**Government 320: Public Opinion and Public Choice**

**Spring 2007**

**Tuesday and Thursday 2:55–4:10 (MG 165)**

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**Office hours: M 2–4 or other times by appointment.**

**Course web page:**

`http://macht.arts.cornell.edu/wrm1/gov320.html`

- **election fraud: is fraud (legitimate) political manipulation?**
- **detecting anomalies**
- **distinguishing anomalies from fraud**
- **diagnosing fraud**

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- **history of fraudulent elections in the United States**

- election fraud: is fraud (legitimate) political manipulation?
- detecting anomalies
- distinguishing anomalies from fraud
- diagnosing fraud
- history of fraudulent elections in the United States
- elsewhere (and election monitoring: observers, PVT)

- detecting anomalies
- Florida 2000: wrong outcome, but why?
  - ex-felon lists
  - butterfly ballot
  - other machines and ballots

- detecting anomalies
- Florida 2000: wrong outcome, but why?
  - ex-felon lists
  - butterfly ballot
  - other machines and ballots
- Florida 2004: fraud alleged
  - conservative Democrats
  - hacked machines?

- Election Forensics
  - statistically analyzing recorded vote counts to detect anomalies and try to diagnose fraud
- regularities and departures from regularities
  - using relationships with covariates to detect outliers
  - checking whether vote counts match expected distributions

- **election forensics and recounts**
  - **two kinds of errors (or frauds) in vote counts**
    - **miscounting the ballots that were cast**
    - **counting falsified ballots**

- **election forensics and recounts**
  - **two kinds of errors (or frauds) in vote counts**
    - **miscounting the ballots that were cast**
    - **counting falsified ballots**
- **recounts can detect the first kind but not the second kind**
  - **exception: physically inspecting ballots may spot signs that some or all are fake**
  - **this depends on there being physical ballots to inspect**
- **statistical analysis may be able to detect both kinds of distortions**

- **an example from the 2006 Mexican presidential election**
  - **relationship between presidential votos nulos and senate votos nulos**
  - **use casilla (ballot box) counts**
  - **the linear predictor is**

$$Z_i = d_0 + d_1 \textbf{logitz}(\textbf{SenateVN}_i)$$

**SenateVN represents the proportion of votos nulos for senate votes at casilla** $i$
**logitz**$(p)$ **denotes the log-odds function adjusted to handle zero counts (add** $1/2$ **to each count before computing** $p$**)**

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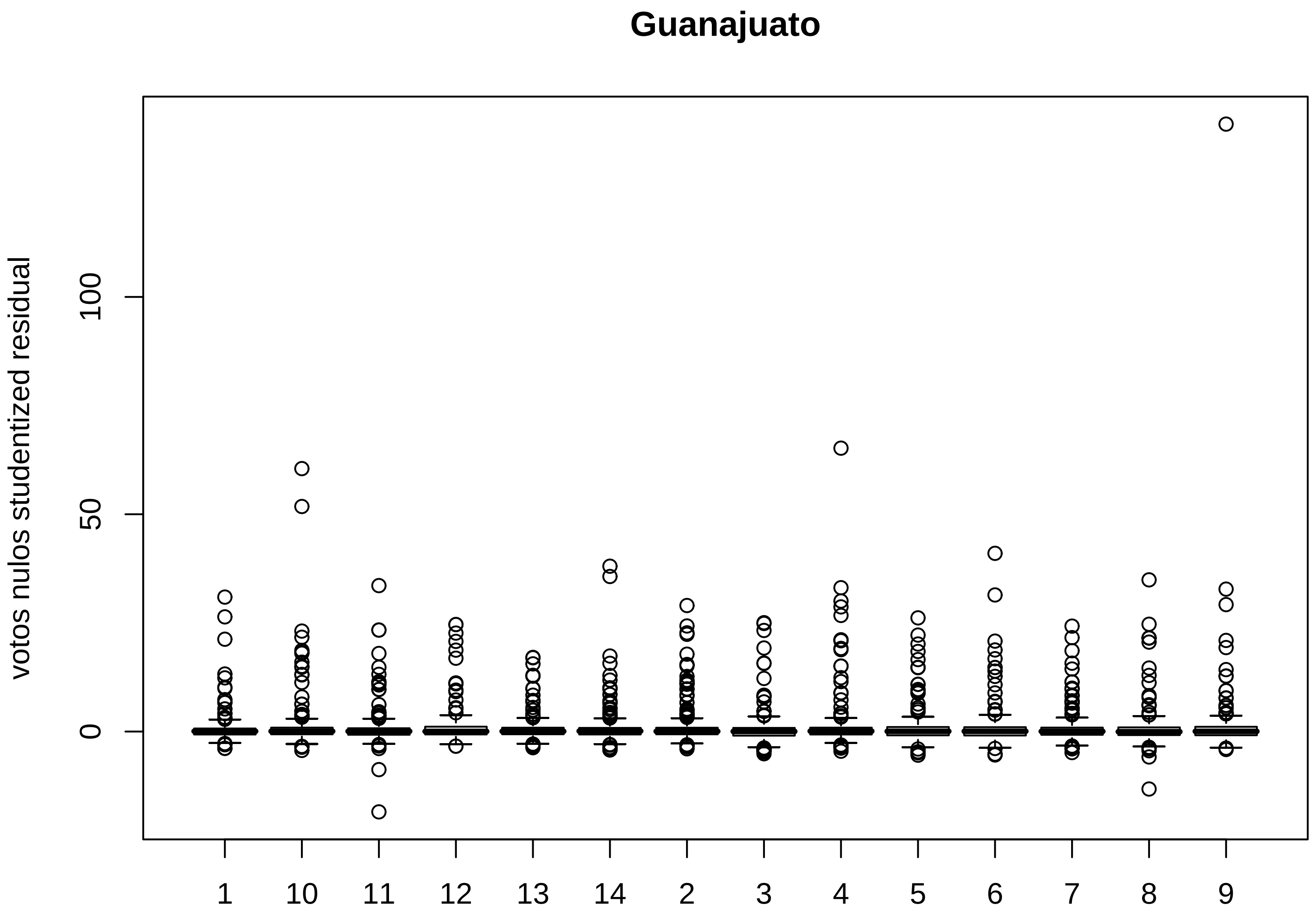
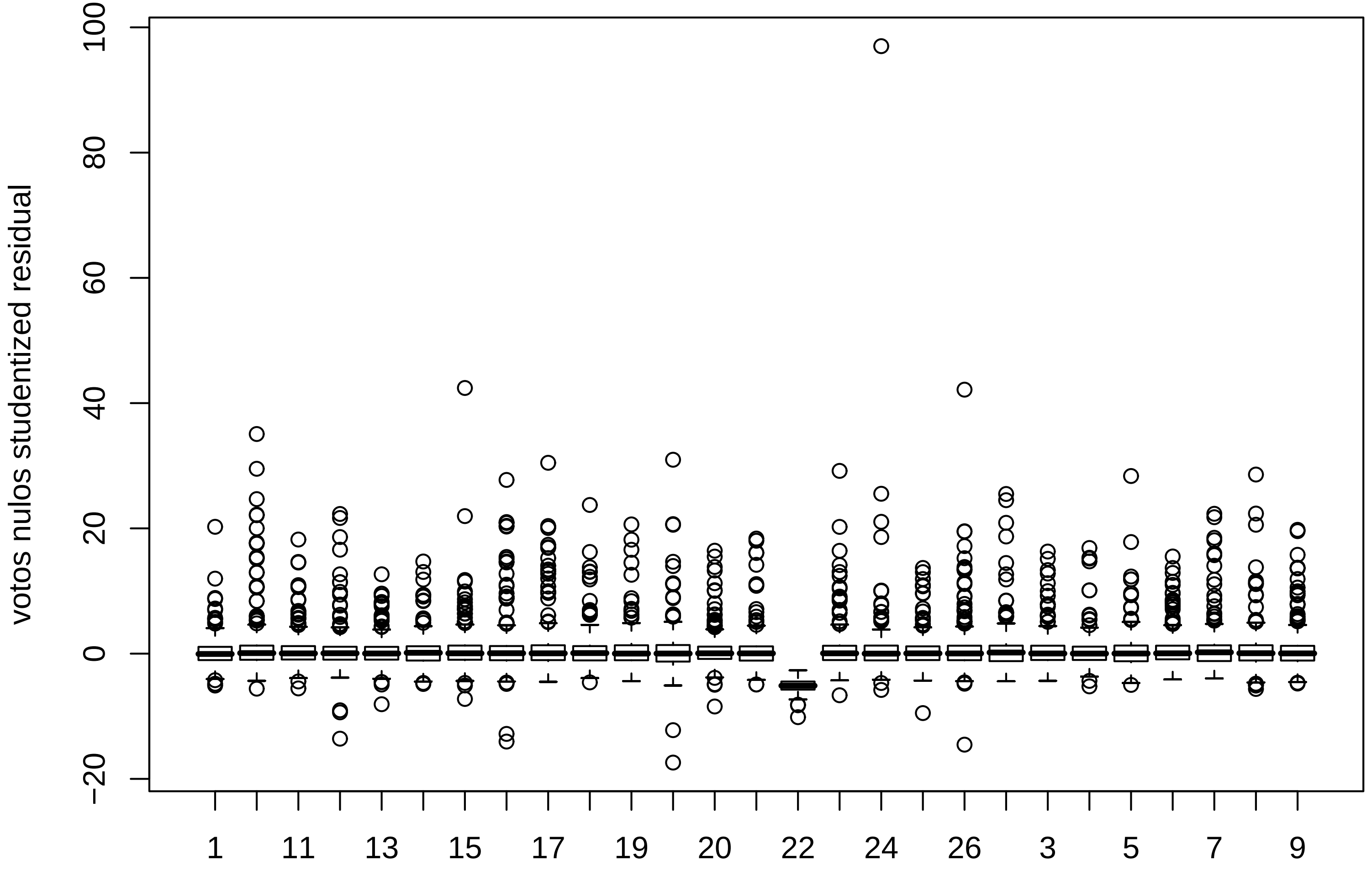
  - **estimate separately for each legislative district**
  - **outliers are prevalent**



Guanajuato
votos nulos studentized residual
0
50
100
1
10
11
12
13
14
2
3
4
5
6
7
8
9

## Distrito Federal



- an example from the 2006 Mexican presidential election
  - relationship between presidential votos nulos and senate votos nulos
  - use casilla (ballot box) counts
  - estimate separately for each legislative district
  - outliers are prevalent
    - 130,020 casillas are in the analysis (from 299 districts)

| proportion of residuals larger than | | |
|---|---|---|
| 2 | 3 | 4 |
| .11 | .06 | .04 |

- **checking whether vote counts conform with expected distributions**

- checking whether vote counts conform with expected distributions
- digits of vote counts and Benford's Law
  - compare vote counts' second digits to the second digit Benford's Law (2BL)
  - there are strong arguments against expecting vote counts' first digits to satisfy Benford's Law for first digits

Frequency of First and Second Digits according to Benford's Law

| digit | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| first | — | .301 | .176 | .124 | .097 | .079 | .067 | .058 | .051 | .046 |
| second | .120 | .114 | .109 | .104 | .100 | .097 | .093 | .090 | .088 | .085 |

- **the statistic is**

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

**where**

  - $q_{B_{2i}}$ **is the expected relative frequency with which the second significant digit is** $i$ **(the values shown in the second line of table of Benford's Law frequencies)**
  - $d_{2i}$ **is the number of times the second digit is** $i$ **among the precincts being considered**
  - $d_2 = \sum_{i=0}^{9} d_{2i}$

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- **with one set of counts (for one office in one area), use the critical value of** $\chi^2_9$ **for test level** $\alpha = .05$**, which is 16.9**
- **looking at multiple sets of counts, control for the false discovery rate (FDR)**

- an example from the 2004 American election: Florida, Miami-Dade County
  - vote counts for major party candidates for president (Kerry and Bush) and for the Senate (Castor and Martinez)
  - also vote counts for eight proposed constitutional amendments
  - with 20 tests, the FDR-controlled critical value for $\chi^2_9$ is 25.5

Florida Constitutional Amendments on the Ballot in 2004

| | | Yes | No |
|---|---|---|---|
| 1 | Parental Notification of a Minor's Termination of Pregnancy | 4,639,635 | 2,534,910 |
| 2 | Constitutional Amendments Proposed by Initiative | 4,574,361 | 2,109,013 |
| 3 | The Medical Liability Claimant's Compensation Amendment | 4,583,164 | 2,622,143 |
| 4 | Authorizes Voters to Approve Slot Machines in Parimutuel Facilities | 3,631,261 | 3,512,181 |
| 5 | Florida Minimum Wage Amendment | 5,198,514 | 2,097,151 |
| 6 | Repeal of High Speed Rail Amendment | 4,519,423 | 2,573,280 |
| 7 | Patients' Right to Know About Adverse Medical Incidents | 5,849,125 | 1,358,183 |
| 8 | Public Protection from Repeated Medical Malpractice | 5,121,841 | 2,083,864 |

Miami-Dade Election Day First-digit Benford's Law Tests

| item | Benf. | item | Benf. |
|---|---|---|---|
| Bush | 29.3 | Am. 4 Yes | 144.8 |
| Kerry | 39.9 | Am. 4 No | 119.6 |
| Martinez | 35.6 | Am. 5 Yes | 115.4 |
| Castor | 22.0 | Am. 5 No | 27.6 |
| Am. 1 Yes | 86.2 | Am. 6 Yes | 98.8 |
| Am. 1 No | 80.5 | Am. 6 No | 84.0 |
| Am. 2 Yes | 95.6 | Am. 7 Yes | 130.3 |
| Am. 2 No | 60.0 | Am. 7 No | 49.9 |
| Am. 3 Yes | 60.5 | Am. 8 Yes | 123.0 |
| Am. 3 No | 51.5 | Am. 8 No | 102.6 |

Note: $n = 757$ precincts. Pearson chi-squared statistics, 8 df.

Miami-Dade Election Day Second-digit Benford's Law Tests

| item | Benf. | item | Benf. |
|---|---|---|---|
| Bush | 7.9 | Am. 4 Yes | 3.3 |
| Kerry | 9.5 | Am. 4 No | 5.7 |
| Martinez | 8.9 | Am. 5 Yes | 17.9 |
| Castor | 12.0 | Am. 5 No | 5.8 |
| Am. 1 Yes | 2.5 | Am. 6 Yes | 4.3 |
| Am. 1 No | 5.5 | Am. 6 No | 9.1 |
| Am. 2 Yes | 16.7 | Am. 7 Yes | 17.1 |
| Am. 2 No | 7.2 | Am. 7 No | 8.4 |
| Am. 3 Yes | 3.3 | Am. 8 Yes | 12.7 |
| Am. 3 No | 12.9 | Am. 8 No | 6.5 |

Note: $n = 757$ precincts. Pearson chi-squared statistics, 9 df.

- why should we expect vote counts to satisfy 2BL?
- model vote counts as results of particular mixtures
- at least two mechanisms can generate counts that satisfy 2BL (and not 1BL)
  - mechA: mix support that varies over precincts with a small random frequency of errors
  - mechB: mix support that varies over precincts with varying precinct sizes

2BL Tests for Simulated Precinct Vote Counts (First Mechanism)

| Size | Benf. | Size | Benf. | Size | Benf. | Size | Benf. |
|---|---|---|---|---|---|---|---|
| 500 | 10.3 | 1,500 | 18.6 | 3,800 | 11.3 | 7,100 | 8.3 |
| 600 | 9.5 | 1,600 | 21.6 | 3,900 | 9.2 | 7,200 | 9.1 |
| 700 | 10.0 | 1,700 | 19.9 | 4,000 | 12.2 | 7,300 | 8.9 |
| 800 | 9.0 | 1,800 | 17.5 | 4,100 | 10.5 | 7,400 | 9.3 |
| 900 | 10.0 | 1,900 | 14.0 | 4,200 | 10.4 | 7,500 | 7.8 |
| 1,000 | 9.7 | 2,000 | 14.1 | 4,300 | 9.1 | 7,600 | 7.9 |
| 1,100 | 10.4 | 2,100 | 9.7 | 4,400 | 10.2 | 7,700 | 9.1 |
| 1,200 | 12.0 | 2,200 | 8.7 | 4,500 | 12.3 | 7,800 | 10.9 |
| 1,300 | 12.3 | 2,300 | 11.6 | 4,600 | 9.9 | 7,900 | 8.7 |
| 1,400 | 13.4 | 2,400 | 12.2 | 4,700 | 11.2 | 8,000 | 9.0 |

Note: Chi-squared statistics, 9 df, 25 Monte Carlo replications.

- **why should we expect vote counts to satisfy 2BL?**
- **while precinct vote counts should satisfy 2BL, counts on voting machines used in each precinct should not**
  - **voting machine counts are subject to "roughly equal division with leftovers" (REDWL)**
  - **simulations verify the REDWL mechanism**

- why should we expect vote counts to satisfy 2BL?
- while precinct vote counts should satisfy 2BL, counts on voting machines used in each precinct should not
  - voting machine counts are subject to “roughly equal division with leftovers” (REDWL)
  - simulations verify the REDWL mechanism
- and actual machine-level vote counts do not satisfy 2BL

Miami-Dade Election Day Second-digit Benford's Law Tests

| item | Benf. | item | Benf. |
|---|---|---|---|
| Bush | 17.2 | Am. 4 Yes | 43.5 |
| Kerry | 44.0 | Am. 4 No | 25.4 |
| Martinez | 11.5 | Am. 5 Yes | 57.6 |
| Castor | 12.7 | Am. 5 No | 25.6 |
| Am. 1 Yes | 43.6 | Am. 6 Yes | 29.7 |
| Am. 1 No | 19.8 | Am. 6 No | 15.3 |
| Am. 2 Yes | 38.7 | Am. 7 Yes | 53.2 |
| Am. 2 No | 11.9 | Am. 7 No | 136.7 |
| Am. 3 Yes | 78.0 | Am. 8 Yes | 54.2 |
| Am. 3 No | 25.7 | Am. 8 No | 23.2 |

Note: $n = 7,064$ precinct-machines. Pearson chi-squared stats, 9 df.

- **the 2BL test can detect artificial manipulations of vote counts that otherwise satisfy 2BL**
- **simulations show a wide range of ways to manipulate the votes can be detected**
  - **adding votes**
  - **subtracting votes**
  - **switching votes**

Simulated “Repeater” Vote Switching: Receive Votes When Above Expectation

| | Receiver (cand. 1) | | | Donor (cand. 2) | | |
|---|---|---|---|---|---|---|
| fraction | 500 | 1000 | 2000 | 500 | 1000 | 2000 |
| 0 | 9.6 | 8.7 | 12.4 | 11.1 | 11.9 | 13.0 |
| 0.01 | 11.2 | 13.3 | 15.0 | 9.3 | 10.3 | 11.4 |
| 0.02 | 12.7 | 17.7 | 27.1 | 8.8 | 12.2 | 13.2 |
| 0.03 | 15.5 | 27.2 | 44.1 | 10.5 | 10.7 | 14.2 |
| 0.04 | 25.6 | 41.8 | 68.9 | 10.9 | 13.1 | 16.9 |
| 0.05 | 24.8 | 38.1 | 67.2 | 11.2 | 13.6 | 17.1 |
| 0.06 | 23.6 | 42.2 | 74.2 | 12.0 | 15.1 | 19.3 |
| 0.07 | 28.2 | 48.4 | 89.9 | 12.9 | 15.6 | 22.1 |
| 0.08 | 33.5 | 58.1 | 112.8 | 13.5 | 17.3 | 26.5 |
| 0.09 | 32.7 | 56.5 | 107.7 | 12.9 | 18.0 | 29.3 |

Simulated "Repeater" Vote Switching: Receive Votes When Below Expectation

| | Receiver (cand. 1) | | | Donor (cand. 2) | | |
|---|---|---|---|---|---|---|
| fraction | 500 | 1000 | 2000 | 500 | 1000 | 2000 |
| 0 | 9.6 | 10.3 | 12.8 | 9.7 | 10.3 | 12.2 |
| 0.01 | 10.0 | 13.1 | 15.0 | 10.4 | 11.4 | 14.3 |
| 0.02 | 12.6 | 18.3 | 28.0 | 11.8 | 12.7 | 19.9 |
| 0.03 | 18.6 | 26.8 | 50.3 | 13.5 | 18.3 | 22.8 |
| 0.04 | 25.9 | 44.5 | 80.0 | 12.4 | 19.4 | 26.7 |
| 0.05 | 26.5 | 45.4 | 74.8 | 16.1 | 21.5 | 31.4 |
| 0.06 | 28.5 | 46.6 | 87.1 | 14.8 | 21.5 | 37.9 |
| 0.07 | 33.1 | 57.1 | 102.2 | 17.0 | 24.9 | 42.1 |
| 0.08 | 39.0 | 71.8 | 128.4 | 16.8 | 26.3 | 45.4 |
| 0.09 | 38.0 | 68.1 | 126.9 | 19.6 | 27.0 | 40.9 |

- **wider application of the 2BL test: recent American presidential votes**
  - **precinct vote counts in the 2000 and 2004 elections, separately for the precincts in each county**
  - **impose FDR-control using the number of counties in each state**
    - **(see maps [in showmappbenf0004fdr.R])**

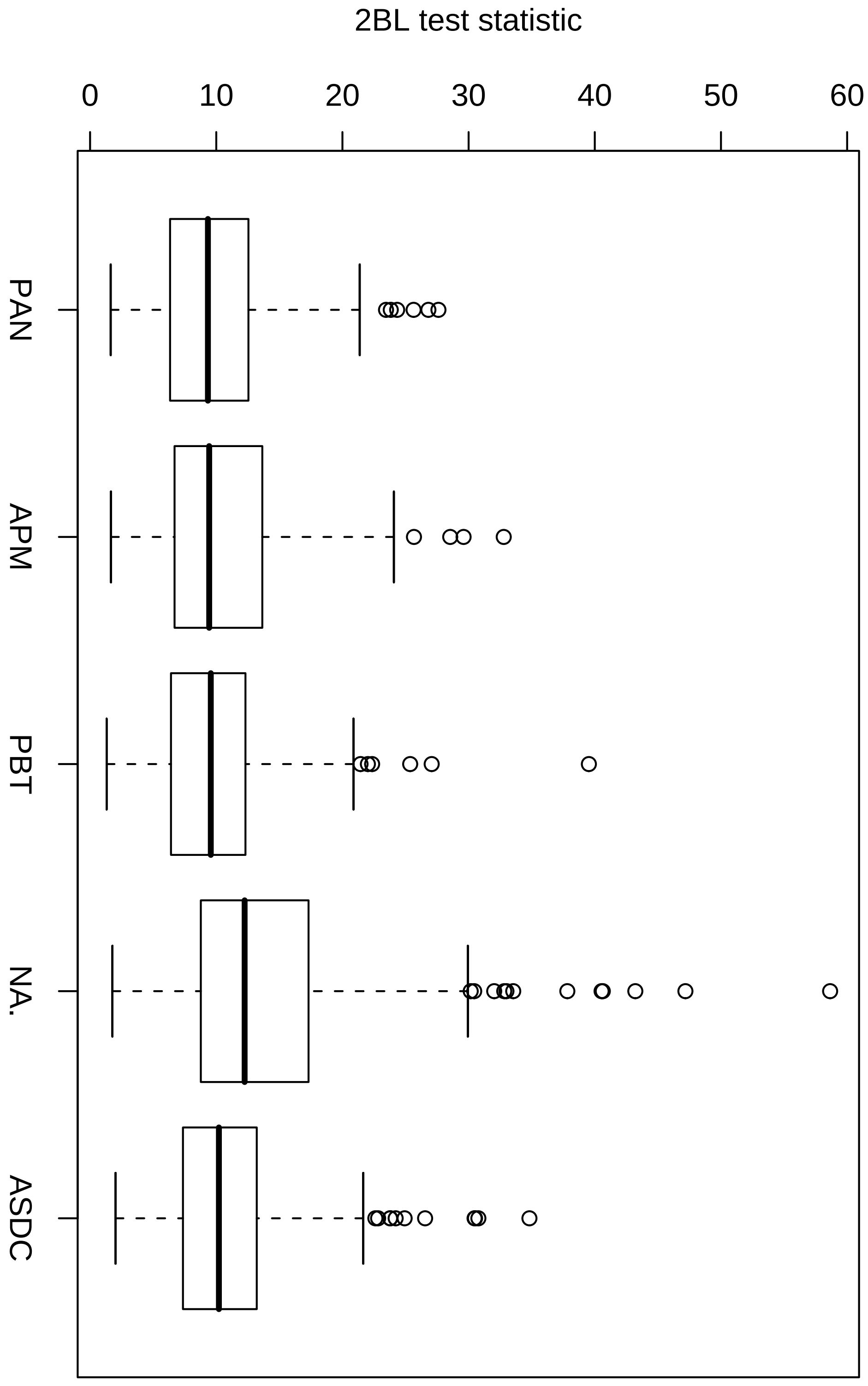
Counties with Signficant 2BL Tests using State-specific FDR Adjustment: 2000

| | | 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 |

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

- the 2BL test applied to votes for president in the 2006 Mexican election
  - seccion vote counts, separately for the secciones in each legislative district
  - over all 300 districts, the FDR-controlled critical value for $\chi_9^2$ is 32.4
  - over 1500 district-party combinations, the FDR-controlled critical value for $\chi_9^2$ is 36.4


2BL test statistic
0
10
20
30
40
50
60
PAN
APM
PBT
NA.
ASDC

- the statistical tests and the partial recount done of votes for president in the 2006 Mexican election
  - the original count included 41,791,322 ballots
  - 40,588,729 votes were recorded for one of the parties
  - the original difference between the PAN and PBT vote totals was 243,934 votes, which is 0.58 percent of the ballots cast

- the statistical tests and the partial recount done of votes for president in the 2006 Mexican election
  - the original count included 41,791,322 ballots
  - 40,588,729 votes were recorded for one of the parties
  - the original difference between the PAN and PBT vote totals was 243,934 votes, which is 0.58 percent of the ballots cast
- the recount
  - about nine percent of the casillas were manually recounted
  - I use data from 11,651 recounted casillas (which I think is all of them)

Net Vote Count Changes in the Mexico 2006 Recount

| | PAN | APM | PBT | NA. | ASDC |
|---|---|---|---|---|---|
| original | 15,000,284 | 9,301,441 | 14,756,350 | 401,804 | 1,128,850 |
| change | $-13,333$ | $-1,885$ | $-58$ | $-1,578$ | $1,836$ |

Note: Some of the recounted votes included here are from casillas that were canceled in the final official results.

- **relationship between the 2006 Mexican recount changes and the two kinds of statistical tests**
- **definitions for casilla-level variables**

$$\textbf{CHANGE} = \begin{cases} 1, & \textbf{if the vote count changed for any party} \\ 0, & \textbf{otherwise} \end{cases}$$

$$\textbf{NULOS2} = \begin{cases} 1, & \textbf{if the votos nulos } |\textbf{residual}| \geq 2 \\ 0, & \textbf{otherwise} \end{cases}$$

- **definitions for district-level variable**

$$\textbf{2BL} = \begin{cases} 1, & \textbf{if the 2BL statistic for any party} \geq 16.9 \\ 0, & \textbf{otherwise} \end{cases}$$

## Recount Changes and Test Statistics

| | CHANGE | | |
|---|---|---|---|
| NULOS2 | 0 | 1 | $n$ |
| 0 | 0.33 | 0.67 | 9,200 |
| 1 | 0.28 | 0.72 | 2,215 |

Pearson chi-squared = 20.1

| | CHANGE | | |
|---|---|---|---|
| 2BL | 0 | 1 | $n$ |
| 0 | 0.29 | 0.71 | 5,001 |
| 1 | 0.33 | 0.67 | 6,650 |

Pearson chi-squared = 21.5

- **relationship between the 2006 Mexican recount changes and the two kinds of statistical tests**
  - **unusually large votos nulos counts for a casilla are associated with more vote count changes if that casilla is recounted**
  - **unusually large 2BL test statistics for a district are associated with fewer vote count changes when casillas in that district are recounted**
- **does this mean that the 2BL test is picking up the fact that votes were faked, in ways that the recount did not detect?**

- **relationship between the 2006 Mexican recount changes and the two kinds of statistical tests**
- **is the 2BL test picking up the fact that votes were faked, in ways that the recount did not detect?**
- **consider the possibility of strategic voting (to mw07.pdf)**

- **is election manipulation election fraud?**
- **are either election manipulation or election fraud heresthetic?**
  - **election manipulation as dimension manipulation (unlikely)**
  - **election manipulation as agenda control**
  - **election manipulation as strategic voting**
- **the key issue is dictatorship (or oligarchy), which heresthetic (via Arrow's theorem) is normatively justified to oppose**
- **election fraud seems intuitively to be dictatorial, but why is that?**