

# Detecting Voter Fraud in an Electronic Voting Context

## An Analysis of the Unlimited Reelection Vote in Venezuela

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# Election Integrity and Electronic Voting

- Election integrity is important for the elected government to have legitimacy, and to prevent political conflict.

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- There are concerns about election integrity as new technologies are introduced.

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- Election integrity is important for the elected government to have legitimacy, and to prevent political conflict.
- There are concerns about election integrity as new technologies are introduced.
- Specifically, voting machines are sometimes perceived as *black boxes*, and may be vulnerable to hacker attacks, to erroneous or malicious software, or to manipulation by vendors with partisan political interests (Kohono et al. 2004; State of Alaska Division of Elections 2007, 2008; California Secretary of State 2007; Ohio Secretary of State 2007).

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- Election integrity is important for the elected government to have legitimacy, and to prevent political conflict.
- There are concerns about election integrity as new technologies are introduced.
- Specifically, voting machines are sometimes perceived as *black boxes*, and may be vulnerable to hacker attacks, to erroneous or malicious software, or to manipulation by vendors with partisan political interests (Kohono et al. 2004; State of Alaska Division of Elections 2007, 2008; California Secretary of State 2007; Ohio Secretary of State 2007).
- Pre- and post-election audits, as well as election forensic tools are important because they compensate for the black box nature of electronic voting.

# Aim of the Study and Previous Research

- Most of the forensic tools applied in our paper were previously developed to study election fraud in Russia and Ukraine (see Myagkov, Ordeshook and Shakin 2009).

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- Most of the forensic tools applied in our paper were previously developed to study election fraud in Russia and Ukraine (see Myagkov, Ordeshook and Shakin 2009).
- These tools are designed to detect *artificial* election heterogeneity, unexplained by socio-demographic factors.

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- These tools are designed to detect *artificial* election heterogeneity, unexplained by socio-demographic factors.
- Ukraine 2004 offered the perfect social science experiment when the presidential runoff was repeated twice within a month period, with the same candidates, issues and electorate, but fewer opportunities for electoral fraud.

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- These tools are designed to detect *artificial* election heterogeneity, unexplained by socio-demographic factors.
- Ukraine 2004 offered the perfect social science experiment when the presidential runoff was repeated twice within a month period, with the same candidates, issues and electorate, but fewer opportunities for electoral fraud.
- In this paper, we compare election returns in the 2007 and 2009 Venezuela referendums, where relatively similar constitutional reforms were put to a vote twice during a short period of time – approximately 1 year. Thus, similar to the Ukrainian case, the unlimited reelection vote in Venezuela offers an excellent opportunity for applying our set of forensic indicators.

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- Introduced before the 2004 presidential recall referendum.

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- Introduced before the 2004 presidential recall referendum.
- Has been used in 5 national elections – 3 constitutional referendums, 1 presidential election, and 1 parliamentary election.

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- Introduced before the 2004 presidential recall referendum.
- Has been used in 5 national elections – 3 constitutional referendums, 1 presidential election, and 1 parliamentary election.
- Security features (Carter Center 2007):
  - Encryption of voting information.
  - Randomization of information to prevent reconstruction of voting sequence.
  - Disabling unnecessary physical access points
  - Chain of custody procedures

# Touch Screen System (Smartmatic)

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Source: BBC Mundo

## 2009 Referendum

¿Aprueba usted la Enmienda de los artículos 160, 162, 174, 192 y 230 de la Constitución de la República, tramitada por la Asamblea Nacional, que amplía los derechos políticos del pueblo, con el fin de permitir que cualquier ciudadano o ciudadana en ejercicio de un cargo de elección popular, pueda ser sujeto de postulación como candidato o candidata para el mismo cargo, por el tiempo establecido constitucionalmente, dependiendo su posible elección, exclusivamente, del voto popular?

SI

NO

VOTAR

Source: Sumate

# 2007 and 2009 Constitutional Referendums

- Some contents of the 2007 referendum
  - Removal of presidential reelection term limits.
  - Abolishing the autonomy of the central bank.
  - Expropriation of large land estates.
- The opposition alleged that some of these reform proposals were unconstitutional.
- The referendum failed to pass in 2007, but Chavez managed to obtain court approval for holding a new referendum in 2009.
- The 2009 referendum proposed the elimination of reelection term limits for public offices, including the presidency.
- The opposition argued that this was a mere repackaging of some of the 2007 proposals, and that it was unconstitutional – the same referendum proposal cannot be put to a vote more than once during the same National Assembly period.

- The analysis of individual election figures was done using *mesa* (voting table) level data.



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- The analysis of individual election figures was done using *mesa* (voting table) level data.
- The comparison of election returns across elections was done using polling place level data, after exactly matching 8,815 polling places which were open during the three elections of interest.

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- The analysis of individual election figures was done using *mesa* (voting table) level data.
- The comparison of election returns across elections was done using polling place level data, after exactly matching 8,815 polling places which were open during the three elections of interest.
- The average number of voters per polling place in 2007 and 2009 was 1,230 and 1,744, respectively.

- The analysis of individual election figures was done using *mesa* (voting table) level data.
- The comparison of election returns across elections was done using polling place level data, after exactly matching 8,815 polling places which were open during the three elections of interest.
- The average number of voters per polling place in 2007 and 2009 was 1,230 and 1,744, respectively.
- Source: In the case of the 2007 and 2009 referendums, we used a Python script to download the data from the web-page of the National Elections Council (CNE). Also, we downloaded 2006 election returns from the ESDATA web-page.

# Election Returns: Ternary Plots

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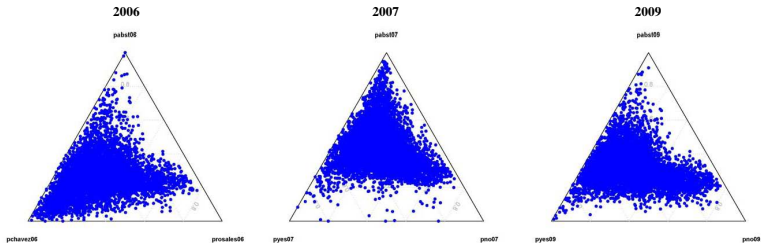
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- *Detection of anomalies in the distribution of turnout.* If turnout varied based on purely random reasons, unrelated to socio-demographic factors or political attitudes, then we'd expect the distribution of turnout to look approximately normal. Thus, examination of the distribution of turnout in relatively homogeneous data can be used to detect *artificial* heterogeneity.

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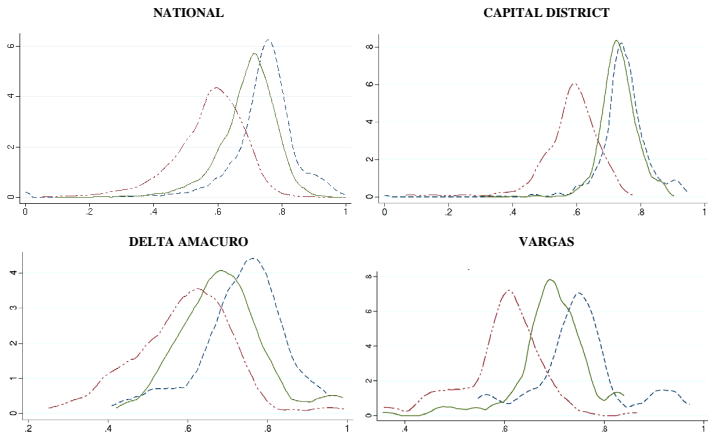


Figure: BLUE: 2006, RED: 2007, GREEN: 2009

# Turnout Distribution: The Russian Case

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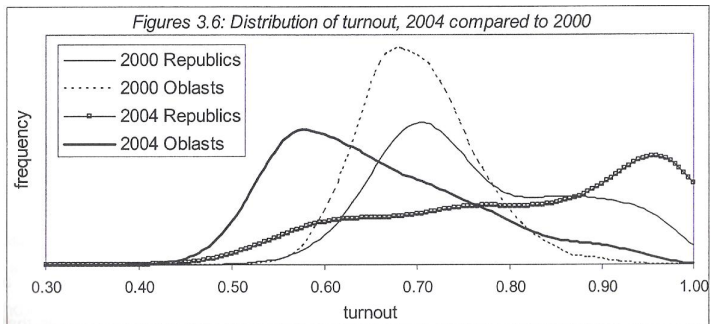
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Source: Myagkov, Ordeshook and Shakin (2009, Table 3.6)

# Forensic Tools (II): Distribution of Last Two Digits

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- *Detection of anomalies in the distribution of the last two digits of precinct-level election returns.* If election protocols were manipulated and filled in a non-random manner, unrelated to actual votes being cast, then we would expect heuristics for filling out protocols (see Berber and Scacco 2008, Shpilkin 2008), such as:
  - Rounding-off of the last digit to 0 and 5.



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  - Avoiding rounding-off of the last digit to 0 and 5.

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  - Rounding-off of the last digit to 0 and 5.
  - Avoiding rounding-off of the last digit to 0 and 5.
  - Avoiding sequences of paired-numbers – There is experimental evidence that when people is asked to write sequences of random numbers, they tend to write down paired numbers less frequently (Chapanis 1953, Rath 1966, Boland and Hutchinson 2000).

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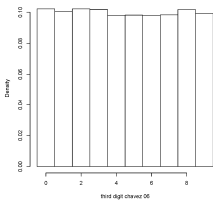
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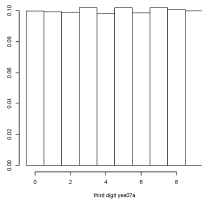
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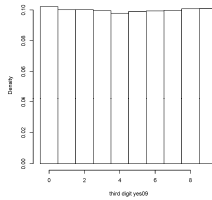
Last Digit 2006 ("Chavez" option)



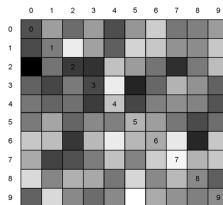
Last Digit 2007 ("yes" option)



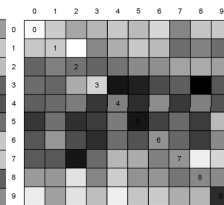
Last Digit 2009 ("yes option")



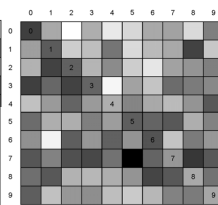
Last 2 Digits 2006 ("Chavez" option)



Last 2 Digits 2007 ("yes" option)



Last 2 Digits 2009 ("yes option")



# Forensic Tools (III): Regression Analysis of Vote Flows

- *Regression analysis of the flow of votes between elections* The idea is to estimate a contingency table showing the proportion of votes received by each alternative in the current election proceeding from each alternative in the previous election, including those who abstained.

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- Model:

$$y_{1i} = \beta_{11}x_{1i} + \beta_{12}x_{2i} + \beta_{13}(1 - x_{1i} - x_{2i}) \quad (1)$$

$$y_{2i} = \beta_{21}x_{1i} + \beta_{22}x_{2i} + \beta_{23}(1 - x_{1i} - x_{2i}) \quad (2)$$

$$y_{3i} = \beta_{31}x_{1i} + \beta_{32}x_{2i} + \beta_{33}(1 - x_{1i} - x_{2i}) \quad (3)$$

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- Coefficients should lie between 0 and 1, but this may not be the case due to aggregation bias (King 1997) or electoral fraud (Myagkov, Ordeshook and Shakin 2009).

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- In this paper we estimate a model with random coefficients by region, which should help mitigate aggregation issues. We do not restrict the coefficients because this would prevent us from detecting unreasonable figures caused by electoral fraud.

# Results: Regression Analysis of Vote Flows

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## Flow of votes between 2007 and 2009

	Yes 07	No 07	Abst 07
Yes 09	0.97	-0.08	0.28
No 09	-0.11	0.94	0.14
Abst 09	0.13	0.10	0.56
Vertical sum	1.00	0.96	0.98

- Main observations:
  - Voters who supported the yes option in 2007, overwhelmingly support the yes option in 2009.



# Results: Regression Analysis of Vote Flows

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- Main observations:
  - Voters who supported the *yes* option in 2007, overwhelmingly support the *yes* option in 2009.
  - Voters who supported the *no* option in 2007, overwhelmingly support the *no* option in 2009.

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Vertical sum	1.00	0.96	0.98

- Main observations:
  - Voters who supported the *yes* option in 2007, overwhelmingly support the *yes* option in 2009.
  - Voters who supported the *no* option in 2007, overwhelmingly support the *no* option in 2009.
  - New turnout is split 2 to 1 between the *yes* and *no* alternatives in 2009.

# Forensic Tools (IV): Predicted Vote vs. Actual Vote

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- Assuming voter preferences are *in equilibrium*, we can estimate a model of voter choice in a previous election, and then use it to predict voter choice in the current election. Then, we can determine which precincts deviate significantly from expected values, and use that as a signal of election irregularities (Alvarez and Katz 2008).

# Results: Predicted Vote vs. Actual Vote in 2009

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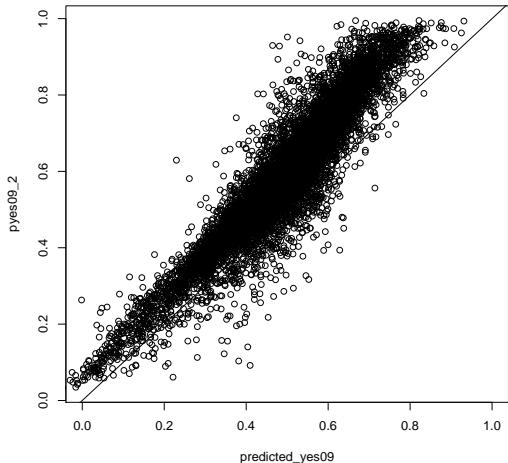
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# Forensic Tools (V): Turnout vs. Vote Share of Eligible Electorate

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- *Detection of anomalies in the relationship between turnout and vote shares.* If turnout were unrelated to a candidate's support, then the slope of a univariate regression between a candidate's share of the eligible electorate and turnout should approximate the candidate's overall proportion of the total turnout – i.e., it shouldn't be larger than 1 or smaller than 0.

# Results: Turnout vs. Vote Share of Eligible Electorate

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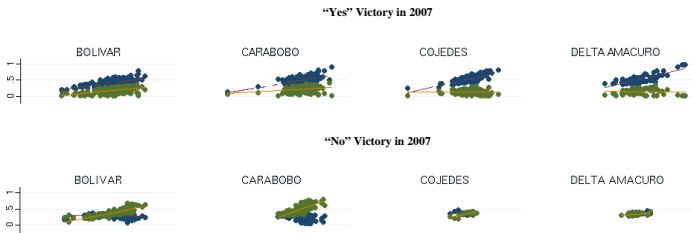
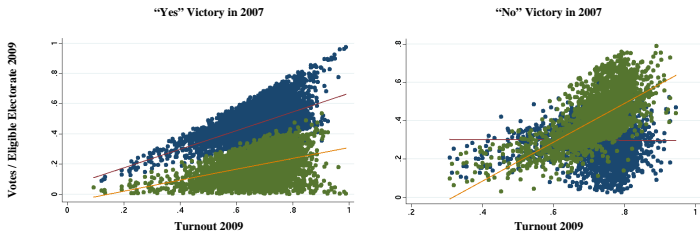
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- Studying the integrity of electronic elections is a challenging task – manipulation of the software code can lead to types of fraud difficult to detect with some of our forensic indicators.

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- Studying the integrity of electronic elections is a challenging task – manipulation of the software code can lead to types of fraud difficult to detect with some of our forensic indicators.
- Elections taking place within a short period of time, with similar electorates and issues, offer an excellent opportunity for applying tools designed for detecting anomalies and outliers in election returns.

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- We did not find evidence of widespread electoral fraud in the last two Venezuela referendums – such as, generalized support for the ‘yes’ alternative in 2009 in polling places where the ‘no’ alternative won in 2007 – but we did detect anomalies and outliers in different stages of our analysis.

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- Elections taking place within a short period of time, with similar electorates and issues, offer an excellent opportunity for applying tools designed for detecting anomalies and outliers in election returns.
- We did not find evidence of widespread electoral fraud in the last two Venezuela referendums – such as, generalized support for the ‘yes’ alternative in 2009 in polling places where the ‘no’ alternative won in 2007 – but we did detect anomalies and outliers in different stages of our analysis.
- These anomalies are not, by themselves, proof of electoral fraud. Results should be interpreted by experts on the electoral context of the different regions, and used as a complement to pre- and post- election audits, as well as reports from election observers.

# Future Research

- Develop tests of hypothesis associated with some of the forensic tools, to determine to what extent deviations from our expectations constitute strong signals of electoral fraud.

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- Improve the regression analysis of the flow of votes. In particular, we'd like to:
  - Take care of the compositional nature of the dependent variables by employing the methodology suggested by Katz and King (1999).

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- Improve the regression analysis of the flow of votes. In particular, we'd like to:
  - Take care of the compositional nature of the dependent variables by employing the methodology suggested by Katz and King (1999).
  - Address the ecological inference problem by specifying second-level models to explain heterogeneity of random coefficients across regions, taking socio-demographic factors and spatial-correlations into account (Gotway and Young 2004; Calvo and Escolar 2004; Haneuse and Wakefield 2004).