second set of potential threats: efforts to tamper with the process of voting itself, either early or precinct voting, or ballot transport and tabulation. Note that our elite respondents uniformly saw these as threats likely to disrupt the process; each of these threats ranked 5.0 or greater on the 1 to 10 point scale. Tampering with early voting had the greatest estimated potential of disruption (an average of 6.9), followed closely by the threat posed by tampering with precinct e-voting machines (an average of 6.8). Despite the potential for disruption, though, note as well that the elite respondents saw these as having a relatively low likelihood of occurrence in the current election cycle; tampering with precinct tabulators received the highest average ranking (2.4), the rest averaged right around 2 on the 1 to 10 point scale. Furthermore, none of these threats were perceived as highly difficult to mitigate, as tampering with early and precinct e-voting, as well as ballot transport and tabulation, received average ratings of around 3 on our ten-point scale.

Finally, in the bottom section of Table 1, we provide the same information for the third set of potential threats: an array of unintentional problems with early and precinct voting, as well as with ballot processing. Here we find that some of these unintentional problems were perceived as somewhat of a threat for disruption, especially unintentional problems with early and precinct e-voting machines and their associated paper trails. Interestingly, some of these unintentional problems were among some of the most likely to occur in the current election cycle, especially problems with early voting and precinct paper trails, and processing of absentee and provisional ballots. Elite respondents also saw the early and precinct voting paper trail problems as relatively more difficult to mitigate, relative to the other unintentional problems we posed to them.

Another question in our elite survey that produced helpful data was the third and final question: "For each part of the electoral process in the county where you vote, please rank he relative chance that the problems (intentional or unintentional) will occur in upcoming elections in November 2006. Please label the risk that is most likely as 1, and the one that is least likely as 6." The set of problems we asked about included illegal or double voting, coercion or deception in voting, voter registration, problems with precinct voting, problems with absentee voting, and problems in post-election ballot processing and tabulation.

What we have done with these data is produce in a simple table (Table 2) the counts of responses in each of the categories.[20] Overwhelmingly, our elite respondents saw that voter registration was the most likely threat to the election process in their county (12 of 22 respondent rated that as most likely). Second in terms of likelihood were problems with absentee voting, as 4 respondents rated it as most likely to be a threat, and 7 respondents rated it as the second-most likely threat. Third most likely in terms of perceived threats are problems with precinct voting, as 3 rated that as the most likely threat and 5 rated it as the second most likely threat.

[Table 2 about here]

In conclusion, we see that a survey-based approach for eliciting data from election elites as to potential threats is a viable methodology. Of course, future efforts to gather similar data can learn important lessons from our pilot study. First, our survey instrument was lengthy and complex, even drawing complaints about length and complexity from experts in the field; thus future survey-based efforts might concentrate on gathering data in less complicated ways. Second, we were unable to obtain a large pool of survey respondents to this survey. This indicates that perhaps other efforts, including working more closely with organizations that have credibility with election administrators (in particular) might be productive, as would other

[20] There are only twenty two responses to this question; one of the survey respondents did not answer this question.

methods for increasing the sample size in future elite threat assessment surveys. Third, working to obtain data that is more representative of the various components of the population of election administrators, academics, policymakers and advocate representatives should be pursued, including both quantitative (survey) and qualitative (focus group) methods.

Risks Assessments in Elections: General Public Attitudes and Concerns

From 2004 to 2006, we have conducted several surveys asking American voters about their confidence in various voting technologies. In January 2006, we also asked 2,025 respondents in a national probability sample a survey question that was designed to mirror, as best as possible, the type of open-ended question that were included in the election threats questionnaire discussed in the previous section.[21] The difference is that the January 2006 survey used a closed-ended question format and came at the end of a series of questions on election reforms and election problems.

The specific question asked of all survey respondents was: "What do you perceive as the greatest threat to the integrity of the electoral system?"

a. Intentional voting fraud, such as by tampering with electronic voting machines or stuffing the ballot box,

b. unintentional human errors by poll workers or election officials,

c. voter registration fraud,

d. illegal voting such as voting twice,

[21] The survey was in the field from January 18-24, 2006. Interviewing was done by professional telephone survey interviewers from International Communications Research (ICR). We used ICR's "national telephone omnibus survey", which is national telephone probability sample, collected twice a week. The question on election threats came at the end of a series of questions on election confidence, election reforms, and voting technologies. The data we present here are weighted using the population weights provided by ICR with the data.

e. intimidation through which voters are coerced to vote for a specific candidate or ballot measure,

f. some other problem, or

g. don't know".

In examining the descriptive statistics given in Table 3, there are two findings that are of immediate interest. First, it is relatively clear from these data that this is an issue that most American adults are relatively uncertain about. In the sample, 33.8 percent of respondents did not have an answer to this question and 0.9% of respondents refused to answer the question. In addition, 36% of respondents gave the answer "some other problem." That so many respondents answer "some other problem" can also be interpreted as another indication of uncertainty on the part of the respondent, some or all of these survey respondents may have seen this as a simple answer to provide interviewers to avoid the perception that the respondent was actually uninformed about this problem. As roughly 7 of 10 respondents might have no opinion about potential threats to the electoral system indicates that this issue may not have yet permeated into the minds of most Americans.

[Table 3 about here]

Second, if we examine the responses to the actual threats provided in the list, we see that the category "intentional voting fraud" has the highest incidence of response (12.3%), followed by "unintentional human errors" (6.9%), and "voter registration fraud" (5%). In addition, illegal voting—such as voting twice—and voter intimidation both were the greatest concern of between 2% and 3% of respondents. These four forms of fraud--intentional voting fraud, voter registration fraud, illegal voting, and intimidation—are forms of intentional fraud and together approximately 22% of the respondents in our sample indicated that some form of intentional election fraud is a significant concern. By examining the data more closely, we can determine the subpopulations of voters who are most concerned about intentional election fraud.

The subpopulations of voters that are greatest interest initially are race, partisanship, and a voter's registration status.[22] The differences between black and white voters are of especially high interest given the amount of discrimination that has occurred toward black voters in the past. In addition, the debates over election reform have traditionally had a very specific dynamic, with conservatives and Republicans being very concerned about voter registration fraud and liberals and Democrats being concerned about intimidation. Since 2003, the historical concern among Republicans about intentional fraud via ballot box stuffing—as was alleged in Cook County in 1960—has been compounded by concern among Democrats about intentional tampering with electronic voting machines to steal elections for the Republicans. Finally, we examine the differences between registered voters and the unregistered; if the unregistered have very high levels of concern about fraud, it could be playing into the cost component of their "calculus of voting" and keeping them from participating in the electoral process.

When we examine differences between White and Black respondents, we find that both groups have similar general concerns about election fraud. Nearly ten percent more Black respondents (almost 4 of ten Blacks in our sample) had no opinion about fraud concerns, relative to Whites (29.9% of White respondents expressed no opinion). But approximately 70 percent of both populations did not select a specific fraud concern; 77 percent of White respondents and 75 percent of Black respondents did not select an intentional fraud concern from the list offered. There are important differences between Blacks and Whites regarding the type of intentional election fraud that concerns them most. Black respondents were slightly more likely to be

[22] Given that relatively few respondents provided a substantive answer to this question, we have little data that we can use for multivariate statistical analysis. Thus here we focus on the simple bivariate correlations, and leave more detailed multivariate statistical studies for future research.

concerned about intentional voting fraud, registration fraud, and voter intimidation. By contrast, Whites are more concerned about illegal voting.

Given the problems that have faced Black voters throughout history, these findings are not surprising. Even in 2000, the concerns about voter registration fraud—as exemplified in claims that Black voters were systematically purged from the rolls—were very high. Such concerns came to the fore again in 2004, with claims that the voter registration forms of Democrats in Nevada were not being submitted to the State correctly. Recent work by Alvarez, Hall, and Llewellyn found that Black voters have less confidence generally that their vote will be counted accurately compared to White respondents, so we are not surprised the minority voters have a specific concern focused on fraud that can be perpetrated against voters—such as intimidation or registration fraud.[23]

When we examine fraud concerns among Democrats, Independents, and Republicans, we find that some of the anecdotal findings about fraud hold true but some do not. Specifically, Republicans are much more concerned about voter registration fraud than are Democrats. However, Democrats and Republicans are equally concerned about voter intimidation, just as they are equally concerned about illegal voting. One area where there is a large gap among partisans is in the area of concern about intentional voting fraud. Democrats are 4 percentage points more likely to be concerned about intentional election fraud than are Republicans or Independents. Given the close and contentious nature of both the 2000 and 2004 presidential elections and how liberal interest groups have used concerns about the security of electronic voting as an issue, it is not surprising that Democrats have this concern.

When we compare registered voters with those who are not registered, we find that there are interesting differences as well. Not surprisingly, those who are not registered to vote were

[23] Alvarez et al., "Are Americans Confident Their Ballots Are Counted?"

more likely to have no opinion about threats to the electoral system (39%, relative to 32.3% for registered voters). But registered voters were much more likely to be concerned about the threat of unintentional problems, such as human errors, to the electoral process. Registered voters are also more concerned than the unregistered in voter intimidation. Given that registered voters see more of the process than those who are not registered, the registered voters have likely encountered small issues at the polls that give rise to these concerns. The responses of the individuals who voted in 2004 are very similar to the responses of registered voters.

In addition to the groups of greatest interest shown in Table 3, we also examined perceptions of fraud across basic demographic characteristics of the population, we find some interesting variations but also much agreement across groups. For example, men are slightly more concerned about voter registration fraud than are women (6% to 4%) and women are more likely to answer "don't know" (37% to 31%) as opposed to "some other problem" (34% female, 38% male). Concerns about election fraud vary little across various age cohorts, although young people (aged 18-27) are more likely to answer "don't know" and not "some other problem." There is a similar pattern of "don't know" versus "some other problems" in the income data, with lower income individuals more likely to answer "don't know" compared to other things. One interesting variation is among those individuals with some college education, but not a college degree. These individuals are 5 percentage points more likely to be concerned about intentional voter fraud—such as tampering with electronic voting machines or stuffing ballot boxes—than either (a) individuals with a high school education or less or (b) individuals with a college degree or advanced degree.

Electronic Voting and Threats to the System

There has been a large amount of attention paid to concerns that voters may have with electronic voting equipment. In several surveys, we have asked respondents if they agree, disagree, or don't know if electronic voting systems (1) increase the potential for fraud; (2) are more accurate; (3) make it easier for people with disabilities to vote; and (4) are prone to unintentional failures. Given the level of concern about electronic voting, we are interested in seeing whether people who are concerned about electronic voting have broader general concerns about election fraud. The descriptive analysis examining views of fraud and concerns about electronic voting are shown in Tables 4.

First, we present a simple analysis of whether people who are concerned about electronic voting fraud are concerned about fraud generally. Here, we find that individuals who think that electronic voting systems increase the potential for fraud are 10 percentage points more likely to think there is intentional election fraud compared to individuals who do not think electronic voting increases the potential for fraud. The concerned respondents are also twice as concerned as people who no opinion about electronic voting's potential for fraud. When we consider the specific election fraud concerns that individuals who are concerned about electronic voting have, we find that they are more concerned about fraud across the board than are the other respondents. Not surprisingly, more than half of the overall concern relates to concerns about intentional vote fraud. However, these individuals are also much more concerned about voter registration fraud and illegal voting as well. In general, people concerned about electronic voting are concerned about many facets of the voting process.

[Table 4 about here]

By contrast, people who agree that electronic voting systems are more accurate are much less likely to be concerned about fraud than those who disagree with that statement. Respondents who view electronic voting as being accurate are 10 percentage points less likely to be concerned about intentional fraud generally. Those with no opinion about the accuracy of electronic voting systems are also much less likely to be concerned about fraud. When we examine specific fraud concerns, people who think electronic voting is more accurate are less likely to be concerned about voter registration fraud and intentional voter fraud compared to those who do not think electronic voting is more accurate. However, those who think electronic voting is more accurate are also more concerned about unintentional human errors in the voting process and also with the possibility that some people will engage in illegal voting, such as voting twice.

Another interesting aspect of this study is that approximately one-third of respondents did not have an opinion about the positive or negative aspects of electronic voting. When we examine these individuals and their concerns about fraud, we find that they are less likely to be concerned about fraud generally than are those who have an opinion about electronic voting. Most starkly, the individuals who do not have an opinion about electronic voting increasing the potential for fraud are half as likely to be concerned about intentional voting fraud when compared to the individuals who think electronic voting increases the potential for fraud. The results are slightly less stark for those who think electronic voting is prone to unintentional failures compared to those with no opinion—here, the difference is 6.5 percentage points. For the two questions that explore the positive aspects of electronic voting, the difference between those who disagree with these positive attributes and those with no opinion are again quite large, with the gap between the two groups being 8.9 percentage points or more in size.

For the other two questions, we find similar results. Individuals who are concerned about unintentional failures with electronic voting systems are also concerned generally with fraud across the board. On the other hand, individuals who think that electronic voting will make voting easier for people with disabilities are generally less likely to be concerned about fraud. These data examining concerns about fraud by individuals who are generally supportive or concerned about electronic voting suggest that concerns about intentional fraud are linked to concerns about failures in the voting process generally. By contrast, individuals who are generally positive about the voting process are more positive about fraud not occurring.

Conclusions

The results from these survey experiments illustrate two key different and important issues regarding how we can study and prevent election fraud. First, the data from the national random sample survey show that Americans are poorly informed and relatively unconcerned about election fraud. For those voters who are concerned about election fraud, the concern centers on actual intentional voting fraud, where illegal ballots are cast in the election. The data also suggest a "sore loser" effect from the most recent elections, as Democrats are more likely to be concerned about illegal voting compared to Republicans. Fortunately, we do not see fraud as being a greater concern among non-voters or non-registered voters; concerns about fraud do not seem to be keeping people away from the polls.

We also see that some individuals are just more worried about fraud generally than are other individuals. For example, respondents who are concerned about electronic voting fraud specifically are more concerned about all types of fraud, especially intentional fraud, when compared to those individuals who either are not concerned or have no opinion about the potential for electronic voting fraud. Likewise, individuals who are concerned about the accuracy of e-voting systems in counting ballots are also more likely to be concerned about intentional election fraud.

Thus, when we think about how national population survey data like ours that asks about threats to the electoral system or election fraud can be used in threat assessment analysis, we have two different reactions. On one hand, that the population seems generally uninformed about election fraud, and that their perceptions seems systematically affected by their political orientations, suggests caution in the use of this sort of data in threat assessment analysis. But on the other hand, as the general population is one of the ultimate consumers of election administration services, it is important to understand the public's concerns and level of knowledge, and to incorporate their concerns into fraud and threat prevention. To the extent that perceptions of threat and fraud influence public confidence in the integrity of the electoral process, studying the public's perceptions is important.

Second, a different set of implications arise from our study of the elite-level survey results. Substantively, when we examine the opinion of individuals about specific fraud risks and the ability to mitigate these risks, we find that disruptions to elections are the most highly disruptive are also among the easiest to mitigate. This is similar to the problems faced on the Internet; denial of service attacks are problematic but can be mitigated with effective deterrence and prevention.[24] However, there is a more basic reason to survey informed individuals about the likelihood that various threats to elections will occur. Basic theories of economics and psychology tell us that markets—be they stock markets, betting parlors, or in this case, decision or prediction markets—are highly effective at predicting the future. There is a wealth of literature discussing the efficiency of betting markets: such markets take advantage of collective

[24] The authors have both actually been to the location where the major Internet domains are managed. All we can say about the experience (we signed non-disclosure agreements to get in the door) is that it is incredibly impressive to see how the management process works and how attacks to the system are addressed.

knowledge and the aggregation of information to produce effective estimations of outcomes. Other types of markets, like The Iowa Electronic Market or the Hollywood Stock Exchange, have proven highly effective at predicting the outcomes of non-market outcomes (like presidential elections and weekend box office grosses for movies) that other methods sometimes have difficulty forecasting with accuracy.[25]

Suggesting that such markets be used for predicting problems with elections could be controversial; witness the concerns raised about the Policy Analysis Market that the Defense Department attempted to develop in 2002-2003 to help predict changes in the conditions that are conducive to a terrorist incident occurring.[26] However, such approaches can be used to identify potential threats and determine where resources should be focused to develop a more secure election system. A prediction market trying to forecast election problems could be done at the state or local level, aggregating the knowledge of poll workers, poll watchers from political parties and interest groups, habitual voters, and other interested players in the election process. Given the wide variation that exist in state election laws and local implementation of these laws, conducting such work could be highly effective in improving our perceptions of the actual threats that exist in the election process.

But, using prediction markets to aggregate information might prove difficult or problematic in the area of forecasting election problems, as well-informed elites might perceive that they do not have an incentive to reveal what information they have about potential threats to election systems, as they might believe that the revelation of that information might strategically be used against them. As we noted above in our discussion of our elite survey, the low response

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[25] Joyce Berg, Forrest Nelson, and Thomas Rietz, "Accuracy and Forecast Standard Error of Prediction Markets," 2003, http://www.biz.uiowa.edu/iem/archive/forecasting.pdf; Charles R. Plott, "Markets as Information Gathering Tools," *Southern Economic Journal*, 67,1 (2000), p. 1-15; James Surowiecki, *The Wisdom of Crowds*, (New York, Anchor, 2005).
[26] See http://hanson.gmu.edu/policayanalysismarket.html for further information about this project.

rate we received in reaction to our survey, especially from the election official community, might reflect such concern. If so, that indicates that much care is needed when it comes to the development of future elite surveys on threat assessment and election fraud, and careful presentation to potential survey respondents exactly how the data will be used. In any case, clearly more research on how we can obtain information from voters and elites about their perceptions of election threats, so that information can be used in threat assessment analysis, is required.

Table 1

Description	Disruption	2005 Likelihood	2006 Likelihood	Mitigation
Double voting: absentee and precinct	2.8	2.8	2.9	2.8
Double voting: multiple precincts	3.0	2.0	2.1	2.2
Double voting: multiple jurisdictions	2.9	3.0	3.4	4.1
Illegal voting	2.8	2.9	2.9	3.8
Vote buying	4.3	2.6	2.9	5.0
Registration fraud	3.1	3.2	3.3	4.5
Absentee fraud	4.1	3.5	4.0	4.7
Coercion: absentee voting	4.9	3.3	4.0	5.6
Coercion: precinct voting	4.6	2.5	2.7	2.7
Deception and Intimidation	5.3	2.5	2.5	3.4
Disruption: absentee voting	5.6	1.5	2.1	5.6
Disruption: early voting	5.2	1.3	2.2	5.2
Disruption: precinct voting	6.3	1.3	2.3	5.5

Tampering:	Disruption	2005 Likelihood	2006 Likelihood	Mitigation
Early e-voting	6.9	1.7	2.2	3.5
Early voting paper ballots	5.3	1.8	2.2	3.3
Early voting tabulators	5.3	1.5	2.1	2.7
Precinct e-voting	6.8	1.7	2.2	3.6
Precicnt paper ballots	5.0	1.7	1.9	3.4
Precinct tabulators	5.6	1.8	2.4	2.9
Ballot transport	5.6	1.5	1.8	3.4
Ballot tabulation	6.1	1.8	1.9	3.0

Unintentional problems:	Disruption	2005 Likelihood	2006 Likelihood	Mitigation
Early e-voting machines	4.2	3.1	3.5	3.7
Early paper ballots	3.7	3.7	2.6	3.7
Early voting paper trails	4.2	3.5	4.6	4.8
Precinct vote tabulators	3.8	2.2	2.4	2.5
Precinct e-voting machines	4.1	3.2	3.8	3.0
Precinct paper ballots	3.2	2.8	3.0	3.1
Precinct paper trails	4.0	3.1	4.3	4.3
Processing absentee ballots	3.8	3.6	4.0	2.7
Processing provisional ballots	3.7	3.7	4.0	3.3

Table 2

	Most likely	2	3	4	5	Least likely
Illegal or double voting	2	2	1	8	3	6
Coercion or deception in voting	2	2	3	3	7	5
Voter registration	12	1	3	2	2	2
Problems with precinct voting	3	5	4	2	4	4
Problems with absentee voting	4	7	6	1	3	1
Problems with post-election affairs	3	1	3	4	4	7

Table 3

	Aggregate		Party Affiliation			Race		Registered	
	Frequency	Percent	Rep.	Dem.	Ind.	White	Black	Yes	No
Voter registration fraud	100	5.0%	6.9	3.8	4.9	5.6	5.2	5.0	5.3
Illegal voting	62	3.1%	3.5	3.0	2.9	3.1	0.5	3.4	1.8
Intentional voting fraud	249	12.3%	11.2	15.1	10.7	12.8	13.5	12.2	12.8
Unintentional human errors	140	6.9%	7.3	6.9	6.1	8.1	5.2	7.4	4.8
Intimidation	43	2.1%	2.4	1.7	2.3	2.0	4.7	2.3	0.8
Some other problem	731	36.1%	36.6	33.4	39.8	37.8	31.6	36.8	34.0
Don't know	683	33.8%	31.1	35.8	32.6	29.9	39.4	32.3	39.0
Refused	17	0.9%	1.0	0.3	0.7	0.9	0.0	0.6	1.5

Table 4:

E-Voting Fraud Potential				
	Agree	Disagree	No Answer/ No Opinion	Total
Intentional Fraud	30.4	20.6	15.2	22.5
Unintentional Fraud	69.6	79.4	84.8	77.5
Voter registration fraud	6.4	4.9	3.3	5.0
Illegal voting	4.1	2.4	2.5	3.1
Intentional voting fraud	17.3	10.9	8.0	12.3
Unintentional human errors	7.5	7.2	6.0	6.9
Intimidation	2.5	2.5	1.3	2.1
Some other problem	37.8	40.6	29.8	36.2
Don't know	23.7	30.6	48.5	33.7
Refused	0.7	0.9	0.6	0.7
E-Voting Accuracy				
	Agree	Disagree	No Answer/ No Opinion	Total
Intentional Fraud	20.2	30.2	19.6	22.4
Unintentional Fraud	79.8	69.8	80.4	77.6
Voter registration fraud	4.3	5.8	4.8	4.8
Illegal voting	2.8	2.7	2.5	3.1
Intentional voting fraud	10.2	19.8	9.9	12.4
Unintentional human errors	6.5	5.8	8.3	6.9
Intimidation	1.9	2.1	2.4	2.1
Some other problem	39.0	37.7	31.2	36.2
Don't know	33.8	25.7	39.7	33.7
Refused	0.4	0.6	1.3	0.7

Appendix: Elite Survey Instrument

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Contemporary Election Fraud:
A Quantitative Analysis of Election Fraud Cases in California

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Abstract

Studies of electoral fraud have generally consisted of demonstrating the existence and pervasiveness of fraud in various contexts based on elite interviews, voter surveys, newspaper stories or case-study analysis. Yet none of these studies has yielded data with sufficient variation across time or space to permit systematic testing of hypotheses regarding the frequency of electoral fraud. In addition, many of these studies have gone where the fraud is by intentionally studying cases or countries where fraud is considered problematic. In this paper we conduct a quantitative analysis of election fraud using data from California's 58 counties between 1994-2003. Our data consist of all electoral fraud cases filed during this period and are disaggregated by allegation and resolution. We conduct event count regressions to test hypotheses about the timing and location of fraud cases, including measures of competitiveness, ideology, economics and demographics. Our results provide evidence that fraud allegations are associated with competitiveness, ideology, race and county election outlays. Results are similar across a variety of specific violations as well as case outcomes.

1 Introduction

Maintaining the integrity of the electoral process is a fundamental goal of election administrators in democracies across the world. If questions arise about the integrity of balloting or vote tabulation, the legitimacy of the subsequent governing regime can — and often is — undermined. Thus election administrators have developed systems to monitor and protect the integrity of the electoral process in democratic elections.

But despite these protections, claims about significant election fraud arise quite frequently, even in long-established democratic nations like the United States. Allegations of election fraud in the United States have a long history, and have been documented as far back as the very early elections held during the founding of the republic. But while there are often allegations made about election fraud, there is a surprising lack of empirical evidence regarding how frequently election fraud arises, how many votes it potentially influences, and where in the electoral process fraudulent activities occur. This is especially true of the contemporary political period in the United States.

Allegations about election fraud in the United States also arise during debates about significant changes to the electoral process. Examples range from Congressional debates about voter registration (heard during debates about the "National Voter Registration Act"), or about broader election reform proposals like the recently enacted "Help America Vote Act" (2002). But these debates about election fraud also occur during state and local debates about changes to election procedures, with prominent examples being how allegations of potential election fraud derailed ballot measures that would have implemented election-day voter registration in California and Colorado in 2002.

In this paper we offer an analysis of a unique database. In the past decade, the California Secretary of State has established an office that investigates election fraud allegations throughout the state. This database provides information on all election fraud cases that were referred to this office between 1994 and 2003, and provides information on how each case was resolved. This database is organized by year and by county, and by the precise nature of the allegation (for example, did it concern voter registration or absentee voting fraud). After merging our election fraud database with other political and demographic databases, we test a series of hypotheses about what factors produce higher levels of observed cases of election fraud across space and time. We find evidence that election fraud allegations are associated with competitiveness, ideology, race and election outlays.

2 Studying Electoral Fraud

Research on election fraud in the United States is difficult. First, obtaining data on election fraud is difficult, and sometimes impossible. There are no national regulations nor standards for reporting election statistics of any type, especially for reporting allegations, prosecutions, convictions, and other statistics on election fraud.[1] Second, election fraud might be difficult to detect; after all, those who might be motivated to perpetrate election fraud will take steps to minimize the odds that they are caught! So it might be possible that any statistical data that we obtain about election fraud underreports the true rate of fraud, and therefore any data we can collect and analyze might be subject to unknown selection biases.

Perhaps due to a lack of consistent data on election fraud, there has been relatively little empirical analysis of election fraud in the social science research literature. One extensive literature on election fraud in the United States focuses on historical studies of election fraud, including research on fraud during the "Gilded Age", during the late 1800's; much of this literature tries to estimate the extent of election fraud (e.g. Argersinger 1985-1986). There are other, largely historical, studies of American election fraud that focus

[1]Eventually, the recently-passed "Help America Vote Act" (H.R. 3295) will require that states and counties collect and report statistical information on the conduct of elections under their jurisdictions. However the exact type of data, whether there will be reporting standards, and whether the data will be readily available to the interested public, are currently unclear. The "Help America Vote Act" established the "Election Assistance Commission", which is tasked with developing the statistical reporting guidelines; at the time we are writing this paper the Election Assistance Commission has just been formulated.

on different geographic locations or certain components of the election process. For example, there is a historical study of election fraud in the early twentieth-century in Pittsburgh (Mayfield 1993), and studies of nineteenth-century New York (Cox and Kousser 1981), Texas (Baum 1991), South Carolina (King 2001), and Mississippi (1989). Miller (1948) examined fraud allegations in absentee voting, while others have studied allegations of fraudulent voter registration, especially in historical perspectives (e.g., Keyssar (2000), Harris (1929)). Last, there is a chapter on election fraud with information from the contemporary period in Sabato and Simpson (1996), as well as studies by Fund (2004), Campbell (2005) and Gumbel (2005).

Outside of the United States, there have been studies of election fraud, especially in what Lehoucq (2003), in his review essay on election fraud, calls "pre-reform political systems". These are nations that do not meet minimal requirements for a functioning democracy, and thus, have electoral administration systems that appear to allow for much more rampant election fraud. Important examples of this literature include Costa Rica (Lehoucq and Molina 2002), Imperial Germany (Anderson 2002), Argentina (Sabato 2001), and Brazil (Graham 1990).[2] The general conclusions of this literature are that there are many different ways in which political agents attempt to illegally manipulate election outcomes; however the evidence is weak that many of these manipulations are in fact decisive in determining electoral winners or losers (Lehoucq 2003).

Recently, following the 2000 American presidential election and the subsequent attention paid to observed electoral irregularities in that election (especially in Florida), there has been renewed interest in studying electoral irregularities and fraud. There is growing interest in using sophisticated statistical or econometric techniques to try to model election regularities — and to then identify election irregularities, or "outliers" (Wand et al. 2001; Mebane and Sekhon 2003).[3] Detected "outliers", say in precinct-by-precinct or

[2]Lehoucq (2003) provides an more extensive literature review, covering sources in French and Spanish, in addition to English.

[3]While this new interest is developing among methodologically-sophisticated social scientists, the basic idea of using outlier detection to identify potential electoral fraud has appeared earlier in some historical studies of fraud, including Baum (1991), Oberst and Weilage (1990) and Powell (1989).

county-by-county analyses, can then be examined in further detail to determine if their outlier status is due to actual fraud or to other idiosyncratic reasons. This is a promising avenue for future studies of election fraud.

Last, there is an extensive and growing literature on political corruption. This research literature spans an examination of historical political machines and corruption in American cities, for example Tammany Hall in New York (Riordan 1994). Other components of this literature are comparative in nature, especially studying political corruption across nations (e.g., Rose-Ackerman 1999; Myerson 1993; and Persson and Tabellini 2000). As this literature tends to cover the more general issues of political corruption, sometimes works in this area cover types of corruption that take place in the electoral arena; an example of this is vote buying (Hasen 2000).

Regarding the causes of electoral fraud, the research literature has pointed to a variety of potential explanations for why electoral fraud varies across time and space in specific nations, as well as across nations. Political factors, especially political competition, have been shown to explain the variance in election fraud, with there typically being a positive correlation between competitiveness and various measures of election fraud (Dominguez and McCann 1996; Eisenstadt 1999). Institutional factors, in particular the particular mechanisms used to elect members to legislative bodies (for example, whether majoritarian or proportional systems were used to translate votes into representation), appear to explain much of the variance in election fraud in Costa Rica, with more fraud occurring under majoritarian rules (Lehoucq and Molina 2002). Other studies have documented how economic interests (Anderson 2000), partisanship and incumbency (Botana 1979), and urbanization (Dominquez and McCann 1996) also appear to have correlations with the extent of election fraud across space and time. Below we operationalize variables that allow us to test for these various correlates of election fraud in our database.

3 Election Fraud in California, 1994-2003

To study the relationship between various factors and fraud allegations, we obtained a database from the California Secretary of State's Election Fraud Investigation Unit (EFIU).[4] Our databases include information on all electoral fraud cases referred to the Secretary of State's Office from 1994 to 2003. They also indicate the nature of each allegation and the final action taken. It covers exclusively those cases that went through the Secretary of State's Office and were resolved (i.e., we do not have information on federal or local cases, nor cases which were unresolved at the time we received the data).[5] Importantly, however, we also know which county and year the case originated in, allowing us to link allegations of fraud to county characteristics.

In Table 1 we provide summary data on the types of election fraud in our databases: the number of cases that were opened and resolved during this period. We partition the cases into four categories: voting fraud, registration fraud, absentee fraud and miscellaneous fraud. Voting fraud cases were allegations of: consideration for voting, corruption of voters, double voting, fraudulent voting, intimidation of voters, non-citizen voting, payment for voting, tampering with voting devices or violations of ballot secrecy. Voter registration fraud involved allegations of alteration of voter registration party affiliation, charging fees for registration, fraudulent voter registration, holding the voter registration card more than 3 days, non-citizen registration, residency, or voter registration after dead-

[4]This serves to distinguish our research from most of the previous research on election fraud. Lehoucq (2003) noted that there were six different methodological approaches to studying election fraud: collect survey data from voters or political agents; undertake qualitative studies and use in-depth interviews of political participants; study memoirs of political agents; analyze reports of fraud from political agents (typically parties) that are filed with appropriate authorities; study media reports of fraud; use data collected by nonpartisan electoral observers. The data we have appears to cut across two of Lehoucq's categories, as we are studying a database of reported allegations of election fraud, but they are not necessarily allegations with a political motivation as the allegations in our database can come from a wide variety of sources, including as far as we can determine any source, political or non-political.

[5]The other database we received breaks allegations of fraud down by type and year but not by county; this database covers all cases opened between 1994 and 2002, including all completed and pending cases over the same time period, and indicates that our data do not omit any cases filed before 2000. Given that this second database does not have geographic variation, we focus our attention in this paper on the more extensive database, which gives data for closed cases, by time, over time and counties.

lines. Absentee voting fraud was the violation of absentee voting requirements, fraudulent absentee voting, or the non-return of absentee ballot application. All other types of cases are included in the miscellaneous category.[6]

[Insert Table 1 Here.]

In Table 1 we see that the incidence rate of reported cases of election fraud in California during this period of time is 1285 cases opened and resolved. Overall, the specific types of election fraud with the highest incidence rates are fraudulent voter registration (469 cases), followed by double voting (153 cases opened) and non-citizen registration (153 cases opened), and falsified petitions (109 cases opened).

As two of the most prevalent types of fraud case involved voter registration (fraudulent voter registration and non-citizen registration), it is the most widely reported type in our dataset, with 703 cases reported during the time period of our data. Voter registration fraud constitutes approximately 54% of all cases of voter fraud reported to the Secretary of State's office during this period. On the other end is absentee voting fraud, of which there were only 9 cases reported in this time.

In Table 2 we provide data on the final action by type of fraud, during our period of study. We break the action down by the four broad categories of fraud — voting, registration, absentee and miscellaneous fraud. In the database we were provided, there are a broad range of actions that where taken; but in most cases the fraud allegations were dropped due to no evidence of a violation (336 cases were resolved this way), insufficient evidence (228 cases), the statute of limitations (184 cases) or a lack of intent (146). These four resolutions encompass 894 of the cases in our data, a total of nearly 70% of the cases.

[Insert Table 2 Here.]

[6]There was a large list of other types of miscellaneous fraud, including: alteration of election returns, electioneering, failure to file nomination papers, failure to maintain records on paid personnel, false declarations of candidacy, falsified petitions, fictitious name on nomination paper, handling of ballots, mass mailing of penal provisions, misleading of voters, misuse of information, misuse of signatures on petition, misuse of voter rolls, neglect to perform official duties, printing of simulated sample ballots, suppression of nomination papers, threats to circulator, vandalism of political signs, and other non-specified violations.

On the other hand, we see that in 66 cases convictions were the result of the investigation of the allegation — including 6 cases of voting fraud, and 34 cases of registration fraud. While 66 may seem like a relatively small number, it is also important to recognize that it is costly to investigate and prosecute election fraud, and that 66 convictions demonstrates a commitment in California to resolving election fraud cases in the courts when possible.

Again, our study is the first study to disaggregate election fraud cases and study them across space, time, and type of fraud. Figures 1 and 2 display the geographic variation in fraud allegations overall and for each of the four categories we constructed. It is clear from these figures that fraud allegations are spread across the state, though there are clearly more allegations in more populous counties. Further, southern California counties exhibit a concentration of fraud allegation, though there are similar counties both near the bay area and in the middle of the central valley. Examining the right-hand map in Figure 1 shows that these findings are partly driven by the populousness of these counties. When fraud allegations per capita are mapped, a somewhat different pattern emerges, with smaller, northern counties exhibiting greater fraud allegations per capita and the southern counties exhibiting relatively lower rates. Comparing the results across our categories of fraud in Figure 2 leads to similar conclusions about total fraud, with similar patterns emerging across each. A similar shift occurs in this figure when we map fraud cases per capita (not shown).

[Insert Figure 1 Here.]

[Insert Figure 2 Here.]

So, do these statistics indicate that election fraud is common or rare in contemporary California? On one hand, the fact that any election fraud cases are alleged indicates that some fraud must exist. But on the other hand, from 1994 through 2002 almost 73 million votes were cast in statewide primary and general elections alone in California, while there were 1,285 cases of alleged fraud that were opened by the EIFU in this period: this is about one case of alleged election fraud for about every 57,000 votes cast in California statewide elections. That is a low incidence rate. However, these data only measure the number of cases that were opened; they do not describe, per allegation, how extensive the purported election fraud was. Thus, a case can represent allegations of only a handful of illegal votes, or it could represent an allegation that thousands of illegal votes were cast, and with only this data alone we do not know if a specific allegation regarded one illegal vote or thousands.

What is also interesting to note in Table 1 is the relative incidence rates for the different forms of election fraud. First, many discussions of absentee voting criticize the liberalization of vote-by-mail to include convenience absentee voters, in addition to those who should cast absentee ballots because of need. In fact, the Caltech/MIT Voting Technology Project's report recommended replacement of convenience absentee voting with early voting; one of the stated reasons for this recommendation was fraud and security. The evidence provided here indicates that these fraud concerns might be over-estimated, though clearly more analysis of data from California and elsewhere on this topic is necessary. Rather, most forms of election fraud concern voter registration. There are many issues with voter registration, as shown above. Some of these issues might be somewhat specific to California, especially the issue of non-citizens registering and voting. However, while there clearly are reasons to be concerned about fraud and security regarding voter registration, it seems from the data presented above that while most cases of fraud regard voter registration irregularities, the total number of illegal registrations perpetrated is quite low.

Of course, one additional dimension to our data is the over-time variation in fraud cases. During this period of time, California has experimented with many innovations and reforms, ranging from efforts to make voting more convenient (making voting by mail and early voting easier and more convenient), making the registration process easier (implementation of "Motor Voter" reforms), and many efforts associated with changing the process, procedures, and methods by which Californians vote on election day in their local precincts (for example, the elimination of punchcard voting systems, in favor of either optical scan or electronic voting devices). Below, when we discuss our multivariate statistical results, we will dig deeper into the question as to whether these many changes have had any detectable effect on election fraud in California.

4 The Correlates of Fraud

In this section we use our unique data set on fraud allegations in California to study how different factors relate to the incidence of fraud charges. We also study whether there is variation across these factors in their influence on the four distinct categories of fraud we outlined previously. Finally, we study the ultimate resolution of allegations by investigating the number of allegations that are resolved in the five most common ways: administrative action, conviction, lack of intent, no violation and statute of limitations. This last set of analyses is important for a variety of reasons, but perhaps most importantly, it allows us to partially overcome some of the limitation of our data as a measurement of actual fraud. Of particular importance is our ability to isolate allegations that result in convictions.

But what factors explain the variation in fraud allegations across counties? With no similar quantitative studies of data like ours on election fraud to draw upon, we focus on variables suggested by the previous related research on election fraud. That literature has found a variety of potential correlates of election fraud, which we examine with our data below. Those correlates of election fraud are political competition (Dominguez and McCann 1996; Eisenstadt 1999), economic explanations (Anderson 2000), partisanship (Botana 1979) and demographic factors like urbanization (Dominquez and McCann 1996).

Perhaps the most critical variable to focus on is the opportunity for fraud to influence electoral outcomes — we would expect fraud attempts to occur mainly in electoral circumstances that are conducive to altering outcomes. Specifically, the potential benefits from fraud are much greater when only a handful of votes can change the outcome of an election. Thus we expect that fraud is most likely to occur in highly competitive races with small margins of victory.

Unfortunately, we can not link our fraud allegations to specific races, which makes it more difficult to assess the effect of competitiveness on the occurrence of fraud. Of course, many fraud cases are not associated with specific races or the nature of the allegation is such that it would be impossible to know if any specific race motivated the actions (this would be true, for example, of many allegations of voter registration fraud). Because we have county-level data, however, we can study the effect of local competitiveness on fraud allegations. In practice, then, we test the effect of a county's average competitiveness on the incidence of fraud allegations. We hypothesize that counties that are more competitive exhibit a greater number of fraud cases.

To test this hypothesis, we include a measure of average district competitiveness. We construct this by using data from gubernatorial elections in 1994 and 1998 to calculate the absolute margin of victory in these two elections, then combine these values into one variable based on the most proximate election for each year. Thus competitiveness for 1994-1996 is constructed from the 1994 gubernatorial election results, and for 1997-1999 from the 1998 election. We also include the Democratic vote share in these two elections, constructed by assigning election results to years in the same way, to control for partisan effects. While our competitiveness measure may miss out on election-to-election incentives for committing fraud, we feel it is an appropriate measure since it would be impossible to control for vote margin in all races in each county. Thus we rely on results from a common, statewide election.[7]

In addition to competitiveness, there are a variety of other factors that we want to consider, including demographic measures, economic performance, population size and density, education, age and partisanship. To measure the effect of county demographic factors, we include measures of a county's *Total Population, Population Density*, the percent of the population that is *African American*, the percent that is *Hispanic*, the percent

[7]Our results are not affected by the choice of the gubernatorial returns — similar measures constructed using returns for other statewide elections produced almost identical results.

that has completed a *High School Education* and the *Median Age*. We expect that counties with larger, more dense populations experience greater levels of fraud. The effect of other variables may be different for different types of fraud. For example, we might expect the percent hispanic to increase registration fraud but not absentee fraud. Increased education and age should produce lower levels of voting and registration fraud, but may increase levels of absentee fraud.

We also control for economic factors, including the *Percent Unemployed* and *Per Capita Personal Income*. We expect fewer fraud allegations when economic performance is good. In addition, we include variables measuring county election expenditures, using data on *Election Operating Expenses* and *Election Capital Expenditures*. These variables capture county investment in staffing and monitoring elections and updating election machines, respectively, and we expect that they will be related to observed levels of fraud. We run versions of our analyses with these variables measured both in total and on a per capita basis. We control for changes in fraud over time by including a linear time trend variable. This variable helps us determine how various reforms in California over the last decade have resulted in greater amounts of fraud, or at least in more allegations of fraud. Descriptive statistics for the dependent and independent variables used in our analysis are contained in a table in the appendix (Table 7). Finally, we occasionally include an indicator variable for Los Angeles county in 1998 to account for the fact that it has an extremely large number of voter registration fraud allegations that year.

Because our dependent variable is the number of fraud allegations in a county per year, we do not use standard linear regression models for our analysis. Because they do not reflect the true nature of the data generating process, parameter estimates are usually biased and inconsistent (King 1988), particularly in cases like ours when the number of events is at or near zero for many observations. Because of the problems standard regression models suffer from when estimated on data corresponding to counts of discrete events we estimate models designed for count data, such as Poisson and negative binomial regression.[8] Because we expect that there are a variety of factors at the county level that may effect fraud allegations, we estimate a Poisson model with (Gaussian) random effects.

4.1 Total Allegations and Allegations by Category

The results for the total number of fraud allegations as well as the results for our four subcategories of allegations are presented in Table 3. Because measures of some of our county-level data are not available in 2000 and later years, our analysis covers 1994-1999. Since the fraud allegations data are more complete in this interval than for later years, restricting attention to these cases is reasonable. Overall the results demonstrate that a variety of factors influence allegations. And while the pattern of significance varies a little across the four categories of allegations, the direction of significant effects is generally consistent.

[Insert Table 3 Here.]

The results for the random effects Poisson specification with total election outlays are presented in Table 3, and the results for the models using per capita outlays are Table 4. In general, the results are similar, with the one exception arising as the competitiveness variable. This variable is significant when total outlays are used, but not when we substitute per capita outlays. As our margin variable is not strongly correlated with any of the outlays variables (all less than 0.08), we are not sure why the cause of the different findings. The effect of electoral margin is smaller across the board for each of the four categories of fraud. It is again significant for registration fraud when total outlays are used, and nearly so with per capita outlays.

[Insert Table 4 Here.]

Last, we include as a covariate in our models a time counter, that gives us the ability to test whether or not election fraud has changed significantly over the span of years

[8]For a good introduction to and overview of count models, see Box-Steffensmeier and Jones (2004) and Long (1997). For a more detailed presentation, see Cameron and Trivedi (1998).

in our dataset (here 1994-1999). We find that overall, the time counter has a positive but statistically insignificant sign in our total fraud model, indicating that in that way of studying the incidence of election fraud in California, there is no statistical support for the hypothesis that election fraud has increased or decreased during this period. When we turn to the four broad categories, though, we see that the sign on the time counter is negative (but insignificant) in the voting, absentee, and other models.

However, we see in the registration fraud model that the sign on the time counter is both **positive and significant**. This indicates that, controlling for all of the other variables in that model, there has been a statistically significant increase in voter registration fraud cases filed per county in this period of time. On one hand, this could be seen as evidence that voter registration fraud itself might have gone up during this period; but on the other hand, it might also be possible that this reflects increased attention to election fraud, especially voter registration fraud, between 1994 and 1999 in California. Further research as to what is behind this result is in order.

We are interested not just in the significance of the coefficients, but also in the substantive effect they imply for each independent variable. Because we estimate a negative binomial regression, the coefficients do not directly indicate how changes in each variable result in changes in the number of violations.[9] To determine this relationship, we constructed first differences based on the coefficient estimates for each variable. These first differences are presented in Table 5. These numbers represent the change in the dependent variable resulting from an increase in each independent variable from one standard deviation below its mean to one standard deviation above its mean, holding all other independent variables constant at their mean values. In addition, we give the predicted number of violations when all variables are at their mean or mode in order to put the magnitude of the first differences in perspective.

[Insert Table 5 Here.]

For our competitiveness variable, the results in Table 5 indicate that a two standard

[9]Since $E[Y_i] = \exp(x_i\beta)$, the marginal effect of a variable x_k is $\beta_k \times \exp(x_i\beta) = \beta_k \times E[Y_i]$.

deviation decrease in competitiveness, corresponding to a change in average margin of victory from 12% to 28%, results in 0.21 fewer total fraud cases. Relative to the mean prediction of 1.0, this represents a fairly large substantive effect. For voting fraud, the first difference indicates 0.11 fewer allegations relative to a baseline of 0.43.

Turning to our other independent variables, we finds that a variety of factors influence fraud allegations and that there are some differences for different types of cases. Counties with a greater Democratic vote share consistently have significantly fewer fraud cases, with significant coefficients in both tables for total and registration fraud. The first difference of -0.81 indicates that the marginal effect of partisanship on total fraud cases is reasonably large.

Our election expenditures variables demonstrate a systematic relationship between county spending and reduced levels of fraud. Counties with greater total election operating expenditures have fewer overall fraud allegations as well as fewer registration and absentee allegations. With the exception of absentee allegations (though recall the few number of positive cases here), these results persist when per capita expenditures are used. The first differences indicate that a two standard deviation change in this variable generally results in about a 100% in allegations. Similar results obtain for total capital expenditures, which have a negative and significant coefficients for all categories save absentee; per capita capital expenditures have significant effects for total and registration fraud.

Demographic variables also exert as effect on fraud allegations. Median age has a significant and negative effect for total registration fraud as well. Race also matters: counties with a greater proportion of blacks have significantly more total fraud, registration fraud and voting fraud. At the same time, the percent Hispanic has no effect on fraud. Economic factors also have mixed effects, with wealthier counties associated with increased fraud allegations for all type of fraud except absentee.[10] Unemployment is not found to

[10]There are very few allegations of absentee fraud in our data, which helps explain the general lack of findings for this category.

have a significant effect. For population characteristics, we find, not surprisingly, that larger counties have more fraud. The first differences are generally about 75% larger than the mean number of cases, indicating that this variable has a large effect.

4.2 The Resolution of Allegations

In this section, we study the outcomes of all fraud cases filed. While we have a total of fourteen different outcomes, only six of them happen with sufficient frequency to allow meaningful regression analysis. These six categories are Administrative Action, Conviction, Lack of Intent, No Action Taken, No Violation, and Statute of Limitations; they represent about 70% of all cases.[11] Our dependent variable in this section is the number of cases filed in a county that are resolved in each way.[12] Of course, the number of cases resolved varies not only with demographic and political characteristics, but also depends greatly on the number of cases filed. Fortunately, event count models can accommodate variation in the maximum number of possible events, commonly referred to as exposure, across units. We control for this by including the natural logarithm of the number of allegations in a county as an independent variable. If the coefficient on this variable is constrained to one, the model is equivalent to estimating the percent of cases reaching a resolution in a county. Rather than impose this constraint, however, we follow the recommendations of Maddala (1983) and King (1989) to estimate a coefficient for this variable. An implication of this approach is that we exclude counties with no allegations in a given year since the count of resolutions must be zero.

These models are particularly important due to our ability to isolate cases that end in convictions. Because our data measure the number of fraud allegations, they do not correspond directly to actual fraud. By separately studying cases that end in convictions

[11]The other categories not analyzed separately are: Combined, Declined, Dismissed, Diversion Program, Pending Action, Turned Investigation Over To DA, and Unable to Locate Suspect.

[12]Specifically, the dependent variable is the number of cases filed in each year that ultimately end with a specific resolution. Of course, cases are not necessarily resolved in the same year that they are filed, but since we are studying the nature of the violation, we control for characteristics concurrent with the violation rather than the resolution.

we may obtain a better correspondence with actual fraud than just with alleged fraud. In addition, we also know which cases end with a finding of no violation, which gives us a sense of whether incorrect allegations of fraud are cased by factors similar to those that influence total allegations or convictions. Measures of other outcomes fall somewhere between these two extremes, such as lack of intent and no action taken.

The results for our random effects Poisson regression analysis of outcomes are presented in Table 6. Overall the results demonstrate that a variety of factors influence how allegations are resolved and that the direction and significance of these factors varies across our six different categories. Interestingly, while vote margin does not have a significant impact for most of the outcomes, it is significant and negative for cases that ended with findings of either lack of intent or no violation. While this does not demonstrate that more fraud happens in competitive counties, it suggests that fewer baseless cases are brought, which is consistent with our expectation that increased competitiveness leads to more fraud. On the other hand, the coefficient for cases with convictions is, while not significant, also negative.

[Insert Table 6 Here.]

Turning now to our other variables, we see that the proportion of blacks in a county significantly decreases the number of cases that expire due to the statute of limitations, increases the number of cases with no action taken and decreases the number of cases with no violations. The percent of a county's population that is Hispanic decreases the incidence of administrative action. But while it has no effect on statute of limitations, it does significantly increase the number of cases for which no action is taken.

Percent unemployed has a significant effect for two categories, decreasing the incidence of both administrative action and convictions. Per capita income increases administrative action and statute of limitation, but increases cases with no violation. More populous counties have less cases ended with administrative action or no action and more cases concluding with a finding of lack of intent; denser counties have the same negative finding for administrative action, but a positive finding for lack of intent. Median age significantly increases both of these categories. Election operating expenditures decrease administrative action cases while capital outlays are associated with more cases in this category. The latter category also leads to more cases with no action taken. Lastly, we see that the likelihood of some outcomes changes over time. Administrative action is decreasing over time whereas cases ending with no action taken increase over time.

5 Discussion and Conclusion

In this paper we have argued, based on the database we have obtained about the number of election fraud cases opened and resolved in recent history in California, that election fraud — while it does clearly happen in California — appears to be a relatively rare phenomenon. Our argument that the incidence of election fraud is low in contemporary California elections flies in the face of "conventional wisdom". For example, in a brief discussion of election fraud in California, Larry Sabato and Glenn R. Simpson title a chapter section "California: The Golden State for Vote Fraud", and assert that fraud is widespread in California. Unfortunately, despite sweeping claims about widespread fraud in California's electoral system, even Sabato and Simpson cannot point to more than a handful of allegations of election fraud, with few of these alleged cases actually being investigated thoroughly and carefully by election administrators and law enforcement officials. This suggests that even those who claim that election fraud is widespread in California might be misinterpreting their own evidence. Why, given the common assumption that election fraud is widespread, does election fraud seem so rare?

Of course, critics might argue that fraud is widespread, but undetected. This could be true, but it is impossible to verify. Yet, to assert that fraud is widespread and undetected is difficult to believe when we consider how closely scrutinized most elections are, even at the lower-levels, in California and the United States. Most elections, even those that are not very close, are contested, are followed by partisan or other interest groups, and do receive some media coverage. Also, election administrators, their staffs, and all of the volunteers who help run elections, are involved and scrutinize the process. Given all of the interested and informed observers of elections in America, it is hard to imagine that widespread fraud goes undetected.

Additionally, there is now a relatively new group of observers who have economic and professional incentives to help clients monitor and detect election fraud — the growing field of lawyers who specialize in election law and the social scientists who assist their efforts as expert witnesses. Election law is rapidly growing as a legal field in its own right, with a peer-reviewed journal (the *Election Law Journal*), two casebooks, and specialized courses now taught in election law at many law schools throughout the nation. A search of the American Bar Association's membership data (September 15, 2006) reveals 806 lawyers who practice "election, campaign, and political law" in the United States. With such a strong and growing interest in legal and academic circles with election law, there is a much stronger possibility that monitoring of election outcomes by interested parties and their legal representatives is occurring, and that election fraud is being detected and possibly deterred.

Furthermore, to commit fraud of a scale large enough to influence even a very close election, say involving even just a few hundred votes, is a difficult endeavor. Either one would have to determine a way to recruit collaborators, each of whom would then cast dozens of illegal votes, or one would have to determine a way to illegally register and vote for hundreds of fictional people (or to illegally cast votes for previously registered people). Given the potential costs of being caught while committing fraud, and the small odds of being successful, even by a simple cost/benefit analysis, election fraud does not seem to be a good way to use resources to get elected to office (or to see a favored candidate elected).

Perhaps, instead, with so many observers fraud is deterred and prevented. Perhaps election administration has progressed to a point where sufficient systems are in place to prevent and detect fraud. Perhaps election regulations are sufficiently enforced, and the penalties are stiff enough, to also prevent fraud. At this point, without much additional research, it is difficult to pinpoint a precise answer to this question. What we can say with some precision is that based on this analysis, it is clear that there is little evidence of widespread election fraud in recent years in California.

Furthermore, the data we have analyzed in this paper also shed some light on the relative frequencies of different types of election fraud in California. Somewhat surprisingly to us, we found that the incidence rate of allegations and substantiated cases of absentee voting fraud are extremely rare, despite many assertions to the contrary. Perhaps less surprisingly, we found that allegations and substantiated cases of various forms of voter registration fraud are more common, though still relatively rare when placed in the context of the millions and millions of votes cast during the period covered by our database.

Despite the relatively low incidence of fraud cases, we do find that allegations are more likely to occur in certain counties. Our results provide evidence consistent with many previous studies of fraud, indicating that race, population demographics, partisanship and competitiveness all have significant impacts for at least one of voter, registration, absentee or miscellaneous fraud. Despite these findings, however, our results also indicate that the most consistent substantive predictors of fraud allegations in a county are population size, per capita income, and county election expenditures, and that that these variables have relatively large substantive effects as well.

In addition, we find little evidence that fraud allegations increase in California over the ten-year period that our data cover. This results holds for total allegations and for each of four categories of allegations, with the exception of registration fraud, which shows a positive trend over the period studied. The good news is that extensive reforms that liberalized the boting process in California have not lead to a general increase in fraud allegations; at the same time there is some evidence that they may have influenced registration fraud in isolation. Because of the nature of our data, we can not say if this is because attempted fraud is on the rise or whether election officials have been more vigilant regarding registration fraud, particularly given the aforementioned reforms. We hope to investigate this question in further detail.

Besides providing information about the incidence of fraud cases in California counties, our approach suggests a method, similar to outlier detection approaches (Wand et al. 2001; Mebane and Sekhon 2003), that may be useful for detecting electoral fraud in California and elsewhere. Because our statistical approach provides information about how a variety of factors predict fraud allegations, one could generate predictions about how much fraud is expected to occur in a specific (but generally similar) county or other geographic unit. This approach could make it easier for researchers or election officials to focus their efforts on areas that have the potential to be particularly fraud-prone. Perhaps more importantly, it could also provide information about institutional, political or legal arrangements that reduce fraud by isolating specific political units that appear to be unusually successful in generating low levels of fraud.

We hope that our analysis presented here, in addition to the new interest in election fraud by other contemporary scholars, will lead to productive new approaches for studying — and hopefully preventing — election fraud. Obviously, the type of analysis we present in this paper needs to be conducted using data from other states. Accordingly, we encourage other states to being to collect the statistical data necessary to study election fraud quantitatively in the future. Second, we need to collect more refined data, information that reveals not just that allegations of fraud were made, investigated, and prosecuted; additionally, we need to know how for each case how many illegal votes were cast, because only with that information can we determine whether election fraud influences election outcomes. Promising areas for studying illegal votes quantitatively are court records of election fraud litigation, and possibly media reports of election fraud.

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Table 1: Electoral Fraud in California, 1994-2003

Allegation Category	Type	Cases
Absentee Ballot Requirements	Absentee	4
Alteration of Election Returns	Misc	8
Alteration of VRC Party Affiliation	Registration	51
Become or withdraw as a Candidate	Misc.	1
Charging Fee for Registration	Registration	1
Consideration for Voting	Voting	4
Corruption of Voters	Voting	4
Double Voting	Voting	153
Electioneering	Misc	28
Failure to File Nomination Paper	Misc	1
Failure to Maintain Records on Paid Personnel	Misc	7
False Declaration of Candidacy	Misc	22
Falsified Petitions	Misc	109
Federal Violation	Misc	1
Fictitious Name on Nomination Petition	Misc	1
Fraudulent Absentee Voting	Absentee	6
Fraudulent Voter Registration	Registration	469
Fraudulent Voting	Voting	96
Handling of Ballots	Misc	1
Holding VRC More than 3 Days	Registration	23
Intimidation of Voters	Voting	11
Mass Mailing Penal Provisions	Misc	1
Misleading Voters	Misc	5
Misuse of Information	Misc	13
Misuse of Signatures on Petition	Misc	1
Misuse of Voter Rolls	Misc	1
Neglect to Perform Official Duties	Misc	43
No Violation/Not Identified	Misc	37
Non return of Absentee Ballot Applicatications	Absentee	3
Non-Citizen Registered	Registration	153
Non-Citizen Voting	Voting	7
Payment for Voting	Voting	1
Printing of Simulated Sample Ballot	Misc	2
Residency	Registration	5
Suppression of Nomination Paper	Misc	1
Tampering with Voting Devices/Secrecy of Ballots	Voting	6
Threats to a Circulator	Misc	2
Vandalism of Political Signs	Misc	1
Verification of Signatures	Misc	1
Voter Registration after 54th Day	Registration	1
TOTAL		1285

Table 2: Final Action by Type of Fraud, 1994-2003

	Voting	Registration	Absentee	Misc.	Total
Administrative Action	24	102	0	2	128
Combined	2	4	0	4	10
Conviction	6	34	1	25	66
Declined	25	25	0	20	70
Dismissed	2	7	0	2	11
Diversion Program	0	1	0	1	2
Insufficient Evidence	30	139	1	58	228
Lack of Intent	17	119	0	10	146
No Action Taken	9	18	1	18	46
No Violation	90	143	7	96	336
Pending Action	2	1	0	0	3
Statute of Limitations	25	81	3	75	184
Turned Investigation Over to DA	2	7	0	9	18
Unable to Locate Suspext	6	22	0	9	37
Total	240	703	13	329	1,285

Table 3: Random Effects Poisson Regression Estimates for Number of Fraud Cases Filed per County, 1994-1999 (With Total Election Outlays)

	Total	**Voting**	**Registration**	**Absentee**	**Other**
% African American	15.02 ∗ ∗	16.85∗∗	16.91 ∗ ∗	−3.86	3.86
	(3.97)	(6.35)	(5.39)	(13.73)	(4.30)
% Hispanics	2.37	3.48	3.68	7.22	−0.25
	(1.77)	(3.11)	(2.55)	(6.53)	(1.94)
% High School Graduates	8.38∗	1.17	14.79 ∗ ∗	19.19	−2.69
	(4.57)	(7.82)	(6.44)	(14.85)	(5.12)
% Unemployed	−2.84	−14.14	−2.17	10.37	−7.73
	(4.58)	(8.93)	(6.42)	(16.41)	(5.70)
Per capita income	0.04 ∗ ∗	0.07∗∗	0.05 ∗ ∗	−0.03	0.02 ∗ ∗
	(0.01)	(0.02)	(0.01)	(0.04)	(0.01)
Total population	0.53 ∗ ∗	0.58∗	0.81 ∗ ∗	−1.37	−0.1
	(0.16)	(0.34)	(0.24)	(0.86)	(0.26)
Population Density	−0.02	−0.17	−0.15	0.11	0.21
	(0.26)	(0.40)	(0.39)	(0.53)	(0.28)
Median Age	−0.18 ∗ ∗	0.03	−0.28 ∗ ∗	−0.18	−0.13
	(0.08)	(0.13)	(0.11)	(0.29)	(0.09)
Democratic Vote	−2.67 ∗ ∗	−1.53	−5.20 ∗ ∗	0.45	−0.65
	(0.69)	(1.53)	(0.96)	(4.64)	(1.21)
Vote Margin	−0.53∗	−0.92	−1.03 ∗ ∗	3.5	−0.27
	(0.28)	(0.61)	(0.40)	(2.39)	(0.50)
time	0.07	−0.03	0.14 ∗ ∗	−0.29	−0.02
	(0.05)	(0.11)	(0.07)	(0.36)	(0.08)
Los Angeles 1998	1.18 ∗ ∗		2.32 ∗ ∗		
	(0.16)		(0.23)		
Election Operating Exp.	−0.13 ∗ ∗	−0.14	−0.27 ∗ ∗	0.94 ∗ ∗	0.18
	(0.06)	(0.14)	(0.09)	(0.47)	(0.12)
Election Capital Exp.	−2.14 ∗ ∗	−3.14∗∗	−2.57 ∗ ∗	−11.56	−0.93∗
	(0.37)	(0.95)	(0.60)	(11.88)	(0.54)
Constant	0.01	−4.59	−1.15	−14.27	5.74∗
	(3.05)	(5.45)	(4.10)	(10.16)	(3.21)
Dispersion ($\ln(\alpha)$)	−0.07	0.38	0.23		−0.65
	0.27	0.32	0.31		0.37

N=342, 57 groups. Standard errors in parentheses. * Significance at 10% level, ** at 5% level. Random effects poisson model with Gaussian distributed random effects. Models without dispersion estimates showed no evidence of overdispersion — estimates are from Poisson regression.

Table 4: Random Effects Poisson Regression Estimates for Number of Fraud Cases Filed per County, 1994-1999 (With Per Capita Election Outlays)

	Total	Voting	Registration	Absentee	Other
% African American	11.43 **	12.14**	12.81 **	3.79	4.32
	(3.98)	(6.19)	(5.20)	(11.78)	(4.32)
% Hispanics	1.38	2.08	2.48	8.98	−0.26
	(1.86)	(3.31)	(2.44)	(6.51)	(1.97)
% High School Graduates	9.47 **	2.4	15.73 **	23.44*	−1.24
	(4.53)	(7.55)	(6.31)	(14.07)	(5.11)
% Unemployed	3.25	−6.6	4.49	5.87	−6.53
	(4.61)	(8.84)	(6.41)	(14.94)	(5.74)
Per capita income	0.04 **	0.06**	0.04 **	−0.01	0.02 **
	(0.01)	(0.02)	(0.01)	(0.04)	(0.01)
Total population	0.31 **	0.32*	0.30*	0.32*	0.25 **
	(0.13)	(0.19)	(0.17)	(0.19)	(0.13)
Population Density	−0.13	−0.14	−0.34	0.22	0.2
	(0.26)	(0.42)	(0.38)	(0.50)	(0.29)
Median Age	−0.16*	0.02	−0.22*	−0.22	−0.14
	(0.08)	(0.13)	(0.11)	(0.31)	(0.09)
Democratic Vote	−1.81 **	−0.31	−4.40 **	0.55	−0.57
	(0.68)	(1.54)	(0.96)	(4.44)	(1.20)
Vote Margin	−0.1	−0.23	−0.61	2.67	−0.2
	(0.27)	(0.60)	(0.40)	(2.34)	(0.47)
time	0.09*	−0.03	0.18 **	−0.43	−0.03
	(0.05)	(0.11)	(0.07)	(0.36)	(0.08)
Los Angeles 1998	1.19 **		2.36 **		
	(0.16)		(0.23)		
Election Operating Exp.	−0.18 **	−0.09	−0.35 **	0.1	−0.07
	(0.07)	(0.13)	(0.11)	(0.28)	(0.10)
Election Capital Exp.	−1.14 **	−0.82	−2.26 **	−14.1	−0.02
	(0.32)	(0.57)	(0.61)	(11.95)	(0.44)
Constant	−1.48	−5.52	−3.06	−15.44	5.16
	(3.06)	(5.41)	(3.97)	(10.44)	(3.26)
Dispersion ($\ln(\alpha)$)	−0.17	0.31	0.14		−0.59
	0.28	0.32	0.31		0.35

N=342, 57 groups. Standard errors in parentheses. * Significance at 10% level, ** at 5% level. Random effects poisson model with Gaussian distributed random effects. Models without dispersion estimates showed no evidence of overdispersion — estimates are from Poisson regression.

Table 5: Marginal Effects for Number of Fraud Cases Filed per County, 1994-1999 (Using Total Election Outlays)

	Total	Voting	Registration	Absentee	Other
% African American	0.836	0.076	0.570	−0.002	0.034
% Hispanics	1.705	−0.134	0.414	0.023	0.049
% High School Graduates	2.150	−0.008	0.854	0.041	−0.105
% Unemployed	−0.826	−0.145	−0.379	0.008	−0.228
Per capita income	1.007	0.136	0.470	−0.005	0.113
Total population	1.773	0.089	0.778	−0.048	−0.070
Population Density	0.309	0.060	−0.015	0.001	0.126
Median Age	−2.130	−0.119	−1.173	−0.015	−0.319
Democratic Vote	−0.807	−0.021	−0.577	0.001	−0.057
Vote Margin	−0.205	−0.023	−0.115	0.008	−0.018
time	0.190	−0.020	0.171	−0.008	−0.016
Election Operating Exp.	−1.176	−0.049	−0.413	0.113	0.211
Election Capital Exp.	−0.318	−0.039	−0.174	−0.015	−0.034
Mean	0.985	0.080	0.432	0.008	0.260

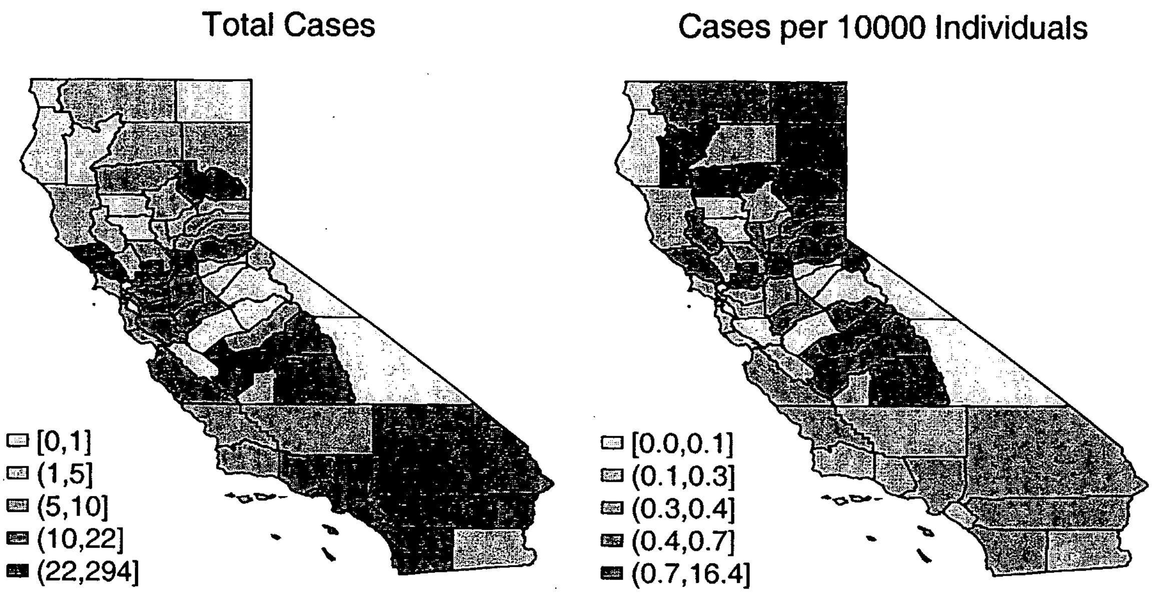
Based on estimates in Table 3. Marginal effects represent the change in the predicted value of the dependent variables when each independent variable is increased from one standard deviation below its mean to one standard deviation above its mean, holding all other variables fixed at their respective means.

Table 6: Random Effects Poisson Regression Estimates for Resolutions of Fraud Cases per County, 1994-1999

	Admins. Action	Conviction	Lack of Intent	No Action Taken	No Violation	Statute of Limitations
% American Africans	0.77	9.14	−0.74	16.66 **	−5.78 **	9.97 **
	(4.44)	(5.61)	(3.63)	(7.62)	(2.59)	(3.72)
% Hispanics	−9.11 **	−4.17	−1.74	17.41 **	2.29	−2.4
	(3.21)	(3.12)	(1.97)	(5.33)	(1.50)	(2.13)
% High School Graduates	−54.03 **	−14.99	−5.32	−6.54	5.49	−0.73
	(11.89)	(9.55)	(6.23)	(11.72)	(3.82)	(5.66)
% Unemployed	−63.74 **	−26.36 **	−0.46	−6.48	2.84	2.61
	(14.93)	(10.79)	(6.06)	(11.90)	(4.05)	(6.58)
Per capita income	0.09*	−0.02	0.01	0.03	0.02*	−0.03 **
	(0.05)	(0.02)	(0.01)	(0.03)	(0.01)	(0.01)
Total population	−0.69 **	−0.06	0.20 **	−0.65 **	−0.02	−0.03
	(0.15)	(0.12)	(0.08)	(0.20)	(0.06)	(0.09)
Population Density	−0.76 **	−0.03	−0.22	0.80 **	−0.06	0.35*
	(0.37)	(0.26)	(0.21)	(0.34)	(0.13)	(0.20)
Median Age	0.55 **	0.03	−0.13	0.79 **	−0.04	0.03
	(0.17)	(0.15)	(0.11)	(0.30)	(0.08)	(0.10)
Democratic Vote	2.68	−1.74	−0.25	−1.99	0.81	−3.97 **
	(2.12)	(2.49)	(1.40)	(2.68)	(1.05)	(1.48)
Vote Margin	−0.16	−1.19	−1.34 **	1.16	−1.10 **	−0.32
	(1.24)	(1.18)	(0.59)	(1.44)	(0.51)	(0.66)
time	−0.89 **	0.07	0.07	0.62 **	−0.07	0.11
	(0.19)	(0.19)	(0.11)	(0.26)	(0.08)	(0.11)
Election Operating Exp.	−0.33 **	0.25	0.16	−0.39	0.03	−0.03
	(0.17)	(0.18)	(0.11)	(0.40)	(0.09)	(0.13)
Election Capital Exp.	3.30 **	−3.64	0.06	1.48*	−0.85	−0.55
	(0.84)	(2.30)	(0.52)	(0.85)	(0.69)	(0.67)
Exposure (ln Violations)	2.83 **	0.67 **	0.79 **	2.27 **	0.89 **	0.73 **
	(0.25)	(0.17)	(0.10)	(0.27)	(0.08)	(0.10)
Constant	19.21 **	10.10*	5.96*	−34.92 **	−4.51*	0.18
	(6.39)	(5.60)	(3.24)	(8.18)	(2.40)	(3.79)
Dispersion ($\ln(\alpha)$)					−5.57	−1.94 **
					(14.68)	(0.84)

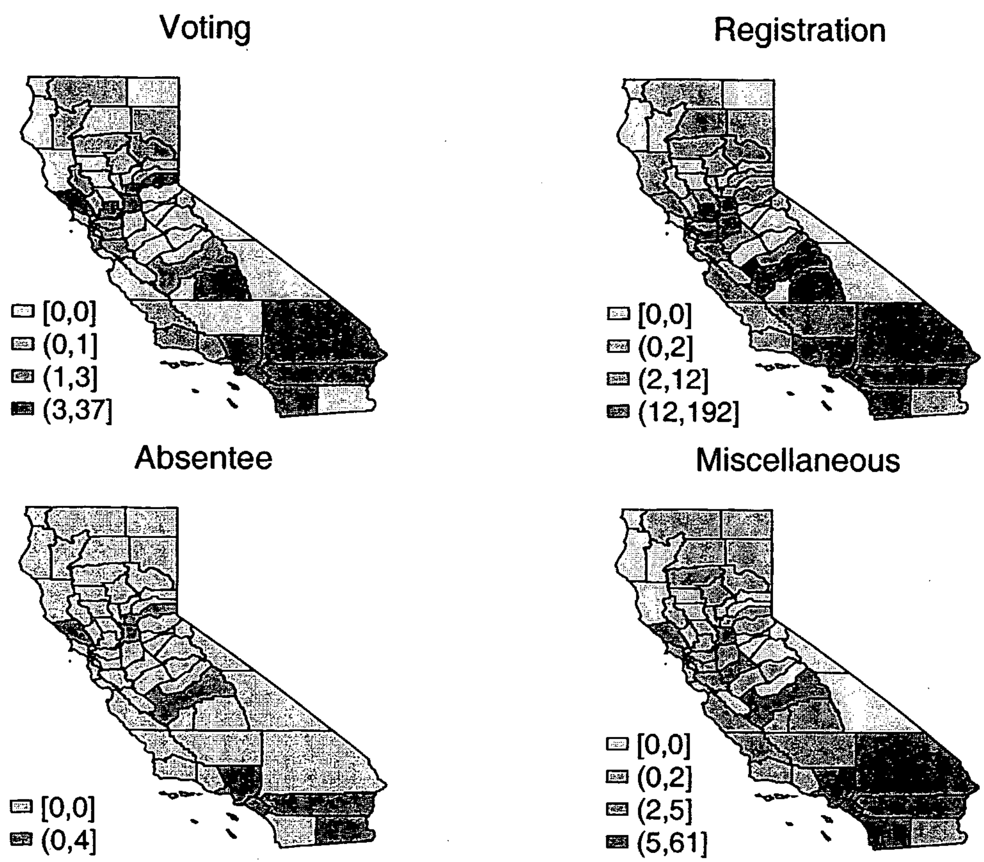
N=167, 48 groups. Standard errors in parentheses. * Significance at 10% level, ** at 5% level. Random effects poisson model with Gaussian distributed random effects. Models without dispersion estimates showed no evidence of overdispersion — estimates are from Poisson regression.

Figure 1: Total Electoral Fraud Violations per County, 1994-1999



Note.

Figure 2: Total Electoral Fraud Violations by Offense Category per County, 1994-1999



Note.

A Appendix

Table 7: Descriptive Statistics for Variables Used in Analysis

	Mean	SD	Min	Max
Violation Cases	3.01	9.61	0.00	131.00
Voter Fraud	0.49	1.78	0.00	18.00
Registration Fraud	1.72	7.90	0.00	124.00
Absentee Fraud	0.03	0.21	0.00	2.00
Miscellaneous Fraud	0.77	2.06	0.00	18.00
Administrative Action	0.36	2.91	0.00	49.00
Conviction	0.15	0.61	0.00	6.00
Lack of Intent	0.49	2.29	0.00	29.00
No Action Taken	0.38	5.22	0.00	97.00
No Violation	0.69	1.81	0.00	13.00
Statute of Limitations	0.47	1.49	0.00	14.00
% American Africans	0.04	0.04	0.00	0.16
% Hispanics	0.24	0.16	0.04	0.75
% High School Graduates	0.69	0.09	0.51	0.85
% Unemployed	0.09	0.05	0.02	0.29
Per capita income	21.07	11.47	0.00	52.76
Total population	0.56	1.30	0.00	9.79
Population Density	0.45	1.20	0.00	8.76
Median Age	36.12	4.60	29.00	44.60
Democratic Vote	0.44	0.13	0.21	0.80
Vote Margin	0.21	0.15	0.00	0.65
Time	2.50	1.71	0.00	5.00
Los Angeles, 1998	0.00	0.05	0.00	1.00

N=342.

Administering Elections to Deter Fraud:

Applying Chain of Custody Procedures to Elections

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1. Introduction

For anyone who has ever watched an episode of *CSI* or remembers the O.J. Simpson murder trial, the idea of a chain of custody is familiar. There is some item—a weapon, a blood droplet, a DNA sample—that is of interest. The challenge is to preserve this item so that it can be produced in court later in the same condition it was in at the crime scene. This is generally done by taking the item and recording its original condition—perhaps a photograph is taken or a written report describing the condition is made. Then, the item is secured in some container and sealed so that the item cannot be accessed without people knowing. Finally, each stage of this process is witnessed, often by various individuals signing reports, the seals, or logs that track the movements of the item of interest. When this process is followed correctly, at the end of the day both sides in the legal dispute do not question the authenticity of the item; the item is assumed to be the original. This chain of custody process is designed to ensure that a fraud is not perpetrated on the court—that the item produced in court is in fact the exact item found at the crime scene.

Such a process is common in the legal world and provides the item in question with evidentiary value; its providence can be traced and confirmed. The beauty of this process is that it is also relatively simple to replicate in other settings; tracking and securing items through the use of seals, logs, and witnesses requires the establishment of processes and procedures but is not otherwise difficult to modify and replicate. However, as we discuss in this paper, this process and procedure has not been uniformly adopted across the various states for the security of voting systems. Many state laws assume a process without defining one. However, there are models for securing ballots and voting systems that provide a chain of custody for the ballots and machines and ensure that the votes produced at the end of the election are authentic.

This paper has five parts. First, we review the principle of chain of custody as it exists in a legal context and consider its application to elections. Second we consider the importance of standard operating procedures as mechanisms for standardizing certain operations within an organization. We then illustrate the chain of custody and standard operating procedure ideal by using two cases: the election law and regulations in the State of Georgia and the election processes in Travis County, Texas. Finally, we consider the most common gaps in state election laws that create potential problems for preserving the chain of custody of ballots in an election environment.

2. Chains of Custody

The concept of a "chain of custody" is a basic principle in the legal study of evidence. The following excerpt from *Evidence Law* provides a basic definition of the concept of a chain of custody:[1]

> Items that were actually involved in the transaction or occurrence that gave rise to the litigation are called 'real evidence.' ...Real evidence is authenticated by showing that the exhibit in court is the actual item from the transaction or event and that it has not undergone any significant change. ...'Real evidence' is frequently authenticated...by reference to its distinctive characteristics... [it] often can be authenticated by simple identification. Documents, for example, are probably the most common 'real evidence' and they are usually authenticated...by identification of the handwriting. Real evidence that is non-documentary is often authenticated...by distinctive characteristics or circumstances.

[1] Roger C. Park, David P. Leonard, and Steven H. Goldberg, *Evidence Law: A Student's Guide to the Law of Evidence as Applied in American Trials*. Thompson-West, 2004.

> When the item of real evidence is not distinctive, or when its condition at the time of testing or trial is critical, a chain of custody is the most effective way to authenticate the exhibit. A perfect demonstration of the chain of custody would include testimony about every link in the chain, from the moment the item was picked up at the scene of the event to the time it was offered into evidence. Each person who touched the exhibit would describe how and from whom it was received, where it was and what happened to it when in the witness' possession, and the condition in which it was received and the condition in which it was delivered to the next link in the chain. The witness would describe the precautions taken to ensure there was no change in the condition of the exhibit and no opportunity for someone not the in chain to have possession of the item.

Chains of custody are especially important for "fungible evidence, because these items have no unique characteristics."[2] One observer has noted that such fungible items should be kept in locked or sealed containers (e.g., boxes or envelopes) that are also signed by the custodians. This process ensures that the fungible items are neither contaminated nor misidentified.[3] In addition, chains of custody are critical "if the condition of the object, not merely its identity, is the relevant issue."[4] One key to the maintenance of a chain of custody is to be able to account for the item in question throughout is handling. There should be no major brakes in the chain of custody for any given item. To give an example of a problematic chain of custody, drugs in a narcotics case were excluded when six people handled three pills

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[2] Paul C. Giannelli, *Understanding Evidence*, Lexis-Nexis, 2006.
[3] Giannelli, 2006.
[4] Giannelli, 2006.

over a nine-day period and there were no marks made on the envelope containing the pills to show how they had been handled nor were there marks on the pills to show they were the same pills that had been seized.[5]

Another key aspect in chains of custody is to be able to provide that there are routine set of procedures in the office—standard operating procedures—for the processing and handling of items. This may also include the use of documentary processes, such as the use of property receipts, to show how an item was handled in the chain of custody. The requirements of chains of custody require that the chain be kept diligently and adequately, but the chain does not have to be "infallible." For example, the "mere possibility of [item] tampering [is an] insufficient basis for excluding evidence."[6] The Seventh Circuit has ruled that "evidence kept in official custody is presumed to be authentic absent specific evidence of tampering"[7] and the First Circuit has noted that "the links in a chain of custody need not be welded together but, rather, may be more loosely connected...chain-of-custody evidence most be adequate—not infallible."[8] Two key aspects of evaluating the adequacy of a chain of custody are (1) ensuring that there has not been an "abuse of discretion" by the government in handling the item in question—that is, they followed basic chain of custody rules—and (2) determining that there has not been bad faith or some proof of tampering in the handling of the evidence. Absent these problems, there is a general presumption that the evidence in question has integrity.[9]

There are interesting similarities and differences in the importance of chains of custody in elections versus a legal setting. The standard for introducing evidence in a legal setting requires first that the chain of custody meet a certain minimum threshold. Once this threshold

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[5] State v. Reese, 56 Ohio App. 2d 278, 382 N.E. 2d 1193, 1194-1195.
[6] Christopher B. Mueller and Laird C. Kirkpatrick, *Evidence, 3rd ed.*, New York: Aspen Publishers, 2003, 1004. The case quote refers to a ruling in United States v. Mora, 845 F2d 233, 237.
[7] United States v. Smith, 70 Fed Appx. 359.
[8] United States v. Myers, 294 F.3d 203.
[9] See Park et al, 2004, 566, especially footnote 23.

is met, the jury can determine if any questions with the chain of custody should cause the weight of the evidence to be discounted. Damning evidence against a defendant that has a weak chain of custody might be considered much less damning when weighted in this manner.

In an election, the same legal standard has to be considered—what standard has to be met for the courts to determine that ballots challenged are legitimate—but there is also another standard that has to be considered. Specifically, does the custody of the election materials—especially the ballots and voting machines—meet a standard whereby the candidates and the voters are confident that the election outcome was fair. If the chain of custody is robust, then everyone can be confident, regardless of the outcome, that the ballots cast are the official ballots and the count is correct. If the chain of custody rules or procedures are weak or questionable, then the losing side may argue that the outcome is unjust. There is research evidence showing that losers are generally disposed to be less confident in election outcomes than are winners.

Weak procedures can serve to exacerbate the loss of confidence among those on the losing side in an election.[10] Ballots are the type of fungible item that requires a high level of care for the authenticity of the item to be maintained. Moreover, the use of the secret ballot means that a voter cannot authenticate their own ballot later.[11] Because of this inability to validate a transaction later, a voter has to be confident that the security of the ballot box is high and that that security remains high throughout the election process—from when it is cast to when the election is certified and a winner chosen. Breaks in the chain can break the confidence of voters and candidates.

3. How Can Chains Be Broken?

[10] See Alvarez, Hall, and Llewellyn 2006 for a review of this literature.

[11] Many states have laws, in fact, that invalidate any ballot that contains any sort of distinguishing or identifying symbol, word, or name written on it.

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One of the major problems that election administrators face is what social scientists call a "principal-agent" problem, which two of us have recently written about (Alvarez and Hall 2006). Take a typical, but stylized, election administration situation. The chief election official in a reasonably-sized county is faced with running an election involving a thousand voting precincts. She must then find these thousand sites, and they will come from a wide variety of sources (schools, churches, businesses, and private residences), all of which are outside of her direct control. She will need to recruit perhaps four to six individuals to staff each of the thousand voting locations (thus needing four to six thousand people). She will also need to recruit dozens (maybe even a few hundred) individuals to get materials to each voting location before the election, to get the materials back from each voting location after the election, and to assist in election night and post-election canvass procedures.

In a typical employment situation, the employer structures the working relationship via some type of contract: they employer specifies the tasks to be done, the compensation for the work, and then sets up some sort of monitoring system to insure that the employee does the task efficiently and effectively. But, the employee has the incentive to "shirk" — that is, to do the job with the least amount of effort, which is counter to the employer's goals. Herein lies the basic "principal-agent" problem, how can the employer set up this relationship to minimize shirking behavior, while also not incurring excessive compensation or monitoring costs?

As we argued in our recent work, election officials face this problem in a particularly severe way: they typically have few resources to adequately compensate the many individuals who they rely heavily on for the proper conduct of an election, ranging from the thousand individuals or entities in our example who are donating the space for each voting location, to the thousands involved in balloting and election logistics.[12] Furthermore, election officials

[12] (Alvarez and Hall 2006)

have few resources to devote to monitoring, especially given that the bulk of the effort of conducting an election occurs on a single day (Election Day), often in geographic locations, which cover many square miles.

The principal-agent problem thus has implications for the chain of custody issue, in a variety of ways. If election officials lack resources to adequately train the thousands involved in the conduct of an election, the simple lack of training may lead some or many of the workers to not understand appropriate chain of custody procedures. If election officials lack resources to compensate the election workers, this may lead the workers to either pay insufficient attention to maintaining the chain of custody, and in some cases, may lead election workers to deliberately violate the chain of custody as they engage in activities that are unrelated to their election work. If election officials cannot adequately monitor Election Day workers, again chain of custody procedures may be violated, either because election workers are deliberately shirking their duties or because a lack of training leads them to misunderstand the chain of custody and to the election workers making incorrect decisions about how to handle election materials that violate the chain of custody.

Note, also, that the principal-agency problem that election officials face can lead to serious chain of custody problems, even without any necessary attempt at political manipulation of an election, or any deliberate malfeasance. That is, poorly trained election workers, who lack supervision, can violate the chain of custody without any incentive or desire on their part to actually affect the outcome of an election, in any particular way.

We have recently seen a variety of real-world cases where the chain of custody issue has arisen in election administration, most likely due to poorly trained and supervised election workers. For example, in the spring primary in Cuyahoga County, Ohio, where we had access to a detailed precinct incident reporting system, we found that more than 15% of precincts reported a problem with seals and locks.[13] The report noted these reports in detail:

> Incidents related to the seals on the voting machines, the printer canisters, and the bags in which post-election materials were to be returned to the election offices accounted for a small number of incidents. A total of 4.2 percent of all incidents were related to seals. Seals were reported broken on machines and canisters most often, with some precincts reporting that they could not seal all of their machines at the beginning of the election. The chain of custody of a voting machine and its ballots can be, in part, confirmed through the sealing and locking of the machine and the tracking of the seals and locks used. If after the election the authenticity of the seals and locks cannot be effectively known—or there are questions as to whether the machines were in fact even sealed and locked throughout the process—it raises questions about the balloting (both the electronic and the associated paper ballots) [ESI 2006, page 60].

Thus, in this one example we have quantitative data that gives us some perspective on how extensive such chain of custody issues can be.

Another type of chain of custody issue arose, again in the spring of 2006, in Cook County, Illinois. There the county was (like Cuyahoga) implementing a new set of voting technologies, and thus was also implementing many new procedures along with the new voting machines. However, the election officials there appear not to have foreseen that a previously-effective procedure, election-night transmission of precinct tallies from the voting locations to the election tally center, might be not work as planned with the new voting technologies. In brief, in what has been reported as having occurred in "dozens" of voting locations, for some

[13] (ESI 2006)

reason the electronic transmission of precinct tallies on election night failed for the election workers. Reportedly, these problems arose either because the election worker could not merge the tallies from the two different voting systems in place in each voting location, or because the electronic transmission technology failed.[14]

But upon failure of the electronic transmission procedure or technology, however, election workers resorted to a variety of mechanisms to get tallies (and data cards from voting machines) to the central election counting location. Reports were that some election officials took cabs, and no doubt other means of public and private transportation to get the data cards and tallies to election headquarters. While the immediate coverage of these innovative means of tally and data card transmission focused on the delays they produced in the early election-night tallies, subsequent coverage focused on how this produced breakdown in the chain of custody in this election: while election workers were probably simply trying to do the right thing, in the absence of training and supervision in this contingency, they were transporting these important election materials in insecure ways. This second example provides additional insight into how easy it is that procedural or technological problems, in a situation where election administrators have little control over election workers, can produce breakdowns in the chain of custody.

3. Standard Operating Procedures

The maintenance of chains of custody is not magical but they do require having standard operating procedures for the handling of items. Standard operating procedures (SOPs) form the basis for many organizational activities and they may or may not be explicitly documented by an organization. As Graham Allison noted,

[14] See http://electionupdates.caltech.edu/2006/03/ballot-chain-of-custody-questions-in.html for details and links to contemporary media coverage of these problems.

> Organizations must be capable of performing actions in which the behavior of large numbers of individuals is carefully coordinated. Assuming performance requires clusters of rehearsed SOPs for producing specific actions...Each cluster comprises a "program" (in terms both of drama and computers) which the organization has available for dealing with a situation. The list of programs relevant to a type of activity....constitutes an organizational repertoire.... When properly triggered, organizations execute programs... The more complex the action and the greater the number of individuals involved, the more important are programs and repertoires as determinants of organizational behavior.[15]

Allison goes on to note the benefits of SOPs. These include the reduction of uncertainty regarding how to handle standard situations, an improvement in average organizational performance in completing tasks involving SOPs, and an improvement in coordination among organizational actors.

The development of such SOPs is typically done in an iterative process.[16] At the inception of a new organization or of a complex enterprise within an existing organization, the organization can either borrow SOPs from a similar organization/enterprise, or it can develop a set of simple SOPs that allow the organization to operate. However, simple SOPs can leave an organization in the position of having routines and procedures that treat all activities equally. Instead, an organization needs to have more complex SOPs that prioritize and structure its activities. The key here is for the organization to have experience, the ability to learn what is most important, and the ability to develop SOPs that routinize these activities.

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[15] (Graham Allison1969, 700)
[16] (Johnson 1990)

Such routines minimize uncertainty and create a stable operating environment for the organization.

As was noted at the outset, SOPs do not have to be formalized. However, SOPs function most effectively when they are created within a legal framework. Such a legal framework provides the organization with a rationale and authorization to engage in the activity in question and to create a process for tackling the issue. Typically, statutory language provides the broad framework for the activity in question; through regulatory activity, the agency can develop detailed SOPs to govern its activities. This legal framework has several benefits for the development of SOPs. Such a framework provides legitimacy to the organization's actions; it is acting within a clear legal mandate. It also formalizes the requirements on the actors implementing the activity. The answer to the question "Why do we do it this way?" is clear; we do it this way because the law requires it. Importantly, this process also allows agencies to learn. The use of regulations allows an organization to change the rules as new experiences and changes in the environment suggest problems or limitations with the current SOPs.

4. Georgia Election Law and Chains of Custody

Shortly after the November 2000 election, the Georgia Secretary of State took a hard look at the performance of voting equipment throughout the state and determined that Georgia actually faired worse than Florida in the total number of undervoted races which appeared at the top of the ballot. In response to those findings steps were undertaken to unite all 159 of Georgia's counties in the use of a single statewide uniform system of voting. During the 2002 General Assembly session, legislation was enacted which provided for the use of Direct Electronic Recording electronic voting machines (DRE's). This legislation provided the broad framework for the future implementation of a system which had yet to be selected. This enabling legislation provided for the manner in which DRE's must function, the required format of the ballot design, maintenance and storage requirements, and basic procedures designed for the tabulation of votes.

In May of 2002 Georgia made its vendor selection and began the process of implementing a uniform system of electronic voting. Prior to this date, Georgia had four types of voting systems which comprised a myriad of different types of equipment developed by a number of different vendors. Each type of system functioned in a different manner and while each of these systems had some sort of governing legislation it was a nearly impossible task to maintain current up-to-date legislation which provided effective oversight and controls in how each jurisdiction applied the use of its particular brand of voting equipment.

One of the challenges faced during this period was the task of not only implementing a uniform system of voting but also that of ensuring that all 159 counties used the system in a consistent manner. With the framework of enabling legislation now in place one of the critical next steps was to develop rules which further defined the use of the system with particular focus on the issues of security and transparency. These procedures were adopted as Rules of the State Election Board, rules which have the effect of law.

The main goal in developing these rules was to draft them in such a manner that there could be no question as to the intent and purpose of the rule, leaving no room for various interpretations or applications of the requirements. Another critical objective was to create a workable set of rules to which election officials could easily adapt. To that end, Georgia convened a number of its forward thinking election officials to assist in proposing and reviewing these rules. To date Georgia still brings election officials to the table for constructive dialogue and review of any newly proposed rules or rule revisions.

The original set of rules were adopted in 2002 and consisted of uniform definitions, detailed descriptions of required ballot design, storage, maintenance, logic and accuracy requirements, and tabulation procedures just to name a few. Each and every year since that time the rules have been tweaked and revised to ensure consistency and uniformity. Since the adoption of the first set of rules in 2002, subsequent revisions and additions have focused on voting system security and include levels of detail designed to deter election fraud at all levels of the process. These security rules have proven to be the most cumbersome and time consuming to administrate but at the same time have been demonstrably effective by adding a level of protection and transparency which is vital to ensuring an elections process which can be proven to be reliable and trustworthy.

Prior to the implementation of a statewide uniform system, chain of custody was mainly relegated to the individual counties who developed procedures which fit their own individual form of voting equipment. Today's rules are specific to one form of voting equipment and they are mandatory not optional. These rules include documented evidence of storage, such as mandatory logs noting the location and custody of each voting unit and tabulation equipment. Election Officials are also required to submit a written request to the State prior to relocating tabulation servers and each move must be approved and reviewed. Oaths must be administered to any person who has contact with the voting equipment if such person is not an employee of the county elections office. In addition the election official must maintain a log of all persons who are allowed access to the storage facility; this includes maintenance and emergency workers.

Much emphasis has been placed on the right of the public to observe all phases of the elections process. One such example is the rule regarding Logic and Accuracy. The original version of these rules, first adopted in 2002, have been revised to provide for greater transparency and public oversight while at the same time striking a necessary balance to protect the equipment from anyone who may wish to attempt fraud or deception during the critical phase of programming and sealing each unit.

Tighter controls have also been placed upon the storage of voting equipment once units have been delivered to the polls. If secure storage space at the poll, with restricted access, is unavailable election officials must provide interlocking padlocked cables to secure voting units. Poll officials are not allowed to use any voting unit whose seal numbers do not match those which were documented publicly during the Logic and Accuracy process without first notifying the elections office of the discrepancy.

Not only have the requirements been tightened for the actual voting units themselves but also for every component of the voting system, including memory cards, voter access cards, unit keys and encoders. Poll officials and election technicians must sign a receipt for each item which is entrusted to them and upon return of the equipment they must account for each item. Any item not returned must be noted on a form specified by the Office of the Secretary of State and the form shall then be returned to the Secretary of State at the time of certification.

Chain of custody rules also extend to the use of DRE's for in person absentee voting. Even though these units remain in the control and possession of election officials at all times, specific rules have been adopted which call for documented evidence of use of each unit on a daily basis. For example, each day the election official is required to record the opening and closing public count totals on every unit. If at any time the opening number does not match that of the previous days closing, the Secretary of State must be notified immediately and that unit shall not be used until the discrepancy can be resolved to the satisfaction of the Secretary of State.

Counties who have strictly adhered to the Georgia Election Code and the Rules of the State Election Board have found that while the added controls can be time consuming and in some instances even costly to perform, the advantage far outweighs the difficulty. Election Officials have been called upon in court contested elections to validate the elections process. Through the presentation of detailed logs and forms which clearly demonstrate a documented chain of custody and standard uniform operating procedures these election officials consistently affirm the dedication exhibited by Georgia Elections Officials to prevent election fraud.

5. Chains of Custody in Travis County

The election officials in Travis County, Texas developed a chain of custody process for their election materials when they transitioned to new electronic voting equipment.[17] Two events—the 2000 election contest in Florida and the events of 9/11—served to shape this effort. The goal of this effort was rather simple: "to make sure that [the] election was protected and the public could trust that it was safe, fare and accurate, no matter what happened [in Travis County] or anywhere in the world."[18] Achieving this goal required creating a process of understanding what it meant to hold an election in Travis County, identifying the threats that existed in this election process, and developing SOPs that mitigate against these threats.

The centerpiece of the model used in Travis County is "the egg," shown in the Figure below. The egg is a metaphor for the election process; the center yoke is most fragile part of the election process, when ballots are being voted. The storage of machines between elections—which are at the top and bottom of the process—also is an area where there are threats to the system, but the overall threat is smaller. By identifying these threats

[17] This section draws from Dana DeBouivoir, Travis County Clerk, "Method for Developing Security Procedures in a DRE Environment," an Election Center Professional Practices Submission, 2005 as well as from a two-day visit to Travis County by two of the authors (Alvarez and Hall) in 2005.
[18] DeBouivoir 2005, 1.

systematically, Travis County has been able to develop SOPs that fit their election operations and mitigate against the specific threats that they face. Many of the threats that they have addressed are relatively low-risk threats but are ones that could be devastating to an election and can be addressed with relatively low-cost solutions. For example, the absentee ballots in Travis County are opened in a trailer outside the main election office. This is designed to ensure that any problem with the mail—such as someone putting anthrax or something that resembles anthrax—into a letter will not contaminate the entire election facility and undermine the ability to count ballots and operate the election.

The efforts in Travis County have centered around three types of activities: transparency, testing, and security. These activities are all key part of an efficient and effective voting process, as identified by the international election community. The Administration and Cost of Elections (ACE) Project – a collaboration of IFES, an international nonprofit organization that supports the building of democratic societies; the International Institute for Democracy and Electoral Assistance (IDEA); and the United Nations Department of Economic and Social Affairs (UNDESA)—has identified eight principles for effective vote counting The underlying normative theory underlying this effort is: "to establish and maintain public confidence in the electoral process, vote counting systems and procedures should incorporate the fundamental principles of vote counting in a democratic election."[19] Achieving this requires that elections should (1) be transparent, (2) be secure, (3) be professionally run, (4) provide accurate results, (5) maintain voter ballot secrecy, (6) provide timely results, (7) have clear responsibility and accountability throughout the counting process, and (8) provide an equitable playing field to all election participants.

[19] See http://www.aceproject.org/main/english/vc/vc20.htm

In Travis County, these various principles are achieved through specific SOPs. Take the issue of physical security. The county has an array of SOPs designed to promote a secure election environment. At the most basic level, there are procedures that govern who can have access to specific parts of the election offices. The public entry area is open to everyone. A next layer of the building is open only to election personnel who have specific keys. Still other parts of the facility are restricted to a smaller number of personnel. Finally, there is the area where the ballots and voting machines used in an actual election are stored. These areas cannot be opened by election officials—only the sheriff department can open them. However, the sheriff department cannot get to the room where these materials are located without being accompanied by an election official with access to the space where these items are stored. This two-key, two-person access rule creates a much higher level of security for the materials than would exist if a single individual could access these materials.

A second related issue is the testing of voting machines. The testing process requires that there be an extensive process for conducting logic and accuracy testing. Once an election is created, it is then tested by teams of election personnel, who vote the ballots and then ensure that the tabulation process works effectively. The County is also able to do a "hash code" test, where they can compare the software they are loading on the voting machines with the software that was certified and is on file with the National Institute of Standards and Technology (NIST). Such testing allows the county to ensure that the version of the software that is loaded onto the voting machines and is used in the election is the certified version of the software.

The final issue is transparency. Travis County addresses this by making all key activities in the election process, such as the logic and accuracy testing of machines or the tabulation process, open to the public. Moreover, designated party officials specifically witness these activities, and are required to complete a form stating the activity that they have witnessed. In the event of a dispute, the County has witnesses and documentation that show who witnessed these key events and when, which provides documentation of a chain of custody of the election process. These documents are then stored within the physical security of the election office, again promoting the chain of custody of these documents.

6. Implications for Best Practice

Effective chain of custody rules provide all of the actors in the election process—candidates, parties, and voters alike—with confidence that the integrity of the voting process and the ballots produced in that process has been maintained. Maintaining the chain of custody will not completely eliminate the possibility for election fraud or election snafus; it will certainly minimize the changes that fraud or snafus can arise, and should help election officials and other interested parties determine where any malfeasance or other problems arose. After the election, the election official should be in a position to show to any interested party where the ballots or related election materials were in the process and who had custody over these items throughout all steps of the process. Outside observers should be able to trace the whereabouts of all election materials, before, during and after the election — and be able to replicate tabulations of election materials and ballots. There should never be a question regarding how ballots were stored or handled in such a situation because the election official will have put into place a process that accounts for how such handling and storage will be done.

The chain of custody process does presume that the election official will think through the voting process from start to finish so that there are no breaks in the chain. In the examples provided above of voting in Cuyahoga County and Cook County, the problems associated with the chain of custody in the voting process occurred because the election officials had not attempted to implement the chain of custody rules for the new voting equipment prior to holding the election. Instead, the election officials either implemented old rules without considering how the new technology interacted with the new rules or implemented new rules without simulating how such rules would work in practice. Such problems strongly suggest that election officials had not trained poll workers clearly and carefully regarding how to implement the new rules. (If such training had been done, problems with the chain of custody would likely have been identified). Given preliminary evidence that has found that the voter-poll worker interaction is important to the confidence that the voter has in the fairness of the election process, such training is important for direct participants in the voting process to be confident that the election was conducted properly.[20]

In our thinking, election administrators should proceed in two ways to develop and implement appropriate chain of custody procedures. The first is that election officials themselves should implement an audit of the procedures in their own jurisdictions, and determine exactly what procedures they have in place now to insure that they have a complete accounting in any election of the exact whereabouts of all election materials, and that there has been appropriate supervision of all election materials before, during and after an election. The results of these custody audits should then allow election administrators the opportunity to implement improvements in their procedures, and to better produce contingency plans for when these procedures go awry.

Second, the election official community, perhaps under the auspices of the Election Assistance Commission or another similar entity, should being to study the chain of custody procedures currently in place across all election jurisdictions in the United States, and after such a survey has been completed, suggest best practices that election officials can use as models for their own jurisdictions. Similarly, such best practice studies should be done

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[20] Thad Hall, Quin Monson, Kelly Patterson, "The Human Dimension of Elections: How Poll Workers Shape Public Confidence in Elections," Unpublished Manuscript.

internationally, and lessons that can be learned (both positive and negative) from the international experience should be documented so that election administrators can learn from the experiences of others.

In the end, maintaining a thorough and appropriate chain of custody of election materials should be one of the primary mechanisms that election officials can use to prevent election fraud. In the event fraud is alleged, if there are strong controls and documentation of custody in place in a jurisdiction, forensic study of the controls and documentation may shed substantial light on whether fraud did occur and might help investigators identify the perpetrators. Furthermore, maintaining the custody of all election materials in an appropriate and controlled way should help election officials as they seek to demonstrate to their primary clients—voters, politicians, and the media—that the election process in their jurisdiction has integrity and that all concerned should be confident in the outcome of there administrative efforts.

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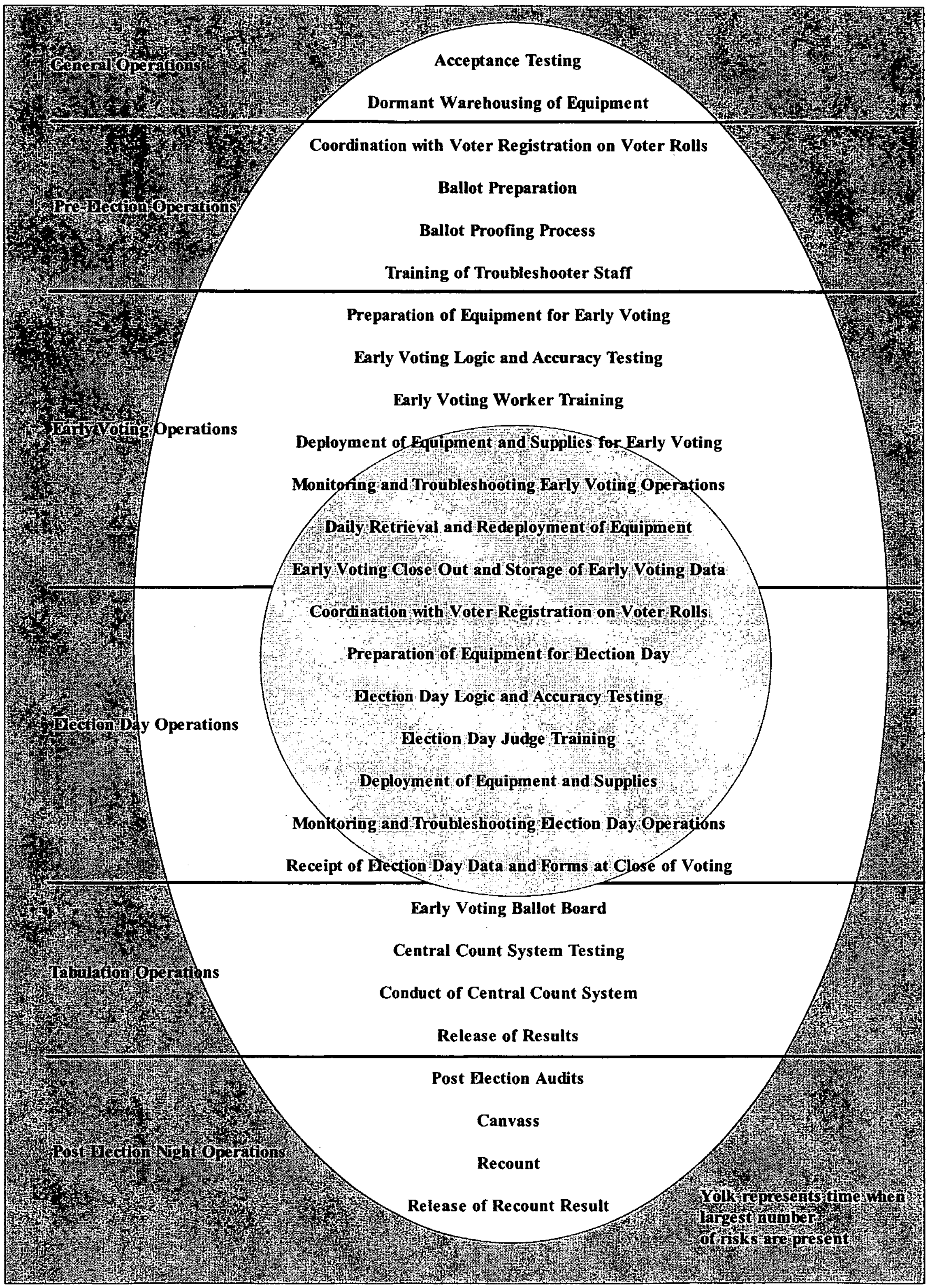
Travis County Risk Assessment Process



016546

Election Forensics: The Second-digit Benford's Law Test and Recent American Presidential Elections *

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Abstract

Election Forensics: The Second-digit Benford's Law Test and Recent American Presidential Elections

While the technology to conduct elections continues to be imperfect, it is useful to investigate methods for detecting problems that may occur. A method that seems to have many good properties is to test whether the second digits of reported vote counts occur with the frequencies specified by Benford's Law. I illustrate use of this test by applying it to precinct-level votes reported in recent American presidential elections. The test is significant for votes reported from some notorious places. But the test is not sensitive to distortions we know significantly affected many votes. In particular, the test does not indicate problems for Florida in 2000. Regarding Ohio in 2004, the test does not overturn previous judgments that manipulation of reported vote totals did not determine the election outcome, but it does suggest there were significant problems in the state. The test is worth taking seriously as a statistical test for election fraud.

Arguably we are not much closer than we were one hundred years ago to understanding how to administer elections that not only are secure and fair but are widely believed to be secure and fair. As long as there have been elections there have been election scandals, and certainly throughout the history of the United States (Gumbel 2005). Notoriously, serious defects in election administration produced the wrong outcome in the 2000 American election for president (Wand, Shotts, Sekhon, Mebane, Herron, and Brady 2001; Mebane 2004b). Responses to the 2000 election controversy have in some ways created as many problems as they have solved. In particular, the events of 2000 sparked a rush to replace older mechanical voting technologies with machines based on electronic computers. Some states made such changes on their own, notably Florida (MacManus 2004), while others were prompted to change by provisions of the Help America Vote Act of 2002 that made use of punchcard ballots and lever machines illegal and provided funds to help pay for their replacement.

Debates about the accuracy and security of different voting technologies have continued up to the present. In 1934, Joseph Harris wrote about a primary defect of paper ballots: "The counting of paper ballots, often lasting far into the night, and made by tired and frequently incomptent persons, is highly conducive to mistakes and frauds. Many election officers and men in public life have realized the inherent defects of this procedure and have sought to remedy it" (Harris 1934, 261). But in 2006, Aviel Rubin lamented the insecurity of a wholly electronic system being used in Maryland: "All of the votes from our entire precinct were right there in the palm of my hand. I could have substituted those five [memory] cards with five identical but bogus cards from my pocket, changing all the ballots, because Diebold did not protect the data with appropriate cryptographic measures." (Rubin 2006, 256). It seems unlikely that technological developments alone will solve the problems and resolve the questions many have about election administration, at least not in the foreseeable future.

While the technology to conduct elections continues to be imperfect, it is useful to investigate methods for detecting problems that may occur. The class of such methods I refer to as *election forensics* are based on statistical tools and are intended to examine elections after the fact. Election forensics focus on the recorded votes, asking whether there are significant anomalies. Do the votes relate to covariates in ways we should expect, or are some votes outliers (Mebane and Sekhon 2004)? Are there other regularities the votes should exhibit? The analysis by Wand et al.

(2001) of the consequences of the butterfly ballot in the 2000 presidential election features both of these kinds of analysis. That study finds that the vote for Buchanan in Palm Beach County was a significant outlier, that the vote for Buchanan on election day ballots in Palm Beach County did not relate to the vote on absentee ballots in the same way as it did in other Florida counties, and that the vote for Buchanan did not track the vote for other Reform Party candidates running in Palm Beach County.

Of course the most challenging ambition for election forensics is to be able to detect election fraud. An examination merely of recorded votes and their correlates can never by itself prove that regularities or irregularities the recorded votes may exhibit are the result of fraudulent intentions. But allegations of fraud may identify specific methods purportedly used to perpetrate the fraud, and the forensic analysis may be able to check for traces of those methods. Such an analysis may help reduce suspicions that election results are fraudulent. A study of votes cast in Ohio in the presidential election of 2004 commissioned by the Democratic National Committee documents many problems with the way the election was administered, but it does not find evidence to support charges that George W. Bush won only because tens of thousands of votes that were cast in favor of John Kerry were instead counted as votes for Bush (Mebane and Herron 2005).

The ideal method for election forensics would be one that depends neither on special assumptions about the particular political configurations contesting the election nor on any particular theory about how the election was conducted. Ruled out, for instance, would be ideas about the coalitions supporting a particular party or candidate. In general we should expect a method that is based on particular theories to be more powerful than a method that eschews such foundations, at least if the theories are correct. But any particular theory is likely also to be controversial. A diagnosis of election fraud—or of its absence—that depends on such theorizing may only be as convincing as is the theory it depends on.

An ideal method for election forensics would also be one that could be applied routinely, perhaps even automatically, without requiring special expertise or sophisticated technical judgment. Such a method might be a foundation for routine election audits. For instance, election officials might apply a simple test to publicly available information and then perform some kind of intensive manual inspection of places or equipment that performed poorly on the test. All precincts might be subject to manual recounts, for example, with the subset chosen for recounting selected at random but with selection probabilities that depend on the outcome of the routine test.

While such an ideal method may well not exist, in this paper I want to illustrate the use of one possible candidate. A method that may come close to satisfying our ideal set of requirements is to test whether the second digits of reported vote counts occur with the frequencies specified by Benford's Law (Raimi 1976; Hill 1995). In Mebane (2006) I study this second-digit Benford's Law (2BL) test for vote counts. I identify a pair of flexible mechanisms that may generally characterize vote counts and that satisfy the 2BL distribution in a wide range of circumstances. I show that the 2BL test is sensitive to many patterns of vote count manipulation, including patterns that would occur in some kinds of election fraud. I argue that while the 2BL test may be generally suitable for precinct-level data, it is not useful for vote counts at the level of individual voting machines.

The 2BL test is not precisely theory free, and its suitability for a wide variety of electoral contexts has yet to be demonstrated. But it does fulfill the goal to free tests for election fraud from being bound to a particular idea about the substance of the campaigns or about the grounds for voters' decisions. The 2BL test uses only the vote counts themselves. No covariates are involved, and no statistical models need to be estimated. Given precinct-level vote count data, the test is very quick to compute (the hard part is obtaining the precinct data). The test results are not sharply diagnostic: Mebane (2006) shows the test can be triggered when votes are not being manipulated at all, and even if manipulation is occurring the test cannot indicate whether the manipulation is due to fraudulent actions.

The relationship between the 2BL test and manual recounts is unclear. While the 2BL test is far from perfect, there are also limits on the kinds of fraud a manual recount may detect. Harris (1934) discusses many kinds of fraud, but there is a basic distinction between two broad classes. One class of frauds involve miscounting the ballots. For example, Harris writes, "The old form of voting fraud—that of repeating—has largely disappeared. It is safer and cheaper to have the election officers steal the election. This may be done by turning in an election return which is not based upon an actual count of the ballots, and does not at all correspond to the votes cast" (Harris 1934, 262). The other class of frauds involves falsifying ballots: "Another method of stealing an election is to stuff the ballot box with marked ballots, writing in the poll books the names of voters who failed to vote or who have died or moved away" (Harris 1934, 262). A routine recount may uncover a fraud of the first kind, but it would do nothing to reveal a fraud of the second kind. But the 2BL test may be sensitive to either kind of fraud. A statistical test, such as the 2BL test, and a program of manual recounts may reinforce one another but they are not redundant.

This potential capacity for the 2BL test to signal frauds that a recount cannot catch is of course one of the strongest arguments in its favor during a time, such as now, when many jurisdictions are using electronic voting machines that do not produce a reliable audit trail, so that useful recounts are impossible. The Diebold system in Maryland that Rubin (2006, 256) writes about is one example. There is very little reason to believe such systems are secure. Rubin's worry about memory cards being swapped is not the most serious potential problem. If malicious software is installed on the machines, as demonstrated by Feldman, Halderman, and Felten (2006), then all the vote counts and every available electronic record may be falsified. Such falsification may be done in ways that would escape detection by the 2BL test. Neither the 2BL test nor any other statistical test is a panacea.

I illustrate use of the 2BL test by applying it to some of the precinct-level votes reported in recent American presidential elections. Because the controversies attending some of these election outcomes have been examined using other tools, this kind of survey will one hopes help build intuition about what the 2BL test can and cannot do. After briefly describing how to perform the 2BL test, I return to Florida, 2000, to see whether the test flags any of the problems that are amply well documented to have happened there. Notwithstanding Florida's comprehensive reform of election administration after 2000, problems occurred in some places—e.g., in Miami-Dade and Broward counties during the 2002 gubernatorial election (New York Times 2002, 2003)—and allegations arose regarding suspected manipulation of the presidential votes in 2004. So I look at data from the 2004 election in Florida. Next I consider whether 2BL test results support the conclusions reached by Mebane and Herron (2005) about the 2004 election in Ohio. After that I take a look at 2BL test results for presidential votes from across the U.S. in 2000 and 2004.

The Second-digit Benford's Law Test for Vote Counts

The 2BL test for vote counts in J precincts uses the distribution of second digits shown in Table 1. Let $q_{B_2 i}$ denote the expected relative frequency with which the second digit is i. These $q_{B_2 i}$ values are the values shown for each digit in Table 1. Let d_{2i} be the number of times the second digit is i among the J precincts being considered, and let $d_2 = \sum_{i=0}^{9} d_{2i}$ denote the total number of second digits. If some precincts have vote counts less than 10, so those small counts lack a second digit, then $d_2 < J$. The statistic I use for a 2BL test is the Pearson chi-squared statistic:

$$X_{B_2}^2 = \sum_{i=0}^{9} \frac{(d_{2i} - d_2 q_{B_2 i})^2}{d_2 q_{B_2 i}} .$$

These statistics may be compared to the chi-squared distribution with 9 degrees of freedom (χ_9^2), which has a critical value of 16.9 for a .05-level test.

*** Table 1 about here ***

In general we will not be examining only one set of precincts or one set of vote counts. We may be interested in the sets of precincts in different counties or different electoral districts. We may want to look at the votes cast for different candidates, for different offices or for different ballot items. To get a simple omnibus test result, one could pool all the different vote counts together. But especially in the case where the test rejects the hypothesis that the second digits of all the vote counts follow the 2BL distribution, it will be more perspicuous to test each natural subset of precincts separately. Doing so may allow one to identify for which set of precincts the test is signaling a problem. So the votes recorded for a presidential candidate in all the precincts in a county may be considered a set and tested together, but each county is treated separately.

When computing the 2BL test for multiple sets of precincts, we need to adjust any assessment of statistical significance for the fact that we are looking at multiple tests. The method I use to do this is to adjust the test level applied to hypothesis tests for the false discovery rate (FDR) (Benjamini and Hochberg 1995). Let $t = 1, \ldots, T$ index the T independent sets of precincts being tested. For instance, if we were testing the precincts in a state separately for each county, T might denote the number of counties in the state. Let the significance probability of the test statistic for each set be denoted S_t. In our case this probability is the upper tail probability of the

χ_9^2 distribution. Sort the values S_t from all T sets from smallest to largest. Let $S_{(t)}$ denote these ordered values, with $S_{(1)}$ being the smallest. For a chosen test level α (e.g., $\alpha = .05$), let d be the smallest value such that $S_{(d+1)} > (d+1)\alpha/T$. This number d is the number of tests rejected by the FDR criterion. If the second digits of the vote counts in all of the sets do follow the 2BL distribution, then we should observe $d = 0$.

Florida 2000 and 2004

For the votes recorded for president in 2000, I have usable data for precincts in 34 of Florida's 67 counties. A few counties have too few precincts to support a useful analysis (e.g., Baker County has eight precincts plus a total for the absentee ballots). I use only counties that have at least ten precincts. But for other counties I simply do not have data. The counties I analyze include the largest Florida counties and most of the most controversial ones.[1]

I compute the 2BL test for the votes recorded for George W. Bush and for Al Gore. I include the totals reported for absentee ballots. I treat the absentee totals as if they come from a separate precinct, sometimes as if they come from more than one if the totals are reported for multiple absentee aggregations. I treat each county's precincts as a separate set, and I also treat separately the Bush and Gore vote totals. For 34 counties and two candidates we have $T = 68$ separate test statistics. Adjusting for the FDR gives 28.7 as the critical value the 2BL statistic must exceed to signal a significant departure for the 2BL distribution.

None of the 2BL test statistics comes close to exceeding that FDR-aware critical value. The largest statistic is $X_{B_2}^2 = 22.7$ for the vote for Gore in Gilchrist County. Four other statistics are larger than the single-test critical value of 16.9—one statistic is for votes recorded for Bush and three are for votes recorded for Gore. None of those counties (Bradford, Manatee, Pinellas and St. Lucie) is among those associated with the biggest controversies in 2000. Notably, both Duval and Palm Beach counties have small statistic values—in both, $X_{B_2}^2$ is just larger than 5 for Gore and slightly larger than 11 for Bush—even though in both counties high proportions of ballots were spoiled due to overvotes.

[1]For 27 counties I obtained data from Dave Leip (http://www.uselectionatlas.org): Bay, Bradford, Brevard, Broward, Charlotte, Clay, Columbia, Duval, Flagler, Hillsborough, Lee, Leon, Marion, Martin, Miami-Dade, Okeechobee, Orange, Osceola, Palm Beach, Pasco, Pinellas, Polk, Putnam, St. Johns, St. Lucie, Seminole and Volusia. I downloaded data for Collier, Gilchrist, Gulf, Hernando, Manatee and Monroe counties from the counties' Board of Elections websites. Data for Escambia County were captured by Dave Rusin.

For the major party presidential votes recorded in Florida in 2000, then, the 2BL test does not signal any significant problems. Clearly the test is not responding to some major distortions that happened in some of the counties. Neither the overvotes nor the undervotes that plagued voters in the state cause the test to trigger.

Let's fast forward, then, to 2004.

By 2004, all of Florida's counties used either precinct-tabulated optical scan or electronic touch-screen voting machine technology. While these and other changes significantly improved election administration and reduced the frequency of errors (MacManus 2004), allegations nonetheless arose that vote totals had been manipulated using both modalities. Allegedly the scanners that tabulated the paper ballots were hacked, so that suspiciously many registered Democrats were recorded as voting for Bush (Washington Post 2004). These allegations largely evaporated in light of the finding that registered Democrats had long been voting for the Republican presidential nominee in the referent parts of Florida (Mebane 2004a). Moreover, careful comparisons between parts of the state that used different kinds of voting technology but were otherwise similar fail to turn up significant differences in voting patterns (Sekhon 2004; Wand 2004). Finally, a manual reinspection of the ballots in three of the supposedly affected counties finds no signs of manipulation (Miami Herald 2004). At the other end there were allegations that some counties that used electronic voting machines recorded a surprisingly large number of votes for Bush (Zetter 2004). The statistical analysis supporting these allegations was widely discredited as unsound, but nonetheless the suspicions they abetted remained in the air (e.g. Miller 2005).

For computing the 2BL test in Florida in 2004, I have usable precinct data from 50 counties.[2] I compute the 2BL test for the votes recorded for Bush and for Kerry. I include the totals reported for absentee ballots and for early voting, treating these totals as if they are from separate precincts as given in the reported data. For 50 counties and two candidates we have $T = 100$ separate test statistics, which implies an FDR-aware critical value for the 2BL statistic of 29.7.

Once again, none of the 2BL test statistics is larger than the FDR-aware critical value. One

[2]I obtained data for all 50 counties from Dave Leip. Added to the set of counties analyzed for 2000 are Alachua, Calhoun, Citrus, Dixie, Gadsden, Hamilton, Hardee, Hendry, Highlands, Holmes, Indian River, Jackson, Lake, Levy, Nassau, Okaloosa, Sarasota, Sumter, Suwannee, Taylor, Wakulla and Walton counties. Missing for 2004 are Hernando, Monroe, Osceola, Polk, St. Lucie and Volusia counties.

value comes close. For the vote for Bush in Manatee County, $X^2_{B_2} = 28.5$. The next largest value is $X^2_{B_2} = 21.4$, for the vote for Bush in Collier County. In all there are eight statistics larger than the single-test critical value of 16.9—three statistics are for votes recorded for Bush and five are for votes recorded for Kerry. Because we are looking at so many different tests, however, these single-test results are not a compelling indication of departures from the 2BL distribution. For the major party presidential votes recorded at the precinct level in Florida in 2004, the 2BL test does not signal any significant problems.

Ohio 2004

When measured in terms of controversies and challenges, clearly the most important state in the 2004 American presidential election was Ohio. The state's electoral votes were pivotal in determining the Electoral College winner, and indeed the votes from the state were challenged in Congress when the electoral votes were counted (New York Times 2005). That challenge was prompted in part by a report that documented extensive and serious difficulties voters in the state experienced due to partisan and poor election administration (House Judiciary Committee Democratic Staff 2005). The Democratic National Committee (DNC) sponsored a study to further document and diagnose what happened in Ohio (Voting Rights Institute 2005).

One of the principal findings of the DNC study was that an examination of precinct vote totals from across the state produces "strong evidence against the claim that widespread fraud systematically misallocated votes from Kerry to Bush" (Mebane and Herron 2005, 2). Specifically this claim refers to the results of matching precincts and wards that did not change boundaries between 2002 and 2004, and then robustly estimating an "overdispersed binomial regression model that has the proportion voting for Kerry depending on the proportion voting for the Democratic candidate for governor (Tim Hagan) in the 2002 election" (Mebane and Herron 2005, 13–14). Using D2002 to represent the proportion voting for Hagan (versus Republican candidate Bob Taft) and $\text{logit}(p) = \log(p/(1-p))$ to denote the log-odds function, the model uses the following linear predictor:

$$Z_i = d_0 + d_1 \text{logit}(\text{D2002}_i) \ . \tag{1}$$

Mebane and Herron state, "If the vote for Kerry were the same as the vote for Hagan except uniformly higher, then we would have $d_0 > 0$ and $d_1 = 1$" (2005, 14). The stated parameter values are almost but not quite what they find. In Table 2 I reproduce the parameter estimates they report (Mebane and Herron 2005, 77, Table 30). The estimates for d_0 are positive, and "the estimate for d_1 is not substantially different from 1.0 in either the precinct analysis or the ward analysis" (Mebane and Herron 2005, 14). But careful examination shows the difference between the estimate for d_1 and the value 1.0 to be statistically significant. Does this small but significant difference point to a big hole in Mebane and Herron's substantive conclusion?

*** Table 2 about here ***

Mebane and Herron's explanation for equation (1) is a bit terse and does not fully articulate the rationale for the parameter values they focus on. Before I consider what the 2BL test may suggest about the matter, let me try to explain their model more explicitly.

First let's think about the votes for Hagan and for Taft in the 2002 gubernatorial election. Suppose for simplicity that the differences in support for Hagan and Taft across precincts can be largely explained in terms of a single variable x—call this "precinct net party strength"—so that the number of votes expected for each candidate in precinct i is well described by the model

$$E(\text{number for Hagen}_i) = n_i \exp(a + bx_i)$$
$$E(\text{number for Taft}_i) = n_i \exp(c + dx_i)\,.$$

Here n_i is a measure of the number of potential voters in precinct i, a, b, c and d are constants with $\text{sign}(b) = -\text{sign}(d)$, and x_i varies from precinct to precinct. This variable x does not prefectly capture the support for each candidate, so the actual number of votes each receives differs somewhat from the expected values. But given the value of x, the proportion of votes expected to go to Hagen is

$$E(\text{D2002}_i) = \frac{\exp(a + bx_i)}{\exp(a + bx_i) + \exp(c + dx_i)} = \frac{1}{1 + \exp[-(A + Bx_i)]}\,,$$

where $A = a - c$ represents the difference between the candidates' overall base levels of support and $B = b - d$ represents the net degree to which their support varies across precincts in relation to x. Applying the logit function to this expectation recovers the linear predictor we would use in a binomial model if we could observe x, namely $\text{logit}[E(\text{D2002}_i)] = A + Bx_i$.

If the vote for Kerry were the same as the vote for Hagan and the vote for Bush were the same as the vote for Taft, then the same model would apply to Kerry's share of the votes as applies to Hagan's. In that case we might hope that our imagined model for $E(\text{D2002}_i)$ does not depart too far from the observable values D2002_i, so that $\text{logit}(\text{D2002}_i) \approx A + Bx_i$ is a good approximation. Since we are not committing to any particular definition for the unobservable variable x, the idea that the approximation is a good one should be easy to accept. But then it follows that if Kerry's vote share were the same as Hagan's, then the linear predictor in the model for Kerry's vote share should be the same as in the model for Hagan's vote share. Hence in equation (1) we would have $d_0 = 0$ and $d_1 = 1$. That is, using D2004 to represent the proportion voting for Kerry instead of Bush, we would have

$$E(\text{D2004}_i) = \frac{1}{1 + \exp[-(A + Bx_i)]} \approx \frac{1}{1 + \exp[-\text{logit}(\text{D2002}_i)]} .$$

In saying that Kerry's support may be "uniformly higher" than Hagan's, the idea is that the difference between the overall base levels of support for Kerry and Bush may be more favorable to Kerry than the corresponding difference between Hagan and Taft is to Hagan. This may happen even while Kerry's and Bush's support varies across precincts in relation to x in the same way as does Hagan's and Taft's. That is, if we use G to denote the difference between Kerry's and Bush's base levels of support and H to denote the net degree to which their support varies in relation to x, so that

$$E(\text{D2004}_i) = \frac{1}{1 + \exp[-(G + Hx_i)]} ,$$

then it may be that $G > A$ while $H = B$. In this case we would have

$$E(\text{D2004}_i) \approx \frac{1}{1 + \exp\{-[G - A + \text{logit}(\text{D2002}_i)]\}} ,$$

which is to say, in equation (1), $d_0 = G - A > 0$ and $d_1 = 1$.

Of course, both Kerry and Bush received more votes than, respectively, Hagan and Taft, which is to say that overall voter turnout was higher in 2004 than in 2002. The increase in turnout reflects not only the difference that generally occurs between midterm and presidential election years, but also the intensive mobilization efforts undertaken in Ohio in 2004 by the candidates, by the political parties by and other groups. It is possible, but of course not necessary, that the mobilization worked in such a way that each candidate was able to increase turnout more in precincts where his party's base support was already stronger. In terms of a simple model expressing the support for Kerry or Bush in terms of the notional 2002 precinct net party strength variable x, the number of votes for each candidate in each precinct might be related to x_i through coefficients u and v, with $\text{sign}(u) = -\text{sign}(v)$ and $H = u - v$. Intense mobilization that was more effective in precincts where a party was already strong would mean that $|u| > |b|$ and $|v| > |d|$, in which case $H/B > 1$.

In this case, in the linear predictor of equation (1) we would no longer expect $d_1 = 1$. That is,

$$\begin{aligned} E(\text{D2004}_i) &= \frac{1}{1+\exp[-(G+Hx_i)]} \\ &= \frac{1}{1+\exp\{-[G-(H/B)A+(H/B)(A+Bx_i)]\}} \\ &\approx \frac{1}{1+\exp\{-[G-(H/B)A+(H/B)\text{logit}(\text{D2002}_i)]\}} . \end{aligned}$$

So in general in equation (1) we have $d_1 = H/B$ and $d_0 = G - (H/B)A$. If the parties in 2004 tended to mobilize more effectively in precincts where they were already strong in 2002, then we should see $d_1 > 1$.

The force of this more explicit motivation for equation (1), then, is to support a claim that the estimated values for d_1 that are significantly larger than 1.0 reflect the tremendous voter mobilization efforts undertaken on behalf of the candidates. If Bush tended to recruit new voters more effectively in precincts where he was already strong, or if Kerry tended to add voters more in places where he was already strong, then $d_1 > 1$ is what we should expect.

Evidently the analysis that refers to equation (1) depends on a relatively elaborate skein of modelling, even though the ideas it expresses are fairly simple. A serious critique of the model could lead one rapidly into some intricate issues. For instance, is the implicit reference to a single "precinct net party strength" dimension truly compelling if we are thinking about the variation in support for Kerry and Bush over all 5,384 precincts (spread over 47 counties) being considered?

And even if we accept the simple framework of the model, do the results constitute a convincing case that there was not significant fraud? For instance, Mark Lindeman took the data used to produce the estimates reported in Table 2 and applied the following algorithm: "in approximately 10% of precincts, switch some uniform % of votes between 10% and 20% (or half of Kerry's share, whichever is less) from Kerry to Bush" (Lindeman 2006). Using such manipulated data to estimate the model, Lindeman reports obtaining results very similar to the ones reported in Table 2: "no change in slope (of course the intercept decreased), essentially no change in the number of zero weights (18), a substantial increase in sigma" (2006). Leaving aside the important question of whether it was feasible in Ohio to switch a fraction of the votes in a random sample of precincts selected from across the state, the implication remains that there are conceivable patterns of fraud that the approach used by Mebane and Herron (2005), based on estimating equation (1), would fail to detect.

A pattern of vote manipulation such as Lindeman imagines may not be detectable by any kind of statistical analysis, but still it is worthwhile to see whether the 2BL test builds confidence in Mebane and Herron's (2005) analysis or adds to skepticism about it.

To compute the 2BL test, I use the data collected as part of the DNC study for all Ohio precincts. To enhance comparability with the data analyzed by Mebane and Herron (2005), I exclude separately reported absentee vote counts. I compute the 2BL test for the votes recorded for Bush and for Kerry. For 88 Ohio counties and two candidates we have $T = 176$ separate test statistics, which implies an FDR-aware critical value for the 2BL statistic of 31.1.

Now, at last, we find a 2BL test statistic that is larger than the FDR-aware critical value. Of the 176 statistics, one is greater than 31.1. This is the statistic for the vote for Kerry in Summit County, which is $X^2_{B_2} = 42.7$. The next largest value is $X^2_{B_2} = 25.2$, for the vote for Kerry in Scioto county. In all there are 21 statistics larger than the single-test critical value of 16.9—nine statistics are for votes recorded for Bush and twelve are for votes recorded for Kerry. Three counties have statistics greater than 16.9 for both candidates' votes, namely, Cuyahoga, Paulding and Summit counties.

These results do not in a strict sense call into question the conclusions Mebane and Herron (2005) reach, at least as far as the analysis based on estimating equation (1) is concerned.

Summit is not one of the counties that had constant precinct boundaries from 2002 to 2004, so precincts from Summit County were not included in the collection of precincts used to estimate equation (1). But the high proportion of the statistics that are greater than the critical value for a single test may indicate that there was vote manipulation that the earlier analysis failed to detect. Having set a single-test level of $\alpha = .05$, we might expect about five percent of the statistics to exceed the corresponding critical value. But about twelve percent ($21/176 = .119$) of the statistics exceed that value. Of the eighteen counties that have such a statistic, seven are not among the counties that had constant precinct boundaries. Nonetheless, finding that 13 of the 94 statistics that do come from such counties are larger than the single-test critical value is not especially reassuring. Since none of these 13 statistics is close to the FDR-aware critical value—for 94 tests this would be 29.5—the situation with the constant-boundary counties is one where the test signal has not been turned on but it is not clear that it is firmly off.

Presidential Votes across the United States in 2000 and 2004

We have looked at 2BL test statistics from Florida in 2000 and 2004 and from Ohio in 2004, and we have found only one that is large once we take into account the fact that we are considering many such statistics. Are significant 2BL test results in general rare? If so, it might mean either that election fraud that involves manipulation of the votes is genuinely rare, or that the 2BL test is just not sufficiently sensitive. Or perhaps it is simply that despite all the controversy attending the voting in Florida and Ohio in recent elections, in fact those states are exceptional in having relatively little of the kinds of vote shifting that the 2BL test in principle is able to detect. Perhaps in other places—or in other notorious places—more large 2BL test statistics will appear.

To get some perspective on this, I analyze precinct data reporting votes for president across the U.S. in 2000 and 2004. Again I compute the 2BL test for the votes recorded for Bush and for Kerry. Precinct data are not readily available from every state, nor necessarily from every county in states for which some data are obtainable. I use data obtained from Dave Leip—for 35 states in 2000 and for 42 states in 2004—supplemented with other information.[3] I include only counties that have at least ten precincts. Except for the data from Ohio in 2004, I include totals that are

[3]Data for Florida in 2000 and Ohio in 2004 are as described above. For Pennsylvania in 2004 I used data obtained from the Pennsylvania State Election Commission (in a file named PA-2004G-Presidential.xls). I downloaded data for Cook County, IL, in 2004 from Cook County and Chicago election board websites.

reported for absentee ballots as separate precincts. Overall, the analysis uses data from 1683 counties and 129,144 precincts in 2000 and from 1671 counties and 140,373 precincts in 2004.[4] Doing the FDR adjustment for the 2BL test statistics taken over the whole country in each year—i.e., $T = 3366$ and $T = 3342$—gives FDR-aware critical values of about 38.4.

From the boxplot display of the distribution of the 2BL test statistics shown in Figure 1, one can see that there are not many statistics as large as that global FDR-aware critical value. Indeed, in all there are six counties that have 2BL statistics larger than 38.4: Los Angeles, CA, and Cook, IL, in both 2000 and 2004; DuPage, IL, and Hamilton, OH, in 2000; and Summit, OH, and Davis, UT, in 2004. The largest statistics in both years occur for Los Angeles: the statistic for the votes for Gore is $X^2_{B_2} = 54.8$, and for the votes for Kerry it is $X^2_{B_2} = 70.2$.

*** Figure 1 about here ***

The omnibus FDR-aware critical value of 38.4 is lofty indeed. More realistically—but less skeptically—we might consider each county together only with the other counties in the same state. Such a perspective would be relevant, for instance, if each state's election officials were to use the 2BL test to screen the election results from their state. In this case it is reasonable to determine the FDR-adjusted critical value for each state by taking into account only the number of test statistics that may be computed for that state. That is, T equals the number of counties in the state for which there is usable data, multiplied by the number of candidates for whose vote totals we are computing the test.

In 1934, Harris presented case studies detailing election frauds in four cities: Philadelphia, Chicago, Pittsburgh and Cleveland. He wrote, "Recent investigations have brought to light election scandals in the particular cities covered, but it would be a mistake to assume that other cities are free of election frauds" (Harris 1934, 320). Nearly seventy years later, three of these cities again are marked as worrisome. Of course the county containing Chicago (Cook, IL) has already been flagged as having significant 2BL test statistics even when the omnibus FDR adjustment is used.

Table 3, which shows the results of applying the state-specific FDR adjustment, includes

[4]The states with at least one county in the analysis in 2000 are AK, AL, AR, AZ, CA, DC, DE, FL, HI, IA, ID, IL, IN, KS, LA, ME, MI, MN, MT, NC, ND, NH, NJ, NY, OH, PA, RI, SC, SD, TN, VA, VT, WA, WI and WY. For 2004 the states with at least one county in the analysis are AK, AL, AR, AZ, CA, CO, DC, DE, FL, GA, HI, IA, ID, IL, IN, KS, LA, MD, ME, MI, MN, MO, MT, NC, ND, NH, NJ, NM, NV, NY, OH, OR, PA, RI, SC, SD, TN, TX, UT, VA, VT, WA, WI and WY.

among the counties with significantly large 2BL test statistics in 2000 not only Cook, IL, and adjacent counties DuPage and Lake, IL, but also Philadelphia, PA, and Summit, OH, which is adjacent to Cleveland.[5] Cook, DuPage and Summit carry through into 2004, but the 2BL statistics for Philadelphia are not quite as large for that year. In 2004, Phildelphia has $X^2_{B_2} = 21.8$ and $X^2_{B_2} = 23.4$ respectively for Kerry's and Bush's vote totals. The other counties that appear in this list are a mix of urban and rural places.

*** Table 3 about here ***

Over the whole country, the frequency of large 2BL test statistics does not greatly exceed the nominally expected values. There are 230 2BL test statistics greater than the single-test critical value in 2000, and there are 224 test statistics in 2004 that are that large. These counts imply proportions of large statistics not much greater than the single-test level of $\alpha = .05$ would suggest. We have $230/3366 = .068$ in 2000 and $224/3342 = .067$ in 2004. Even more then, perhaps, does the much higher proportion of nominally large 2BL statistics found for Ohio 2004 stand out.

Discussion

The good news is that, as measured by the 2BL test, signs of election fraud in recent American presidential votes seem to be rare. Several of the places that turn up with significantly large 2BL test statistics have been notorious for a century or more. That the 2BL test finds these places suggests it is probably on to something. These results using data from actual American elections tend to reinforce the simulation results of Mebane (2006) that show the 2BL test can spot many patterns of manipulation in vote counts.

The 2BL test is strikingly insensitive to some kinds of distortions that we know significantly affected many votes. The most interesting case here is Florida, 2000. Notwithstanding the well established fact that tens of thousands of votes were lost to undervotes and overvotes throughout the state, the 2BL test does not signal any significant problems with the precinct vote totals. Perhaps the test would have indicated problems if we had 2000 precinct data from all of Florida's counties. But the current analysis does include the largest counties and most of the most controversial ones. The test finds nothing untoward about those places.

[5]Pittsburgh escapes inclusion. Allegheny County has $X^2_{B_2} = 21.2$ for the votes for Gore but 2BL statistics less than 16.9 for Bush in 2000 and for both Bush and Kerry in 2004.

The 2BL test gives a mixed message about Ohio, 2004. We can clearly reject the hypothesis that precinct vote counts throughout the state follow the 2BL distribution. The 2BL test statistic for Summit County is significantly large even when we take the FDR fully into account. Also, suspiciously many counties have 2BL test statistics that exceed the critical value we would use if we were looking at only one test. The 2BL test results do not overturn previous judgments that manipulation of reported vote totals did not determine the election outcome in Ohio, but neither do they completely dissipate the foul odor of suspicion that continues to hang over the state's results.

On the whole, this look at recent presidential election results through the lens of the 2BL test seems to me to enhance the case that it is worth taking seriously as a statistical test for election fraud. The 2BL test cannot detect all kinds of fraud, and significant 2BL test results may occur even when vote counts are in no way fraudulent. But, considering the results from Florida in 2000, the test seems not to be confused by some kinds of distortions in elections that do not involve manipulating the vote totals. Further investigations of the test's performance are clearly warranted.

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Table 1: Frequency of Second Digits according to Benford's Law

0	1	2	3	4	5	6	7	8	9
.120	.114	.109	.104	.100	.097	.093	.090	.088	.085

Table 2: Vote for Kerry versus Bush: 2002 Gubernatorial Vote Regressor

	Precincts			Wards		
Variable	Coef.	SE	t-ratio	Coef.	SE	t-ratio
(Intercept)	0.456	0.00589	77.5	0.64	0.0224	28.6
Logit(Democratic Vote in 2002)	1.040	0.00627	166.0	1.04	0.0266	39.1

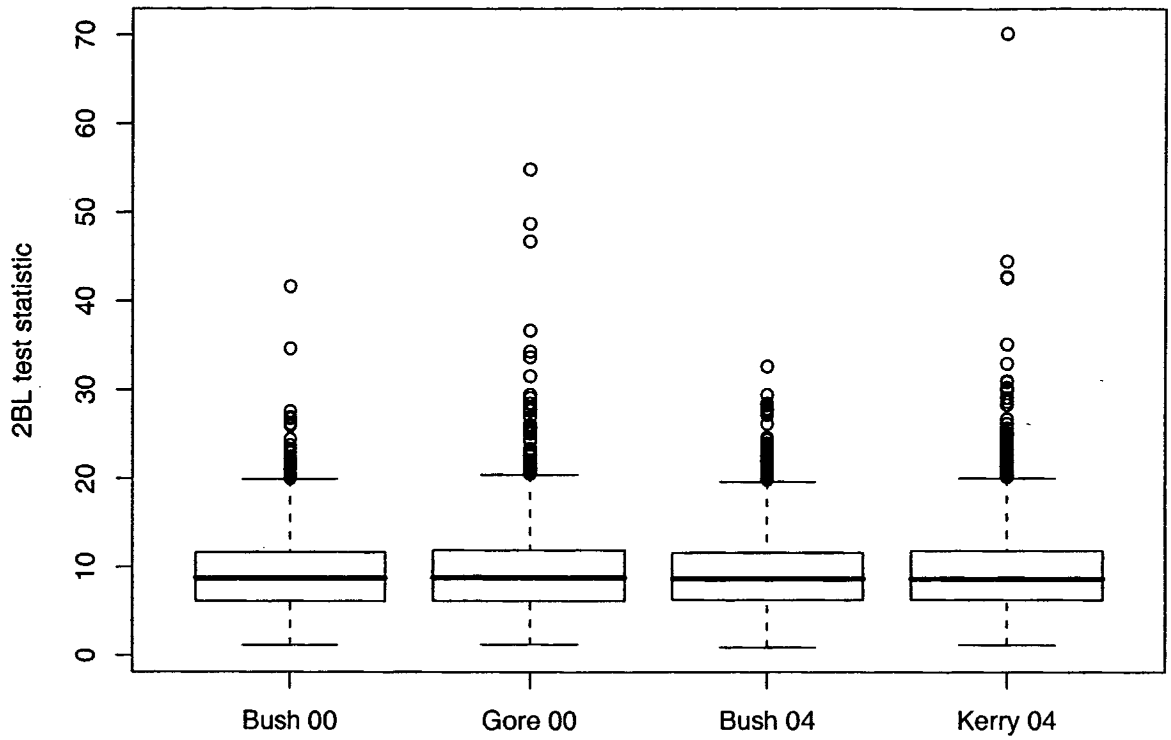
Notes: Robust (tanh) overdispersed binomial regression estimates. For each precinct or ward, the dependent variable counts the number of votes for Kerry versus the number of votes for Bush. Precincts: LQD $\sigma = 2.98$; tanh $\sigma = 2.87$; $n =$ 5,384; 17 outliers. Wards: LQD $\sigma = 9.09$; tanh $\sigma = 8.91$; $n = 357$; no outliers.

Table 3: Counties with Signficant 2BL Tests using State-specific FDR Adjustment

	2000				
		Gore votes		Bush votes	
County	J	d_2	$X^2_{B_2}$	d_2	$X^2_{B_2}$
Los Angeles, CA	5,045	5,011	54.8	4,930	20.3
Kent, DE	61	61	9.0	61	22.2
Latah, ID	34	31	36.7	34	3.8
Cook, IL	5,179	5,097	46.7	4,145	24.4
Dupage, IL	714	714	28.0	714	41.6
Lake, IL	403	403	33.7	402	16.1
Passaic, NJ	295	295	27.7	294	5.6
Hamilton, OH	1,025	1,020	48.7	988	8.9
Hancock, OH	67	67	34.3	67	9.9
Summit, OH	624	624	31.6	612	11.6
Philadelphia, PA	1,681	1,680	29.5	1,249	34.7
King, WA	2,683	2,665	27.0	2,641	8.9

	2004				
		Kerry votes		Bush votes	
County	J	d_2	$X^2_{B_2}$	d_2	$X^2_{B_2}$
Los Angeles, CA	4,984	4,951	70.2	4,929	12.4
Orange, CA	1,985	1,887	26.2	1,904	32.6
Jefferson, CO	324	323	30.0	323	10.4
Kootenai, ID	75	75	30.9	75	12.1
Cook, IL	4,562	4,561	44.5	4,026	27.8
DuPage, IL	732	732	35.2	732	9.1
Clay, MO	76	76	28.4	76	4.0
Summit, OH	475	475	42.7	474	21.0
Davis, UT	213	212	42.6	213	6.0
Utah, UT	247	241	9.2	246	27.6
Benton, WA	177	168	29.2	173	14.8

Figure 1: Precinct-level US 2000 and 2004 Presidential Vote 2BL Test Statistics by County



Note: Each boxplot shows the distribution of the 2BL statistics for a party's seccion-level vote counts over the 300 districts.

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ELECTION FRAUD REFERENCES

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