# Digital Democratization? The Political Consequences of Electronic Voting in Brazil and India

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**Abstract**

What are the political consequences of replacing paper ballots with electronic voting machines when electorates are less educated and fraud is common? This paper studies the political effects of the adoption of electronic voting in two of the world's largest democracies: India and Brazil. Using a regression discontinuity design, I show that in Brazil, the adoption of electronic voting resulted in the de facto enfranchisement of millions of voters and substantially increased political competition by reducing fraud in states governed by dominant political machines. In India, using a difference-in-differences design, I find much more modest effects both on the number of votes successfully cast and the prevalence of fraud. I argue that enfranchising effects of electronic voting are likely to be much larger in political systems with permissive electoral rules, such as those used in Brazil, than in countries with "unpermissive" rules such as those used in India. Furthermore, electronic voting can substantially reduce *tabulation* fraud— which was common in Brazil when paper ballots were used, but not *coercive* fraud, which is more common in India.

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In the last 10 years, over six hundred million voters have cast their ballot using *electronic* voting machines.[1] Voters living in as diverse a range of countries as India, Brazil, Venezuela, and the Philippines now exclusively use electronic voting in national elections and electoral authorities in countries such as Colombia, Indonesia, and Kenya[2] intend to adopt the technology over the next decade. It is possible that in ten years, the majority of all voters living in democratic societies will use computers in the polling booth rather than pen and paper. The spread of electronic voting is arguably the biggest change to the actual mechanics of voting since the broad adoption of the Australian ballot in the late nineteenth and early twentieth century.

Paradoxically, just as the pace of adoption of electronic voting has accelerated in many countries, particularly in the developing world, resistance to its use has increased in many wealthy democracies such as Ireland, the Netherlands, Germany, and the United States. Both Netherlands[3] and Ireland[4] abandoned the use of electronic voting after having partially adopted it in the early 2000s. In 2009, Germany's highest court declared automated voting systems unconstitutional[5]. Californian election officials in 2007 decertified existing electronic voting systems and as a consequence, many counties switched back to paper systems in the 2008 presidential election. In all these cases, opposition to electronic voting has been driven by concerns over security weaknesses and the unverifiability of vote counts.

While much of the resistance to electronic voting stems from concerns over security vulnerabilities, it is remarkable the degree to which election officials in the developing world have embraced the new technology. Despite the many criticisms made by computer scientists and activists, many election management bodies in developing democracies have argued that electronic voting alleviates flaws in the electoral process that are particularly severe in non-industrialized societies. Proponents of electronic voting generally maintain that the new systems provide two broad benefits[6]: increased accessibility and a reduction in fraud (IDEA 2011, 8). With respect to accessibility, proponents claim that electronic voting gives election authorities an enhanced ability to design ballots tailored to the needs of complex election systems and thus

1. A variety of terminology is used to refer to the computers used by voters to cast their ballot, including "direct recording electronic" (DRE) voting machines and "automated voting" machines. There is substantial variety in the devices that fall under the label "electronic voting machines", but in this paper I use the term to apply to all devices wherein voters directly register their choice on a computer and that this vote is recorded and stored electronically. For further detail on the varieties of electronic voting, see The Brennan Center for Justice (2006, 17)

2. Colombian electoral officials intends to adopt electronic voting in the 2014 congressional elections. Indonesia is currently debating its use in the 2014 presidential elections. Kenyan officials are targeting the 2017 parliamentary elections for the switch to electronic voting.

3. Crampton, Thomas. "France to choose president with help of electronic voting", *New York Times*, April 17, 2007. `http://www.nytimes.com/2007/04/17/technology/17iht-evote.4.5324501.html`

4. Deaglán de Bréadún. " Cabinet agrees to dispose of €55m e-voting system", *The Irish Times*, January 12, 2012. `http://www.irishtimes.com/newspaper/ireland/2012/0112/1224310143439.html`

5. "We Do Not Trust Machines", *Newsweek*, May 22, 2009. `http://www.thedailybeast.com/newsweek/2009/05/23/we-do-not-trust-machines.html`

6. A third frequently cited benefit is lower long term costs due to savings in poll worker time and reduced costs for the production and distribution of ballot papers. Given that this factor is less relevant for understanding the political consequences of electronic voting, I do not further address this factor.

reduce inadvertently cast invalid votes, a need particularly acute in societies with high levels of illiteracy.

With regards to fraud prevention, advocates argue that electronic voting systems hinder ballot stuffing and allow for the quick tabulation of results, making manipulation of vote counts more difficult. In general, while acknowledging the risks involved with electronic voting, election officials presiding over the mass adoption of the new systems have argued that the technology is especially effective at reducing problems that plagued paper ballot elections where the rule of law is weak and the electorate is relatively uneducated. A headline from an Indian newspaper article discussing the adoption of electronic voting captures this sentiment: "Messiah Machines - Electronic Voting Machines Stem the Blood Bath".[7]

The claim of election authorities in electronic voting countries that the use of computer technology is particularly beneficial in elections in poorer democracies has yet to be rigorously tested. With some exceptions (Katz et al. 2010), the academic literature of voting technology has overwhelmingly focused either on documenting the security flaws of existing systems or understanding the consequences of adoption in the United States and Europe. Yet social scientific evidence of its consequences in regions where it primarily used—Asia and Latin America—is largely absent. In this paper, I study the consequences of the adoption of electronic voting in two of the world largest democracies: Brazil and India. Both countries were among the first to completely abandon the use of paper ballots in national[8] elections in the early 2000s and have since served as exemplars for other countries seeking to alter their voting systems.

In both cases, I exploit the fact that electronic voting was not adopted across the entire country at once, but instead implemented in stages over several elections. This staged rollout allows for comparisons between regions using paper ballots and those that adopt the new technology. In the case of Brazil, the new voting system was allocated to municipalities (equivalent to a US county) in 1998 using an arbitrary function of the number of voters as counted in 1996. As a consequence, I can examine outcomes in municipalities immediately above and below a cut-point (known as a "regression discontinuity design"). Under some mild assumptions, the differences between municipalities in a narrow window around this threshold can be treated as causal. In the case of India, I rely on the fact that the factors determining which parliamentary constituencies received the new technology are well known and—based on that knowledge—implement a matching analysis to study its effects.

I provide evidence that adoption of electronic voting had very different consequences in the two countries. In Brazil, adoption of electronic voting radically decreased the difficulty in voting and substantially reduced fraud. In India, electronic voting had only marginal effects on both voters' ability to successfully cast a ballot and the prevalence of fraud. The change in ballot format had major effects on the difficulty

7. *The Economic Times*, May 15, 2004.
8. Brazil now uses electronic voting machines in all elections. India still uses paper ballots in many local contests.

in voting in Brazil because the country's permissive electoral system made designing an easy-to-use paper ballot particularly difficult and thus the ballot design made possible by electronic voting machines substantially eased the complexity of voting. India's first-past-the-post system, in contrast, makes paper ballot design much simpler and as a consequence, changing ballot format was of little consequence.

The contrasting effects on fraud can be explained by the fact that the most common type of fraud used to manipulate election outcomes were quite different in each country. In Brazil, the most consequential form of fraud was *tabulation* fraud: political machines would manipulate the vote counting process after election day to benefit their candidates. Tabulation fraud is particularly susceptible to changes in technology and because electronic voting centralized vote counting, it dramatically reduced the scope for decentralized manipulation of vote totals in Brazil. In India, the most significant problem is *coercive* fraud, which is much more difficult to alleviate with voting technology. Fraud that involves the threat or use of force to violently take over or "capture" polling stations is much less amenable to technological solutions since fraud-employing politicians can easily adapt their tactics to counteract any additional safeguards introduced by electronic voting. Overall, I find no evidence that electronic voting affected the prevalence of coercive fraud in Indian elections.

In the case of Brazil, I show that the adoption of electronic voting acted as a de facto expansion of the franchise as it increased the number of counted votes for candidates of the national legislature by about one third. The enormous impact of the ballot format could be attributed, I argue, to how voting technology interacts with the informational demands generated by Brazil's electoral rules. Brazil's open list proportional representation electoral system incentivizes hundreds—and in some cases, thousands—of candidates to run in each district. To cope with this abundance of choices, election authorities designed the paper ballot so as to require voters to physically write the name or number of their preferred candidate. This requirement made voting for illiterates and other low-information voters quite difficult and as a result, an average of about 30% of paper ballots cast were counted as "blank" or "null". The adoption of electronic voting removed this requirement to write and as a result, the percentage of blank and invalid votes fell by about 22 percentage points in federal legislative elections.

Apart from how it affected the voting experience of voters, the adoption of the new voting system in Brazil had a second and equally important impact on the conduct of elections in Brazil: electronic counting of votes increased the barriers to tabulation fraud. Under the paper ballot system, votes counting was decentralized and susceptible to penetration by organized political machines. While low level fraud was widespread, electoral fraud was particularly acute in several states with dominant ruling parties. For these ruling machines, illegal manipulation of the vote count was an important tool in maintaining the incumbent coalition in power. By centralizing the vote counting process in the hands of an insulated

electoral bureaucracy, electronic voting eliminated, by all accounts, fraud in the tabulation of votes.

The two distinct effects of electronic voting in Brazil—the enfranchisement of illiterates and other low information voters and the elimination of fraud—had consequences for the composition of the national legislature. The newly enfranchised elected to cast a "party list ballot" (akin to a party ticket) as opposed to a vote for a particular candidate at a dramatically higher rate than the already enfranchised. Furthermore, this shift towards more partisan voting disproportionately benefited Brazil's major parties with distinct ideological profiles or a record of governing, as opposed to catch-all and other minor parties. The influx of these voters into the electorate, I argue, acted as a sharp and positive shock to the electoral value of these parties' labels. The increase in the size of the electorate may have affected the structure of the party system by tilting the electoral playing field towards Brazil's ideological governing parties over their more inchoate and ideologically diffuse rivals.

The disruption of fraud in the vote counting process in Brazil also appears to have had major consequences for the political fortunes of subnational authoritarian regimes. In states governed by dominant political machines, defined more precisely below, the national legislative and state legislative candidates belonging to the governor's electoral coalition lost an estimated average of 22 and 30 percentage points, respectively, due to the adoption of electronic voting. Since candidates belonging to the governing coalition in political machine tended to be on the far right of the Brazilian ideological spectrum, their loss of votes tended to benefit candidates belonging to centrist and leftwing parties.

In India, the effects of the adoption of electronic voting were much more modest. Because the rates at which invalid votes were cast were already quite low, the adoption of the new voting technology did not substantially increase the number of valid votes cast. Furthermore, there is no evidence that electronic voting machines substantially reduced fraud. Using data from two different elections—the 1999 national parliamentary elections and the 2000 Haryana state assembly elections—I find null effects on the degree of political competition and incumbent party vote share. Most importantly, I examine the effect of electronic voting on whether or not a constituency had to hold a second election (a "repoll") due to coercive fraud. My estimates, based on difference-in-differences design, show no relationship between the adoption of electronic voting and the probability of a fraud-induced repoll.

## Electoral Systems, Ballot Format, and Enfranchisement Barriers

The organization of ballots, electronic or paper, are ultimately functions of the electoral system because the most binding constraint on designers of ballots is the number of choices presented to voters. As well established in the electoral systems literature, the number of candidates competing for office is chiefly a

function of district magnitude, though structural factors play a very important role as well.[9] In single member districts, for example, the number of candidates will be fewer and the task of constructing a ballot is more straightforward. The other main electoral system factor that affects the complexity of the ballot is whether or not voters can cast a *personal* vote.[10] As noted in Carey and Shugart (1995), high district magnitudes and the personal vote interact to create a larger "menu" of candidates for voters to choose among. The more candidates, the greater the challenge for election officials to construct a ballot that does not overwhelm the voter with their choices.

Once the candidates are set for a given election, electoral authorities must make a ballot that is understandable to eligible voters. Historically, ballot designers have introduced a remarkable number of design innovations intended to ease the challenges of complex ballots, including the use of party symbols, candidate photos, and party-specific colors (Reynolds and Steenbergen 2006). While good ballot design can certainly help voters deal with a large number of choices, if the number of candidates is sufficiently large, even well designed ballots cannot fully compensate for the increased difficulty of voting. The higher search costs involved with voting can manifest in high numbers of incomplete or unintelligible ballots cast that have no effect on the distribution of seats. Existing research suggests that informationally-demanding electoral environments—caused by complicated voting technology (Brady et al. 2001; Kimball and Kropf 2008)—or the absence of readily available partisan cues (Bowler, Donovan, and Happ 1992)—is the main contributor to the number of blank and invalid cast in any given election. High numbers of invalid[11] votes can also occur when many voters believe erroneously that they have successfully completed a ballot. Alternatively, the difficulty of completing a ballot may deter voters from even attempting to cast a ballot when they show up to vote, which would further drive up the rates of invalid votes.

Complex ballots are not always *unintended* consequences of complex electoral systems. In the post-reconstruction US South, for example, manipulation of ballot designs was one of the portfolio of tools, including fraud, poll taxes, and literacy tests, used by Democratic party politicians to suppress opposition voters, primarily African Americans but also poor whites. When the Australian ballot was introduced, Southern politicians designed the ballot to be difficult for poor and illiterate voters to cast a valid vote (Kousser 1974, p. 53). Party symbols and party lists, for example, were excised in favor of long and complex ballots that advantaged the educated. The president of the Alabama State Senate explained his support for the Australian ballot by arguing that under it, "the ignorant are practically disenfranchised". This

9. Of course, other institutional constraints can affect the complexity of the ballot. If financial or logistical hurdles to get on the ballot are prohibitively high, for example, then voters will choose among few candidates or parties regardless of district magnitude.

10. This variable only applies to electoral systems with a district magnitude of two or greater. In single member district systems, the personal and party vote coincide.

11. I use the term "invalid" votes to denote votes that are not allocated to a particular candidate or party. The terminology used to describe such votes varies in the literature, as sometimes they are called residual votes (Ansolabehere and Stewart 2008) or spoiled votes.

strategy was judged as effective by Virginia Governor J. Hoge Tyler, who stated that "thousands of defective or improperly marked ballots have been thrown out in every election since the [secret ballot] law was enacted—in many instances as many as one-third or one-half of the ballots deposited" (Kousser 1974, p. 54).

Of course, not all invalid votes are a result of complex ballots. The chief rival explanation for high rates of invalid ballots is political alienation, particularly in countries where voting is compulsory. If voters are dissatisfied with their choices, than they may cast a blank or spoiled ballot to express their disgust. In the case of Latin America, and Brazil in particular, political scientists have traditionally interpreted high rates of invalid votes in this way (e.g. Santos (1987) and Lima Junior (1990)) and have underplayed institutional factors.

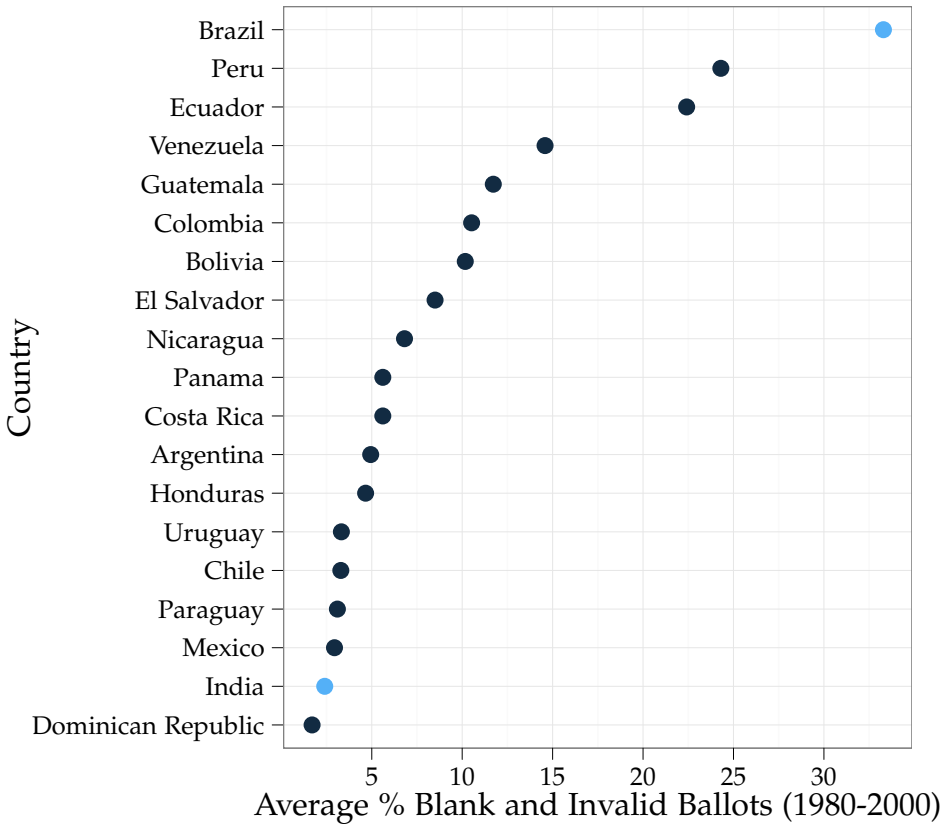



Figure 1: Average percent invalid and blank votes in Latin America and India (1980-2000). Data from Power and Garand (2007) and Indian Election Commission

While some invalid votes are inevitable, whether by design or by accident, the actual rate can vary enormously, even when accounting for the electoral system. Figure 1 shows the average percent of blank or invalid votes in 18 Latin American countries (and India) from 1980 to 2000. Brazil is clearly an outlier on this measure, with average of about 33 percent compared to the regional average (excluding Brazil) of

about 8.5 percent.[12]. India, on the other hand, has low levels of invalid vote rates, despite its much lower literacy rates than virtually all of the other countries listed in the figure. If one interprets Brazil's high rates of invalid votes as a protest vote, then the high rates are less normatively troubling since at least they reflect an affirmative choice by the citizenry. If, however, these high rates instead reflect the difficulty of casting a correctly counted ballot, then the high levels of invalid votes can be viewed as the result of a *de facto* enfranchisement barrier.

## Brazil: Difficult Paper Ballots and High Disenfranchisement

Brazil's procedures for electing most legislators[13] combine large district magnitudes—the number of members to be elected—with predominantly candidate-centered electoral rules. Legislative districts coincide with state boundaries and district magnitude is approximately related to the size of the electorate in each state. The variation in district magnitude is large: ranging from 8 for the smallest states to 70 for the state of São Paulo. Voters can cast votes for a particular candidate, a particular party, or a "blank" ballot.[14] Party votes[15] only affect how many seats a party or coalition will win, while personal votes affect both the number of seats won by the party and which candidates win office. Voters who show up at the polls but do not register any kind of vote at all are said to have cast "null" votes, to use the Brazilian term. Voting is mandatory for citizens between the ages of 18 and 70.

The combination of candidate-centered aggregation rules and the large district magnitudes creates incentives for parties to field a large number of candidates. Unlike in plurality systems, the incentives for voters or parties to coordinate on "viable" candidates are weak at best (Cox 1997). Legislative elections in large states regularly field over 200 candidates for the national legislature and over 400 for the state legislature. In the largest state of São Paulo, the number of candidates was 661 and 1,265 for the Chamber of Deputies (the lower house of the national legislature) and for the state legislature, respectively. The combination of a large number of candidates and the personal vote results in an electoral environment that is more complex than in electoral systems with low district magnitudes or closed lists. Furthermore, voters cannot rely on simple partisan cues since candidates within a party compete against each other.

From 1958 until 1996, all Brazilian voters voted with government-provided paper ballots (Nicolau 2002). Unlike in most democracies where the ballot lists all the possible candidates and/or parties, the sheer

12. In the United States, the average residual vote rate between 1988 and 2000 in US senate elections was 4.2% (Ansolabehere and Stewart 2008, p. 375).

13. Federal Deputies, state deputies, and city councilors are all elected using the same open list proportional representation rules. Senators are elected using simple plurality rules, with each district electing three senators.

14. Seats are distributed to parties or coalitions of parties based on the total number of candidate and party votes of each party or coalition, using the D'Hondt method. After seats are allocated to parties or coalitions, seats are awarded to individual politicians based on the number of personal votes received by each candidate.

15. There is no option for a voter to vote for one party for all offices, known as "straight-ticket" voting.


(a) Paper ballot from the 1982 elections.


(b) Electronic voting machine introduced in 1996.

Figure 2: Ballots in Brazil

number of options available to voters made this option impractical in Brazil. As a result, the ballot required voters to write either the candidate's name or the candidate's number, which is five digits for federal deputy candidates and six digits for state deputy candidates. Voters could also simply write a party name or party number to cast a party vote and not indicate a preference for a particular candidate. An example of such a ballot is shown in figure 2, which is the 1982 ballot for governor, senator, mayor, federal deputy, state deputy, and city councilor.[16]

Expressing a preference on a paper ballot that would be ultimately counted was quite difficult for many voters. For the 19% of the voting age population that was illiterate, writing a five or six digit sequence of numbers was not a trivial task. This is compounded by the fact that in legislative elections, voters vote for multiple offices and would have to fill in a total of 16 to 19 numbers if they were to cast personal votes[17] for all offices. "We don't hold all the names in our head and I didn't know what to write", explained one voter who failed to cast a valid vote in a 1994 news article[18]. One electoral official argued that the large number of blank votes could largely be attributed to illiterates, "who did not want to take a long time writing in a name, thus revealing the fact that they could not write."[19] Furthermore, voters had no way to verify that the number they wrote on the ballot actually corresponded to the candidate or party they intended to vote for. Any error in writing the candidate's name or number could result in the vote not being counted[20]. Such errors were in evidence during tests of the 1994 paper ballot format, where voters often wrote the names of the presidential candidates in the ballot line for federal and state deputy[21].

16. Under the 1988 constitution, the election schedule was altered so that local elections were not held in the same year as national elections.

17. Every other legislative election, voters cast two votes for senators. As a result, the total number of digits they must remember will vary from election to election. In a year where they only vote for one senate candidate, a voter must fill in 2 digits for a presidential candidate, 3 digits for a senate candidate, 5 digits for a federal deputy candidate, and 6 digits for a state deputy candidate.

18. Lessa, Ricardo. "Uso de Duas Cédulas Confunde Eleitores", *Estado de São Paulo*, October 1, 1994.

19. Interview with TSE minister Sepúlveda Pertence.

20. Another election official argued similarly: "Once he [an illiterate voter] cast a ballot, the handwriting was so bad, at times so incomprehensible, that his vote wasn't counted." Testimony of Paulo César Bhering Camarão in Câmara de Deputados, June 6, 2005.

21. Cosa, Rosa. "Votos Viram Salada Partidária", *Estado de São Paulo*, October 1, 1994.

Given the alarming share of the vote that was recorded as null or blank, along with evidence of endemic voting fraud in some regions of the country, the Superior Election Tribunal or "TSE" (*Tribunal Superior Eleitoral*), Brazil's national electoral authorities, decided to abandon the paper balloting system for a new electronic voting system in the early 1990s. The TSE is part of the judicial branch and major decisions are made by a court comprised of five high court justices and two judges appointed[22] by the President. The court is well insulated from political pressure and no major political figure disputes its impartiality, a phenomenon discussed extensively in Fleischer and Barreto (2009).

The court tested a variety of electronic voting systems both for ease of use and for security of the counting process. The TSE settled on an interface reminiscent of banking ATM machines, a technology widespread in Brazil by the early 1990s. The interface is depicted in figure 2. The voter inputs the number of the candidate or party and the candidate or party will appear on the screen for confirmation. Furthermore, there is a dedicated button for a "blank vote". A "null" vote is cast if a voter enters numbers that correspond to no candidate or party and confirms the choice. This design was considered an improvement over the paper system because even illiterate voters could typically recognize and enter numbers without error. Furthermore, voters could verify that the number they inputed corresponded to the candidate they intended to vote for. In a news report discussing the implementation of a new system, an illiterate voter explained that

> [I]t's easier because I don't need paper nor pen. Because I don't know how to write, it used to take a long time. With the new system, I see the picture of the candidate and knowing that the number is correct, everything works ok.[23]

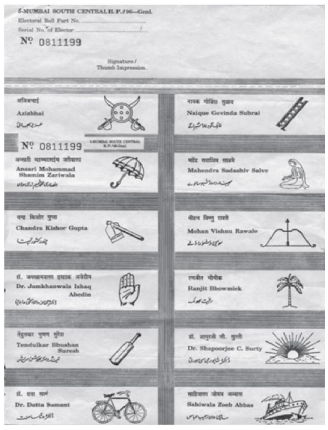
This and similar testimonials suggest that the new system substantially reduced the de facto enfranchisement barrier generated by the interaction of the paper ballot and the open list PR electoral system.

## India: Simple Paper Ballots and Low Disenfranchisement

When compared to Brazil, India's electoral system–first past the post with single member districts–results in a much simpler voting process for the electorate. While India's legislative elections often feature more viable candidates than what formal theories of electoral competition under single member districts would predict (Chhibber and Murali 2006), the number of candidates that a typical voter must choose among is still much smaller than what a typical Brazilian voter would face. In the 1999 parliamentary elections,

22. Out of the seven top justices of the TSE, three are from the highest constitutional court (*Supremo Tribunal Federal*) and two are from the highest appellate court (*Supremo Tribunal de Justiça*). Furthermore, the President is fairly constrained in who he can pick. The supreme court presents a list of six judges to the President and he selects two judges from this list to serve a maximum of four years.

23. *Folha de São Paulo*, October 2, 1998.




(a) Indian paper ballot.

(b) Electronic voting machine.

Figure 3: Ballots in India

for example, the average number of candidates per district was 8.6. Given this smaller choice set, the Indian election authorities face a much less daunting design challenge in constructing ballots that a typical voter could use.[24] The paper ballot in India presented the party symbols and names of all candidates and the voter simply had to mark their preferred party. As a result of the simpler format and non-compulsory voting, invalid vote rates, while high compared to other single member district countries, were much smaller than those observed in Brazil. In 1996, for example, the invalid vote rate was 2.5%, which amounted to about 8.5 million voters.

Paper ballots were fully replaced by electronic voting in the 2004 Lok Sabha parliamentary elections. The Election Commission of India (ECI), a well insulated electoral management body[25], sought to reduce the costs and logistics involved with printing paper ballots, as well as to lessen the scope for ballot stuffing (discussed below). The full introduction of electronic voting machines eliminated the already low level of invalid votes by simply removing the ability to cast such a vote. The right panel of figure 3 depicts the machine chosen by the Indian Election Commission. To vote, a voter simply presses the button next their preferred candidate's name and party symbol. Unlike in the Brazilian case, there is no option for a blank or invalid vote.

24. Prior to 1996, the requirements to appear on the ballot were very low, so as a result, many frivolous candidates would appear on the ballot. Often, these frivolous candidates were added so as to draw support from specific minority groups in order to weaken viable candidates. The Indian Election Commission, however, raised the monetary deposits required to register a candidate and the number of the candidates decreased substantially.

25. The Election Commission of India is a constitutionally protected body, which by most observers, is well insulated from political pressure. The election assistance NGO, IDEA, described the ECI as the "embodiment of EMB independence" (Patidar 2006). For a discussion of the historical development of the ECI's independence, see Rudolph and Rudolph (2001).

## Ballot Format and Varieties of Fraud

The second major motivation for introducing electronic voting is to combat fraud. Electoral officials have argued that the introduction of electronic voting diminishes the opportunity for fraud by reducing discretion during the tabulation of votes. In large complex elections with many offices, vote tabulation is often a decentralized, sprawling, and lengthy affair. Even election management bodies that are well-insulated from political pressure like the TSE in Brazil and the ECI in India cannot always effectively monitor the tens of thousands of poll workers and vote counters that play a role in the tabulation of paper ballots. As a result, the logistics involved with accurately counting millions of votes for thousands of offices are often beyond the administrative capacities of underfunded election bureaucracies. These deficiencies mean that the vote counting process can be penetrated by political machines and other interested parties at many points. Thus, electronic voting is thought to reduce what I call *tabulation fraud*.

In addition to reducing discretion in vote tabulation, election reformers are sometimes also motivated to redesign ballots to reduce the potential benefits of election-motivated violence. A common phenomenon in some democracies is the violent take over of polling stations wherein activists ("thugs") commandeer voting booths and stuff ballot boxes. Electronic voting systems can be tailored to reduce *coercive fraud* by writing software that prevents many votes from being registered in a short amount of time, as well as allowing poll workers to shut down machines at a moment's notice. It is thought that these safeguards at the very least slow down ballot stuffing and give more time for security forces to arrive. By "hardening" the target, electronic voting is thought to reduce the potential benefits of violently seizing control of polling stations for electoral purposes.

### Tabulation Fraud in Brazil

Fraud in Brazil, according to press accounts and interviews with former candidates and electoral officials, was widespread in some regions due to the cumbersome tabulation procedures for counting paper ballots. The qualitative evidence suggests that fraud was primarily a phenomenon that occurred after the counting started (which could last up to two months), while the use of violence to engage in ballot stuffing was quite rare.[26] Under the paper ballot system, votes were counted in a decentralized fashion where counting committees ("juntas apuradoras") were responsible for ballots cast in designated geographic areas. These committees were ostensibly composed of appointed citizens of "moral probity" ("notória idoneidade") unconnected to political candidates, but in practice candidates with special access to the administrative

26. Paper ballots also made vote buying easier because it made vote monitoring easier. A variety of ingenious methods were used to monitor votes, including a system wherein a voter would enter with a marked ballot, cast the ballot, then exit with a blank ballot for the next voter to mark.

machinery of the state or linked to political machines were often able ensure that the committees were stacked in their favor (Viana 1988), particularly in rural areas[27].

Vote counters could commit fraud in a number of ways, but the most common tactic, according to election officials, was to manipulate polling station tabulation sheets by adding votes to machine candidates and then subtracting the amount added from the blank or null vote totals, thus preserving the total number of voters cast.[28] The disenfranchising effect of complex ballots made fraud easier, as described by Federal Deputy Tourinho Dantas:

> If an illiterate voter doesn't know how to read or write, how can he vote? They humiliate themselves at the moment in which they vote. When he goes to the ballot booth and he doesn't know what to do, he casts a blank vote. This vote, in the majority of places, its filled out by those perpetrating fraud. It is by this means that fraudlent votes are cast in so many places.[29]

Another federal deputy from the state of Paraíba discussed his own encounter with this type of fraud:

> In my election, I had to ask for a recount because according to the announced results, I had lost. With the recount, we reversed the fraud that happened in my municipality of Guarabira. More than 800 blank and null votes were given to another candidate.[30].

This tactic was so common that the number of blank and null votes is one of the main criteria used in Brazilian election law[31] to determine whether or not votes should be recounted in a suspect polling station. In several states, abnormally low numbers of the blank and null votes served as prima facie evidence of fraud and consequently triggered recounts (Araujo 1998).

Electronic voting was introduced—in part—to end the perceived widespread fraud in the tabulation process. By most accounts, it succeeded in this task. After electronic voting was introduced, the months-long wait for results was reduced to a matter of hours.[32] Even without a proper paper trail[33], voters and the political class generally trust the electronic voting machines and many view Brazil's early adoption of the technology with pride. A 2008 poll, albeit one commissioned by the election authorities, showed that

27. While fraud was reported to particularly prevalent in northeast Brazil and in rural areas, it was not confined to those areas. Rio de Janeiro electoral officials, for example, overturned he results from the 1994 legislative elections for the entire state and called for new elections because of widespread fraud.

28. See Carvalho, Happy. "'Encontrei uma Quadrilha', Afirma Juiz", *Estado de São Paulo*, October 15, 1994. For another expose on such practices see Lessa, Ricardo. "Juízes Comandam Máquinas das Fraudes", *Estado de São Paulo*, October 16, 1994. In Brazilian political slang, this practice was known as "mapismo".}

29. Tourinho Dantas. *Dîario do Congresso Nacional*, October 27, 1994, p. 13331.

30. Interview with Federal Deputy Avenzoar Arruda, (11/1/2008).

31. Article 88, Law 9.404, September 30, 1997.

32. After the polls close, poll workers immediately print out the results from each machine. Representatives of the parties are asked to inspect the results, sign a document indicating their approval of the results, and then they are given a copy of the results. Finally, the results for each machine are posted publicly at the polling station. After the parties indicate their approval, the results are sent to the capital of the state to be tabulated.

33. Models with a paper trail were tested in the 2002 election, but they were abandoned due to logistical difficulties.

90% of voters had a positive opinion of electronic voting.[34] State and federal legislators that I interviewed in 2008 and 2009 universally agreed that electronic voting had ended fraud in the tabulation process. While critics of the system do exist (e.g. Graaf and Custódio (2002)), by and large the media and elected officials do not question its accuracy.

## Coercive Fraud in India

Election fraud in India was substantially more visible and violent than in Brazil. While tabulation fraud did occur, election officials and candidates more frequently cited violence coupled with ballot stuffing as the most serious type of fraud plaguing the Indian electoral process. Armed gangs hired by political candidates would engage in a practice known as "booth capture", which involved the violent take over of a polling station and the subsequent stuffing of ballots (Witsoe 2012, pg. 13). Sponsors of booth capturing typically target polling stations in communities associated with the opposition. Singh (1980, pg. 914) personally witnessed this phenomenon and described it in detail:

> The gangs storm the flimsy structure, usually a school room or a portable shack. There is usually no resistance from members of the polling party who are not only out-numbered but are also unarmed. The intruders demand and obtain blank ballot papers, force the presiding officer to sign them by candle light, and arrange an efficient assembly line in which one person affixes the thumb impression, another stamps the ballot, the third man folds the paper correctly, and another inserts the folded ballots into the boxes.

In addition to stuffing ballots, these gangs use violence or threats of violence to delay and intimidate voters. After most elections, Indian newspapers feature many accounts of election-motivated deaths, bombings, and ballot snatching. In a tabulation of reports in India's major newspapers, I found that in the 1999 elections 20% of constituencies had at least one report of booth capture.

To reduce the incentives of engaging in election-day violence, the Election Commission of India responds to election violence by nullifying the results of polling stations with voters involved in violent incidents. When incidents are verified, the commission conducts a "repoll" with heightened security several weeks after the election. Turnout is typically lower during repolls, however, and consequently the violence still frequently benefits the candidate sponsoring the armed gang.

Given the history of violent elections, the Election Commission of India sought to design electronic voting machines that would increase the barriers to coercive fraud. To that end, they designed the machines so that they would only accept five votes per minute and after every vote, the polling officer is required to

34. "97% dos eleitores aprovam a urna eletrônica, diz pesquisa do TSE", *G1*, January 15, 2009.

"release" the machine. Quick ballot stuffing is impossible and consequently the chances of being caught by security forces are ostensibly higher. Furthermore, the Commission created a mechanism for poll workers to quickly shut down the machines for the rest of the election day in case of any disturbances. One candidate explained the logic of how the new technology would stymie ballot stuffing: "[A]s rigging EVMs [electronic voting machines] is a time consuming process, people may be discouraged to make an attempt. The danger of the patrolling security forces reaching the booth is greater."[35] A villager in Bhadran, Gujarat even went so far as to claim "I think this will bring to an end to looting of ballot boxes. The diktat of the parties in power will be over now."[36]

Despite Indian election officials triumphalist claims about the effect of electronic voting on fraud, ethnographic and journalistic accounts suggest that booth capturers could adapt to the new technology by suppressing turnout of opposition voters rather than simply stuffing ballot boxes. This underscores the qualitative difference between tabulation and coercive fraud. Coercive fraud is much more adaptable to technological changes in the vote counting process. While ballot stuffing is a particularly efficacious form of coercive fraud, other types are close substitutes. In an article discussing parliamentary elections in Bihar, for example, the reporter found that "[c]omplaints from 11 of the 40 constituencies that went to polls on Tuesday indicate that criminal elements tried hard to prevent voters from going to booths, instead of capturing booths altogether."[37]

Furthermore, when the rule of law is particularly weak, ballot stuffing, while somewhat impeded by the new technology, is by no means impossible. Many reports from the northern state of Bihar, for example, indicate that ineffective police forces leads to rampant booth capture even after the advent of electronic voting machines (Witsoe 2009, pg. 76). This is described quite vividly in the following report from Bihar:

> In what appeared to be a carefully planned series of events, two small bombs exploded near the polling place and party workers threatened the five policemen guarding the booth and then brazenly took control of it. As poll workers and policemen averted their eyes, young party workers pushed the button for their party on the electronic voting machine over and over again, casting vote after fraudulent vote.[38]

This anecdote suggests that electronic voting may not be particularly effective when coercive fraud is the primary mechanism used by politicians to manipulate the electoral process.

35. Shukla, Amitabh. "Life Isn't the Same for Booth Captors", *Hindustan Times*, February 14, 2002.
36. "Bhadran's Electorate Flocks to Try EVMs", *The Times of India*, February 18, 2000.
37. "EVMs Shock Bihar's Booth-Grabbers", *The Times of India*, April 22, 2004.
38. Rohde, David. "On a Newfangled Voting Machine, the Same Old Fraud", *The New York Times*, April 27 2004.

# Consequences of Electronic Voting in Brazil

## Research Design and Data

The key feature of my research design for the Brazil case is that electronic voting was only adopted in municipalities—equivalent to a US county—with an electorate over 40,500, as measured two years before the 1998 legislative elections.[39]

Formally, municipality $i$ has a 1996 electorate $E_i$, which is the "forcing" variable that determines treatment status as follows:

$$T_i = \begin{cases} 1 & \text{if } E_j \geq 40500 \\ 0 & \text{if } E_j < 40500 \end{cases}$$

I wish to estimate the quantity $\tau = \mathbb{E}[Y_i(1) - Y_i(0)]$, where $Y_i(1)$ and $Y_i(0)$ denotes the outcome of interest (e.g. share of null and blank votes) for municipality $i$ with electronic voting machines and paper ballots, respectively. This estimand is unidentified without further assumptions since we only observe $Y_i(1) \mid T_i = 1$ and $Y_i(0) \mid T_i = 0$, but not $Y_i(1) \mid T_i = 0$ and $Y_i(0) \mid T_i = 1$.

The crucial assumption for my study is that the counterfactual outcomes of what would have happened under each treatment condition do not jump abruptly at the discontinuity point. In other words, any abrupt changes in observed outcomes cannot be attributed to any factor other than treatment. Under this smoothness assumption about $Y_i(1)$ and $Y_i(0)$, one can identify a local causal effect at $E_i = 40500$ since on either side of the threshold (with a minimum amount of extrapolation), the outcomes of polling stations in municipalities with electronic voting are valid counterfactuals for the polling stations in municipalities with paper ballots (Imbens and Lemieux 2008, 619). Thus, in this paper I focus on the following quantity:

$$\tau = \mathbb{E}[Y_i(1) \mid E_i = 40500] - \mathbb{E}[Y_i(0) \mid E_i = 40500]$$

This estimand is a "local" average treatment effect (LATE), since it only represents the effect among voters in municipalities with a specific population. In this study, two categories of outcomes are of central interest: those relating the proportion of voters who are enfranchised by the treatment and those relating to how electoral outcomes are affected by the change in technology. For the former, the outcome variable is defined as some measure of vote validity (number of blank votes, null votes, or valid votes) divided by the total number of voters who turned out. I label these local average treatment effects as $\tau_D$. The other category of treatment effect is for outcome variables that are some measure of voters preferences (total number of

39. The exception to this rule are the states of Rio de Janeiro, Alagoas, Roraima, and Amapa where all municipalities used the new technology. The municipalities in these states comprise 4% of the total number of municipalities in Brazil. The stated rationale for covering all municipalities in these four states was that voting fraud was thought to be particularly acute. In all analyses presented below, I drop municipalities from these states.

votes cast for a candidate or party) divided by the total number of valid votes cast. These treatment effects are labeled as $\tau_C$.

**Specification and Inference** To calculate local average treatment effects, I use two main specifications. The first specification estimates the conditional expectation function on each side of the discontinuity using the following local linear regression:

$$\min \sum_{i=1}^{N_i} 1\{-h \geq E_i \leq h\} \cdot (Y_i - \alpha - \beta \cdot (E_i - 40500) - \tau_{RD} \cdot T_i - \gamma \cdot (E_i - 40500) \cdot T_i)^2$$

$\tau_{RD}$ is our parameter of interest. The variable $h$ is the bandwidth, which specifies how much data in a window around $E_i = 40500$ is retained for estimating $\tau_{RD}$. In this application, I set $h$ to be 20,000.[40] In addition to the local linear regression, I also estimate $\tau_{RD}$ by calculating the simple difference-in means using data from a narrow window ("discontinuity sample") around the 40,500 threshold. I use a bandwidth of 5,000 voters, leaving municipalities with a 1996 electorate greater than 35,500 and lower than 45,500, for a total of 114 municipalities.

**Data** Electoral data was obtained from the Supreme Electoral Tribunal at the polling station level and aggregated to the municipal level. Covariates data was obtained from the Institute of Applied Economic Research ("Instituto de Pesquisa Econômica Aplicada" or IPEA).

**Balance** While my identification assumption that the mean of the outcome on one side of the threshold is a valid counterfactual for the mean outcome on the other side of the discontinuity is fundamentally unverifiable, I can test whether or not implications of the identifying assumption are borne out in the data. Specifically, I check if pre-treatment covariates are *balanced*, i.e. statistically similar across the municipalities adopting electronic voting 1998 and those not. Using the two specifications discussed above—discontinuity sample difference-in-means and a local linear regression—I estimate the difference around the discontinuity in the conditional expectation of 18 covariates at $E_j$=40,500. These covariates are measured at the municipal level and include a range of political variables and census socio-demographic characteristics. The full list of covariates and the associated balance statistics are presented in figure 4.

As expected, many of the covariates are severely imbalanced in the full sample. Variables such as 1991 rates of illiteracy and average income are quite imbalanced, which is unsurprising: control municipalities

40. An alternative is to use automatic bandwidth selection algorithms such as the cross-validation procedure suggested by Ludwig and Miller (2007) and the algorithm proposed by Imbens and Karthik (2009). I tried using both approaches on our data, but in each case, they recommended implausibly large bandwidths that would have involved keeping almost all the data when estimating treatment effects. Given the bias that could be introduced when using data far from the threshold, I chose to use covariate balance as the main criterion for bandwidth selection.

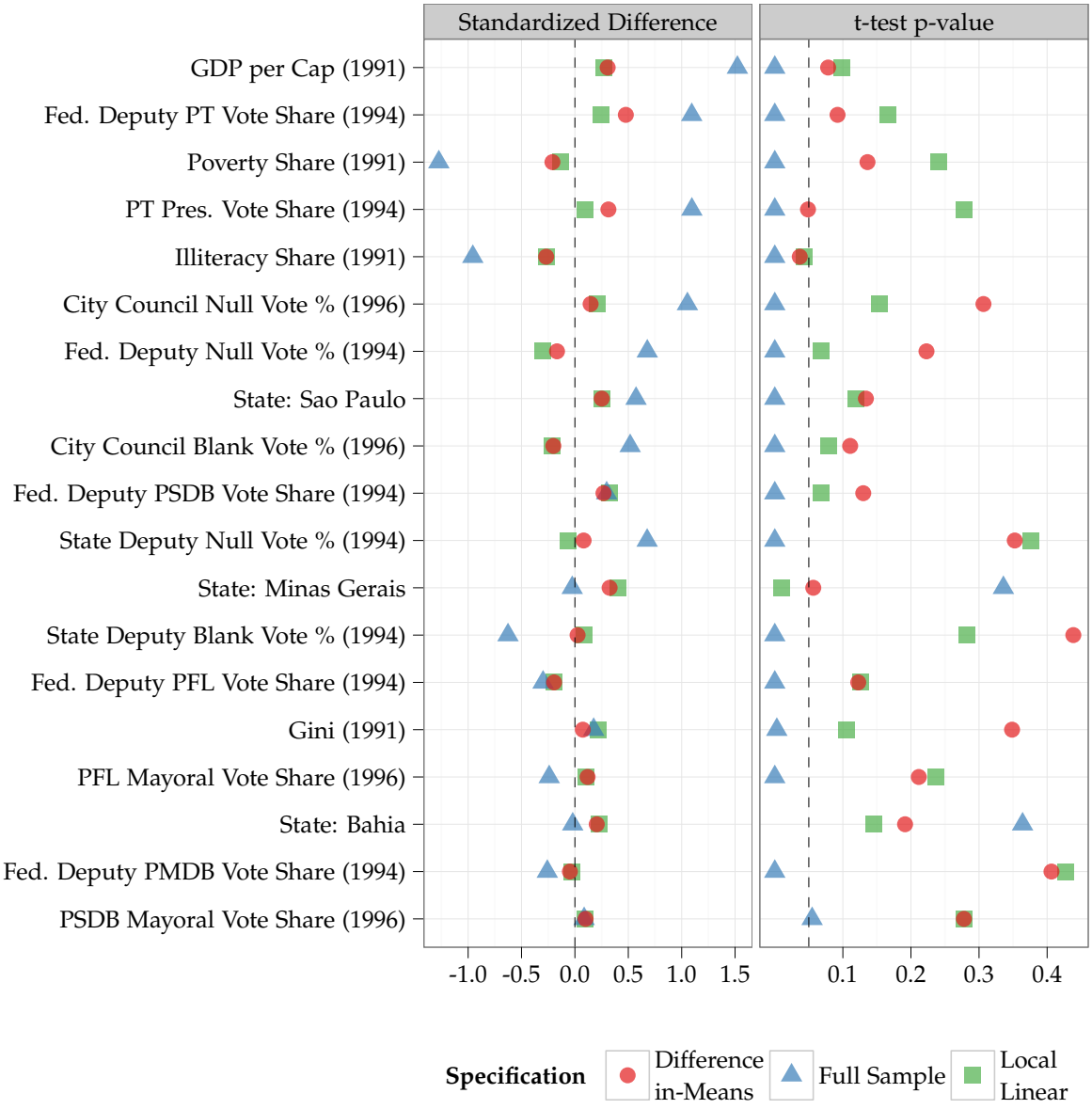



Figure 4: Balance under three different specifications. This plot displays balance statistics for three different estimation procedures. "Full Sample" estimates are from the difference-in-means test using the full sample. "Discontinuity Sample" estimates are from difference-in-means test using only municipalities within 5,000 of the 40,500 electorate discontinuity. "Local linear regression" estimates are from a local linear regression with a discontinuity window of 15,000. The left panel shows standardized differences, which is the estimate, divided by the standard deviation in the full sample. The right panel shows p-values from a t-test of equality of means.

are substantially smaller than treatment municipalities, and population is negatively correlated with development outcomes. Once municipalities far from the threshold are removed, however, balance improves dramatically. For difference-in-means estimates, only 3 of the covariates have a p-value of less than .05, compared to 16 in the full sample. The local linear regression produces similar results. Overall, these balance statistics support the validity of the research design.

## Brazil Results

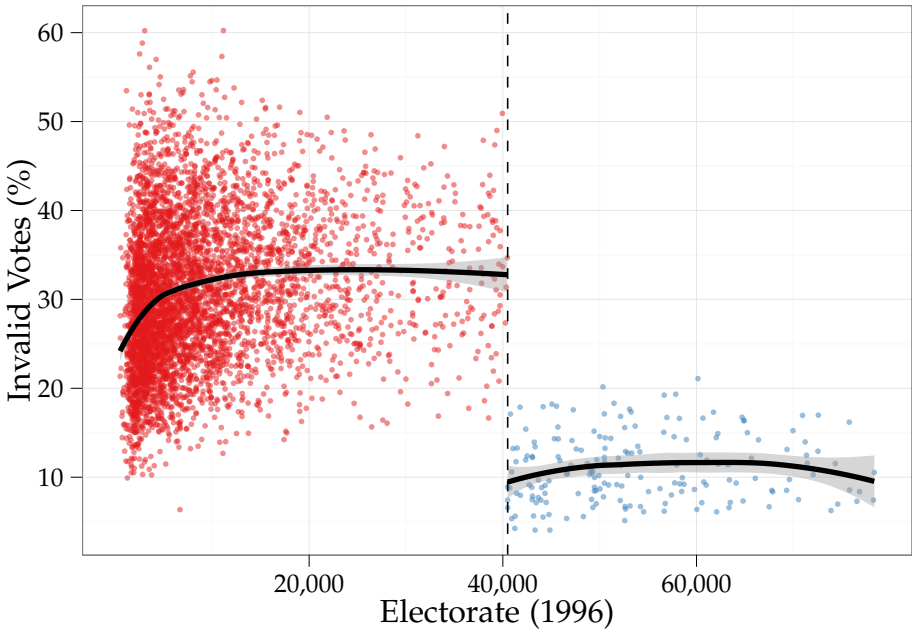



Figure 5: The effect of electronic voting on the percent of null and blank votes. Each dot is a polling station. Polling stations to the left of the vertical black line used paper ballots and polling stations to the right used electronic voting. The black horizontal line is the conditional mean of the outcome estimated with a loess regression.

**Does Electronic Voting Expand the Electorate?** The large effect of the switch in voting technology on the percentage of null and blank votes is clearly evident in Figure 5. The distributions of the percent of null and blank on each side of the discontinuity only barely overlap. The thick black vertical lines represent the conditional mean of null and blank votes at each value of the forcing variable estimated using a nonparametric loess regression. Note that the conditional mean is relatively flat on both sides of the discontinuity, except among municipalities with less than a 1996 electorate of about 10,000. The stability of the conditional expectation over such a large range of the data suggests that the treatment effect at $E_j = 40500$ may apply to municipalities far from the threshold.

Formal treatment effect estimates on null and blank votes—separately and together—are reported in

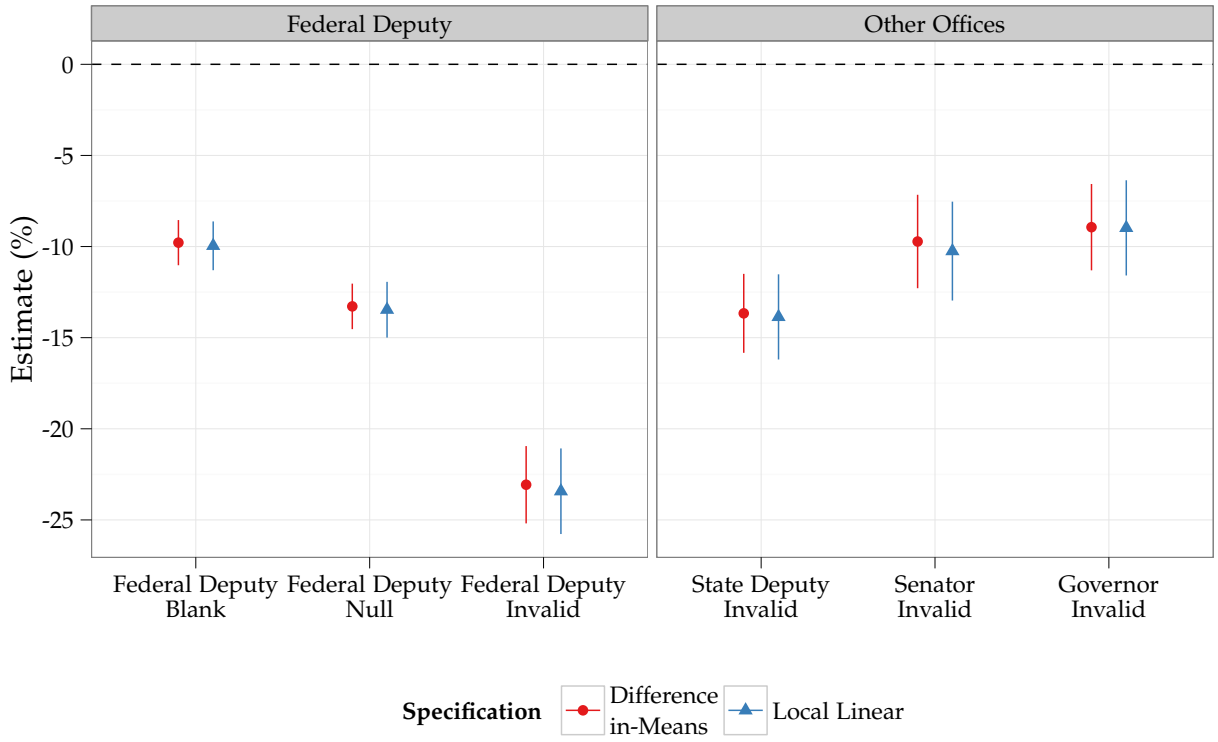



Figure 6: The left plot shows the estimated local average treatment effects of electronic voting on blank, null, and invalid (sum of blank and null votes) votes for federal deputy candidates as a percentage of total votes cast. The right plot shows the effect on percent invalid votes (sum of null and blank votes) for state deputy, senatorial, gubernatorial, and presidential candidates. Lines are bootstrapped 95% confidence intervals that take into account clustering.

the left panel of figure 6. Focusing on the local linear regression estimates, the effect of the shift in voting technology lowered null vote rates by an estimated 13.5 percentage points, blank votes by an estimated 10 percentage points, thus increasing the number of votes affecting political outcomes by about 23.4 percentage points. This number amounts to about a 30% increase in the size of the electorate casting valid votes. While null votes were somewhat more affected than blank votes, the similarity between the two estimates is surprising. A blank vote, in the Brazilian system, is supposed to be an affirmative choice intended by the voter. A null vote, on the other hand, is a residual category (an "undervote", to use the American parlance) for when the voter fails to register any preference at all. Thus, one might expect that electronic voting would affect null votes much more than blank votes, but these estimates belie that expectation. These estimates suggest that a large percent of blank votes were actually mistakenly cast or counted. For comparison, treatment effect estimates on invalid votes for all other offices are reported in the right panel of figure 6. Electronic voting lowers invalid vote rates for all other offices, though estimates are smaller in magnitude. Invalid votes for state deputies, whom are elected using the same electoral rules as federal

deputies, lower by about 13.9 percentage points, almost ten points smaller in magnitude than the federal deputy equivalent. Governors and senators are elected using majoritarian formulas, resulting in fewer candidates and a less complex political environment. Consistent with the "information effect" mechanism, the results for these offices feature smaller reductions in invalid votes. Furthermore, the ranking of the estimate sizes are consistent with the idea that the information effect is highest for the least visible office. Senate invalid votes decrease by 10.2 percentage points and governor invalid votes decrease by 9 percentage points. The heterogeneity in these effects is substantial: the effect estimate for federal deputies is more than twice size of the estimate for governor invalid votes.

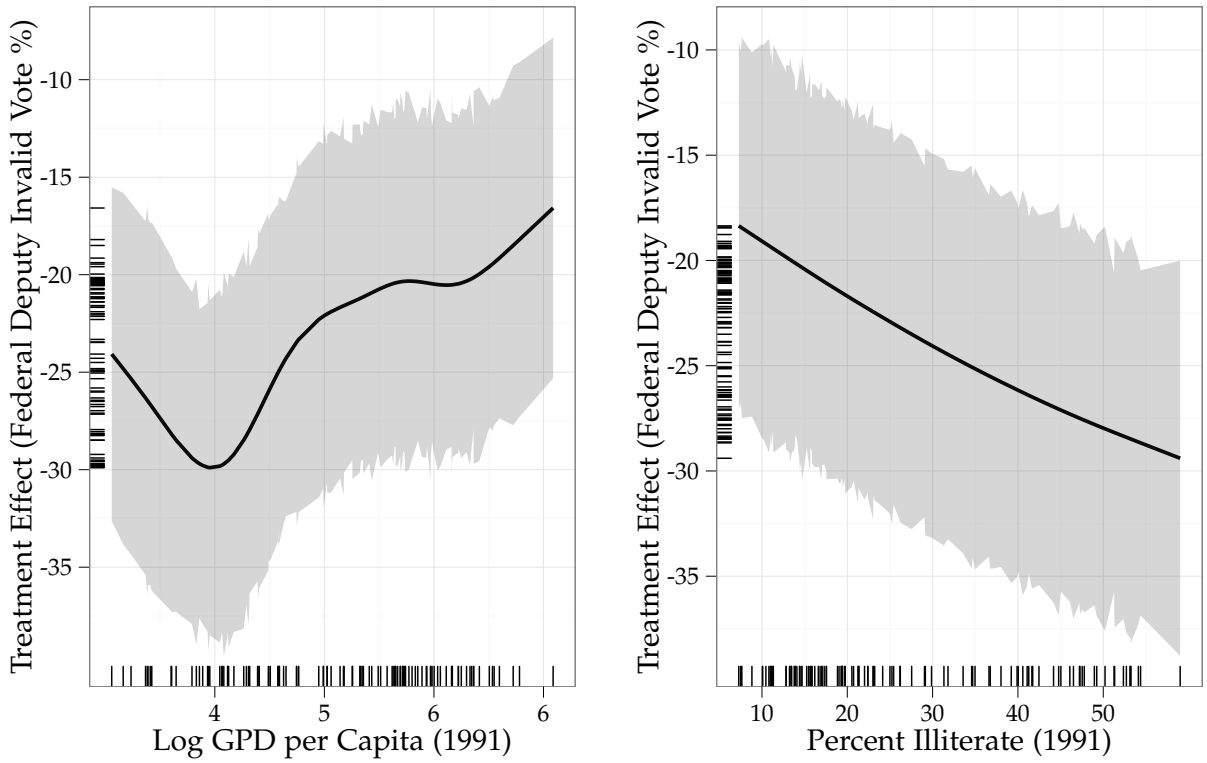



Figure 7: Heterogeneous treatment effects. Plots show how the effect of electronic voting on invalid votes for federal deputy varies by income per capita (left panel) and illiteracy (right panel). Solid line represents estimates from loess regression on the interaction between treatment and the covariate within a window of 5000 around $E_j = 40500$ . Dashed lines are 95% confidence intervals. Dashed lines on margins show marginal distribution of covariate and estimated treatment effects. The treatment effect is larger (more negative) in municipalities with lower GDP per capita and higher illiteracy rates.

While the estimated average local average treatment effect is large, I hypothesize that the information effect would be even greater among poorer and less educated voters. While individual-level data is unavailable to test this hypothesis directly, I can examine how the treatment effect varies by municipalities' sociodemographic characteristics. To that end, I used local weighted polynomial ("loess") regression to es-

timate how treatment effects vary on monthly income per capita and percent illiterate, as reported by the 1990 census. Specifically, I estimated the relationship between the covariate and the outcome separately in the 5,000 population discontinuity window around 40,500, then computed the difference in the predicted values of the two loess regressions.

The differences in estimated effects, presented in figure 7, fit expectations. The treatment effect of electronic voting on invalid votes monotonically decreases in magnitude with income. For illiteracy, the heterogeneity is not strictly monotonic, but increases in magnitude with percent illiterate for most of the range of the data. The heterogeneity, particularly on illiteracy, is substantial. In the municipalities with the highest rates of illiteracy, treatment effect estimates are about -27 percentage points, while in the most literate municipalities, estimates are around -17 percentage points. In the wealthiest municipalities, $\tau_D$ is estimated to be just under -15 percentage points, considerably lower in magnitude than the average estimate. While not dispositive given the problems of making inferences about individual behavior using aggregate data, these heterogenous results do suggest that it was lower income and lower educated voters who were disproportionately affected by the paper ballot system. It is also worth noting that this discontinuity sample excludes both the poorest and wealthiest municipalities in Brazil, since wealth is heavily correlated with population. Thus, the heterogeneity in the treatment effects for the whole population may be even greater.

**What Parties Benefit?** The introduction of electronic voting expanded the percent of voters casting valid votes by about a third, but how did it affect the balance of power in the national legislature? In this section, I examine the consequences of the shift in technology on votes received by Brazil's major parties. Brazil has a highly fragmented legislature, with 18 parties or an effective number of 7.1 in 1998. Rather than examine the effect on all 18 parties, I focus on the five parties with the highest number of seats in the lower house of legislature in 1998, representing 79% of the total seats: the PFL (*Partido de Frente Liberal* or Liberal Front Party, 105 seats), the PSDB (*Partido da Social Democracia Brasileira* or the Brazilian Social Democratic Brazil, 99 seats), the PMDB (*Partido do Movimento Democrático Brasileiro* or the Brazilian Democratic Movement Party, 83 seats), the PPB (*Partido Progressista Brasileiro* or the Brazilian Progressive Party, 60 seats), and the PT (*Partido dos Trabalhadores* or the Worker's Party, 58 seats). During this period, the PSDB lead a majority coalition, which included the PFL, the PPB, and the PMDB. The PT was in opposition.

How do these parties compare to each other? A simple way of differentiating the five major parties is by their ideology and their internal homogeneity. Figure 8 shows the distribution of ideal points estimated from roll call votes cast during the 1994-1998 legislature of the five major parties.[41] The vertical black line

41. Ideal points were estimated using the Bayesian simulation ideal-point estimation technique developed by Clinton, Jackman,

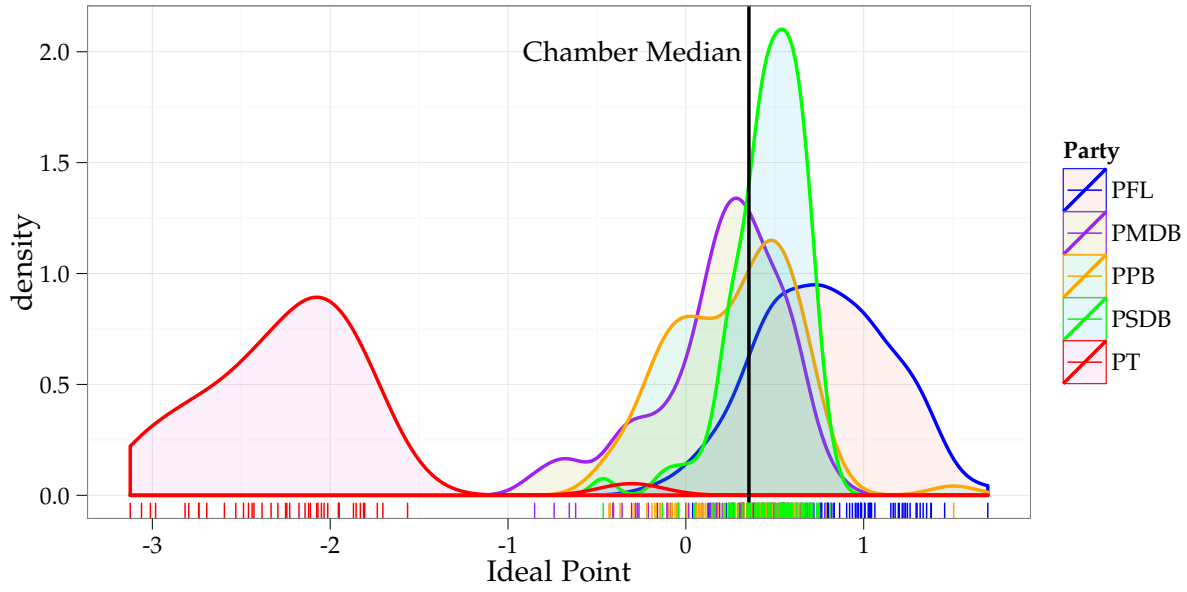



Figure 8: The distribution of ideal points for federal deputies of the five largest parties in the 1994-1998 legislature. Black vertical line is the chamber median. Tick marks on the margin show the marginal distribution of the data.

is the legislative median. According to these ideal point estimates, the five parties can be ordered by their medians from left to right as follows: PT, PMDB, PPB, PSDB, and PFL.[42] Notably, the distribution for PT legislators shows almost no overlap with the ideal points of the four other parties. For the four parties in the majority coalition, there is clear distinction in the variance of the distributions between the PSDB on the one hand, and the PMDB, PPB, and the PFL on the other. The PSDB is considerably more clustered around its median while the other three parties are more ideologically diffuse. According to the ideal point estimates, the variance of ideal points among legislators from the PFL, the PMDB, and PPB is about three times the variance among PSDB legislators.[43]

These differences across parties have implications for interpreting the consequences of electronic voting. These ideal point estimates suggest that all party labels are not equally informative. For example, the PPB and PMDB party label is a relatively poor predictor of legislative behavior. Thus, if electronic voting were to hurt or help one of these parties in the aggregate, it would be difficult to predict with any precision how the chamber median would shift in future legislatures. Any positive or negative effects on the PT, the

and Rivers (2004) as implemented by in the R package PSCL. Ideal point estimates are valid under a spatial model of legislative decision-making where legislators with euclidean "quadratic loss" utility functions make voting decisions based on bills arrayed in one dimensional policy space. This statistical approach uses a Markov Chain Monte Carlo (MCMC) procedure that jointly estimates bill locations on the policy space and legislators ideal points. For local identification, I constrain ideal points to have mean 0 a standard deviation of 1.

42. This ranking is broadly consistent with Power and Zucco Jr (2009, 228)'s survey based ranking, although they place the PPB to the right of the PFL.

43. This characterization of the parties is supported by the literature on Brazilian parties. For example Power and Zucco Jr (2009, 240) describe the PMDB as "centrist, catchall, decentralized, [with] many feuding owners."

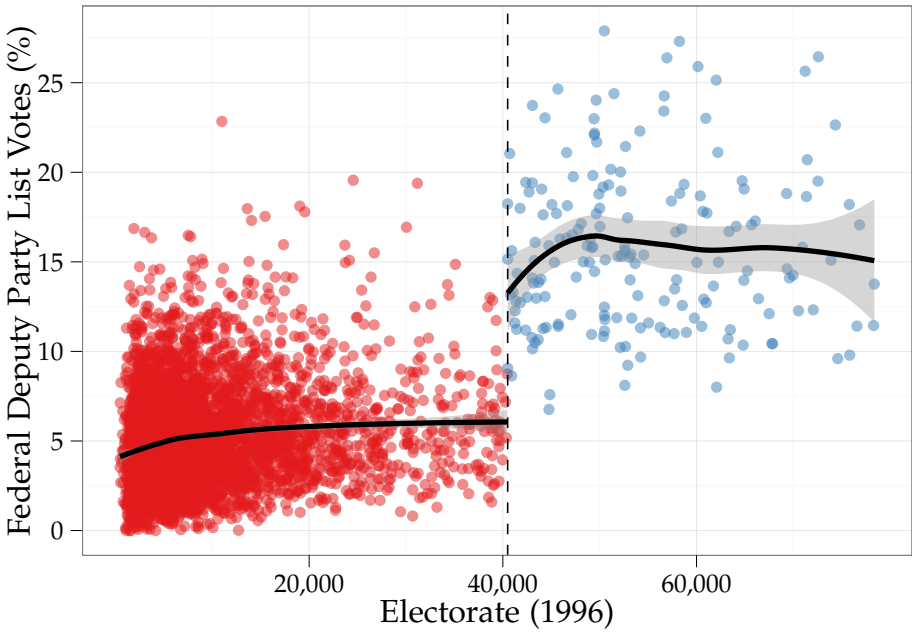



Figure 9: The effect of electronic voting on the percent of party list votes cast. Each point is the share of valid votes cast using the party list option, as opposed to the individual candidate option.. Municipalities to the right of the vertical black line used paper ballots and municipalities to the left used electronic voting. The black horizontal line is the conditional mean of the outcome estimated with a loess regression.

PSDB, and PFL would be more meaningful. PT gains due to electronic voting would clearly move policy making to the left, while PSDB and PFL gains would likely move the median legislator somewhat to the right. Furthermore, these ideal point estimates suggest that the party brands of the PT, the PSDB, and the PFL are more informative for voters. Particularly for voters with low levels of political information, precisely those most affected by voting technology, casting a ballot for a party with a more cohesive brand has more predictable consequences on policy making than for one without.

Before discussing the kinds of candidates for legislative office that newly enfranchised voters chose, it is worth studying the effect of electronic voting on "party list" votes because of the light this might shed on how these new voters respond to Brazil's complex electoral environment. As discussed earlier, voters have the option for casting a ballot for the party list as opposed to an individual candidate. This option is sometimes ignored in the literature on Brazilian voting behavior (though see Samuels (1999)), because of the consensus that partisanship is weak and voter mobilization is largely personalistic.[44] One might think that the type of voter most affected by the complexity of the paper ballot—illiterate and uninformed—would be less likely to have partisan leanings and thus less likely to use the party vote option. Indeed, the consensus in the literature is that Brazilian partisans are more likely to come from the middle class,

44. Under Brazil's electoral rules, party list votes affect the distribution of seats between parties or coalitions, but they do not affect the intra-party or intra-coalition allocation of seats.

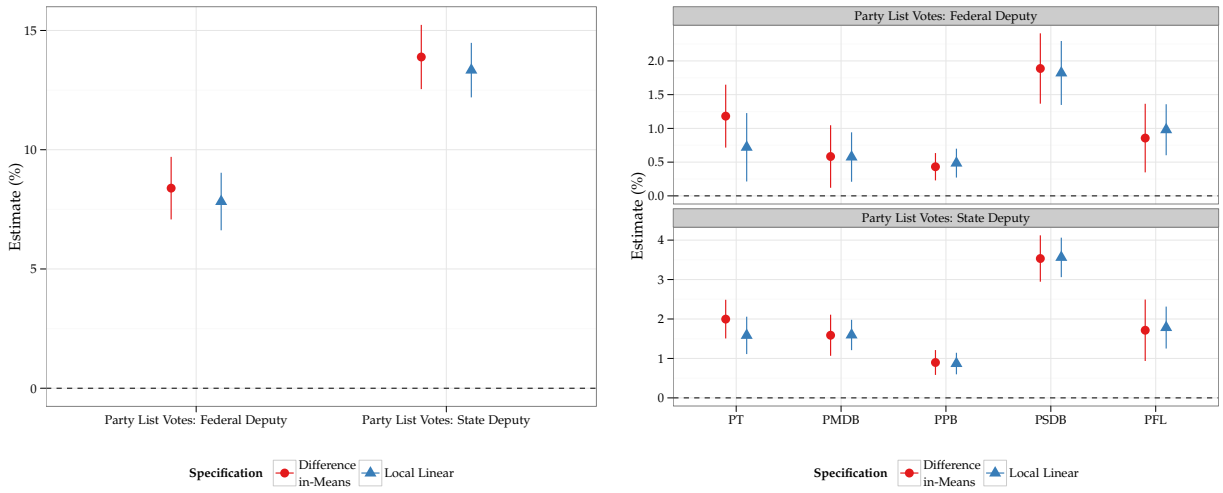



Figure 10: The left plot shows the estimated local average treatment effects of electronic voting on party list votes for federal deputy of the five largest parties in Brazil, as well as the total number of party list votes. The right side shows the estimated $\delta$, the estimated difference in vote shares between newly enfranchised and already enfranchised, for each variable. Lines are bootstrapped 95% confidence intervals that take into account clustering.

at least in the late 1990s (Samuels and Zucco 2010, 16). But a countervailing hypothesis, one informed by the literature that conceives of party labels as information shortcuts, would predict just the opposite. This literature suggests that the least informed would be the precisely the type of voters most likely to rely on the party cue since they are unlikely to have formed an opinion about individual candidates.

Figure 9 displays strong evidence that electronic voting sharply increased the percentage of votes cast for party lists. This figure displays the total number of federal deputy party list votes cast for any party as a percentage of valid votes cast in each municipality in the sample. Notably, the distributions on each side of the discontinuity show little overlap. Point estimates and their associated 95% confidence intervals are presented in the top panels of figure 10. Formal estimates for both federal deputy and state deputy list votes are presented in the left side of figure 10. The late estimate $\tau_c$ for the federal deputy vote using the local linear specification is about 7.8 percentage points (standard error of 0.6). The effect on state deputy party list votes is a substantially higher 13.3 percentage points (standard error of 0.6). These point estimate suggest that the rate at which the previously disenfranchised voters use the party list option is substantially higher than those who could vote using the old paper ballot system. If we assume that electronic voting does not disenfranchise voters and that it does not affect the votes of those who could cast a valid vote using paper ballots, then the 7.8 point estimate implies that around 35% of newly enfranchised voters cast list votes. Even if the two assumptions required to derive that estimate are not true for all voters, these results still suggest that the newly enfranchised voters cast party list votes at much higher rates than the

average voter.

One probably should not interpret this finding as revealing that the Brazilian poor are in fact partisans, a finding that would conflict with the existing literature (Mainwaring 1999; Samuels 2006). A more likely mechanism is that since excluded voters are disproportionately uninformed and less politicized voters, the party vote acts as a device that relieves them of the need to choose one out of hundreds of candidates to vote for. Instead, these uninformed voters can decide among one of about a dozen party labels, a considerably simpler task.

Which parties benefited most from this jump in party list votes? In figure 10, on the right side I show the estimated treatment effect ($\tau_C$) on the federal and state deputy party list votes of the five largest parties in Brazil. Notably, $\tau_c$ for all five parties are positive and statistically significant for both offices. Using the local linear estimates, ranking the federal deputy estimates by magnitude give the following order: PSDB ($\hat{\tau}_c = 1.8$), PT ($\hat{\tau}_c = 0.7$), PFL ($\hat{\tau}_c = 1$), PMDB ($\hat{\tau}_c = 0.6$), and PPB ($\hat{\tau}_c = 0.5$). The rank ordering for state deputy list votes is precisely the same as those for federal deputy list votes. The ordering of these effects correlates perfectly with the distinctiveness of each party label's brand. As discussed earlier, the PMDB and the PPB are the most ideologically incoherent major parties and their federal deputy party list point estimates are about half of those found for the more distinctive PT and PFL. Presumably, this incoherence makes their labels less useful for the information-scarce voters enfranchised by electronic voting and as a result, they benefit the least from the influx of new voters. The ruling party, the PSDB, gained the most. It is likely that the PSDB benefitted from the concurrent presidential campaign, where President Henrique Cardoso of the PSDB was handily re-elected with 53% of the vote in the first round. Voters who approved of President Cardoso could easily reward his party's legislative co-partisans by casting a party vote without the need to develop an opinion about a particular candidate.

While the party list estimates are of theoretical interest given what they reveal about the informational value of a party label, the aggregate impact of electronic voting must take into account the more common candidate vote. To do so, I estimated the effect of the change in voting technology on the candidate vote for the five major parties as a share of (non-partylist) valid votes. These estimates are shown in Figure 11. Unlike the party list estimates, these effects are less precisely estimated and most are statistically indistinguishable from 0 in at least one of the specifications. Among federal deputy candidates, the estimates suggest that the PT ($\hat{\tau}_c = 1.3$) and the PPB ($\hat{\tau}_c = 0.5$) most benefitted, though these estimates are rather imprecise. PT state deputy candidates, in contrast to state deputy candidates from other parties, clearly benefitted from the adoption of electronic voting as their aggregate vote share increased by an estimated (local linear specification) 8.5 percentage points (standard error of 8.5). In contrast to their federal deputy counterparts, PPB state deputy candidates lost votes as a result of electronic voting ($\hat{\tau}_c$ = -4.1, standard

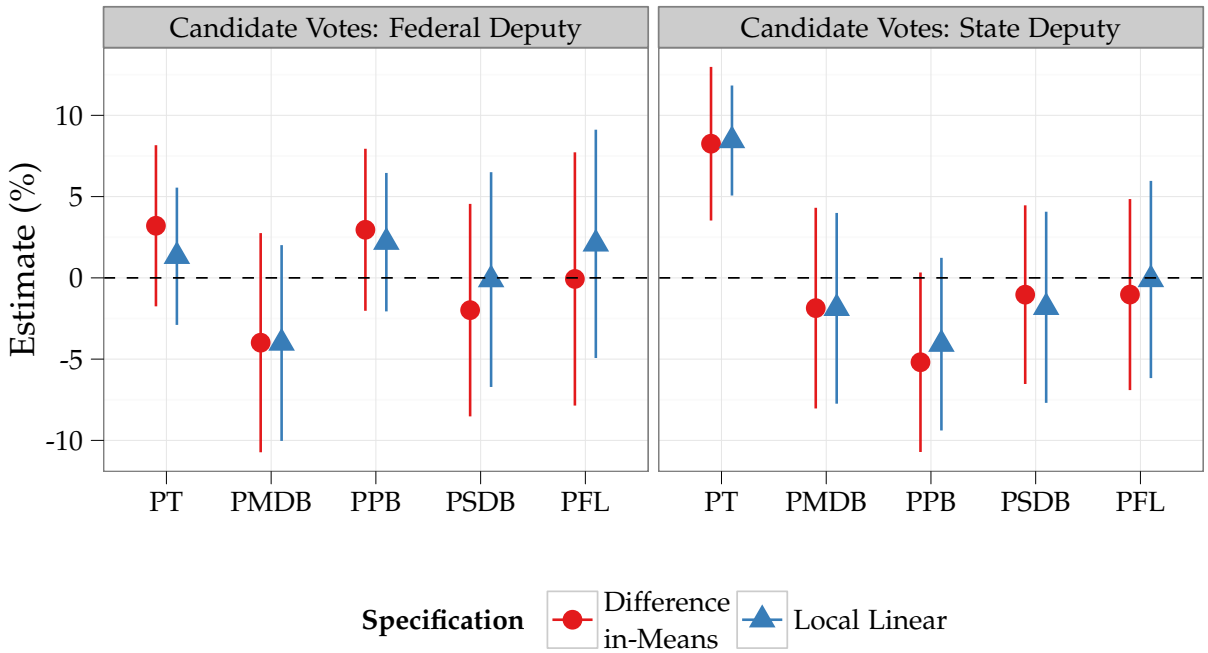



Figure 11: The left plot shows the estimated local average treatment effects of electronic voting on candidate votes for federal deputy of the five largest parties in Brazil. The right plot shows esimates for state deputy candidates. Parties are ordered by estimated median ideal point.

error of 2.7).

Overall, these candidate vote estimates suggest that electronic voting did not dramatically change the fortunes of Brazil's major parties, with one partial exception. Of the five largest parties, the left-wing PT benefitted most consistently as both its federal deputy and state deputy candidates increased their vote share by about four to seven percentage points. When combined with the party list results, it is clear that the biggest winners from the advent of electronic voting were the PT and the PSDB. In addition to not receiving substantially more candidate votes, the more ideologically diffuse parties like the PPB and the PMDB received fewer party list votes than the PT and PSDB. An open question is whether or not these effects persist to future elections. If these newly enfranchised voters continued to depend disproportionately on party list votes and related cues when casting their ballot in subsequent elections, then electronic voting may have acted as a positive shock to the value of belonging to one of Brazil's more distinctive programmatic parties.

**Did Electronic Voting Reduce Tabulation Fraud?** The expansion of the electorate by about one third did not, on the aggregate, have a large effect on the partisan distribution of power in the national legislature. Yet as discussed above, an additional motivation for the adoption of the new technology was to combat

tabulation fraud. While officials claimed that low level fraud was pervasive throughout the country, it was in states with dominant political machines that distortion of votes was considered to be most consequential. Did removal of the ability to directly alter vote totals affect the political equilibrium in these states?

In this section*, I show that in three states with dominant political machines—Bahia, Maranhão, and Paraíba—electronic voting had an enormous effect on the incumbent coalition's vote share. In contrast, in a comparison group of states from the same region with more competitive party systems, the new technology had no effect on the incumbent coalitions' ability to stay in office. Indeed, in two of the political machine states, ruling parties faced their first serious opposition challenge in the elections following full adoption of electronic voting.

**Competitive and Non-Competitive Party Systems** In Brazil, national partisan competition is strongly structured by state-level politics, with the degree of competition varying widely across states (Borges 2010). Many states' party systems are quite competitive and in these states, different governing coalitions regularly alternate in and out of power. On the other end of the spectrum are states where—at least through the early 2000s—a single ruling party controlled both the governorship and the state legislature over many elections. These states are easily identified: out of the 27 states, five between 1990 and 2006 had one or fewer transfers of power between governors of different parties. Notably, all of partisan turnovers occurred after 1998, when electronic voting was introduced to most municipalities. Out of these five, four of the ruling parties had a high share of seats in the state legislature and all of them were in the socioeconomically backward Northeast. The four states with strong indications of being governed by a hegemonic ruling group or "political machine", are Bahia, Ceará, Maranhão, and Paraíba.[45]

Out of the four states with the fewest partisan turnovers and high levels of legislative dominance, Bahia, Maranhão, and Paraíba were governed in the 1990s by conservative political machines.[46] Bahian state and municipal governments were dominated by the political machine of Antonio Carlos Magalhães (ACM), a three term governor that rose to prominence during the military dictatorship and successfully enhanced

45. The median number of transfers of power between governors of different parties in all states was 3, out of a total possible of 5. The mean percentage of the state assembly controlled by the party of the governor for all states was 18, while the mean among the four machine states was 27.3 percent. While this percentage of seats controlled by the governor's party may seem low compared to those found in two party systems, in practice, governing parties are typically part of large multi-party coalitions. Epstein (2009), in a study of state-level party systems, categorizes all four states as "hegemonic" which he defines as a system wherein "one party wins the lion's share of the seats in every election, including majoritarian polls, eliminating true electoral choice for rational voters through unfair, if not illegal means" (343). The one other state that Epstein categorizes as hegemonic is Pernambuco, but that state had 3 episodes partisan turnover in gubernatorial elections, as well as about an average share of state legislative seats controlled by the governor's party.

46. The fourth case–Ceará—has a ruling group based in the PSDB that is ideologically distinct from the machines in the other three states. Unlike in Bahia, Maranhão, and Paraíba, a modernizing group lead by businessman Tasso Jereissati defeated the oligarchic machines that ruled during the military dictatorship and succeeded in completely marginalizing the previous ruling families (Ames 2002, pgs. 126-127). The PSDB governed the state through 2006 and modernized governance of the state in a progressive direction, as discussed by Tendler (1997). I omit Ceará from the following analyses given its ruling party's ideological distinctiveness, but the overall conclusions are robust to its inclusion.

his power after the transition to democracy via his position as minister of communications in the federal government (Souza 1997). A perhaps even more dominant electoral group than Magalhães's in Bahia was José Sarney's in Maranhão, whose machine, with one brief exception, has governed the state since 1965 (Costa 2006). In addition to retaining his grip on Maranhão politics, Sarney has maintained a high profile position in national politics, serving as president between 1985 and 1990 and president of the senate since 2009. In Paraíba, state politics are dominated by the group led by Ronaldo José da Cunha Lima, a PMDB (now PSDB) politician and governor between 1991 and 1994. After his term, Cunha Lima served in the senate and was succeeded by close allies in the governor's seat, including his son in 2006.

The dominant coalitions in Bahia, Maranhão, and Paraíba are typically classified as right-wing and this characterization is borne out in the voting patterns of the machines' congressional delegations. One of way showing this is to rank all federal deputies left to right from -219 to to 219 using the ideal points estimated above, with 0 signifying the median legislator. The median machine candidate from those three states occupies position 152, far to the right of the chamber median. This right-leaning tendency persists even when examining intra-party differences. For example, the median rank of PFL legislators not coming from machine states is 150, while PFL federal deputies belonging to the machine's coalitions have a median rank of 189. While all three delegations are right of the chamber median, Bahian machine legislators are the most extreme, with a median ranking of 194. Given machine deputies' ideological positions, any loss in the ability of machines to elect candidates would most certainly move the chamber median to the left.

I compare the consequences of electronic voting in the three machine states to competitive non-machine states in the same region: Piauí, Pernambuco, Rio Grande do Norte, and Sergipe. Unlike Bahia, Maranhão, and Paraiba, these four states had competitive elections with incumbent coalitions facing real chance of defeat and furthermore, the governor's party controlled an average or below average share of the seats in the state legislature.[47] These states had no hegemonic political group controlling the state apparatus for extended periods of time and left-of-center and right-of-center political coalitions alternated in and out of power. The incumbent governments were basically centrist: the median legislator from these states' incumbent coalitions was 63 (with 0 being the chamber median), which was far to the left of median incumbent legislator from political machine states.

**Evidence of Fraud** There is substantial circumstantial evidence that these machines used fraud to help maintain their dominant position. While direct indications of fraud are unavailable for obvious reasons, two main pieces of evidence suggest that manipulation of the vote count was particularly acute in these

47. Between 1990 and 2006, Piauí, Sergipe , and Rio Grande do Norte had 2 transfers of power between governors of different parties. Pernambuco had 3. In 1994, governor's party controlled 16.7%, 4.2%, 33.3%, and 32.7% of the state legislature in Minas Gerais, Piauí, Sergipe , Rio Grande do Norte, and Pernambuco, respectively.

states, especially in Bahia and Maranhão. One indicator is legal cases involving fraud in the vote count process, which were adjudicated at substantially higher rates than the national average in the state electoral tribunals of Bahia and Maranhão. Between 1980 and 1998, 603 cases involving accusations of fraud were heard in Maranhão's regional electoral tribunal, about six times the national average rate of 108 cases (median of 58).[48] In Bahia, the number of fraud cases were comparatively fewer at 265, though still over two times the national average.[49]

A second piece of evidence indicative of extensive fraud in Bahia, Maranhão, and Paraíba is the existence of patterns present in aggregate electoral results consistent with qualitative accounts of how fraud operates. As discussed above, political machine candidates would typically take advantage of huge numbers of invalid and blank votes arising from the difficulty of voting with paper ballots, and transfer those votes to themselves. The implication of these accounts is that in municipalities using paper ballots, a negative correlation should exist between the share of the valid vote received by the incumbent candidates and the number invalid votes across polling stations. The logic of these contrasting patterns being that candidates with access to state machinery would be able to penetrate the vote counting process in paper ballot municipalities and switch invalid votes to themselves. In polling stations with electronic voting, this correlation should change. Similarly, one would expect that voting technology would not affect the relationship between invalid votes and incumbent vote share in competitive municipalities.

Figure 12 shows the bivariate relationship between the share of invalid votes and incumbent coalition candidate vote shares in both competitive and political machine states. The data shown is within a narrow window around the discontinuity point (bandwidth of 5000), so differences between electronic voting and paper ballot municipalities—if my identification assumptions are valid—are causal. The nonparametric loess estimate is separately estimated in paper ballot and electronic voting municipalities. In the three competitive states, the correlation between invalid votes and incumbent coalition vote share is negative, regardless of the voting technology used. In political machine states, the relationship is positive in electronic voting municipalities. The observed relationship, however, is substantially different in paper ballot municipalities in political machine states, one that is consistent with large scale voting fraud. In these states, there is a *negative* relationship between invalid votes and incumbent coalition vote share. In paper ballot polling stations with fewer than 10% blank and invalid votes, candidates belonging to the incumbent coalition received on average over 90% of all valid votes. Though not dispositive, the negative relationship is consistent with interview and newspaper accounts of political machines transferring invalid votes to

48. These figures were obtained at the TSE website: `http://www.tse.gov.br`. To calculate these figures, I searched in the online database of cases using the keywords of "apuracão" (tabulation) and "fraude" (fraud). Experimenting with other key words gave similar results.

49. When normalized by state population, both states, particularly Maranhão, are still outliers.

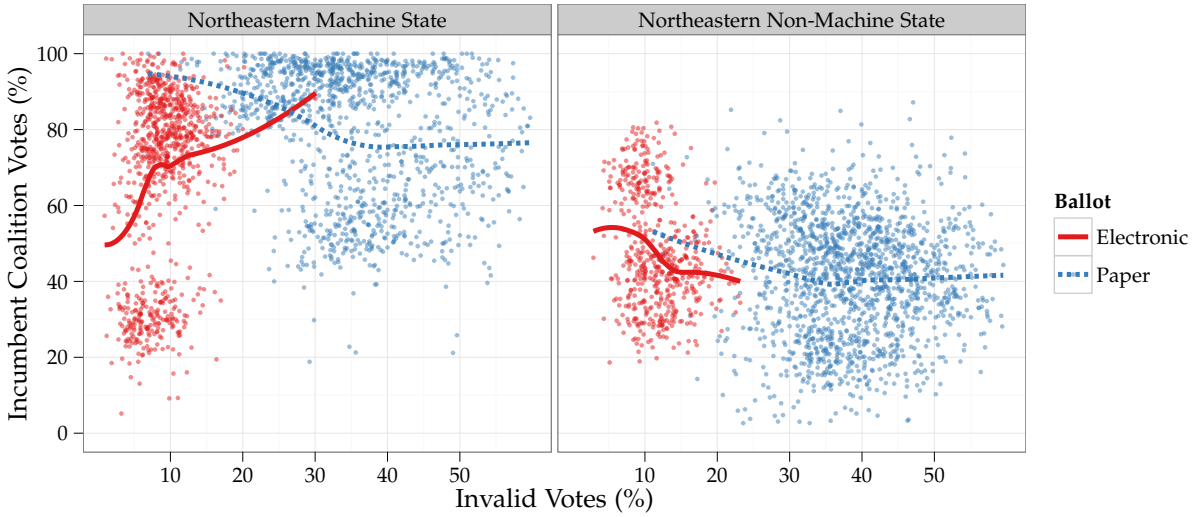



Figure 12: The relationship between the vote share of candidates belonging to the incumbent coalition and the share of invalid votes. The right panel presents polling station level data within a small window (bandwidth of 5000) around the discontinuity cut point from Northeastern states with competitive party systems and the right panel shows data from Northeastern states with dominant political machines. The red points are data from municipalities with electronic voting and the blue dots are data from municipalities with paper ballots. The thick lines are smoothed loess regressions estimated separately in electronic and paper ballot municipalities. In competitive states, the correlation between invalid votes and incumbent coalition votes is mostly negative regardless of voting technology. In political machine states, electronic voting causes the relationship to switch from a negative to a positive one.

their favored candidates, thus inducing a negative correlation only in paper ballot municipalities where stealing votes was relatively easy.

Given the considerable evidence of widespread fraud in "political machine" states, what are the consequences of introducing voting technology that largely eliminates it? Figure 13 visually depicts the basic results. In the left panel, in states with little of evidence of widespread fraud used by the incumbent to preserve their hold on office, the effect of electronic voting appears to be negligible. At the discontinuity point, there is no shift at all in the distribution of support for candidates from the incumbent coalition. In states with dominant incumbent governments (right panel), the effect of changing voting systems is quite different: the support for incumbent candidates drops substantially at the discontinuity.

Point estimates and their associated confidence intervals are reported in 14 for the effect of electronic voting on the vote share of candidates belonging to the incumbent coalition in both competitive (left panel) and political machine states (right panel). The effect in uncompetitive states is consistently large and negative for both federal and state deputies. The estimates are about -22 percentage points for federal deputies and -30 percentage points for state deputies. The baseline percent of valid votes received by

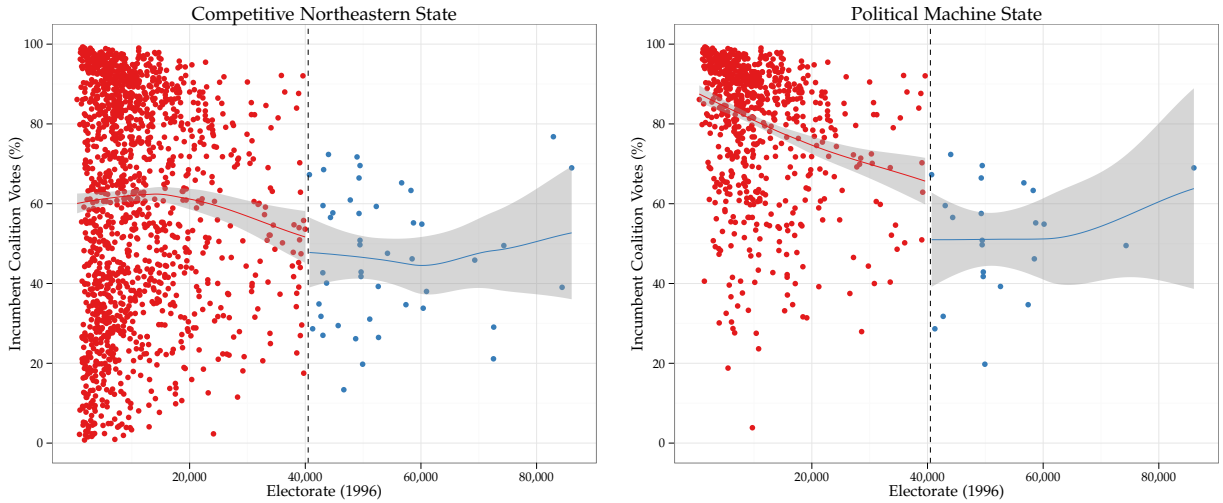



Figure 13: The effect of electronic voting on the vote share received by federal deputies from the state's incumbent coalition. The left panel shows data from states with competitive party systems and the right panel shows data from states with hegemonic ruling parties. Each dot is a municipality. Municipalities to the left of the vertical black line used paper ballots and municipalities to the right used electronic voting.

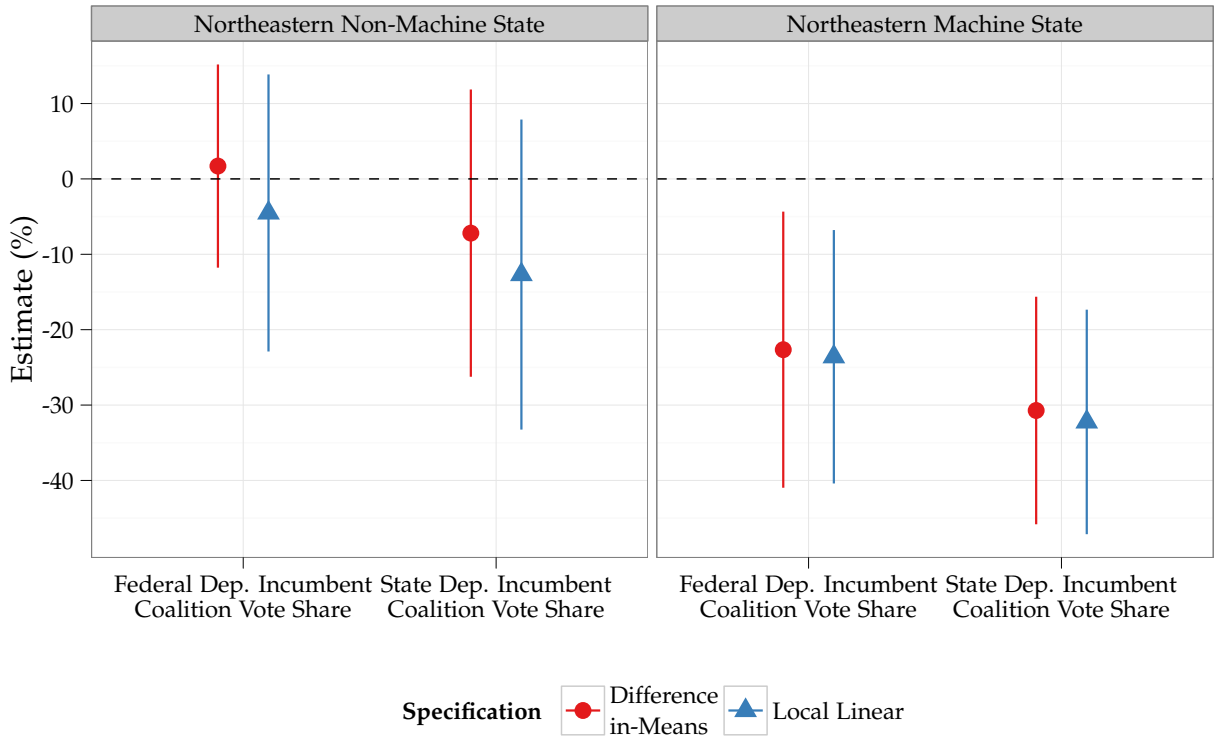



Figure 14: The estimated local average treatment effects of electronic voting on the vote share received by federal deputy and state deputy candidates belonging to the coalition of their states' governor. The estimated effects in competitive Northeastern states are shown in the left panel, while the effect in political machine states are shown in the right panel. .

incumbent machine federal deputy candidates is about 75%, which drops to roughly 53 percent when electronic voting is introduced. While 53 percent incumbent vote share is still substantially higher than the 38 percent incumbent average vote share observed in the competitive states, the effect of electronic voting does amount to a large and sudden increase in the competitiveness of legislative elections in these states with dominant ruling parties. In the comparison group of states with more competitive party systems, the effect on incumbent candidates is much smaller and insignificant.

## Consequences of Electronic Voting in India

To estimate the effects of electronic voting on political outcomes in India, I use data from two different elections. The first panel dataset uses national parliamentary (Lok Sabha) constituencies and the second uses assembly data from the northern state of Haryana. The selection mechanism used by the Election Commission of India to choose the constituencies that would test the new system varies by sample. In 1999, the ECI tested electronic voting machines in 45 relatively urban constituencies spread throughout the entire country. In 2000, the ECI sought to test the new system in a more diverse set of constituencies and thus selected 45 (out of 90) Haryana state assembly constituencies to receive the new machines. The use of different samples alleviates some of the problems involved in generalizing estimated causal effects when "treated" units are unusual and not representative of the general population. Furthermore, the biases associated with each of the two treatment assignment mechanism are likely to be different, thus any consistent results across the two samples should increase confidence in the credibility of the estimated effects.

### Research Design and Data

To analyze the consequences of the adoption of electronic voting machines in India, I combine nonparametric matching with a difference-in-differences approach. First, I match electronic voting constituencies to paper ballot constituencies on important covariates involved in the selection of the districts. I use Genetic Matching[50] (Sekhon, Forthcoming) to maximize covariate balance and then using this matched dataset, I estimate the treatment effect on the treated using a difference-in-differences estimator. To validate the design, I examine whether or not EVM constituencies and their matched control constituencies exhibited parallel trends in key outcome variables over prior elections.

More precisely, I wish to estimate the effect of adopting electronic voting among constituencies that

50. Genetic matching uses a nearest-neighbor matching algorithm to maximize covariate balance. The balance metric maximized by the genetic matching algorithm is the lowest p-value from paired t-tests of equality of means and KS tests of equality of distributions.

adopted electronic voting or the "average treatment effect on the treated" ($\tau_{ATT}$).[51] I make the usual "parallel-paths" assumption:

$$\mathbb{E}(Y_{i,t}(0) - Y_{i,t-1}(0)|T_i = 1, X_i) = \mathbb{E}(Y_{i,t}(0) - Y_{i,t-1}(0)|T_i = 0, X_i)$$

$Y_{it}(0)$ is the control potential outcome of a constituency $i$ at period $t$. This assumption says that, after conditioning on the covariate distribution of electronic voting constituencies, the observed change in average outcomes among constituencies that keep paper ballots is the same change in average outcomes that electronic voting constituencies would have experienced if electronic voting had not been introduced. Under this assumption, the treatment effect on the treated can be recovered using observed outcomes by the following expression:

$$\tau_{ATT} = \mathbb{E}(Y_{i,t} - Y_{i,t-1}|T_i = 1, X_i) - \mathbb{E}(Y_{i,t} - Y_{i,t-1}|T_i = 0, X_i)$$

In practice, I use a fixed effect regression with heteroskedasticity-robust standard errors to compute the estimate.

**Lok Sabha Data**

46 parliamentary constituencies used electronic voting in the 1999 Lok Sabha (national parliament) election, but for the purposes of this analysis, I drop constituencies from states that either exclusively used the new voting system or entirely lacked electronic voting. Furthermore, I drop constituencies that are "reservered" for scheduled castes and tribes, since no such constiuency used electronic voting in 1999. This leaves 35 constituencies that used electronic voting and 307 that used the traditional paper ballot system in the sample.

The ECI chose to implement the new voting system in "urban constituencies with a compact nature and a high level of literacy"[52], thus confounding any simple comparison between paper ballot and electronic voting municipalities. To account for this selection mechanism, I use a matching algorithm to remove paper ballot constituencies dissimilar to electronic voting constituencies on observable characteristics. I condition on both socio-economic confounders and electoral confounders. The socio-economic variables[53]

51. Note that this estimand is distinct from the estimand in the Brazil section, which is the local average treatment effect among municipalities with a population equal to 40,500. While the Brazil estimand is less general, the research design used to estimate it is stronger.

52. Chaware, Dilip. "Electronic Voting Machines Will be Used in the Next General Elections", *The Times of India*, March 29, 1999.

53. Unfortunately, parliamentary constituencies do not match census tracts or other administrative boundaries. To obtain demographic measures, I used a spatial matching procedure wherein I computed the degree of overlap between each parliamentary constituency and each administrative district for which census data is avaiable. For to obtain the parliamentary constituency-level covariate, I compute a weighted average of each covariate where the weight is the degree of overlap between the constituency and the district.

in the conditioning set are 2001 percent of the adult population lacking primary education, the illiteracy rate in 2001, and 2001 percent of the population living in rural areas as defined by the census.[54] The electoral variables are invalid votes, turnout, and level of competition (vote margin between the top two candidates) in 1991 and 1996. Note that I do not match on 1998 electoral variables in order to allow for a placebo test to assess the validity of the design.

Electoral data were obtained from the Election Commission of India. To measure coercive fraud, I used data on ECI-ordered a "repolls" which occur when the electoral authorities find that "any ballot box used at a polling station or at a place fixed for the poll is unlawfully taken out of the custody of the presiding officer or the returning officer, or is accidentally or intentionally destroyed or lost, or is damaged or tampered with, to such an extent, that the result of the poll at that polling station or place cannot be ascertained"[55]. To obtain constituency-level data, I relied on contemporaneous news sources. Using news databases that cover India's major newspapers, I recorded every constituency that had at least one polling station with a repoll due to violence. To check the validity of this measure, I compared my dataset to official datasources (unfortunately, not available for all years) and the two were equivalent.

**Haryana State Assembly**

Members of the Haryana state assembly are elected from 90 constituencies, half of which used electronic voting in the 2000 state elections. Unlike in the case of the national parliament, election officials did not select constituencies based on socio-economic characteristics but instead sought to maximize geographic coverage across the state.[56] That geography was the main criteria for assigning treatment is evident in the fact that imbalance on potential confounders is rather small. In fact, trends in important time varying political variables are basically identical between the 1991 and 1996 election. There is some imbalance in trends between the 1987 and 1991 elections, however, so as a precaution, I condition on pre-treatment covariates. The conditioning set is similar to the one used for the national parliamentary election: turnout, invalid votes, and political competition in the 1987 and 1991 elections.

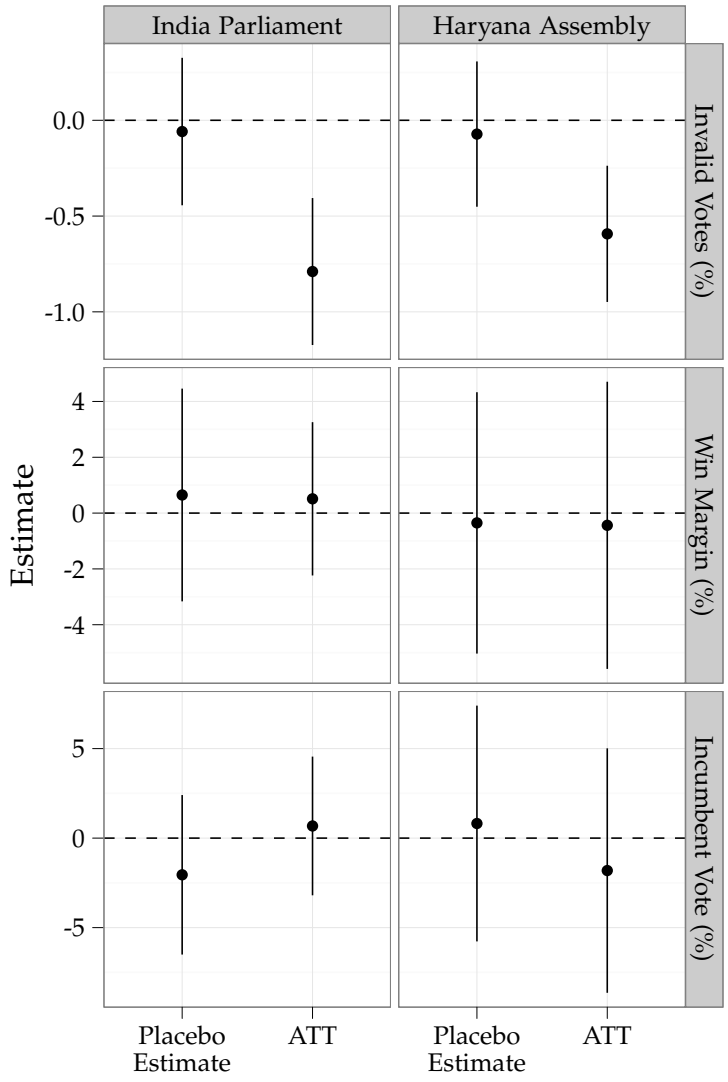



Figure 15: Placebo and ATT estimates of the effect of electronic voting on electoral outcomes in India. The panels on the left side show estimates from national parliamentary elections (n = 77) and the panels on the right show estimates from the Haryana assembly sample (n = 84). Each panel shows the placebo estimate of the effect of electronic voting on elections before the new technology was actually implemented (left point) and the difference-in-differences ATT estimate (right point). Vertical lines are 95% confidence intervals based on Hubert-white standard errors.

## India Results

Figure 15 presents the main results for India. The left side of the figure shows results for the national parliament elections and the right side shows the results for the Haryana legislative assembly elections.

54. Technically, the 2001 census data is post-treatment and thus conditioning on these variables could lead to biased estimates, but it seems highly implausible that electronic voting would have an effect on these indicators in such a short amount of time.

55. Section 58 in The Representation of the People Act, 1952.

56. In India, assembly constituencies are geographically embedded in national parliamentary assemblies. In 2000, election officials wanted to ensure that at least one state assembly constituency in each Haryana national parliament assembly receive the new voting technology. In addition, all assembly constituencies belonging to two parliamentary constituencies, the Rohtak and Karnal parliamentary constituencies, were selected into treatment because they used the technology in the 1999 parliamentary election. Because all assembly constituencies in these two national parliament constituencies received treatment and thus lack corresponding control units, I drop them from the sample.

For each variable, I present placebo estimates and estimates of the average treatment effect on the treated ($\tau_{ATT}$).

**Assessing the Validity of the Design** The "parallel paths" assumption is unverifiable, but pre-treatment trends can provide at least indirect evidence about its validity. If the trajectory of the outcome variables between $t-1$ and $t-2$ are similar across electronic voting constituencies and paper ballot constituencies, then the research assumptions required to estimate $\tau_{ATT}$ are more likely to hold . Figure 15 shows that the design successfully recovers a null result in pre-treatment periods in both samples. Furthermore, while not strictly required for the difference-in-differences estimator, the matching procedure improves balance in the levels of most observable confounders, even those variables not matched on. Post-matching covariate balance is reassuring, because as suggested by Abadie (2005), equivalence on baseline confounders can increase the plausibility of the parallel paths assumption required by the difference-in-differences design. As shown in the appendix, balance improves on a wide range of electoral and socioeconomic variables, particularly in the Lok Sabha sample. Not surprising given the selection mechanism documented above, the Haryana state assembly sample had fairly good balance in pre-treatment covariates even before matching.

**Effect on Invalid Votes, Political Competition, and Incumbent Party Vote Share** The clearest effect of the new voting technology is on the fraction of invalid votes cast. Unsurprisingly given that the Indian electronic voting system disallows spoiled ballots, the share of invalid votes drops nearly to zero in treatment constituencies. The only remaining invalid votes are from postal ballots. In the national parliamentary sample, the treatment causes a change of about -0.8%. To contextualize this effect, the increase in valid votes is larger than the winning vote margin of about 10% of the constituencies in the 1998 elections. In the Haryana sample, the effect is smaller with a point estimate of -0.6%. The smaller size of this effect is not surprising because Haryana had a smaller share of invalid votes to begin with. Given the small size of the effect in both samples, it seems unlikely that the additional votes would have a substantial effect on political outcomes even if they went disproportionately to one party.

Political competition, as measured by the vote margin between the top two candidates, appeared to be unaffected by the new technology in both samples. While imprecisely estimated, both point estimates are near 0. Finally, incumbent party vote share appears to be unaffected in both samples as well.

**Effect on Repolls** The most direct test of whether or not electronic voting affects the prevalence of fraud is to examine the relationship between ballot format and ECI ordered repolls. I hypothesized that coercive fraud is more resilient to changes in voting technology since coercive ballot stuffing can be replaced by

voter intimidation and related tactics. Unfortunately, repoll data was not available for the previous election in Haryana, so that estimate uses a simple difference-in-means estimate with the matched dataset. The Lok Sabha estimate uses the differnce-in-differences estimator. The estimated average treatment effect on the treated of electronic voting on repolls for both the Lok Sabha and the Haryana assembly sample are presented in table 1.

| | Lok Sabha | Haryana |
|---|---|---|
| ATT Estimate | -0.1 | 0.1 |
| SE | 0.1 | 0.1 |
| N | 77 | 42 |

Table 1: Effect of Electronic Voting on Repolls. This table shows the ATT estimate on whether or not a repoll occurred in the constituency. The Lok Sabha estimate uses a difference-in-differences estimator. The Haryana estimate uses difference-in-means estimator. Standard errors are Huber-White.

In both cases, the point estimate is small and statistically insignifcant. In the Lok Sabha sample, the point estimate is negative, while in the Haryana sample, the point estimate is positive. Given the relatively small sample sizes, I cannot rule out small effects, but these point estimates at least provide evidence against the existence of large effects.

# Conclusion

Just as the Australian ballot had far-reaching consequences on the practice of electoral politics, the adoption of the electronic voting has the potential—in some contexts—of dramatically affecting the functioning of democratic institutions. Given that electronic voting is likely to become more common in the coming decades, it is important that political scientists better understand what its consequences will be and how its effects will vary. This research presents a first step in that endeavor.

In the case of Brazil, I document the consequences of a technological change that simultaneously reduced voting barriers and dampened fraud. First, I show that—due to Brazil's highly complex political environment created by open list electoral rules—voting by paper ballot was difficult for a large fraction of Brazilian voters. The introduction of electronic voting dramatically reduced these difficulties, and consequently functioned as a *de facto* expansion of the suffrage. These new voters differed most from already enfranchised voters in their increased propensity to cast a partisan—as opposed to a personal—ballot. Given the fact that Brazil's party system is often characterized as highly personalistic, this change is potentially consequential for the long term dynamics of partisan competition in Brazil. The effects of reducing fraud were particularly acute in a few states ruled by dominant conservative parties. Without the ability to directly manipulate vote totals, candidates belonging to the incumbent political machines suffered large

losses. These electoral setbacks, concentrated among right-of-center candidates, suggest that fraud may have played a key role in sustaining conservative rule.

In India, I find little evidence that the adoption of electronic voting substantially affected democratic politics. Voting in India was already relatively easy so electronic voting could not have the same enfranchising effect that it did in Brazil. Furthermore, politicians who employed fraud engage in practices that are more resistant to technological change. Widespread coercive fraud, even more so than tabulation fraud, is a symptom of state weakness. An important question for future research is explaining variation in the prevalence of coercive fraud. Why do Brazilian politicians generally refrain from open coercion while many Indian politicians seem to use it with impunity?

A key puzzle presented by this study is why a large expansion of electorate in Brazil had only a modest effect on the types of candidates elected. Perhaps surprisingly, the distribution of preferences among the previously disenfranchised were broadly similar to those already enfranchised. Because this enfranchisement was largely unexpected, it is possible that these new voters were largely unmobilized in the 1998 election, and consequently left little imprint on the kinds of legislators elected. This leaves open the question of whether the entrance of these largely poorer and less educated voters represented a new constituency to be mobilized in future elections. If candidates and parties began to adapt their platforms and policymaking to these new voters in future elections, then the long-term effect of their enfranchisement would not be apparent in the data used in this study.

The findings on the effect of electoral reform on the degree of political competition in the Brazilian Northeast, provide insight on the empirical phenomenon of considerable interest to scholars of politics in developing democracies: the combination of state weakness and national electoral competition. As pointed out by Guillermo O'Donnell and others, robust national political competition does not preclude the persistence of authoritarian enclaves where local elites resist the authority of the central state. Cosmopolitan urban centers where the government can provide public goods in a manner more or less consistent with the Weberian notion of an effective state coexist with vast hinterlands where the state's reach is limited or easily corroded. The fact that political machines in several northeastern Brazilian states could penetrate the electoral bureaucracy to commit fraud is one example of this more general phenomenon. While the amount of fraud has declined in most of Brazil since the 1940s, the strength of right-wing machines in Bahia, Maranhão, and Paraíba show that the capacity of the state to regulate elections was still highly heterogenous by the mid-1990s. The adoption of electronic voting, however, could be viewed as a sign of the further centralization and expansion of the authority of the central state vis-a-vis local political organizations, at least in the realm of elections. An insulated federal bureaucracy, through technological innovation and impressive organizational ability, significantly reduced the heterogeneity in the exercise of

state authority and consequently brought genuine political competition to millions of Brazilians living in these oligarchic states. The adoption of electronic voting is thus a vivid example of how the rule of law can emerge through the extension of state authority by a centralized and insulated bureaucracy.

While the downstream political effects of electronic voting and the survival of political machines are of theoretical interest, it is worth highlighting the policy implications of my findings. The voting technology literature has overwhelmingly focused on the US, where effects of voting technology on valid vote rates are typically less than 5%. While normatively problematic, in most cases—the famous Florida "butterfly" ballot notwithstanding—invalid vote rates of that size are unlikely to change electoral outcomes in most cases. My findings show that the potential disenfranchising effects of voting technology can be much larger in electoral systems that require high levels of information to successfully vote, such as when candidate-centered voting is combined with large district magnitudes. In countries with less permissive electoral systems, like India, the potential effects of voting technology are likely to be much more limited. Countries with permissive systems are not rare, as candidate centered and high district magnitude systems are used countries as diverse as Iraq, Colombia, and Finland. In these electoral environments, small changes to the ballot might have enormous effects and thus particular care must be exercised when designing these ballots in those contexts. The high informational requirements are particularly relevant in new democracies such as Iraq, where readily available partisan or incumbency cues are likely to be weaker.

Another implication of these findings is that the literature on *electronic* voting needs to be sensitive to the locus of fraudulent vote manipulation. Computer scientists have heavily criticized electronic voting systems due to their perceived susceptibility to fraud. One commonly invoked danger is that security vulnerabilities could allow incumbents or other actors to easily change vote totals in a centralized computer responsible for vote tabulation. A suspected case of this kind of event is the 1988 Mexican presidential elections, where the central vote tabulation computer crashed after the initial results showed high rates of opposition support. This case, however, was one in which the election administration institutions were politicized and easily manipulated by the governing party. The Brazilian case is an example where the institutional conditions are very different and the introduction of computers into the voting process was, on balance, fraud reducing, at least in the short term. The comparison between Brazil and Mexico suggests an important area of future research: what are the institutional conditions under which electronic voting enhances political competition and what are the conditions in which new voting technology undermines it?

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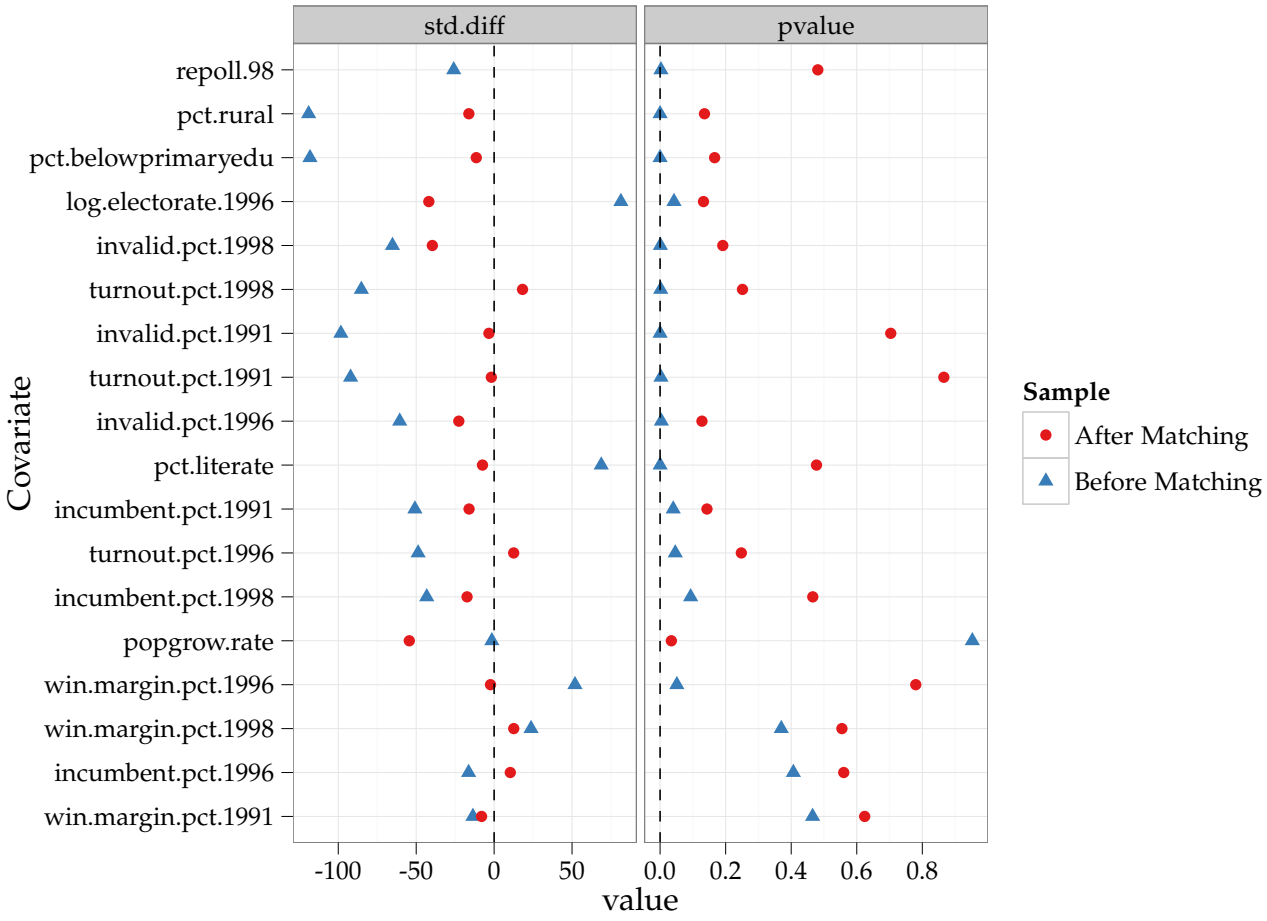


Figure 16: Balance in the Lok Sabha Sample. This plot presents covariate balance statistics before and after matching. The left panel shows the mean difference, scaled by the pooled standard deviation, between electronic voting and paper ballot parliamentary constituencies. The right panel shows p-values from a difference-in-means test.

## Appendix: India Balance Statistics

Figures 16 and 17 show balance statistics before and after matching for the Lok Sabha and Haryana samples. On the left side of each plot, the standardized differences (difference-in-means scaled by the pooled standard deviation) between electronic voting and paper ballot voting constituences are presented. On the right side, p-values from a difference-in-means test are shown. As is evident in the plots, balance generally improves after matching.

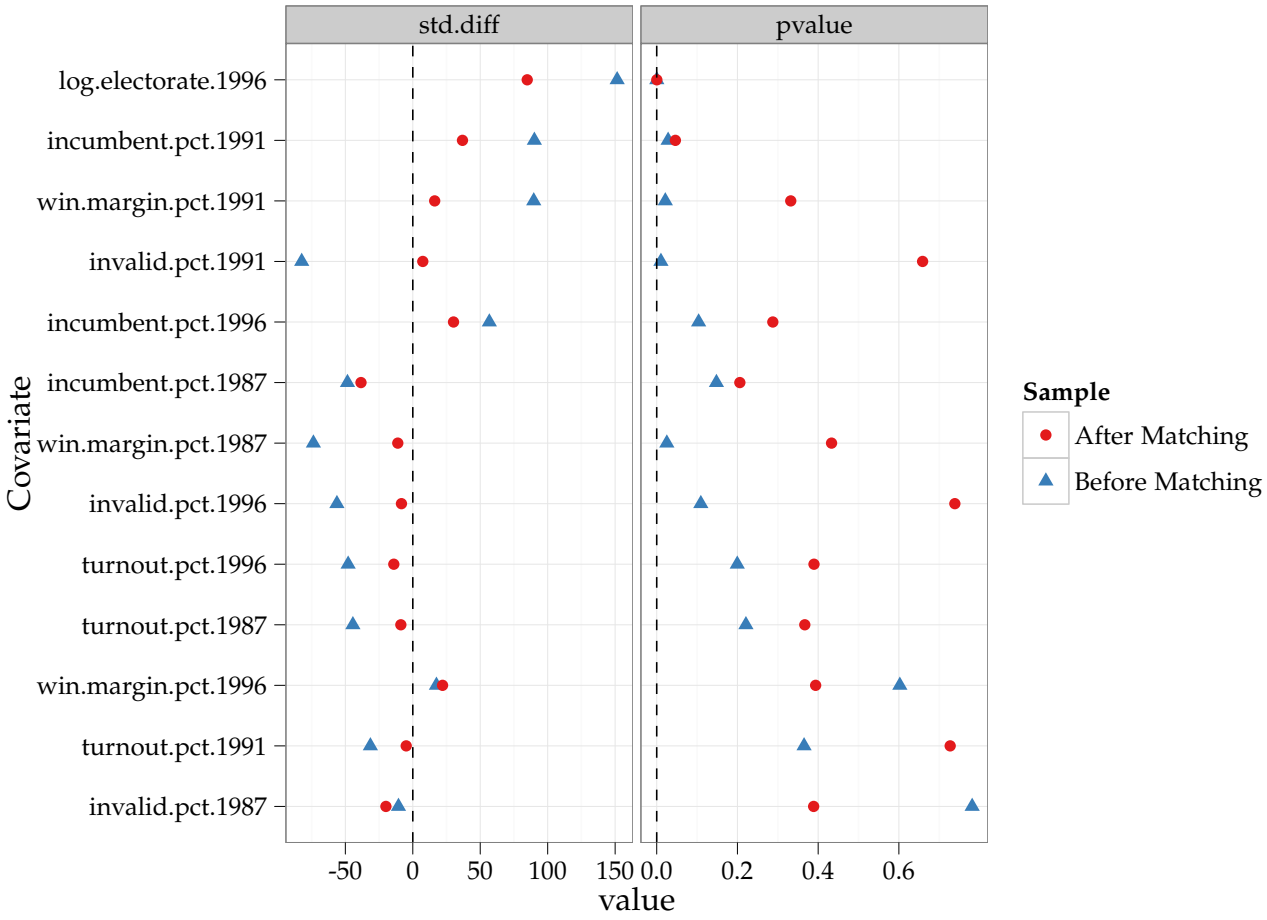


Figure 17: Balance in the Haryana Sample. This plot presents covariate balance statistics before and after matching. The left panel shows the mean difference, scaled by the pooled standard deviation, between electronic voting and paper ballot parliamentary constituencies. The right panel shows p-values from a difference-in-means test.