

**ANALYSIS OF THE VENEZUELAN PRESIDENTIAL
RECALL REFERENDUM OF 2004 AND THE
RELATIONSHIP BETWEEN THE OFFICIAL RESULTS
AND THE SIGNATURES REQUESTING IT IN
COMPUTERIZED CENTERS**

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On August 15th, 2004, Venezuelans had the opportunity to vote in a Presidential Recall Referendum to decide whether or not the President should be removed from office. The process was largely computerized using a touch screen system. In general the ballots were not manually counted. The significance of the high linear correlation (0.99) between the number of requesting signatures and the number of opposition votes in computerized centers is analyzed herein. The same-day audit was found to be not only ineffective but a source of suspicion. Official results were compared with the 1998 presidential election and other electoral events and distortions were found.

1. Introduction. In Venezuela, electoral events are organized by the “Consejo Nacional Electoral”¹ (CNE). On 1998-12-06 the current President won the elections with 3 673 685 (57.79%) votes vs. 2 863 619 (42.21%) votes for his adversaries. The total number of voters in the electoral registry (REP) at that time was 11 001 913.

In 1999 a new constitution was enacted which allows citizens to request a recall referendum (RR) to decide whether the President should continue or step down from office. It can only be activated after half of the period for which the President has been elected has transpired. In order to activate the referendum, a petition has to be sent to the CNE signed by at least 20% of the voters registered in the REP. It is also possible to request a consultative

¹Before the new constitution it was known as the “Consejo Supremo Electoral” (CSE) see <http://www.cne.gov.ve>

non-binding referendum with signatures of 10% of the voters registered in the REP.

In 2000-01-03 a new CNE was designated but failed to organize elections on schedule. Therefore, on 2000-06-05, yet another CNE was designated. On 2000-07-30 the President was reelected for a 6-year period with 3 757 773 (59.76%) votes vs. 2 530 805 (40.24%) for his adversaries. The REP had 11 701 521 registered voters at that time.

In 2002 signatures were collected requesting a consultative referendum which was activated in the middle of a general national strike. The Supreme Court disabled the CNE, therefore the consultative referendum never took place. Citizens then collected new signatures for a recall referendum. This is the legal instrument which the government and opposition represented by the *Coordinadora Democrática* agreed to use having the Organization of American States (OAS) and the Carter Center as guarantors[1]. This ended the strike.

In 2003 the National Assembly was unable to agree on a new CNE so the Supreme Court designated a new temporary CNE on 2003-08-26, even though this procedure was not contemplated in the Constitution. The new CNE rejected the signatures saying that they had been collected before half of the presidential period had transpired.

On 2003-11-28 the signatures were collected again, this time under the supervision of the CNE. On 2004-05-28, an important part of the signatures had to be reverified by the CNE. This was achieved, and on 2004-08-15 the Presidential Recall Referendum finally took place.

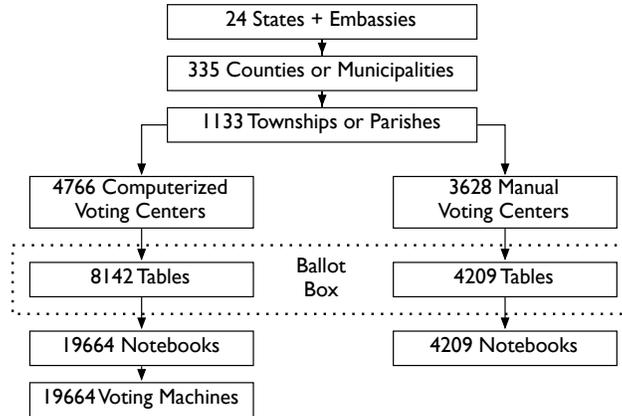


Figure 1: Venezuelan electoral system layout.

2. Layout. Venezuela is politically organized into states, counties (municipalities), and townships (parishes). Each county has one or more voting centers. There can be several voting tables (voting stations) per center, and each one has one or more electoral notebooks. In computerized centers, one voting machine is assigned to each electoral notebook. One ballot box is assigned to each table. Therefore, the ballots from multiple machines are combined into a single box. Please see Figure 1 for more details.

Each voting center has a unique code which in time has remained unchanged². This allows comparing electoral results on a center by center basis.

Although the number of manual centers is large, the number of people registered in those centers is much smaller than in computerized centers. This can be seen in the histograms in Figure 2.

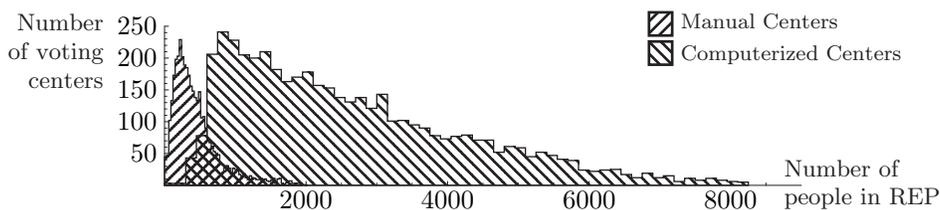


Figure 2: Histogram of size of manual and computerized centers.

3. The Referendum. Touch screen voting machines were used for the first time in Venezuela for the Referendum. These machines gave the voter a paper ballot to be deposited in a box. The boxes were never opened except for some of those selected for auditing. The results were sent from the machines to the CNE servers using TCP/IP connections over telephone lines, then the machine printed out the results and a duplicate set of uncut paper ballots. The voting centers had a continuous satellite TCP/IP connection to be used only by the fingerprint machines which were supposed to prevent anyone from voting twice, even in different voting centers.

In order to give the citizens confidence in the results, two audits were made. The first one was made on the same day of the event (hot audit). The second one was made three days later (cold audit). The whole electoral process and audits were supervised and endorsed by the OAS and the Carter Center. They found no evidence of alterations (tampering) in the results in their final report.

²On 2006, all the voting center codes where changed.

There were only two ways to vote³: SI (yes) or NO. In order for the President to step down, the number of SI votes had to be greater than 3 757 773 and greater than the number of NO votes. The official results were 3 989 008 (40,64%) SI votes vs. 5 800 629 (59,10%) NO votes, with 14 037 900 registered voters in the REP. Most of those votes (87.1%) were cast at computerized centers.

4. The Signatures.

4.1. *Introduction.* In order to activate the Referendum, on 2003-11-28 signatures and fingerprints were collected in a four-day event organized by the CNE, with witnesses from all political parties. Special forms, with serial numbers were supplied by the CNE to all political parties. There were 2676 signature collection centers (SCCs), all of them in Venezuela. No signature collection was allowed outside Venezuela.

There were two kinds of forms: types A and B. Type A forms were used in the SCCs. Type B forms were also assigned to SCCs, but they were meant to be used for house to house signature-collecting (under pro-government witness supervision). There were 618 800 type A forms and 98 286 type B forms. Each form had a maximum capacity of 10 signatures.

The number of signatures required to activate the Referendum was 20% of the REP used to elect the President, i.e. $0.2 \times 11\,701\,521 = 2\,340\,305$ signatures. The law required the publishing of all signatures collected in a newspaper in order for this to be publicly viewed.

The CNE divided these signatures into three categories: valid, invalid and questionable. An important number of questionable signatures had to be recollected in order to reach the required minimum number of signatures.

Opposition groups claimed to have submitted 3 467 051 signatures to the CNE. Once inside the CNE, 19 842 signatures were lost. An additional indeterminate number of signatures were lost before reaching the CNE.

The presumed intention of the signers was to vote YES⁴. However, it was possible that some signers voted NO. This is the case for government supporters who signed the petition because they believed they could use the referendum to help solve the high state of political confrontation. There were also signers who changed their political preferences between the time of the signature collection and the vote.

In the following sections, the results of the referendum will be compared with the signatures collected. This will reveal important facts about these

³In manual voting centers it was also possible to cast a null vote

⁴The OAS and the Carter Center concur with this statement. See [2], Section 5, second paragraph.

results.

4.2. *SI Vote Uncertainty with Regard to Signatures.* Let k be the relative number of SI votes, as defined in Equation 1:

$$(1) \quad k = \frac{\text{SI votes}}{\text{signatures}}$$

Also, let s be relative number of signatures in a voting center, as defined in Equation 2:

$$(2) \quad s = \frac{\text{signatures}}{\text{SI votes} + \text{NO votes} + \text{Null votes}} = \frac{\text{signatures}}{\text{total votes}}$$

For each value of s , there is a maximum possible k which is just $1/s$ as shown in Equation 3:

$$(3) \quad k_{\max} = \frac{\max(\text{SI votes})}{\text{signatures}} = \frac{\text{total votes}}{\text{signatures}} = \frac{\text{total votes}}{s \cdot \text{total votes}} = \frac{1}{s}$$

In voting centers with a large value of s , it is expected to have a k around 1. This is because, each signature tends to become a SI vote, and at the same time k_{\max} gets close to 1.

For example, in a voting center with 1000 total votes and 900 signatures, the number of expected SI votes is between 900 and 1000. Here $s = 900/1000 = 0.9$ and $k_{\max} = 1/0.9 = 1.1\bar{1}$. Therefore, the uncertainty in the value of k is very small, as it should be between 1 and $1.1\bar{1}$. The value of k could be lower than 1 if, for any reason, the number of votes was low with respect to the electoral registry (REP).

The situation is completely different in voting centers with a small value of s . Notice that there is an essential singularity in k at $s = 0$ as shown in Equation 4:

$$(4) \quad k = \frac{\text{SI votes}/\text{total votes}}{s}$$

This singularity can produce very high values of k in the neighborhood of $s = 0$. Hence, the level of uncertainty in k becomes very large.

For example, in a voting center with 1000 total votes and 2 signatures, the number of expected SI votes is between 2 and 1000. Here $s = 2/1000 = 0.002$ and $k_{\max} = 1/0.002 = 500$. Therefore, the uncertainty in the value of k is extremely large, as it should be between 1 and 500.

The aforementioned reasons for uncertainty in k are purely mathematical. In practical terms, high values of k in centers with a small s happen due to the following facts:

- There were only 2676 SCCs compared to 8394 voting centers. Therefore, people living far from a SCC could not sign the petition, even if they wanted to. This affected mostly rural areas.
- There were many people who did not sign the petition because of the fear of negative consequences from the government. On the other hand, voting was secret.
- There were SI votes, from people who could not sign because they were not in the REP or were outside the country at the time of signature collection.
- Some SCCs ran out of forms. Not everyone was able to go to a more distant SCC.
- An undetermined amount of signatures got lost.
- There were SI votes from people who just didn't bother to sign the petition.

Notice that all these issues with the signatures did not affect all voting centers equally. Centers with a small value of s are more likely to have been affected by these issues than centers with a high value of s .

A plot of k vs. s is shown in Figure 3. Notice that when s is not large, **all** the computerized centers are very far away from k_{\max} , clearly contradicting the expected non-linear behavior with respect to s . On the other hand, the manual center results are effectively distributed in the allowed range regardless of the relative number of signatures.

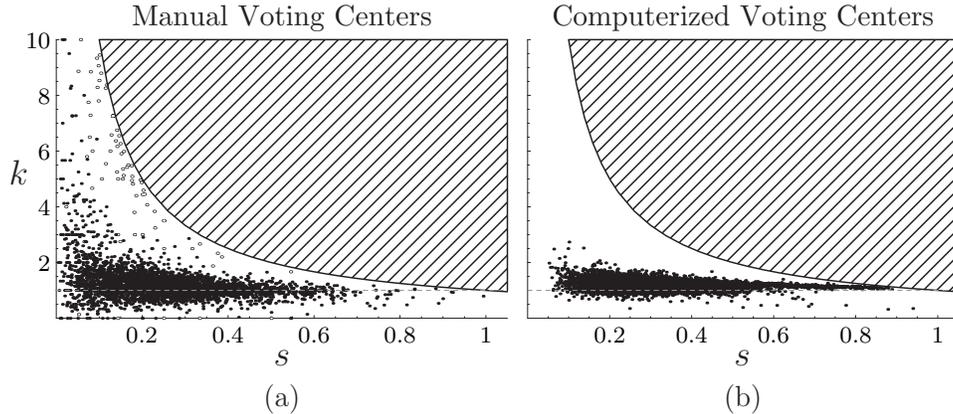


Figure 3: Relationship between k and s for computerized and manual centers. The shadowed area contains the mathematically impossible values of k . The maximum k value is $1/s$. The hollow dots represent voting centers located in consular offices.

In summary:

It is expected that k 's from voting centers with a small value of s will be much more variable than those with large values of s .

4.2.1. *Behavior of k with regard to the size and characteristics of the voting centers.* Although the manual centers tend to have fewer voters than the computerized centers, this does not seem to be the only reason for the different behavior in k . This can be seen in Figure 4.

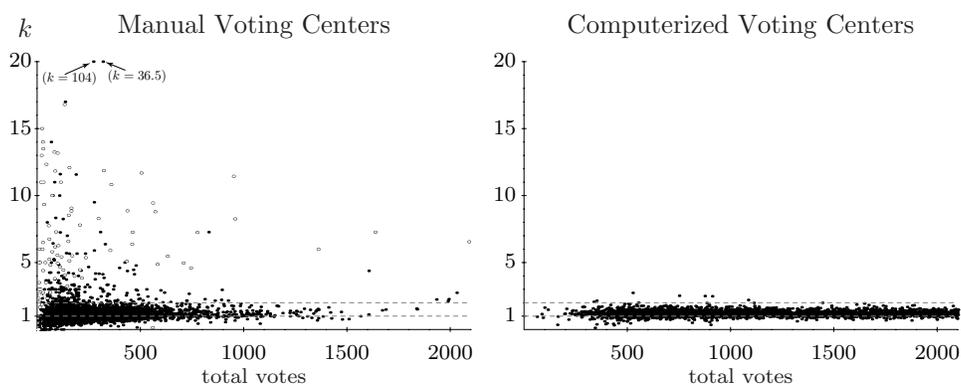


Figure 4: Relationship between k and total number of votes for computerized and manual centers in the same size range. The hollow dots represent voting centers located in consular offices.

There were many small computerized voting centers in rural areas. In fact, many of those used mobile phone lines to connect the voting machines to the CNE servers in order to transmit the results. This was often done due to the lack of regular phone lines in these remote areas.

There were 586 mixed townships which included both manual and computerized voting centers. These mixed townships had 5449 voting centers (2538 manuals and 2911 computerized). Notice in Figure 5 (top) that the behavior of k in these mixed townships, is very different for manual and computerized centers. Appendix B shows an example of a mixed township.

Another interesting comparison is the one related to hamlets (“caseríos”). A total of 2162 voting centers in hamlets were found⁵ (1852 manual and 310 computerized).

⁵The official list of voting centers was searched for the word “CASERIO” in the address field. These produced the list of 2162 voting centers.

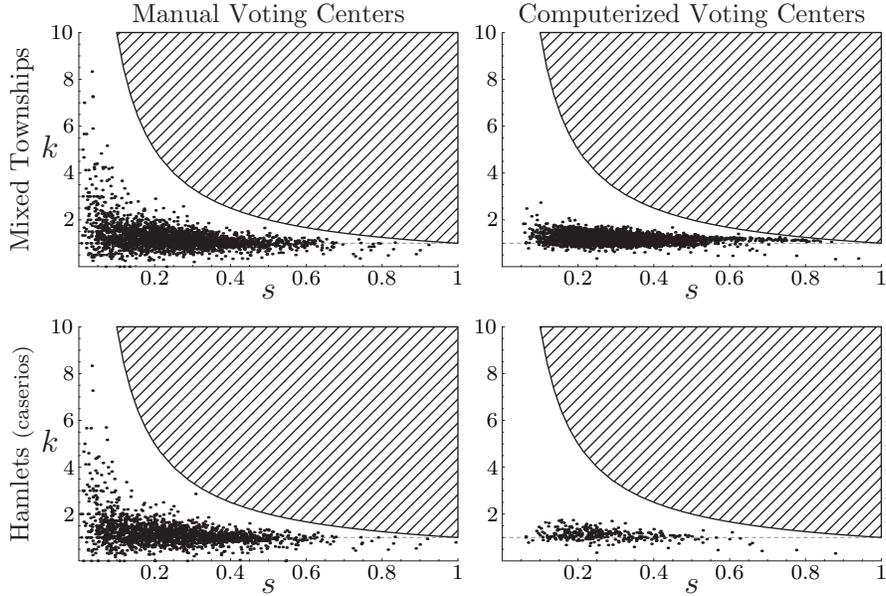


Figure 5: Relationship between k and s for computerized (right) and manual centers (left) for mixed townships (top) and hamlets (bottom).

Due to the reasons mentioned in Section 4.2, many hamlets must have been far away from a SCC. For this reason voting centers located in hamlets should include large values of k . In Figure 5 (bottom) it can be seen that these large values are found only in manual voting centers.

Furthermore, Figure 5 shows that the behavior of the k values in computerized voting centers in hamlets, looks more like the rest of the computerized centers than the behavior of the 1852 manual centers located in the rest of the hamlets.

4.3. *Correlations between SI votes and requesting signatures.* Let r_{SI} be the correlation of SI votes with respect to the number of signatures.

The Carter Center and the OAS said the following in one of their reports[2]:

A very high correlation between the number of signers and the number of YES votes per center in the universe of automated voting machines has been found—a correlation coefficient of 0.988. This means that in voting centers where a high signer turnout was obtained, a high YES vote also was obtained.⁶

What this report does not say is that for manual voting centers, the correlation is 0.607, a much lower value. This difference can be visualized in

⁶This correlation value was reproduced with a difference of just 0.001 which is negligible.

Figure 6. Notice that a straight line from the origin to each of the points has a slope of k . The high correlation value for computerized centers translates into similar k values (or slopes) for most centers.

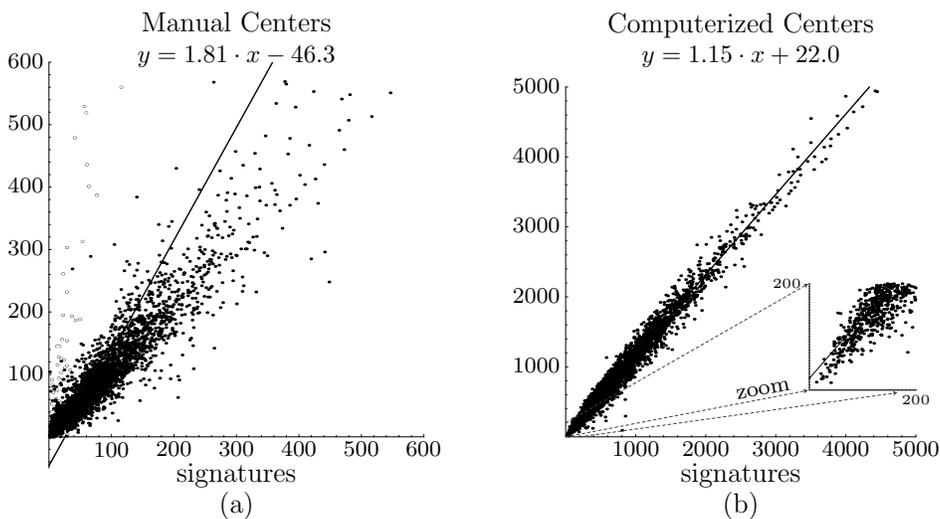


Figure 6: Manual Centers have a correlation of 0.607 with respect to the signatures while computerized centers have a correlation of 0.989. A correlation of 1 would look like a straight line.

In this case, the high correlation in computerized voting centers also implies that in voting centers where a low signer turnout was obtained, a low SI vote was also obtained. This can be seen in the origin of Figure 6b. Hence, when the number of signatures tends to zero, the number of SI votes also tends to zero. But, as observed in Figure 6a, manual centers do not exhibit this behavior.

The behavior in computerized centers seems unexpected because the relationship between signatures and SI votes should not be linear, especially when the number of signatures is small. As explained in section 4.2, you could expect a large number of SI votes if there were a large number of signatures, but as the number of signatures per center decreases, the level of uncertainty in the number SI votes with respect to the number of signatures increases.

In Table 1 the correlations are calculated for centers where signers were a minority ($s \leq 0.5$) and a majority ($s > 0.5$). Notice that as expected, the correlation for manual centers is much higher when there are many signatures (0.947) than when there are fewer signatures (0.613). This is the

expected behavior because when you have many signatures the uncertainty of k is small, and the number of SI votes is equal to $k \times$ signatures so the uncertainty in the absolute number of SI votes is also small.

	$s \leq 0.5$		$s > 0.5$		All	
	r_{SI}	#	r_{SI}	#	r_{SI}	#
Manual	0.613	3 375	0.947	221	0.607	3 596
Computerized	0.983	3 943	0.994	645	0.989	4 588
Both	0.953	7 318	0.996	866	0.973	8 184

Table 1: Correlations of SI votes with respect to the relative number of signatures s per center, for manual and computerized voting centers.

In the case of the 645 computerized voting centers where $s > 0.5$ the correlation was 0.994 which is very high. It stands out that in the computerized voting centers where signers were a minority, the correlation is still very high at 0.983. Furthermore, there is not a single computerized voting center with much more SI votes than signatures as seen in Figure 6b. In other words, for some reason, computerized centers do not seem to show the expected non-linear relationship between signatures and SI votes.

4.4. *Correlation Plot.* In order to further investigate the change of uncertainty as the relative number of signatures varies, a technique similar to a moving average is used. The difference is that instead of calculating an average, a correlation is calculated. A window size of 150 voting centers was used. This is the same number of centers that were audited.

In order to do this, the first step is to sort the voting centers, computerized and manual, according to their s value. Then r_{SI} is calculated for centers in positions 1 to 150. Subsequently r_{SI} is calculated for centers in positions 2 to 151, and so on. The result is shown in Figure 7.

For manual centers, there are large variations in the correlation in the first half of Figure 7. This is the result of outliers coming in and out of the 150 centers calculation window. As the outliers are real official data, they should not be dropped. Instead, logarithms can be used for both the number of votes and signatures. This way the effect of the outlier is taken into account in a better way. The result of using this technique is shown in Figure 8.

Regardless of whether correlations are calculated on a linear scale (Figure 7) or on a logarithmic scale (Figure 8), the important fact to point out is that the reduction in correlation as s decreases is large for manual centers, whereas in comparison it is negligible for computerized centers.

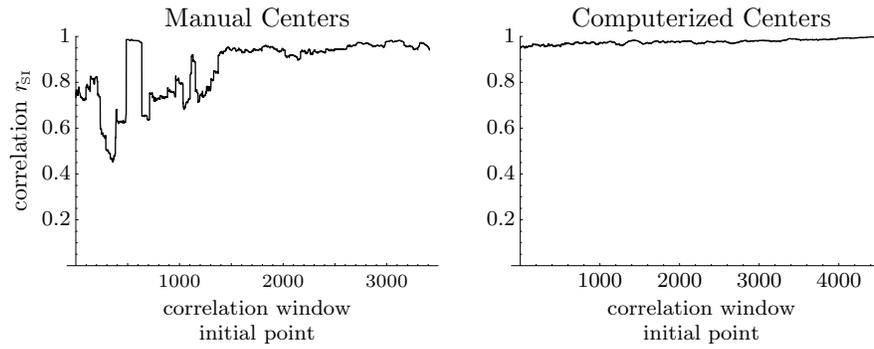


Figure 7: Correlations plot using a window of 150 voting centers.

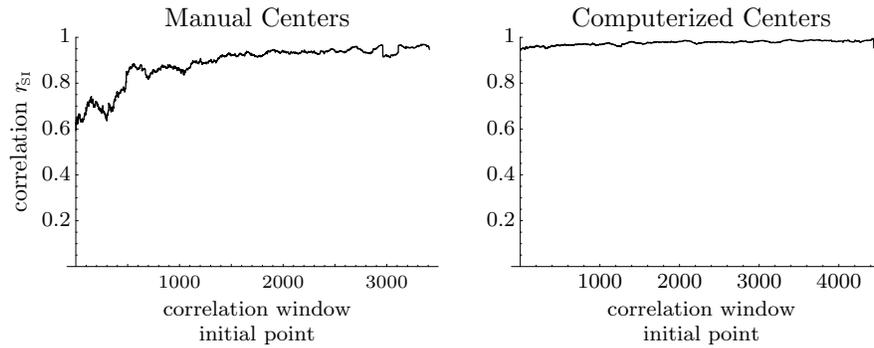


Figure 8: Correlations plot (logarithmic scale) using a 150 voting centers window.

5. The Hypothesis. What has been presented thus far should be enough to cast a serious shadow of doubt with regard to the official results in the computerized centers. Based on this, it is natural to consider the following hypothesis⁷:

Hypothesis:

In computerized centers, official results were forced to follow a linear relationship with respect to the number of signatures.

If this hypothesis were true, because of the reasons explained in section 4.2, the results would be distorted with respect to reality, especially in voting centers with a small s value.

In places where the signatures did not correctly capture the political intention of the people, two things would happen:

1. The number of SI votes, according to the official CNE results, would tend to be much less than the number of real SI votes.
2. The official results of those computerized voting centers would be a poor representation of the political intentions in the area.

In the next section the results of the referendum will be compared to those of the 1998 presidential election in order to find out if these distortions are indeed present.

6. 1998 Election Comparison. Despite the fact that more than 5 years separate the 1998 Presidential election and the Referendum, and that the Referendum was not an election, there are reasons to make the comparison of both events interesting:

- In both cases the future of the presidency was at stake.
- In Venezuela, since 1958 a new President had been elected every 5 years. Immediate reelection was prohibited by the 1961 constitution. Between the 1998 election and the 2004 Referendum, 5 years and 8 months had gone by. On the other hand, the president had repeatedly claimed that he would stay in office at least until the year 2021.
- Both events were open for all Venezuelan citizens in the electoral registry.

⁷The mechanics of how votes could have been altered, and by whom is not studied here. However, the fact that the machines established a TCP/IP connection to the CNE, disconnected and only then printed the results, opens many security holes. These issues are beyond the scope of this article.

- Both cases involved a polarization. In 1998 the top two candidates obtained 96.17% of the valid votes. The other 3.83% of the votes were candidates which were also politically opposed to the winning candidate.
- There were 8431 voting centers in 1998 and 8394 voting centers for the Referendum. Both events involved 8328 common voting centers.
- Comparing 1998 and Referendum results gives an estimation of whether the popularity of the president increased or decreased in the vicinity of each voting center.

Additionally, the 1998 electoral results were used for comparison, because at that time, the CNE could not be under the influence of the current government.

6.1. *Correlations between % of opposition in 1998 and in RR.* By comparing the electoral results (percentage of opposition) on a township by township basis, it was detected that some of them had a high correlation with respect to previous results while others had a very low correlation. Furthermore, it seemed as if townships with higher opposition results with respect to 1998 had a much higher correlation than those where the government increased its performance. This correlation will be called r_{1998} , and the percentage of opposition difference will be called $\Delta\%_{1998}^{RR}$ as defined in Equation 5.

$$(5) \quad \Delta\%_{1998}^{RR} = (\% \text{ Opposition in RR}) - (\% \text{ Opposition in 1998})$$

In order to illustrate this, the results of two townships are plotted in Figure 9. In the “*Olegario Villalobos*” township, the correlation with respect to the signatures and the 1998 percentage of opposition is large at $r_{SI} = 0.988$ and $r_{1998} = 0.984$ respectively. Additionally, notice that the average s is 0.639, so signers were the majority in this township. Therefore, the signatures are likely to have captured the political intentions of voters here.

In the case of the “*Vista al Sol*” township, the average s is very low. Therefore, the uncertainty in the number of SI votes with respect to the signatures could be large, as was shown in Section 4.2. In other words, the signatures are not likely to have captured the political intentions of the township accurately. This uncertainty is just not seen in the official results, as the correlation of SI votes with respect to the signatures is 0.990. Furthermore, the referendum results seem very distorted with respect to the 1998 election, with a negative correlation of -0.667. In this township,

the center with the most opposition in 1998 ended up being the most pro-government, and vice versa⁸.

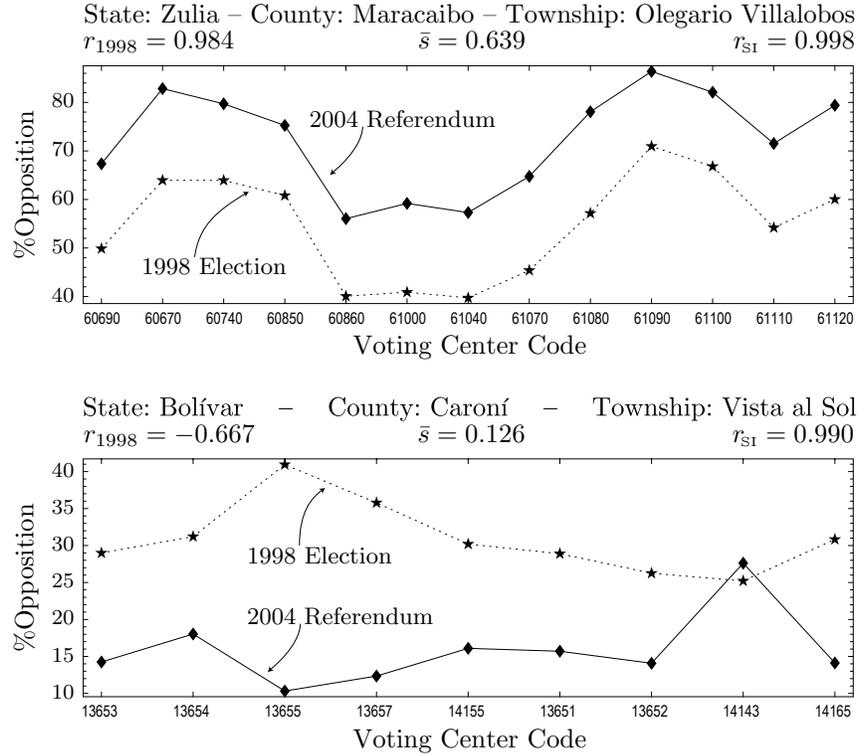


Figure 9: Two sample townships. All the centers shown are computerized voting centers.

The two townships shown in Figure 9 behave consistently with the hypothesis. “*Olegario Villalobos*” was able to increase its percentage of opposition because many signatures were collected, whereas “*Vista al Sol*” could not increase its percentage of opposition because only a few signatures were collected. If this repeats itself in the rest of the country, then r_{1998} would be large when $\Delta\%_{1998}^{RR}$ is large, and r_{1998} would be small when $\Delta\%_{1998}^{RR}$ is small. In an untouched process, these two variables should be independent.

In Figure 10, it is shown that, indeed in all of the country there is a strong relationship between $\Delta\%_{1998}^{RR}$ and r_{1998} for computerized centers at the township, county and state levels. This relationship is much weaker –

⁸This center returned to being the one with the most opposition 77 days later in the state governors election.

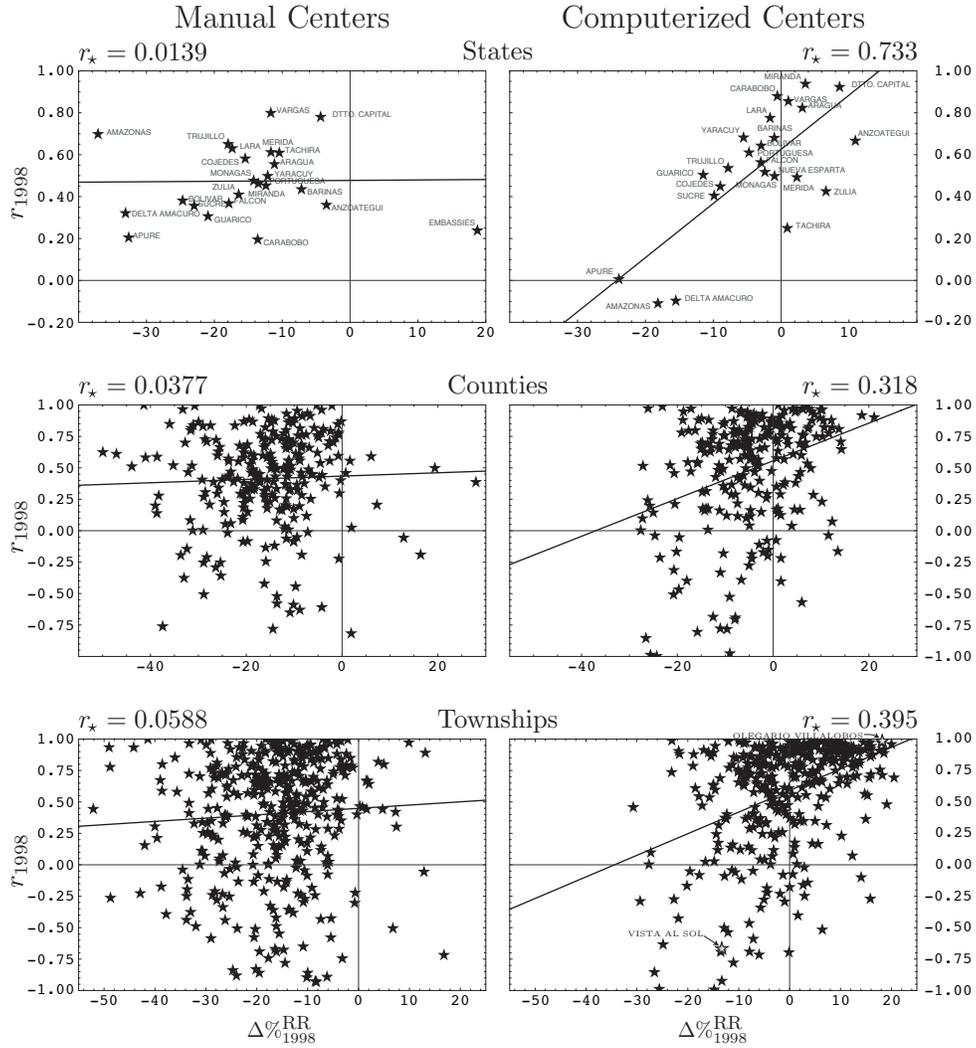


Figure 10: Relationship between r_{1998} and $\Delta\%RR_{1998}$ at state, county and township levels for manual and computerized voting centers. The correlation between $\Delta\%RR_{1998}$ and r_{1998} is shown as r_* . Assuming that $\Delta\%RR_{1998}$ and r_{1998} are independent, the probability of seeing those r_* values is calculated in Appendix D.

almost inexistant– for manual voting centers. This finding is consistent with the hypothesis.

7. Variability in values of k and the correlation between percentage of opposition and values of s , for various electoral events.

In Section 4.2, it was stated that as the value of s decreases, the variability in k is expected to increase. According to Equation 4 this variability must also be present in the relation between s and the percentage of opposition. Therefore, as s becomes small, it should poorly correlate with the percentage of opposition. For this reason, when s is small, it should not determine the percentage of opposition. On the other hand, when s becomes large, it should correlate better with the percentage of opposition.

Let r_s be the correlation of the percentage of opposition and s , and let \tilde{s} be the median of all the values of s for computerized centers. For the subset of computerized centers with $s \leq \tilde{s}$ this correlation will be called $r_{s,s \leq \tilde{s}}$, and for the remaining centers where $s > \tilde{s}$ the correlation will be called $r_{s,s > \tilde{s}}$.

The value of $r_{s,s \leq \tilde{s}}$ should be smaller than $r_{s,s > \tilde{s}}$. These properties just defined are calculated for various electoral events in Table 2.

Table 2: Correlation r_s for computerized centers with s above and below \tilde{s} , for different electoral events.

Date	Event	$r_{s,s \leq \tilde{s}}$	$r_{s,s > \tilde{s}}$	$r_{s,s > \tilde{s}} - r_{s,s \leq \tilde{s}}$
1998-12-06	Presidential Election	0.439	0.685	0.246
2000-07-30	Presidential Election	0.607	0.802	0.195
2004-08-15	Referendum Official Results	0.845	0.830	-0.015
2004-08-15	Exit Polls	0.325	0.739	0.414
2004-10-31	States Governors Election	0.475	0.707	0.232

The exit poll referenced in Table 2 was made under the supervision of Penn, Schoen, and Berland Associates.

The State Governors election took place just 77 days after the Referendum. By counting votes for and against the pro-government candidate, a percentage of opposition was calculated. During this election, the same voting machines were used, but there was an important difference: the paper ballots were manually counted for a randomly selected voting machine in each and every voting center. The results for the correlation r_s for this election are shown in Table 2.

From Table 2 it is clear that only the Referendum official results fail to exhibit a positive correlation difference. Also notice in Figure 11 that for

the Referendum official results, there is not a single voting center with a small s and large percentage of opposition. The fact that only in the official Referendum results $r_{s,s \leq \bar{s}}$ is not smaller than $r_{s,s > \bar{s}}$ is consistent with the hypothesis.

8. Hot Audit. In general, the paper ballots from the computerized centers were not manually counted. The CNE assured the Venezuelan citizens that the voting machines had to accurately reflect the voters intention, because a sample of 192 machines (1% of them) would be randomly selected and audited the same day of the referendum. This is indeed a valid way of eliminating suspicion, as long as the selection is a truly random sample of *all* the voting machines.

The day of the referendum, the CNE informed the public that because of logistical reasons, the sample would be taken from a restricted universe of 20 counties located in urban areas, leaving out of the audit more than 300 counties. At this moment, confidence in the results was adversely affected to say the least.

Computerized voting centers inside and outside of the 20 counties, to which the hot audit universe was reduced, are shown in Figure 12. It is clear that these 20 counties are not representative of all the computerized voting centers. See Appendix E for further details on this subject.

Furthermore, out of 192 centers selected for hot audit, only 26 were actually audited in presence of witnesses representing the opposition and the international observers. The following excerpt from the Carter Center Comprehensive Report [4] is very illustrative:

Auditors, table members, and military personnel were not properly informed that the audit would occur nor were they clear about the procedure to be followed. The instructions themselves did not clearly call for a separate tally of the Yes and No votes, and in some centers, the auditors only counted the total number of voters. (...)

Nevertheless, Carter Center observers were able to witness six auditing processes. In only one of the six auditing sites observed by The Carter Center did the paper ballot receipt counting actually occur. In this place, the auditing was conducted by the *mesa* president, and the recount of the ballots produced exactly the same result as the *acta* printed by the voting machine. In the rest of the sites observed, the auditor appointed by the CNE did not allow the opening of the ballot box, explaining his/her instructions did not include the counting of the Yes and No ballots from multiple machines.

There were also complaints of military denying access to voting centers where audits were being conducted. Carter Center observers could not confirm this claim. (...)

The CNE provided The Carter Center with copies of the audit reports of 25 centers. It was clear from the forms that the audit was not carried out in many places because the fields in the form were left empty, there were no signatures of pro-government or opposition witnesses, etc. The forms were poorly filled out, clearly showing inadequate training. The instructions issued by the CNE to the auditors were either incomplete or unclear. This is a direct consequence of issuing the audit regulation three days before

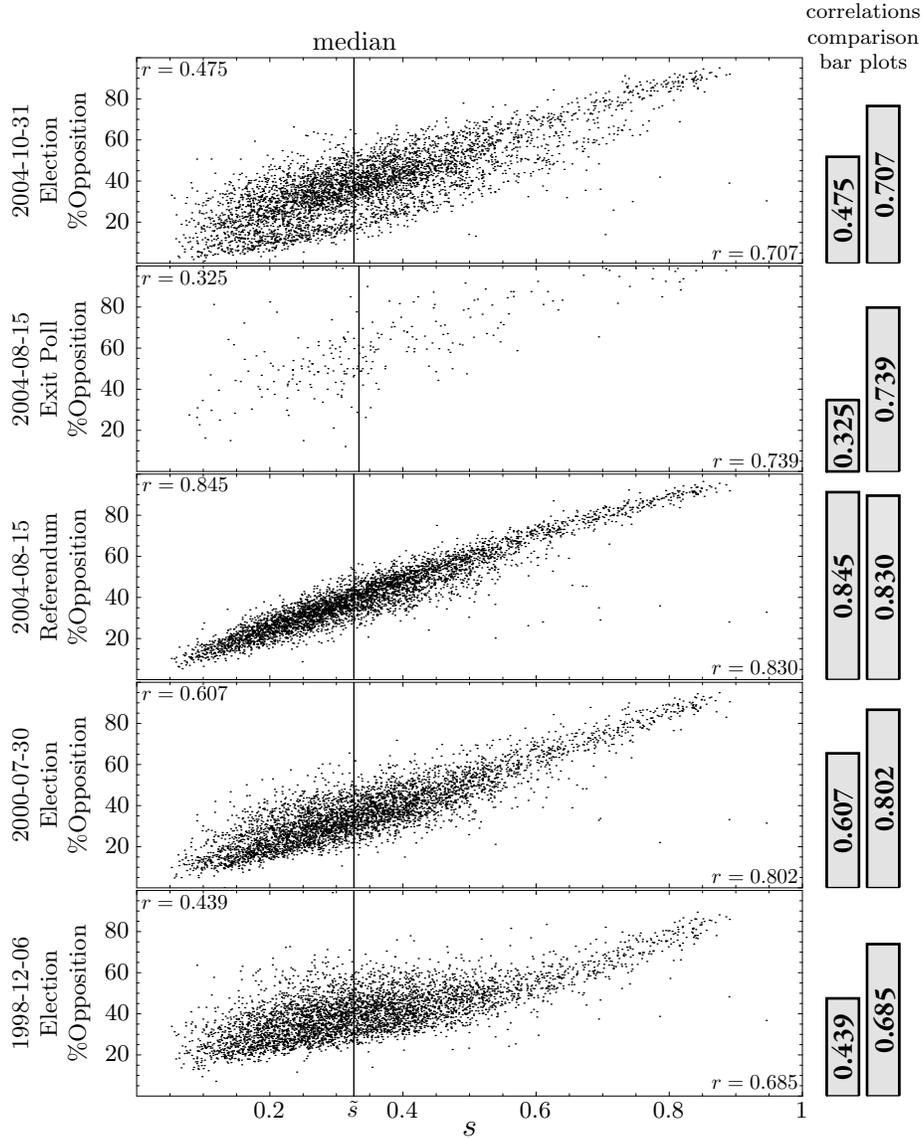


Figure 11: Correlation between percentage of opposition and s for the lower two ($s \leq \tilde{s}$) and upper two quartiles ($s > \tilde{s}$) for computerized centers. The correlation for the lower two quartiles is expected to be smaller than the correlation in the upper two quartiles. This expected difference is not seen in the Referendum official results.

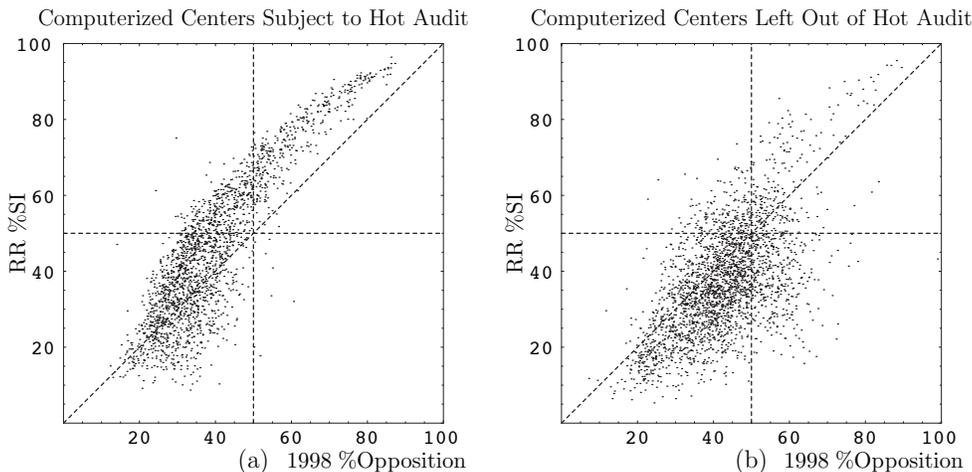


Figure 12: Centers inside (a) and outside (b) of the 20 counties to where the hot audit drawing was restricted.

the election. The final result was that the CNE squandered a crucial opportunity to build confidence and trust in the electoral system and outcome of the recall referendum.

Auditing only 26 centers out of 192 selected centers, is basically a cancellation of the auditing process. But, is there anything special about these 26 centers? If this drastic reduction in audit size was because it was “poorly executed”, and poor execution is independent of the value of s , then the value of s of these 26 centers would behave as a random sample within the s value of the 192 selected centers.

From Figure 13, it is clear that the 26 centers that were actually audited seem to have a much higher value of s than the 192 centers from where they come from. The average s for the 192 selected centers is $\bar{s}_{\text{selected}} = 0.3764$ while for the audited ones it is $\bar{s}_{\text{audited}} = 0.5275$. Additionally, the distribution of the 192 selected centers is positively skewed while the distribution of the 26 audited centers is negatively skewed.

Can this be just a coincidence? A Monte Carlo simulation was done, selecting 26 random centers out of the 192 selected for auditing. The result of this simulation is that the probability of having a $\bar{s}_{\text{audited}} = 0.5275$ is 1 in 2 600 000; and this does not take into account the difference in skewness.

This result is consistent with the hypothesis, because centers with a small value of s are the ones most susceptible to distortions.

It has been shown that the audited centers are not representative of neither the universe of all computerized centers, nor the restricted universe

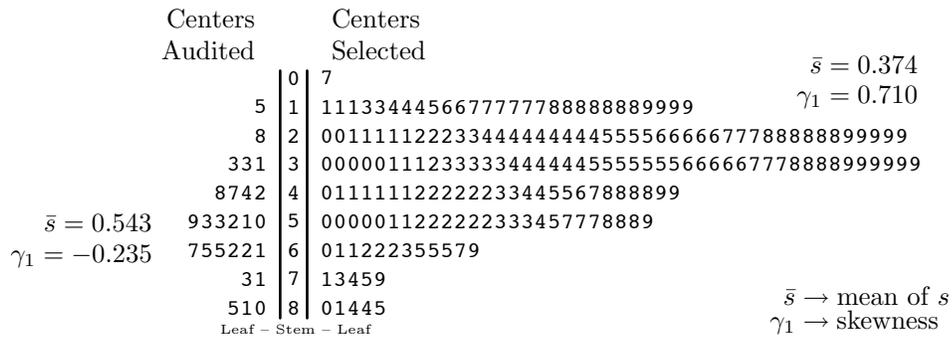
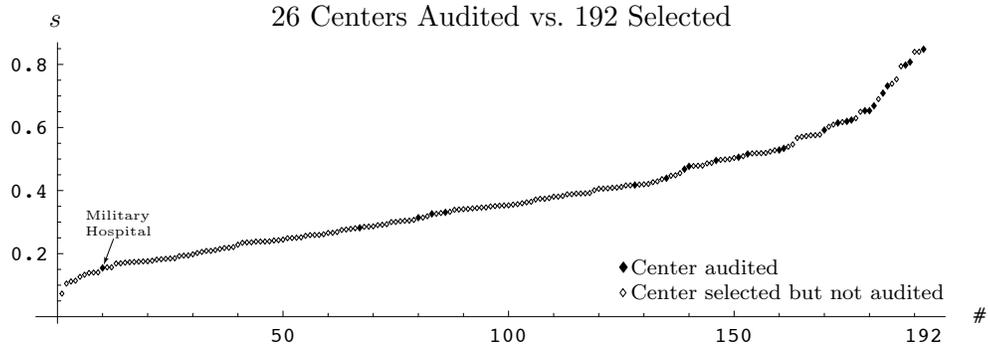


Figure 13: Comparison between the s value of the 192 selected centers and the 26 audited centers. TOP: The selected centers are ordered according to the value of s and plotted. BOTTOM: Back-to-back stem-and-leaf plot showing the same values of s as in the top figure. To obtain s values, multiply stem by 0.1 and leaves by 0.01.

used to select them.

The audited centers are not representative of the universe of computerized voting centers (see Figure 14) because:

1. In the audited centers, the SI won by 63.47% to 40.91%.
2. $\Delta\%_{1998}^{RR}$ is very different.
3. The value of s is much larger.

Additionally, the townships, counties and states where centers were audited are not representative of the other townships, counties and states. They are not representative with regard to their $\Delta\%_{1998}^{RR}$ and the correlation with respect to the 1998 election r_{1998} . This can be seen in Figure 15.

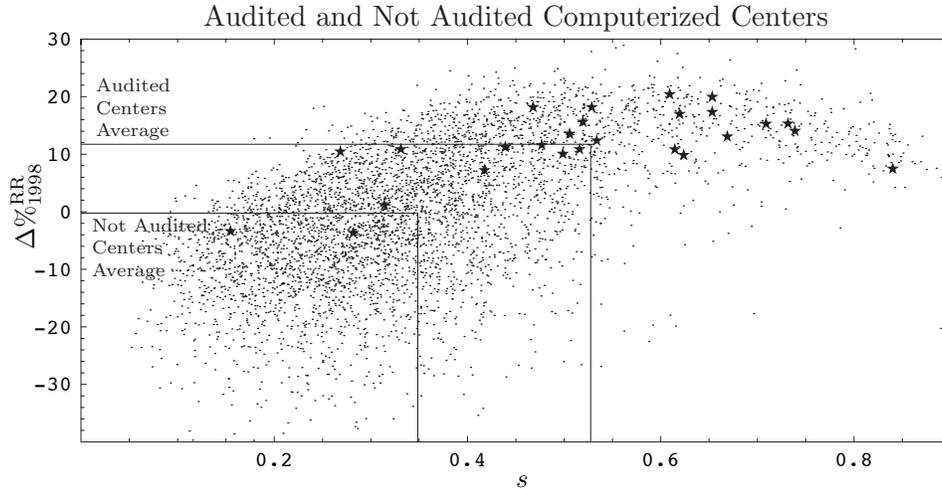


Figure 14: In this figure, the 26 computerized audited centers are compared with the universe of computerized centers. The average s and $\Delta\%_{1998}^{RR}$ are indicated with lines.

9. Cold Audit. Given the fact that the hot audit failed to serve its purpose, another audit was made three (3) days after the referendum. This audit cannot validate the official results mainly because of two reasons:

- The audited entity itself cannot select the centers to be audited. According to the OAS/Carter report [3] “The sample was generated by CNE staff” on its own computer using its own software.
- The control mechanisms that had been implemented to certify that the samples were unaltered were not used.

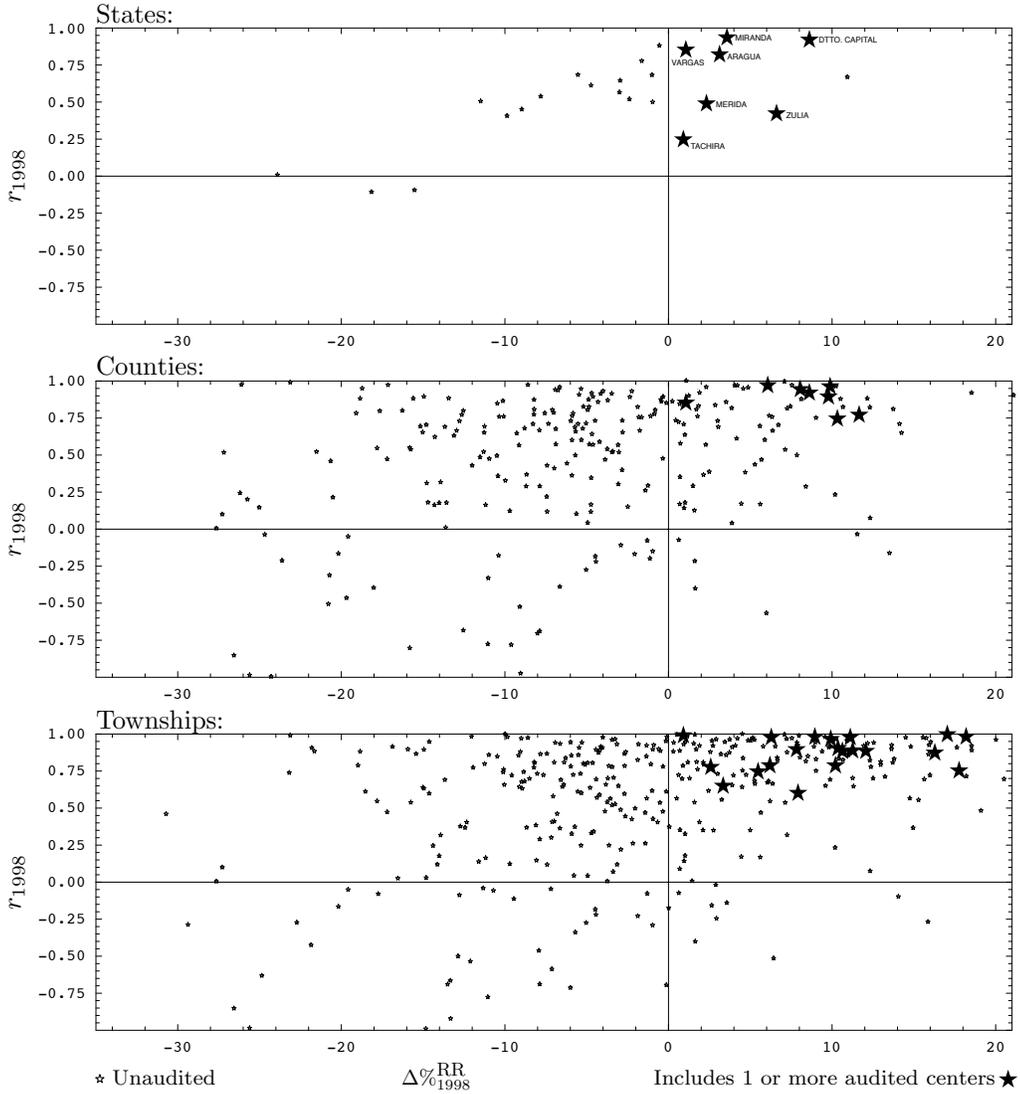


Figure 15: Townships, counties and states where the 26 audited centers are located. The vertical axis is the correlation with respect to the percentage of opposition in 1998 (r_{1998}). The horizontal axis is the difference in percentage of opposition with respect to 1998 ($\Delta\%RR_{1998}$).

The drawing where the centers for audit were selected was broadcast live on the official TV station, but the results were not shown. Usually, the whole idea of transmitting a drawing on TV, is to let the public know the results as they are being generated.

When the ballot boxes were closed and sealed, and the electoral centers closed, the seal was signed by witnesses. The boxes were then taken in the custody of the military.

The following excerpt from the OAS/Carter Center report [3] explains the mechanism used to certify that the boxes were unaltered:

Each box was physically checked to see whether:

1. The material used to seal the box was intact or whether there were signs that it had been taken off and then replaced.
2. There were cracks or holes through which votes might have been extracted or inserted.

If a box was defective in regard to sealing, cracks, or holes, all the boxes of that polling station were excluded from the audit and a note to that effect recorded in the minutes.

However, the witnesses who had signed the boxes were not called to certify the authenticity of the box.

When this audit was questioned, the Carter Center and OAS response was that:

Furthermore, the correlation between the signers and the YES votes is almost identical in the universe and in the sample. The difference between the correlations is less than 1 percent:

	Correlation Coefficient
Universe	0.988
Sample	0.989

This certainly can be used to argue that the boxes opened were representative of the official results, but does not indicate anything in regard to validating the official results.

Interestingly, the drawings for the hot and cold audit included sixteen (16) common centers. These sixteen (16) centers were successfully cold audited, but none of them were allowed to be hot audited.

10. Conclusions. Regarding the computerized voting process, taking into account that:

1. In general, the paper ballots were not counted.
2. The voting machines were connected to a central CNE server *before* printing the results.

3. Neither of the audits could remove the doubts on the official results, let alone certify the results.
4. That the computerized centers in the 20 counties to which the hot audit was restricted are not representative of the universe of all computerized centers (see Figure 12).
5. That the hot audited centers are not representative of the other computerized centers (see Figure 14).
6. That the townships, counties and states where computerized centers were hot audited are not representative of the other townships, counties and states (see Figure 15).
7. The official SI results seem to behave in an excessively linear way with respect to the requesting signatures (Section 4).
8. The problems with the hot audit seem to be more severe than just “poor execution” because the centers actually audited belong to a distribution with a much greater s value than the distribution of the 192 selected centers (Figure 13). Precisely where the high linearity is more unexpected (small s value) is where most audits were suspended.
9. The official SI results seem to be distorted with respect to the 1998 presidential election (Section 6).
10. The percentage of opposition seems to be excessively tied to s particularly in centers with small s (Section 7)
11. That if the hypothesis is true, all the aforementioned items would be expected.

It must be concluded that there are undisputed reasonable doubts as to the truthfulness of the computerized centers’ official results. The OAS and the Carter Center are encouraged to review the significance of having such a high linear correlation between the SI votes and the signatures. Their current interpretation is found in the following excerpt from the OAS/Carter Center report [3]:

“There is a **high correlation between the number of YES votes per voting center and the number of signers of the presidential recall request per voting center**; the places where more signatures were collected also are the places where more YES votes were cast. There is no anomaly in the characteristics of the YES votes when compared to the presumed intention of the signers to recall the president.”

APPENDIX A: DATA PROCESSING METHODOLOGY

All the data was stored on a MySQL database. Calculations were made using *Mathematica 5.2* which was connected to MySQL using the DatabaseLink package. Referendum official results were downloaded from the official CNE website using a Perl script. Electoral results from the 1998 presidential elec-

tion were obtained on an original CNE CD-ROM, and the data was converted from MS Access to MySQL. The REP from July 2004 was also converted from MS Access to MySQL. The CNE signature data was obtained on a CD from Súmate, and is the same version given to the OAS and the Carter Center. This data was supplied in a single text file.

By matching people’s ID numbers (cédula number) from the signatures and REP data, it was possible to find the number of signatures per voting center.

In order to classify voting centers into manual and computerized, the following sources of information were used:

- Súmate’s list of computerized and manual voting centers.
- On CNE web site, computerized centers show results down to the voting machine level, whereas manual voting centers show results down to the table level.

The list of computerized and manual centers obtained using the aforementioned sources was compared on a township by township basis with the CNE infrastructure document[5].

The list of centers effectively audited on the day of the Referendum was obtained from a document given by the *Coordinadora Democrática* to the Carter Center and OAS. A copy of this document can be found at:

<http://www-personal.umich.edu/~gdelfino/rr/hot-audit.xyz>

The coordinates of the voting centers shown in Appendix B were provided by “Delta Electoral”.

The data needed to reproduce this study is available at:

<http://www-personal.umich.edu/~gdelfino/rr/>.

The simulation was done using a deck of cards shuffling algorithm. The random number generator used by this algorithm was the “Wolfram rule 30 cellular automaton generator for integers”, which is provided by *Mathematica*.

APPENDIX B: A MIXED TOWNSHIP EXAMPLE.

Miguel Peña is a township in Valencia county, Carabobo state. It is one of the townships with more population in the country. It had 32 voting centers, 28 computerized and 4 manual.

In Figure 16, a partial aerial view of this township is shown. In it, notice that manual and computerized voting centers are in the same urban neighborhood. Despite this, the values of k are much higher for the manual centers than for the surrounding computerized centers, regardless of the total number of votes.

In Figure 17 notice that in this township, the lowest k value of the 4 manual centers is greater than the maximum k value of the 28 computerized voting centers.

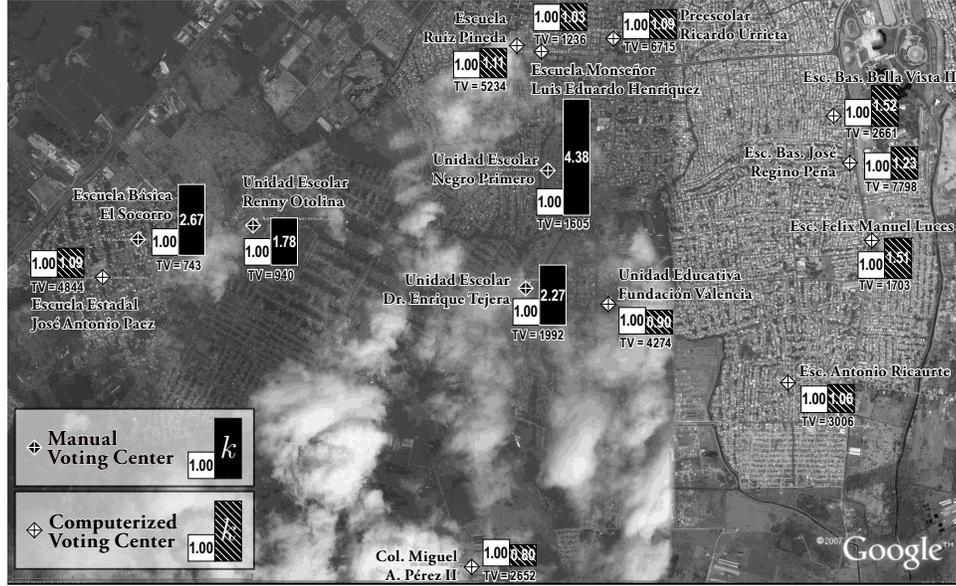


Figure 16: Partial aerial view of Miguel Peña township (taken from Google Earth). Manual vs. computerized voting centers are compared in regards to their k value and total number of votes (TV). The image is centered at Latitude $10^{\circ}7'32.66''$ N and Longitude $68^{\circ}1'22.48''$ W.

APPENDIX C: ADDITIONAL NON-LINEARITY PLOTS

According to the exit polls made under the supervision of Penn, Schoen, and Berland Associates, the opposition won the Referendum by a wide margin. By changing the numerator of Equation 4 from percentage of SI votes to percentage of SI from exit polls, a value of $k_{\text{exit polls}}$ can be calculated. The result, for computerized centers only, is plotted on Figure 18.

Similarly, k_{1998} can be calculated by using the percentage of opposition in the 1998 presidential election in the numerator of Equation 4. The result, for computerized centers only, is shown on Figure 19

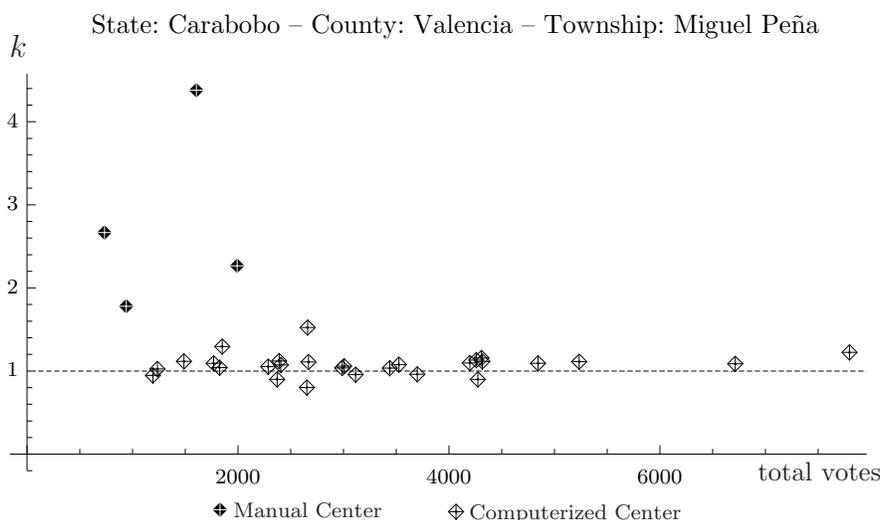


Figure 17: Behavior of k vs. total votes in all of Miguel Peña's voting centers. Manual and computerized centers are shown.

APPENDIX D: MONTE CARLO SIMULATIONS FOR CORRELATION BETWEEN $\Delta\%_{1998}^{RR}$ AND r_{1998} .

Assuming that $\Delta\%_{1998}^{RR}$ and r_{1998} are independent, regardless of being calculated at state, county or township level, then the correlation between them r_* must be casual. In order to find the probability that the observed r_* is casual, it is possible to reorder the values of r_{1998} with respect to $\Delta\%_{1998}^{RR}$. This reordering was made 100 000 times and the correlation was calculated each time. In all cases, the resulting distribution was found to be normal. The estimated probabilities for manual and computerized centers at state, county or township level are shown in Figure 20.

APPENDIX E: DIFFERENCES IN CHARACTERISTICS, OFFICIAL RESULTS AND REP VARIATION OF THE 20 COUNTIES SUBJECT TO HOT AUDIT DRAWING IN COMPARISON TO THE OTHER COUNTIES.

When the CNE decided to restrict the audit to 20 urban counties, it created two groups of computerized centers:

- 2040 computerized centers inside the 20 counties and therefore subject to be selected in the drawing. Variables referring to these centers will use a 20 as a subindex (\bullet_{20}).

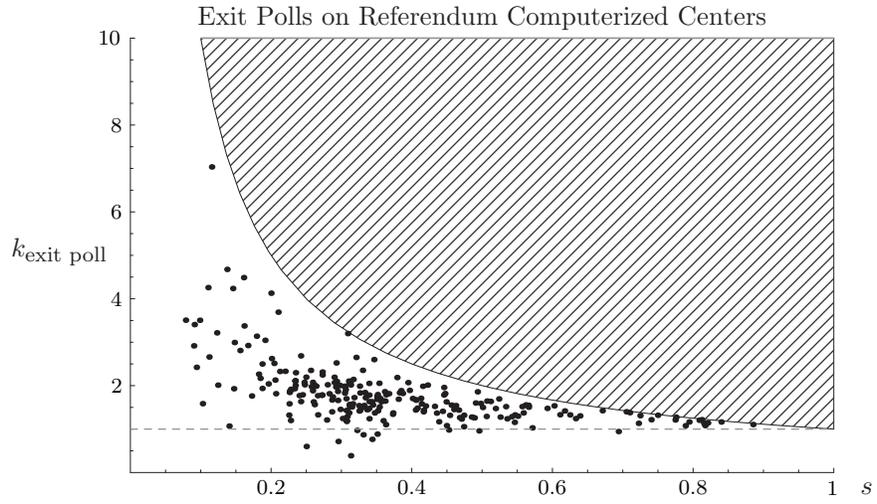


Figure 18: Exit Polls at computerized centers.

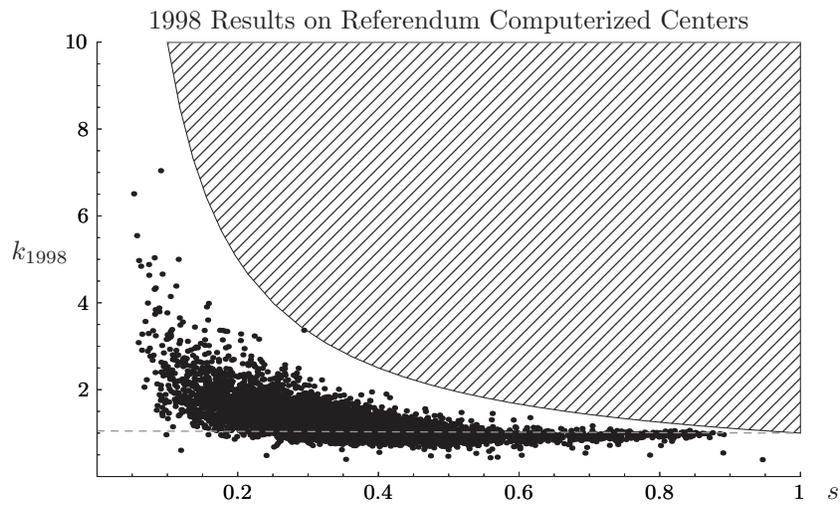


Figure 19: 1998 Presidential Election at computerized centers.

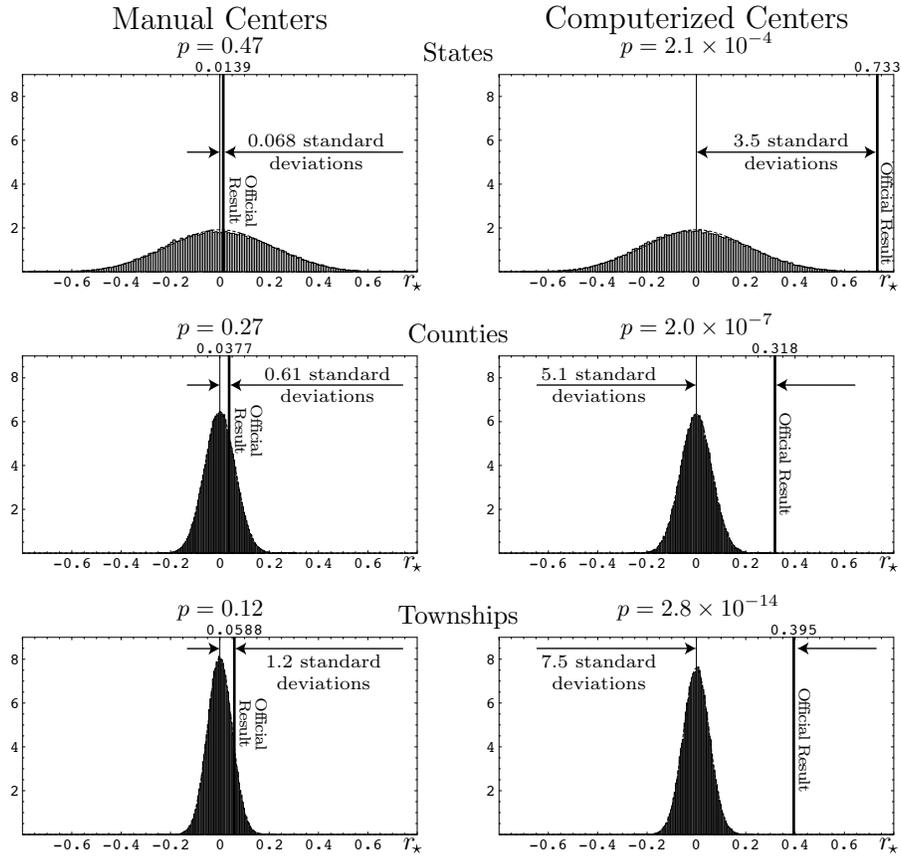


Figure 20: Comparison of official results correlation r_* vs. expected value distribution found after 100 000 simulations for manual and computerized centers at state, county or township level. The simulation results follow a normal distribution, which is shown as a dotted line. The probability of the official r_* happening by chance is indicated as p .

- 2553 computerized centers not subject to hot audit at all. Variables referring to these centers will use a \emptyset as a subindex (\bullet_{\emptyset}).

In Figure 12 it is shown that the behavior in computerized centers in the 20 counties is very different from that of the rest of the country.

E.1. Differences in Characteristics. When the CNE set up the signature collection event, it established the number of signature collection centers (SCC) directly in proportion to the number of people in the electoral registry (REP) for each county. A lot of people live in urban counties, therefore, a lot of SCCs were assigned to these counties. So the access from where the people lived to where they had to sign was much easier in these 20 counties. On the other hand, voting centers are more numerous and better distributed throughout the national territory.

For example, a county like Chacao in the Miranda state has 27 km² of area and 11 SCCs. In Chacao there were 24 voting centers, all of them computerized. On the other hand, the much larger Macanao Peninsula in Margarita Island has an area of 330.7 km² and only had 3 SCCs. There were 8 voting centers in Macanao, all of them computerized.

In Figure 21, it can clearly be seen that the 20 counties have higher s values which is consistent with the ideas just explained.

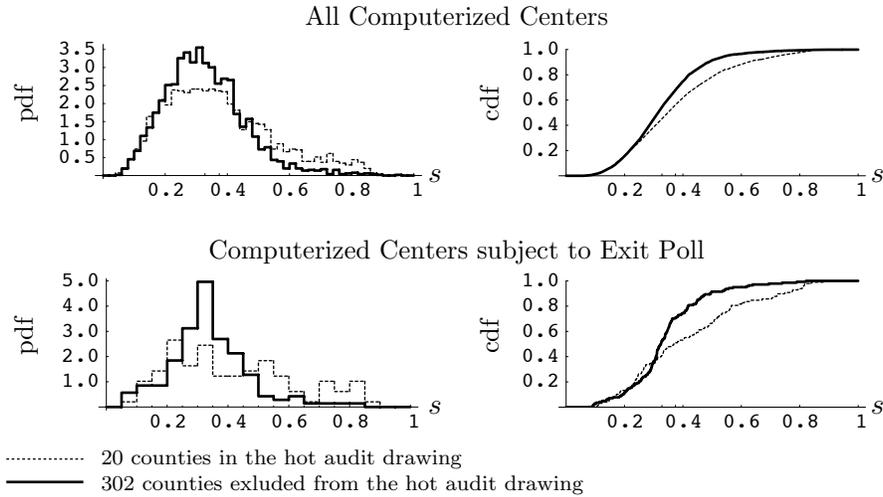


Figure 21: Comparison of s probability density function (pdf) and cumulative density function (cmf) for computerized centers inside the 20 counties of the hot audit and in the 302 excluded counties.

There were many computerized centers in rural areas where it was much

more difficult to sign than to vote. When the audit universe was restricted to 20 *urban* counties, all computerized centers in rural areas, the ones with a higher uncertainty in k , were excluded from the hot audit drawing universe.

E.2. Differences in Results. When the value of s decreases, in general, it is expected that the k values should increase, after all, $k_{\max} = 1/s$. Hence, a larger k is expected in rural counties than in the 20 counties of the hot audit where signing was less troublesome. However, in the official results, exactly the opposite is happening, as shown in Figure 22.

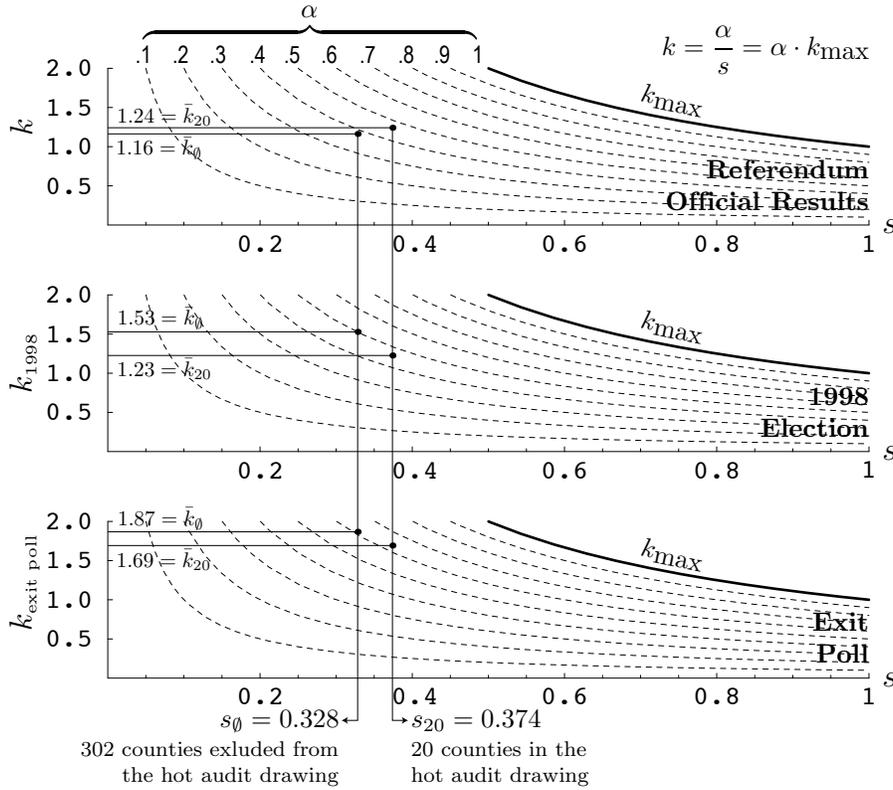


Figure 22: Comparison of average k and s values for the computerized centers inside and outside the 20 counties to which the hot audit universe was restricted. These \bar{k} and \bar{s} values are shown for the official referendum results, for the 1998 presidential election and for the referendum exit polls.

Considering that for the official referendum results \bar{k}_{20} is the average of 2040 voting centers and \bar{k}_0 is the average of the remaining 2553 voting centers, how likely is it that just by chance, \bar{k}_{20} be larger than \bar{k}_0 by 3.4%?

What could be expected is that \bar{k}_{20} would be smaller than \bar{k}_\emptyset . Contrary to official results, in the exit polls and in the 1998 election \bar{k}_{20} is significantly less than \bar{k}_\emptyset , as shown in Figure 22.

As seen in Figure 23, the distribution of k values among the 2040 auditable centers is quite different from that of the 2553 non-auditable centers. The k values in the 2040 auditable centers tend to be larger than in the other 2553 non-auditable centers. The portion of centers with k smaller or near to 1, is much smaller in the 2040 auditable centers than in the other 2553. That is contrary to what happened in the 1998 election and in the exit poll. Additionally, note that the k pdf seems to be much more symmetric than that in the 1998 results or the exit polls.

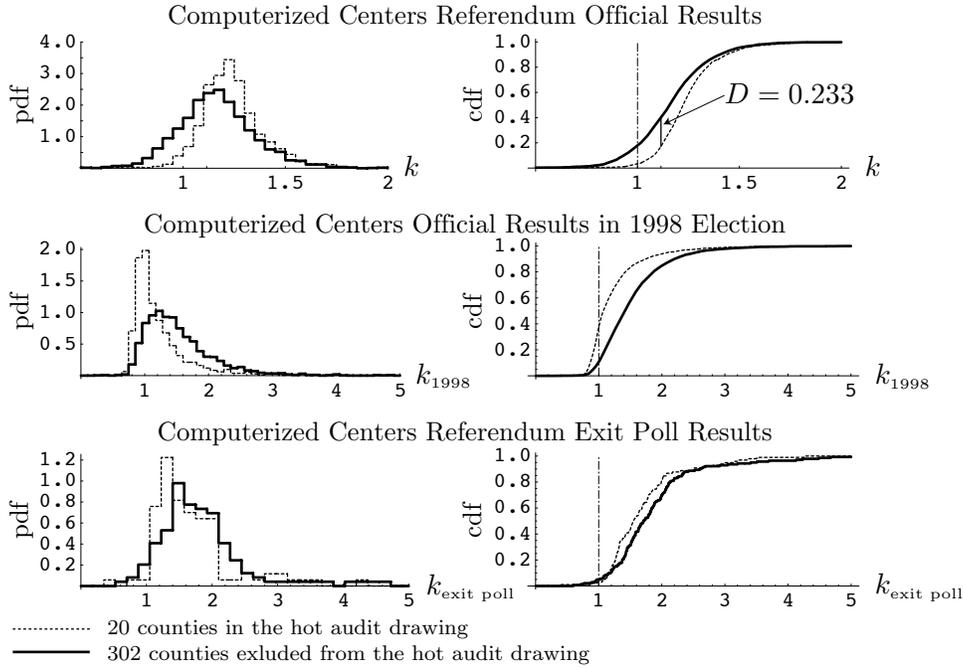


Figure 23: Comparison of k probability density function (pdf) and cumulative density function (cmf) for computerized centers inside the 20 counties of the hot audit and in the 302 excluded counties. The maximum cmf difference (Supremum) for the official results is shown as D .

How likely is it that k_{20} cmf be below k_\emptyset cmf with such a large difference ($D = 0.233$)? Being conservative and assuming that both k_{20} and k_\emptyset distributions came from the same continuous distribution, the probability can be estimated using the Kolmogorov–Smirnov Test for two samples. This proba-

bility was found to be in the order of 2.6×10^{-54} . For the reasons previously exposed, the distribution of k_\emptyset should be greater —not equal— than that of k_{20} . Hence, the actual probability should be much smaller.

E.3. Electoral Registry (REP) Differences. Between April and July 2004, 1 842 959 (14.9%) voters were added to the REP. In the computerized centers the number of voters went from 10 849 321 to 12 390 159. In Figure 24 it is shown how differently these increments were distributed in the computerized centers. Furthermore, in Figure 25, it can be seen that the selected 192 centers to be hot audited exclude an area where the government has important gains without a big increase in the REP.

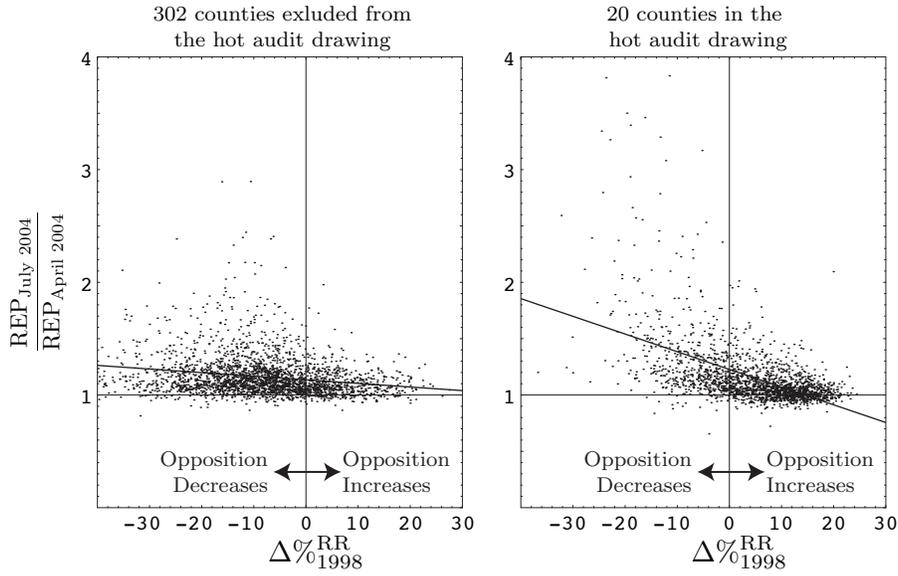


Figure 24: REP Variation vs. $\Delta\%_{1998}^{RR}$ in computerized centers inside and outside the 20 counties of the hot audit drawing. A least-square line is included in both cases.

ACKNOWLEDGMENT

The authors would like to thank all the people who contributed and supported this effort. Countless hours of volunteer work helped make this paper a reality.

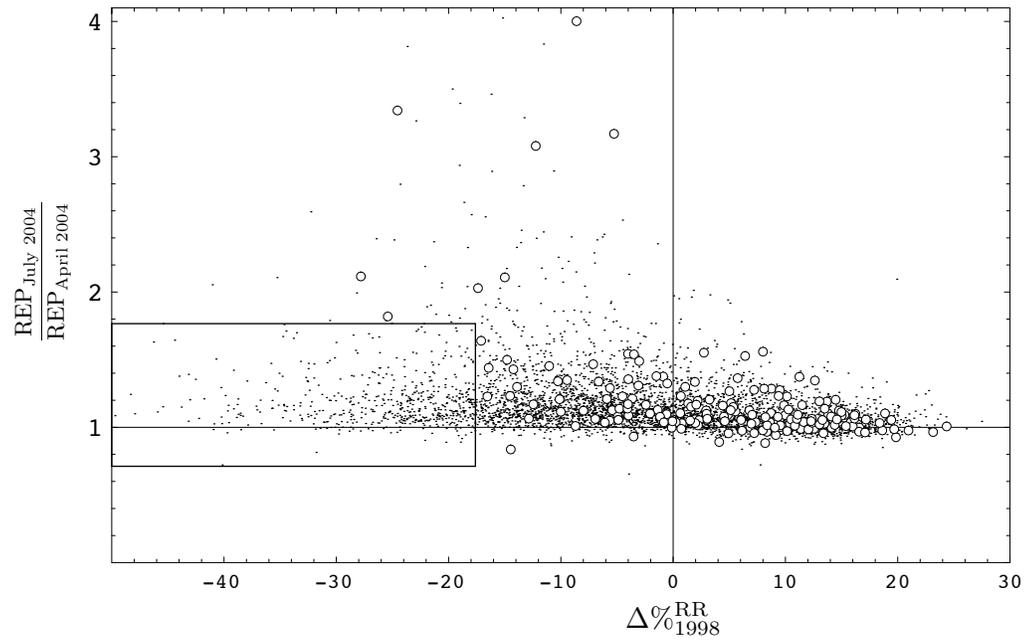


Figure 25: REP Variation vs. $\Delta\%_{1998}^{\text{RR}}$ in all computerized centers indicating the 192 selected for hot auditing. None of the 192 selected centers were in the rectangle area.

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