INTERNATIONAL CENTER FOR PUBLIC POLICY

—

WITHIN THE

PUBLIC FINANCE RESEARCH CLUSTER

Working Paper 25-04

Electronic Voting and Invalid Votes: Evidence from a Natural Experiment in Peru

Fernando M. Aragón

Alberto Chong

Angelo Cozzubo

February 2025

Georgia State University

ANDREW YOUNG SCHOOL OF POLICY STUDIES

Tel: 404-413-0233
Fax: 404-413-0244

Website:
pfrc.gsu.edu

Address:
55 Park Place NE
7th Floor
Atlanta, GA 30303

Mail:
Public Finance Research Cluster
P.O. Box 3992
Atlanta, GA 30302-3992

International Center for Public Policy
Andrew Young School of Policy Studies

The Andrew Young School of Policy Studies was established at Georgia State University with the objective of promoting excellence in the design, implementation, and evaluation of public policy. In addition to four academic departments, including economics and public administration, the Andrew Young School houses nine leading research centers, including the International Center for Public Policy.

The mission of the International Center for Public Policy (ICePP) is to provide academic and professional training, applied research, and technical assistance in support of sound public policy and sustainable economic growth in developing and transitional economies.

ICePP is recognized worldwide for its efforts in support of economic and public policy reforms through technical assistance and training around the world. This reputation has been built serving a diverse client base, including the World Bank, the U.S. Agency for International Development (USAID), the United Nations Development Programme (UNDP), finance ministries, government organizations, legislative bodies, and private sector institutions.

The success of ICePP reflects the breadth and depth of its in-house technical expertise. The Andrew Young School's faculty are leading experts in economics and public policy and have authored books, published in major academic and technical journals, and have extensive experience in designing and implementing technical assistance and training programs. Andrew Young School faculty have been active in policy reform in over 70 countries around the world. Our technical assistance strategy is not merely to provide technical prescriptions for policy reform, but to engage in a collaborative effort with host governments and donor agencies to identify and analyze the issues at hand, arrive at policy solutions, and implement reforms.

ICePP specializes in four broad policy areas:

- Fiscal policy (e.g., tax reforms, public expenditure reviews)
- Fiscal decentralization (e.g., reform, intergovernmental transfer systems, urban finance)
- Budgeting and fiscal management (e.g., local, performance-based, capital, and multi-year budgeting)
- Economic analysis and revenue forecasting (e.g., micro-simulation, time series forecasting)

For more information about our technical assistance activities and training programs, please visit our website at icepp.gsu.edu or contact us at paulbenson@gsu.edu.

Electronic Voting and Invalid Votes: Evidence from a Natural Experiment in Peru

Fernando M. Aragón, Alberto Chong, and Angelo Cozzubo[1]

February 2025

Abstract

This paper examines the impact of electronic voting in Peru. Our empirical analysis exploits variation from a natural experiment to implement a difference-in-difference strategy. Our estimates indicate that electronic voting reduced the share of invalid votes by almost two-thirds. This reduction appears to be driven by fewer voter errors rather than changes in protest voting. However, in contrast to recent studies, we find no evidence of substantial changes in other electoral outcomes, such as turnout or vote composition.

Keywords: electronic voting; natural experiment; invalid votes; Latin America

JEL Codes: P10, O12, O10

[1] Aragón: Department of Economics, Simon Fraser University; email: faragons@sfu.ca; Chong: Department of Economics, Georgia State University and Department of Economics, Universidad del Pacífico, email: achong6@gsu.edu; Cozzubo: NORC at the University of Chicago and Department of Economics, Pontificia Universidad Católica del Perú, email: cozzubo-angelo@norc.org.

Introduction

Despite the ubiquity of mobile phones and other information and communication technologies (ICT), in many developing countries the predominant method for casting votes remains the traditional paper ballot (International IDEA, 2023b). An alternative technology leverages electronic devices like computers or voting machines for recording votes. These electronic voting technologies promise several advantages. They can potentially lower the costs of vote processing, reduce electoral fraud, and diminish the number of votes invalidated due to voters' mistakes. These invalid votes (also called residual votes in the US context) are quantitatively important and can effectively disenfranchise large proportions of the population.[1]

Electronic voting, or e-voting, intersects with public choice theory in several important ways. For instance, it may influence voter participation by making the process more accessible and may impact the incentives to engage in the electoral process. In fact, electronic voting may influence voting behavior particularly in marginalized or less technologically savvy populations and potentially raise issues about equity and access to the process. In addition, it may reduce the costs associated with traditional voting methods and influence the decisions and allocation of resources. This is compounded by the fact that since the design and implementation of these systems involve various stakeholders, their interests may shape their development and regulation and potentially affect the ability to verify election results as well as hold officials accountable.

The empirical evidence on the impact of electronic voting on many of the above issues and several others remain relatively limited, especially in the context of countries with compulsory voting systems. Examples of earlier studies that examine the introduction of electronic voting technologies are the case of the United States during the early 2000s (Ansolabehere and Stewart III, 2005; Stewart III, 2011) as well as more recent work in Brazil, the Philippines, and India that document large impacts on electoral fraud and invalid votes, as well as observable shifts in the provision of public services and end outcomes, such as infant mortality (Debnath et al., 2017, Fujiwara, 2015, Peralta, 2018).

This paper examines the impact of electronic voting on the share of invalid votes and other electoral outcomes, such as turnout and vote composition. Our contribution is to examine these questions using quasi-experimental variation from a new context. In particular, we exploit a natural experiment during the 2016 presidential and parliamentary elections in Peru. That year, the electoral authority implemented a pilot project on electronic voting (e-voting) in which voters would vote using computers instead of paper ballots. The pilot was initially announced in 30 district municipalities in Lima city, but it was only implemented in 19 districts due to logistical delays. We exploit this variation and data from the 2011 and 2016 elections to implement a difference-in-difference (DiD) strategy.

We find evidence of a large reduction in invalid votes. The estimated reduction in invalid votes is around two-thirds of the baseline value. This figure represents around 9 percent of votes cast in presidential elections in the study area, and over 20 percent of votes cast in parliamentary elections. Interestingly, our evidence is consistent with the effects being driven by fewer voters'

[1] For instance, the share of invalid votes in Brazil, Indonesia, and the Philippines is above 10 percent. In some countries, such as Peru and Ecuador, this share is greater than 25 percent (International IDEA, 2023a).

mistakes rather than changes in protest voting. We observe, for instance, a negligible impact of electronic voting on invalid votes in simple, two-candidate, runoff elections. We also document larger impacts in areas with older, less educated populations. Despite the large reduction on invalid votes, we do not find substantial effects of electronic voting on other electoral outcomes. We find a statistically significant reduction in turnout, but the magnitude is very small. Importantly, we do not find any change in measures of vote composition, such as the vote share of the main opposition party.

Our findings contribute to two important debates on elections, particularly pertinent to countries with compulsory voting systems. First, they suggest that electronic voting technologies do not necessarily enhance electoral outcomes or government policies. This result contrasts with studies in other contexts, such as Brazil, the Philippines, and India, which document reductions in invalid votes and significant changes in electoral outcomes and public goods provision (Debnath et al., 2017; Fujiwara, 2015; Peralta, 2018). Several factors could explain these contrasting results, including differences in technology, institutions, or voter preferences. While we cannot determine why our results differ, our findings emphasize that conclusions from previous research may not be directly applicable to different settings. Therefore, caution is necessary when evaluating the potential impacts of electronic voting interventions. Second, our results contribute to the debate on the determinants of invalid votes, an issue of particular interest in Latin American politics due to the high levels of invalid votes in the region (Power and Roberts, 1995). Research on invalid voting has expanded rapidly over the past few years. While the determinants of invalid voting may be rather broad, the existing literature tends to highlight two main explanations (Power and Garand, 2007). The first is that invalid votes result from voter errors due to complex voting procedures, apathy, or confusion. The second is that voters spoil their ballots as a form of protest voting (Alvarez et al., 2018)[2].

The empirical evidence, however, remains inconclusive. Some studies, primarily from Brazil, find evidence supporting the voter error explanation (Freire and Turgeon, 2020, Power and Roberts, 1995). Other studies from Bolivia and Brazil support the protest voting hypothesis. Recent research using data from several Latin American countries also finds evidence of invalid voting as a form of protest (Cohen, 2018, Lioy, 2024). In contrast, our results suggest that, in the Peruvian case, a significant share of invalid votes may be due to voter error rather than protest voting.

Understanding Invalid Voting

Invalid voting, understood as casting blank or spoiled ballots, represents a significant yet understudied aspect of comparative political behavior. While much of the existing literature on voting behaviors centers around party identification and choice, invalid voting remains primarily overlooked, even in regions where it is notably significant, such as Latin America and the Caribbean (Power and Garand, 2007). This region includes several countries where mandatory voting laws are

[2] Kouba and Lysek (2018) perform a meta analysis using both individual-level and aggregate-level data as well as the results of experimental and qualitative studies and find that compulsory voting, quality of democracy, fragmentation, protest, and closeness of the electoral race may play roles in explaining invalid voting

widely enforced and often see high rates of invalid ballots. Hirczy (1994) underscores this dynamic, observing that compulsory voting is inherently tied to an increase in invalid ballots, as individuals who are disinterested or disengaged are compelled to participate in elections.

Understanding invalid voting is crucial, as a significant share of these ballots can skew the accurate representation of voters' intentions, thus undermining democratic principles and election legitimacy (Dahl, 1989). Furthermore, blank and null votes can be considered indicators of dissatisfaction with the political system or specific aspects of the electoral process. These ballots can signify a protest against the *status quo*, disillusionment with the available choices, or even structural issues within the electoral system (Power and Roberts, 1995). Hence, invalid ballots "arise from the sum of voter errors and deliberate attempts to signal political discontent" (Katz and Levin, 2018). As such, the study of invalid voting provides a lens through which broader questions about electoral behavior, civic engagement, and political dissatisfaction can be examined.

One theoretical framework for explaining the causes of invalid voting is provided by McAllister and Makkai (1993), later expanded by Power and Roberts (1995) and Power and Garand (2007), who categorize the phenomenon into three rationales: socioeconomic, protest-based, and institutional. From a socioeconomic perspective, invalid ballots are considered a byproduct of social structures, where low levels of development and limited urbanization in societies become a barrier to accessing political information. Moreover, this approach emphasizes the role of educational and informational disparities in shaping voting behaviors, suggesting that individuals from lower socioeconomic backgrounds may lack the resources or skills to effectively participate in the electoral process, thus resulting in invalid votes. This scenario is exacerbated by compulsory voting, where citizens lacking sufficient access to information or skills to make an informed decision are required to participate, likely leading to an increase in blank and spoiled ballots.

The protest perspective, on the other hand, frames invalid voting as an expression of voter discontent. In fact, protest voting refers to the act of casting a ballot for a candidate or party not because of genuine support, but as a way to express dissatisfaction with the available options or to make a political statement. Thus, according to this view that invalid ballots may reflect widespread dissatisfaction with the incumbent government, adverse economic conditions, or disapproval of the broader political regime. Following the taxonomy of Alvarez et al. (2018), protest voting can manifest in five primary forms. First, insurgent party protest voting occurs when voters select anti-establishment or ideologically extreme candidates to express their discontent. Tactical protest voting, by contrast, involves voting for a less preferred party to signal dissatisfaction with the primary party choice. Blank, null, or spoiled ballots are another form of protest where voters intentionally invalidate their ballots to show discontent. A fourth version of protesting is marking an "official protest option" included in recent elections, such as the "none of the above" category, signaling dissatisfaction explicitly. Finally, organized protest voting can emerge when political elites mobilize voters to protest by intentionally spoiling ballots[3].

[3] With respect to organized protest voting it is pertinent to highlight the case of the 2001 Peruvian presidential elections. During this electoral process, the presidential challenger, along with international observers, criticized the ruling government's use of public resources on behalf of the incumbent's campaign including voting procedures. The challenger ended up withdrawing from the runoff vote, urging his supporters to spoil their ballots in protest. In response, over 3.7 million Peruvian voters, comprising nearly 31 percent of the electorate,

Electronic voting may help reduce protest voting. If electronic voting allows for a wider range of candidates or parties to be represented, voters may feel that their preferences may be better captured, reducing the need for protest votes. When voters perceive that their choices accurately reflect their views, they may be less inclined to vote for non-mainstream candidates as a form of protest (e.g., Ferguson, 2016; Norris, 2015). If electronic voting systems are perceived as secure, transparent, and fair, voters may have greater confidence in the electoral process and may lead to lower instances of protest voting. If electronic voting makes the voting process easier and more accessible, voters may be more likely to participate in the system as intended rather than feeling compelled to cast a protest vote (Bennion and Dickerson, 2019). High participation rates can lead to better representation of the electorate's views, making protest votes less necessary. However, if the system is poorly designed or if there are technical issues, it may lead to frustration and voters might express their dissatisfaction through protest voting. If there are concerns about the integrity of the system, voters may be more inclined to protest vote as a form of dissent against a system they do not trust (Teixeira, 2022). In the context above, electronic voting can simplify the voting process and encourage individuals to engage in protest voting, as they may feel empowered to express their dissatisfaction.

The last perspective posed by McAllister and Makkai (1993) is the institutional one, which suggests that invalid voting arises from the design of the electoral system. In that sense, electoral rules, ballot designs, and party system configurations may unintentionally promote the casting of blank or null votes. According to Germann (2020), invalid votes often occur due to voter errors, such as misunderstanding electoral rules, selecting more candidates than permitted, or failing to mark ballots correctly. Additionally, Carman et al. (2008) note that voters may inadvertently skip races or fail to mark ballots clearly, leading to invalid votes. Germann (2020) alerts that empirical evidence suggests these errors are not randomly distributed but are more common among voters with lower educational attainment, who may be less familiar with ballot procedures, as seen in the work of Bullock and Hood (2002), Fujiwara, (2015) and Sinclair and Alvarez (2004).

Institutional factors play a crucial role in explaining invalid voting. For instance, ballot complexity and the multiplicity of party options contribute to the prevalence of invalid ballots. Power and Roberts (1995) show that the adoption of *cedula unica*, a single official ballot in Brazil "shifted the 'costs' in ballot complexity caused by open-list proportional representation directly onto the voters," a finding that aligns with McAllister and Makkai's (1993) seminal work on ballot complexity in Australia. In this regard, Power and Garand (2007) argue that invalid voting rates are lower in countries with compulsory voting when party-based voting structures and single-member districts are in place, as opposed to candidate-centered elections and multi-seat districts. The likelihood of invalid votes increases in systems where voters must navigate complex electoral decisions due to multiple candidates per seat or intricate voting rules. A related finding from Poland highlights the impact of ballot design, where transitioning from a single page to a brochure-style ballot caused a spike in invalid votes (Gendźwiłł, 2015). Concurrent elections for multiple offices further complicate the voting process, which may lead to voter confusion. Research by Lysek et al. (2020) and Kouba and Lysek (2016) demonstrates that holding simultaneous elections for presidential and

---

cast blank or spoiled ballots, vividly illustrating the power of organized protest voting in shaping electoral outcomes (Alvarez et al., 2018).

parliamentary offices increases the incidence of invalid voting in presidential contests, as voters face a larger and more complex set of choices. This setting mirrors the challenges observed in the Peruvian case, which is the focus of our study.

Electronic voting may help reduce voter errors by implementing systems designed to prevent invalid selections. Germann (2020) argues that electronic voting systems could increase effective participation by reducing avoidable mistakes but notes that empirical studies from Ansolabehere and Stewart (2005) and Stewart (2006) yield mixed results. On this issue, Herrnson et al. (2012) disentangled a particular relation between electronic voting and invalid votes. They find that voters using electronic ballots generally make fewer errors when presented with straightforward office-bloc ballots, as opposed to ballots with complex straight-party options; while other effects on electronic ballots are not significant.

The adoption of electronic voting in Brazil, amidst high levels of party fragmentation and a complex electoral structure, significantly reduced invalid voting rates and bolstered voter trust (Pomares, 2010). Similar results for trust in the electoral process were found by Alvarez (2011), who reported high trust levels in electronic voting pilot projects in Argentina and Colombia, although socioeconomic factors influence perceived reliability, with older voters without college education expressing higher confidence in direct-recording electronic devices compared to younger, more educated users using optical scan systems. Analogous results were observed in India, where the transition to electronic voting machines (EVM) nearly eliminated invalid votes and slightly increased the vote share for smaller, non-traditional parties (Desai and Lee, 2021). However, the authors note that the impact of EVM on voter error and turnout was minimal, suggesting that this reduction in invalid votes may be more attributable to a shift in protest votes than a reduction in accidental errors. Finally, evidence from Switzerland points to a modest decline in residual vote rates, with Internet voting reducing errors by an average of 0.3 percentage points in municipalities that allowed online voting (Germann, 2020). Although the effect size is small, these findings are essential as the evaluated Internet voting system implemented safeguards to prevent accidental residual voting that comprised (i) prevention of accidental overvotes by allowing voters to select their choice from a drop-down menu, (ii) ensuring only one answer is given, (iii) reducing accidental undervotes that occur when voters mark outside the designated boxes or use ink that scanners cannot read, and (iv) featuring a confirmation screen to review selections before final submission.

In the scope of the reviewed evidence, our contribution lies in its effort to disentangle the effects of ballot changes on invalid voting, while controlling crucial confounding dimensions, such as compulsory voting, electorate characteristics, and others. Following Alvarez et al. (2018) this study moves beyond aggregate country data to explore granular behaviors influencing invalid voting patterns. Moreover, our study addresses a limitation noted by Lysek et al. (2020), who cautioned that aggregate-level analyses cannot fully capture causal mechanisms of invalid voting behavior.

Institutional Background

Peru holds general elections every five years to select the president, vice presidents, and 130 congressional members.[4] Congress representatives are elected through an open list, proportional representation system, while the president and vice presidents are chosen through a simple majority in a two-round system. A runoff election occurs between the top two contenders a few months later if no presidential candidate achieves an absolute majority in the initial round. This paper uses data from the congressional and presidential elections (including runoffs) in 2011 and 2016.

Voting is compulsory for individuals aged 18 to 70 years.[5] Turnout rates are very high: around 82 percent in the 2016 general elections and almost 90 percent in our sample (ONPE, 2016a).[6] Voting is conducted in person using paper ballots (see Figure B.1 in the appendix for a sample ballot), which lists candidates for both Congress and the presidency. The number of choices is substantial; for instance, the 2016 election involved ten presidential candidates and 11 political parties contending for Congress. Presidential runoffs, however, feature only two candidates. Voters express their preferences by marking a cross over the party symbol or candidate's picture. Additionally, for Congress representatives, voters can indicate up to two preferred candidates by writing their numbers beside the party symbol.

The proportion of invalid votes is quite high. For instance, in 2011, invalid votes constituted about 14 percent of the total votes cast in congressional elections and 7% in presidential elections (refer to Table 1). In 2016, the share of invalid votes in congressional elections escalated to nearly 25 percent, while remaining within the range of 4-9 percent for presidential elections. The divergence in invalid votes between congressional and presidential elections might stem from the heightened intricacy of the former due to the option for a preferential vote. A vote is deemed invalid if left blank or if it is deemed null due to failure to adhere to voting regulations. Instances include using a mark other than an X or cross, marking outside the designated area on the ballot, or submitting a damaged or torn ballot. In congressional elections, votes are also deemed null if a voter writes a candidate number next to a different party symbol. Such errors could be accidental or deliberate forms of protest voting.

Electronic Voting in Peru

In 2016, the National Office of Electoral Processes (ONPE) initiated a pilot project to introduce electronic voting (e-voting) through direct recording electronic devices (DRE). In this pilot, voters were still required to vote in person but used an electronic touchscreen or computer instead of paper ballots. The interface closely resembled the paper ballots, featuring identical party symbols

[4] Additionally, voters choose representatives for the Andean Parliament, which we do not include in our primary analysis.

[5] Besides Peru, voting is also compulsory in several Latin American countries, including Brazil, Bolivia, Ecuador, Argentina, and Mexico, as well as in countries outside the region like Greece, Turkey, Egypt, and Australia (International IDEA, 2024).

[6] Turnout rates in other countries with compulsory voting in the region are also very high. For instance, turnout rates in the last presidential election were around 80 percent in Brazil and close to 90 percent in Bolivia. In comparison, turnout rates in countries without compulsory voting, such as the US and Canada, are between 60-70 percent.

and candidate photos. Electronic voting, by design, eradicated common errors such as damaging the physical ballot, employing incorrect markings, marking outside designated areas, or associating a candidate number with a different party symbol. Nevertheless, invalid votes were not entirely eradicated, as voters still had the option to cast blank or null votes.

The pilot was initially intended to include 30 districts in the Lima Metropolitan area.[7] These districts represent 40 percent of the registered voters in the city and about 13 percent of all registered voters in the country. However, five days before election day, the ONPE removed 11 districts from the pilot because they could not install the new voting equipment in all their polling stations on time (OAS, 2016). Consequently, the pilot's implementation was limited to 19 districts, representing only 24 percent of the electorate of the original 30 districts. We use the variation created by this natural experiment as the basis for our identification strategy.[8]

Methods

Data

We use data on electoral outcomes from two periods: the 2011 and 2016 elections, distinguishing among three types of elections: congressional, presidential (first round), and presidential (runoff). This data includes polling stations in the original 30 districts designated for the electronic voting pilot.

Our primary data source is derived from publicly accessible electoral records provided by the National Office of Electoral Processes (ONPE).[9] These records contain the vote counts for each candidate, which include null and blank votes, at the polling station level. These counts are utilized to construct key electoral outcomes like the proportion of invalid votes, voter turnout, and the distribution of votes among parties.[10] For this last variable, we focus on the political party associated with Alberto Fujimori, a former president, as it is the sole major party that participated in all elections, including presidential runoffs, during both years.[11] We complement our electoral data with sociodemographic information at the district level from the 2017 Population Census.

Identification Strategy

Table 1 presents summary statistics for congressional and presidential in 2011, the election before the implementation of electronic voting. The first column presents the basic mean values for the entire sample. In columns 2 and 3, the sample is divided based on whether or not the polling station's district used electronic voting in 2016.

[7] The Lima Metropolitan area includes 50 districts from the Province of Lima and Callao.

[8] If the pilot had been fully implemented, we could have used non-participating districts in the rest of the Lima Metropolitan area or other cities as a control group. However, due to significant differences between Peruvian cities and potential endogeneity in selecting districts for the pilot, this approach would raise concerns about bias from omitted variables.

[9] The records are available at https://www.onpe.gob.pe/elecciones.

[10] The proportion of invalid votes is defined as: (number of blank or null votes)/(total number of votes cast). Voter turnout is calculated as: (total number of votes cast)/(total number of registered votes).

[11] The party underwent a name change, transitioning from Fuerza 2011 to Fuerza Popular.

There are two observations relevant to our empirical analysis. First, the proportion of invalid votes is higher in congressional elections. This pattern potentially stems from the increased complexity of voting using open lists. This emphasizes the necessity of distinct analyses for congressional and presidential elections. Second, the districts that used electronic voting and those that did not are very similar in observable characteristics. They had comparable electoral outcomes in the 2011 elections, such as the share of invalid votes, turnout, and support for Fujimori's party, as well as similar sociodemographic features. The main difference lies in their size: districts that used electronic voting had more polling stations and larger populations. This size discrepancy aligns with the modification of the pilot project due to some districts being unable to install the new voting equipment in all polling stations. This logistical delay was likely more pronounced in districts with larger populations and, therefore, more polling stations, creating a source of quasi-experimental variation.

Table 1. Summary Statistics

	All Districts	Implemented Electronic voting		p-value
		No	Yes	(3) - (2)
	(1)	(2)	(3)	(4)
Congressional elections 2011				
Share residual votes	0.138	0.140	0.130	0.461
Turnout	0.871	0.872	0.870	0.821
Vote share Fujimori's party	0.219	0.226	0.196	0.327
Presidential elections (1st round) 2011				
Share residual votes	0.071	0.073	0.064	0.478
Turnout	0.871	0.871	0.869	0.781
Vote share Fujimori's party	0.200	0.207	0.178	0.296
Presidential elections (run off) 2011				
Share residual votes	0.070	0.067	0.066	0.317
Turnout	0.862	0.865	0.866	0.668
Vote share Fujimori's party	0.629	0.619	0.659	0.226
Census 2017				
% tertiary education	0.356	0.344	0.397	0.280
% age 20-30 years	0.170	0.173	0.160	0.146
% indoor piped water	0.786	0.800	0.740	0.136
% female	0.524	0.521	0.531	0.140
Average population (000s)	238.7	291.7	65.5	0.000
No. polling stations in 2011	14,194	10,880	3,314	
No. polling stations in 2016	8,906	6,678	2,228	
No. districts	30	11	19	

Notes: Table presents simple averages. The unit of observation is the polling station. Columns 2 and 3 split the sample into control and treated groups. Column 4 displays the p-value of the mean comparison test of columns (2) and (3).

Our identification strategy exploits this variation. Specifically, we implement a difference-in-difference (DiD) methodology that compares changes in electoral outcomes between polling stations in districts where electronic voting was used (treated group) and those in districts that were part of the pilot program but did not use electronic voting (control group). This approach allows us to control for any time-invariant differences across districts. It requires us to assume that, conditional on size and inclusion in the original pilot sample, districts that used or did not use electronic voting would have followed the same trend in the share of invalid votes and other electoral outcomes.

Formally, we estimate the following regression model:

$$y_{ijkt} = \beta\,(\text{E-voting}_j \times \text{Year 2016}_t) + \delta_j + \eta_k + \rho_t + \epsilon_{ijkt}, \qquad (1)$$

where the unit of observation is polling station *i*, in district *j*, election $k \in$ {congressional, presidential 1st round, runoff} and year *t*. E-voting$_j$ indicates if the polling station is in a district that implemented electronic voting, while Year 2016$_t$ is an indicator of elections in 2016. Given that the treatment unit was the district, not the polling station, we cluster standard errors at the district level.

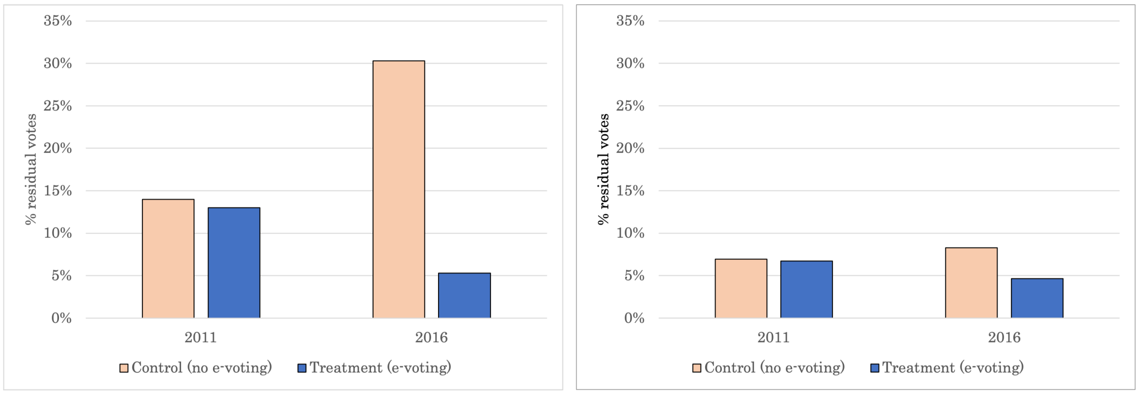
Results

Effect on Invalid Votes

Figure 1 illustrates our identification strategy and main findings for congressional and presidential elections (panels a and b, respectively). Each panel displays the average share of invalid votes in districts where electronic voting was implemented (treated group) compared to districts where it was not (control group).

In 2011, before the introduction of electronic voting, the levels of invalid votes were similar in both districts. However, in 2016, after adopting electronic voting, a notable reduction in residual votes was evident within the treated group. This decline is especially remarkable in the context of congressional elections. This observation offers suggestive indications of the impact of electronic voting on invalid votes.

Figure 1. Share of Invalid Votes, by Election Type



(a) Congressional elections (b) Presidential elections

Notes: Figure displays the average share of invalid votes across polling stations. Panel (a) uses only invalid votes in congressional elections. Panel (b) pools invalid votes in the first round of the presidential election and runoff election.

Table 2 displays the results of our DiD regression model, investigating the impact of electronic voting on invalid votes. The results show a large negative impact across various elections, except for runoff presidential elections (columns 1 to 4). The magnitude of the effect is substantial. For example, when considering all elections (column 1), the reduction of invalid votes is around ten percentage points. This reduction represents almost two-thirds of invalid votes in the control group (15.6 percent). This relative reduction represents around 9 percent of the votes cast in the presidential elections in the control municipalities and over 23 percent of the votes cast in the parliamentary elections (columns 2 and 3). The overall reduction can be attributed to declines in both null and blank votes (columns 5 and 6).

Our findings are robust to aggregating the polling station data at the district level and modifying the set of control variables (see Tables A.1 and A.2 in the appendix). We also conduct a placebo test by creating 1,000 random treatment groups. For each group, we randomly assign treatment status to 19 out of 30 districts and then re-estimate the model from Table 2, column 1. Figure B.2 in the appendix illustrates the distribution of estimated coefficients for these fake treatments. On average, these estimates are zero and significantly smaller than those derived from the actual treatment.

The estimated magnitude aligns with the findings of other studies on the impact of changes in voting technology. For example, Fujiwara (2015) documents a reduction of approximately 50 percent in the share of invalid votes following the introduction of electronic voting in Brazil. Similarly, Hanmer et al. (2010) find that transitioning from punch cards to optical scanning and electronic recording in U.S. states led to reductions in invalid votes ranging from 35 to 90 percent.

Table 2. Electronic Voting and Invalid Votes

	Dependent variable: share of invalid votes					
	All Elections	Congressional Elections	Presidential Elections		All elections	
			1st round	Runoff	Blank	Null
	(1)	(2)	(3)	(4)	(5)	(6)
Has e-voting × year 2016	-0.104***	-0.238***	-0.087***	0.017	-0.037***	-0.067***
	(0.005)	(0.009)	(0.005)	(0.010)	(0.003)	(0.004)
Mean dep. var. control group	0.156	0.303	0.123	0.042	0.056	0.100
Observations	68,788	22,728	22,966	23,094	68,788	68,788
R-squared	0.262	0.355	0.118	0.026	0.448	0.144

Notes: Standard errors (in parenthesis) are clustered at the district level. * denotes significant at 10 percent, ** significant at 5 percent and *** significant at 1 percent. All regressions also include election type, district, and year fixed effects, plus the log of no. parties in the ballot and no. of registered voters in polling stations. All regressions use the share of invalid votes as the dependent variable, except columns 5 and 6, which decompose the invalid votes into blank and null votes, respectively. The mean of the control group's dependent variable is for 2016.

Discussion

We interpret these results as evidence that electronic voting reduces involuntary voters' mistakes. Our interpretation is based on three pieces of evidence. First, the electronic voting technology allows voters to cast null and blank votes, making it unlikely that the decrease in invalid votes is solely due to a mechanical reduction in protest voting (i.e., intentionally spoiling ballots).

Second, we observe a larger effect on invalid votes in elections with more complex voting procedures, such as congressional and first-round presidential elections. In contrast, the impact on invalid votes in runoff presidential elections, a simpler voting procedure in which voters choose between two candidates, is negligible.

Finally, we observe that the impact of electronic voting is smaller in districts with better education and younger populations (see Table 3). To examine these heterogeneous effects, we modify the baseline regression by including a triple interaction ($\text{e-voting}_j \times \text{Year } 2016_t \times X_i$) where X_i represents the normalized value of sociodemographic characteristics at the district level obtained from the 2017 population census. These characteristics include variables such as the share of the population with tertiary education, aged 20-30 years, and with access to indoor piped water.

Table 3. Electronic Voting and Invalid Votes, Heterogeneous Effects

	Dependent var.: share of invalid votes					
	Congressional elections			Presidential election (1st round)		
	(1)	(2)	(3)	(4)	(5)	(6)
Has e-voting × year 2016	-0.247***	-0.253***	-0.249***	-0.095***	-0.096***	-0.095***
	(0.007)	(0.008)	(0.007)	(0.005)	(0.003)	(0.002)
Has e-voting × year 2016	0.033***	0.049***	0.056***	0.017***	0.037***	0.032***
× % tertiary education	(0.007)	(0.016)	(0.013)	(0.004)	(0.006)	(0.005)
Has e-voting × year 2016		0.016	0.023		0.013**	0.013***
× % age 20-30 years		(0.015)	(0.014)		(0.005)	(0.004)
Has e-voting × year 2016			-0.010			0.006
× % has indoor piped water			(0.011)			(0.004)
Observations	22,728	22,728	22,728	22,966	22,966	22,966
R-squared	0.356	0.356	0.357	0.119	0.120	0.120

Notes: Standard errors (in parenthesis) are clustered at the district level. * denotes significant at 10 percent, ** significant at 5 percent and *** significant at 1 percent. All regressions also include election type, district, and year fixed effects, plus the log of no. parties in the ballot and no. of registered voters in polling stations. Districts' sociodemographic characteristics (like percent tertiary education) are obtained from the 2017 Population Census and are normalized using the sample mean and standard deviation.

Other Electoral Outcomes

The decline in invalid votes offers reassurance about the potential advantages of electronic voting technologies. However, previous research indicates that electronic voting may have broader effects beyond reducing invalid votes. These effects encompass changes in voter turnout, the composition of votes, and even governmental policies. The existing literature has underscored at least three possible mechanisms. First, reducing invalid votes might provide an advantage to specific voter groups, effectively leading to the empowerment of a different electorate (Fujiwara, 2015). Second, the introduction of electronic voting could influence the anticipated costs associated with voting, as pointed out by Card and Moretti (2007). Lastly, adopting electronic voting could render certain forms of electoral fraud, such as voter impersonation, more costly (Debnath et al., 2017; Peralta, 2018).

We analyze three key electoral outcomes: voter turnout, concentration of vote share, and vote share of Fuerza Popular, a prominent opposition party associated with former president Alberto Fujimori. The latter two variables are intended to capture potential shifts in the composition of votes. It is important to note that we cannot examine the impact on policies or the identity of elected politicians, given that we study national elections, but the source of variation is at the local level only.

Our analysis reveals a decrease in voter turnout in districts where electronic voting was implemented (see Table 4).[12] The observed decrease is statistically significant, though modest, at approximately one percentage point. A similar, but slightly larger, reduction in turnout (around 3.8 percentage points) was documented by Debnath et al. (2017) after the introduction of electronic voting in India.[13] They interpret this finding as evidence of a decrease in electoral fraud. However, we cannot definitively determine whether our findings indicate reduced fraud or changes in the drivers of voting behavior.

Concerning measures of vote composition (columns 3 to 5), our analysis does not identify any significant impact. This outcome contrasts with the findings of Fujiwara (2015), who observed a higher share of votes for left-wing parties through electronic voting. Considering heterogeneous effects, we observe vote share impacts that differ based on socioeconomic characteristics (see Table A.4 in the Appendix). However, on average, these effects are minor and statistically insignificant. These dissimilar outcomes could be driven by differences between the Peruvian and Brazilian contexts, including variations in the type of electronic voting technology, different voter characteristics, or the scope of the intervention.

---

[12] For more detailed results based on election types, please see Table A.3 in the appendix.

[13] In contrast, Fujiwara (2015) did not discover any significant impact of electronic voting on turnout in Brazil.

Table 4. Electronic Voting and Other Electoral Outcomes

	Turnout	Vote share concentration	Vote share Fuerza Peru		
			Congressional elections	Presidential elections	
				1st round	Runoff
	(1)	(2)	(3)	(4)	(5)
Has e-voting × year 2016	-0.011***	-0.001	-0.003	-0.012	-0.082
	(0.002)	(0.009)	(0.013)	(0.018)	(0.075)
Mean dep. var. control group	0.859	0.859	0.349	0.366	0.458
Observations	68,788	68,788	22,443	22,737	22,956
R-squared	0.230	0.880	0.759	0.812	0.454

Notes: Standard errors (in parenthesis) are clustered at the district level. * significant at 10 percent, ** significant at 5 percent and *** significant at 1 percent. All regressions also include election type, district, and year fixed effects, plus the log of no. parties in the ballot and no. of registered voters in the polling station. Vote share concentration is the Herfindahl-Hirschman Index calculated using parties' vote shares in each polling station.

Final Remarks

This paper examines the impact of an electronic voting intervention in Peru. Our findings support previous research indicating large reductions in the share of invalid votes. In particular, our estimates indicate that electronic voting reduced the share of invalid votes by almost two-thirds. This reduction appears to be driven by fewer voter errors rather than changes in protest voting.

The effect was greater among older, less educated voters, effectively changing the composition of the electorate. However, we do not find evidence of substantial changes in turnout or in vote composition. This last result contrasts with findings from other settings, such as Brazil, India and the Philippines, where electronic voting seemed to trigger changes in vote composition and government policies. This finding emphasizes the importance of exercising caution when extrapolating sights from different settings to evaluate the potential impacts of electronic voting interventions. Given the local scope of the electronic voting intervention, we cannot examine whether our findings apply to other Peruvian areas and therefore cannot fully assess the impact on overall electoral results. Importantly, this also implies that we cannot evaluate the effect of electronic voting on government policies. These are important issues that warrant further research.

References

Alvarez, R. Michael, Gabriel Katz, and Julia Pomares. "The impact of new technologies on voter confidence in Latin America: Evidence from e-voting experiments in Argentina and Colombia." *Journal of Information Technology & Politics, 2011, 8* (2), 199-217.

Alvarez, R Michael, D Roderick Kiewiet, and Lucas Núñez, "A taxonomy of protest voting," *Annual Review of Political Science*, 2018, *21* (1), 135–154.

Ansolabehere, Stephen and Charles Stewart III, "Residual votes attributable to technology," *The Journal of Politics*, 2005, *67* (2), 365–389.

Bennion, E. A., and Nickerson, D. W. (2019). "The Effects of Online Voting on Political Participation." Electoral Studies, 60, 102-113.

Bullock, III, Charles S., and M. V. Hood, III. "*One person—no vote; one vote; two votes: voting methods, ballot types, and undervote frequency in the 2000 presidential election.*" *Social Science Quarterly, 2002, 83* (4), 981-993.

Card, David and Enrico Moretti, "Does voting technology affect election outcomes? Touch-screen voting and the 2004 presidential election," *The Review of Economics and Statistics*, 2007, *89* (4), 660–673.

Carman, Christopher, James Mitchell, and Robert Johns. "The unfortunate natural experiment in ballot design: the Scottish Parliamentary Elections of 2007." *Electoral Studies, 2008, 27* (3), 442-459.

Cohen, Mollie J, "Protesting via the null ballot: An assessment of the decision to cast an invalid vote in Latin America," *Political Behavior*, 2018, *40*, 395–414.

Dahl, Robert A. Democracy and its Critics. *Yale University Press, 2008*.

Desai, Zuheir, and Alexander Lee. "Technology and protest: the political effects of electronic voting in India." *Political Science Research and Methods, 2021, 9* (2), 398-413.

Debnath, Sisir, Mudit Kapoor, and Shamika Ravi, "The impact of electronic voting machines on electoral frauds, democracy, and development," *Democracy, and Development (March 16, 2017)*, 2017.

Ferguson, M. (2016). "The Impact of Technological Change on Political Participation: The Case of Electronic Voting." Journal of Political Marketing, 15(1), 45-58.

Freire, Alessandro and Mathieu Turgeon, "Random votes under com-pulsory voting: evidence from Brazil," *Electoral Studies*, 2020, *66*, 1–1.

Fujiwara, Thomas, "Voting technology, political responsiveness, and infant health: Evidence from Brazil," *Econometrica*, 2015, *83* (2), 423–464.

Gendźwiłł, Adam. "Skąd się biorą głosy nieważne w wyborach do sejmików województw?." [*Invalid Ballots in Polish Regional Elections. Where are they from?*] *Studia socjologiczne, 2015, 219* (4), 53-77.

Germann, Micha. "Making votes count with internet voting." *Political Behavior,* 2021*, 43* (4), 1511-1533.

Hanmer, Michael J, Won-Ho Park, Michael W Traugott, Richard G Niemi, Paul S Herrnson, Benjamin B Bederson, and Frederick C Conrad, "Losing fewer votes: the impact of changing voting systems on residual votes," *Political Research Quarterly*, 2010, *63* (1), 129–142.

Herrnson, Paul S., Michael J. Hanmer, and Richard G. Niemi. "The impact of ballot type on voter errors." *American Journal of Political Science, 2012, 56* (3), 716-730.

Hirczy, Wolfgang. "The Impact of Mandatory Voting Laws on Turnout: A Quasi-Experimental Approach." *Electoral Studies*, 1994, *13*(1), 64–76.

International IDEA, "Invalid votes," International Institute for Democracy and Electoral Assistance (IDEA). Accessed on August 21, 2023 at https://www.idea.int/datatools/question-view/443. 2023.

_ , "Use of E-Voting Around the World," International Institute for Democracy and Electoral Assistance (IDEA). Accessed on August 21, 2023 at https://www.idea.int/newsmedia/media/use-e-voting-around-world 2023.

_ , "Compulsory voting," International Institute for Democracy and Electoral Assistance (IDEA). Accessed on July 11, 2024 at https://www.idea.int/data-tools/data/voterturnout-database/compulsory-voting. 2024.

Katz G, and I. Levin. "General Model of Abstention Under Compulsory Voting. Political Science Research and Methods" 2018, 6(3): 489-508. doi:10.1017/psrm.2016.49

Kouba, Karel, and Jakub Lysek. "Institutional determinants of invalid voting in post-communist Europe and Latin America." *Electoral Studies, 2016, (41),* 92-104.

Kouba K, and J. Lysek "What Affects Invalid Voting? A Review and Meta-Analysis", Government and Opposition", 2019, 54(4): 745-775. doi:10.1017/gov.2018.33

Lioy, Alberto, "âI Would Prefer Not Toâ: Establishing the Missing Link between Invalid Voting and Public Protest in Latin America," *Latin American Politics and Society*, 2024, *66* (1), 106–132.

Lysek, Jakub, Tomáš Lebeda, and Karel Kouba. "Turning out but not voting: invalid ballots in post-communist parliamentary elections." *Comparative European Politics, 2020, 18*, 190-214.

McAllister, Ian, and Toni Makkai. "Institutions, society or protest? Explaining invalid votes in Australian elections." *Electoral Studies*, 1993, *12* (1), 23-40.

Norris, P. (2015). "Strengthening Electoral Integrity." *Cambridge University Press.*

OAS, "Report to the Permanent Council: Electoral Observation Mission – Peru," Report, Organization of American States (OAS), Washington, DC 2016. available at https://www.oas.org/eomdatabase/GetFileA.aspx?id=386-1046-27-0.

ONPE, "Participación Ciudadana en las Elecciones Generales 2016," Oficina Nacional de Procesos Electorales (ONPE). Accessed on July 8, 2024 at

https://www.web.onpe.gob.pe/modElecciones/elecciones/elecciones2016/PRPCP2016/Participacion ciudadana-Total-Todos-Pie.html 2016.

__ , "Training Material 2016 Elections," Oficina Nacional de Procesos Electorales (ONPE). Accessed on July 2, 2023 at

https://www.onpe.gob.pe/elecciones/2016/EG/informativo/docs/materialcapacitacion/Afiche-Comovotar-EG2016-2.pdf 2016.

Peralta, Abigail, "The impact of election fraud on government performance," *Texas A and M University*, 2018.

Pomares, J. "A comparative analysis of the process of introduction of electronic voting in Argentina and Brazil." *Unpublished mimeo*, 2010.

Power, Timothy J and J Timmons Roberts, "Compulsory voting, invalid ballots, and abstention in Brazil," *Political Research Quarterly*, 1995, *48* (4), 795–826.

Power, Timothy J and James C Garand, "Determinants of invalid voting in Latin America," *Electoral Studies*, 2007, *26* (2), 432–444.

Sinclair, DE Betsy, and R. Michael Alvarez. "Who overvotes, who undervotes, using punchcards? Evidence from Los Angeles County." *Political Research Quarterly, 2004, 57* (1), 15-25.

Stewart III, Charles. "Residual vote in the 2004 election." *Election Law Journal, 2006, 5* (2), 158-169.

Stewart III, Charles "Voting technologies," *Annual Review of Political Science*, 2011, *14*, 353–378.

Teixeira, R. A. (2022). "Disruptive Technologies and Electoral Behavior: The Impact of Electronic Voting and Social Media on Protest Voting." *International Journal of Public Opinion Research*, 34(1), 58-78.

Online Appendix

Additional Tables

Table A.1. Robustness Check Aggregating Data at District Level

	Dependent variable: Share of Invalid Votes			
	All	Congressional elections	Presidential elections	
			1st round	Runoff
	(1)	(2)	(3)	(4)
Has e-voting × year 2016	-0.100***	-0.256***	-0.099***	0.045***
	(0.005)	(0.011)	(0.007)	(0.010)
Mean dep. var. control group	0.151	0.296	0.118	0.0390
Observations	177	58	58	58
R-squared	0.595	0.980	0.931	0.586

Notes: Standard errors (in parenthesis) are clustered at the district level. * significant at 10 percent, ** significant at 5 percent and *** significant at 1 percent. All regressions also include election type, district, and year fixed effects, plus the log of no. parties in the ballot and no. of registered voters in polling station. All regressions use data aggregated at district level. Aggregation is done by taking the weighted average of polling-station data using the number of registered voters as weights.

Table A.2
Robustness check: No Control Variables

	Dependent var.: share of invalid votes			
	All	Congressional elections	Presidential elections	
			1st round	Runoff
	(1)	(2)	(3)	(4)
Has e-voting × year 2016	-0.103***	-0.239***	-0.087***	0.017
	(0.005)	(0.010)	(0.005)	(0.010)
District FE	Yes	Yes	Yes	Yes
Covariates	No	No	No	No
Observations	68,788	22,728	22,966	23,094
R-squared	0.252	0.333	0.118	0.026

Notes: Standard errors (in parenthesis) are clustered at the district level. * significant at 10 percent, ** significant at 5 percent and *** significant at 1 percent. All regressions also include election type, district, and year fixed effects.

Table A.3. E-voting and Other Electoral Outcomes,

By Election Type

	Turnout			Vote share concentration		
	Congressional elections	Presidential elections		Congressional elections	Presidential elections	
		1st round	Runoff		1st round	Runoff
	(1)	(2)	(3)	(4)	(5)	(6)
Has e-voting × year 2016	-0.015***	-0.013***	-0.005*	0.001	-0.007	0.004
	(0.002)	(0.002)	(0.003)	(0.007)	(0.013)	(0.012)
Mean dep. var. control group	0.862	0.860	0.857	0.862	0.860	0.857
Observations	22,728	22,966	23,094	22,728	22,966	23,094
R-squared	0.267	0.250	0.197	0.384	0.568	0.370

Notes: Standard errors (in parenthesis) are clustered at the district level. * significant at 10 percent, ** significant at 5 percent and *** significant at 1 percent. All regressions also include election type, district, and year fixed effects, plus the log of no. parties in the ballot and no. of registered voters in the polling station. Vote share concentration is the Herfindahl-Hirschman Index calculated using parties' vote shares in each polling station.

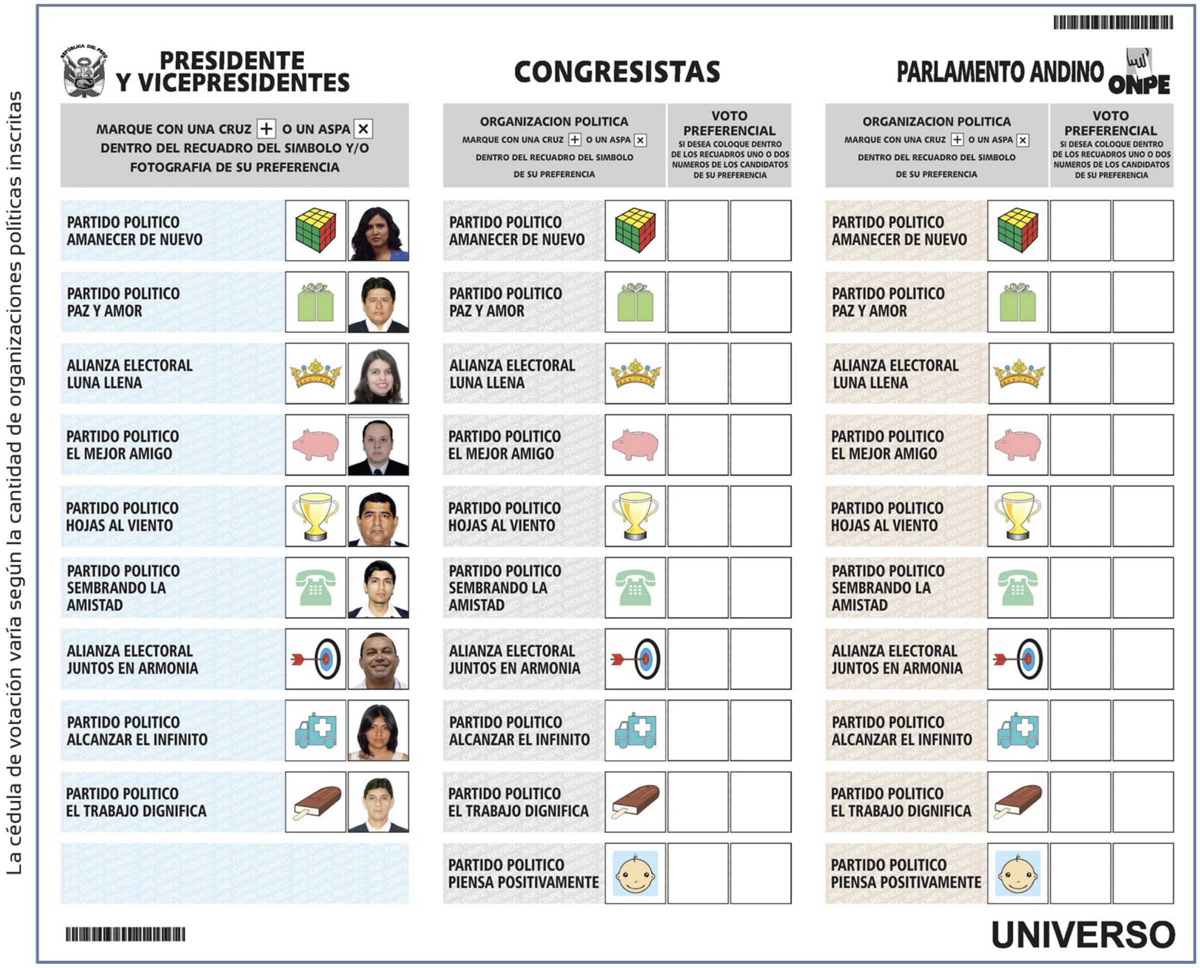
Table A.4. Electronic voting and Other Electoral Outcomes, Heterogeneous Effects

	Turnout			Vote share Fuerza Peru		
	Congressional elections	Presidential elections 1st round	Presidential elections Runoff	Congressional elections	Presidential elections 1st round	Presidential elections Runoff
	(1)	(2)	(3)	(4)	(5)	(6)
Has e-voting × year 2016	-0.015***	-0.012***	-0.004*	0.006***	0.009***	0.008***
	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Has e-voting × year 2016	-0.003	-0.004	-0.003	0.038***	0.021***	-0.031***
× % tertiary education	(0.003)	(0.004)	(0.006)	(0.005)	(0.005)	(0.005)
Has e-voting × year 2016	-0.002	-0.001	-0.002	0.042***	0.038***	-0.005
× % age 20-30 years	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)
Has e-voting× year 2016	0.009***	0.010***	0.009*	-0.005	0.009**	0.069***
× % has indoor piped water	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)
Observations	22,728	22,966	23,094	22,443	22,737	22,956
R-squared	0.269	0.251	0.198	0.773	0.837	0.845

Standard errors (in parenthesis) are clustered at the district level. * significant at 10 percent, ** significant at 5 percent and *** significant at 1 percent. All regressions also include election type, district, and year fixed effects, plus the log of no. parties in the ballot and no. of registered voters in polling station. Districts' socio-demographics characteristics (percent tertiary education) are obtained from the 2017 Population Census and are normalized using the sample mean and standard deviation.

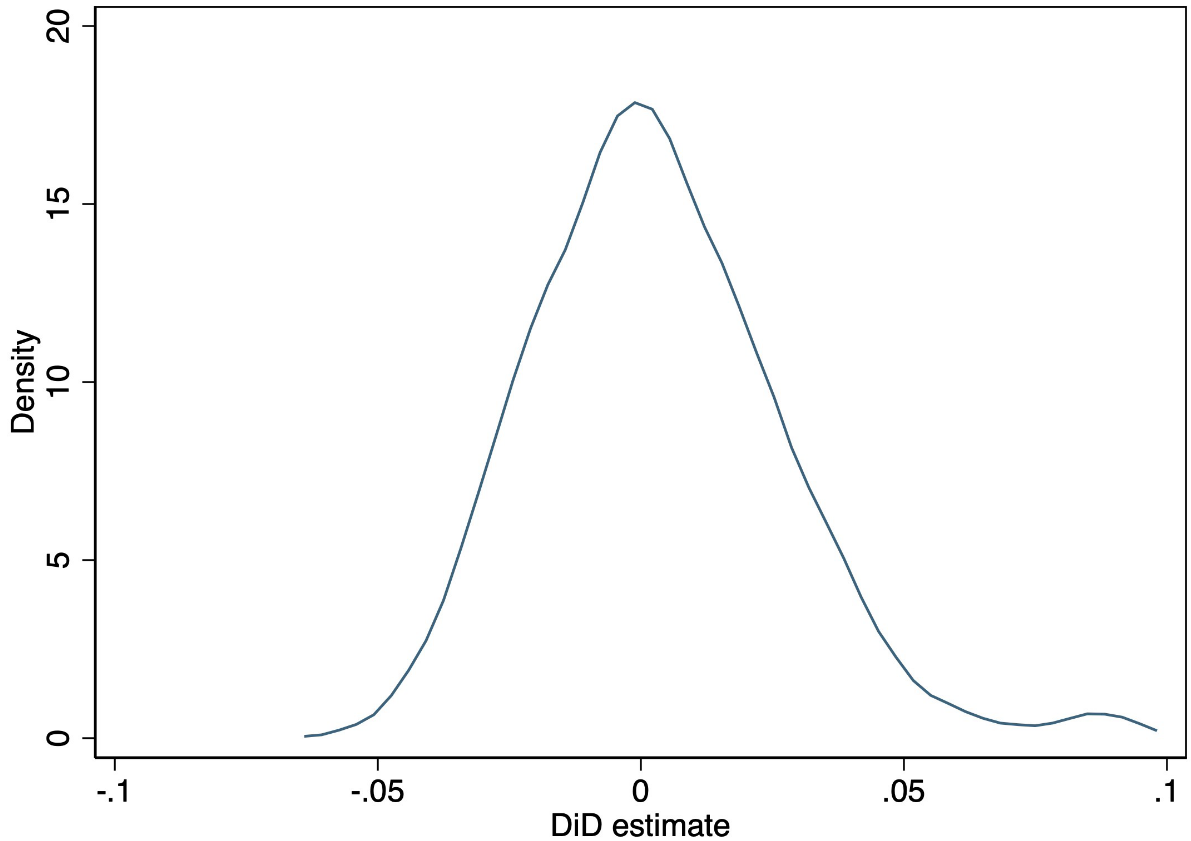
Additional Figures

Figure B.1. Sample of 2016 Ballot



Source: ONPE (2016b).

Figure B.2. Distribution of Estimated Coefficients from Random Treatments



Notes: Figure is the plot of the kernel density distribution of the difference-in-differences estimates using 1,000 random treatment groups. For each group, we randomly assign treatment status to 19 out of 30 districts and then re-estimate the model from Table 2, column 1.