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Electronic voting and Social Spending: The impact of enfranchisement on municipal public spending in Brazil

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Abstract

This article studies the effect of voting enfranchisement focused on the poor in Brazil and its consequences on municipal level social public spending. According to the model constructed in this work, it should be expected an increase in social spending. This prediction is empirically tested using electronic voting (EV) as instrument since it has impacted positively voting enfranchisement, biased toward the poor voter, without having a direct effect on public spending. A 2SLS regression and a differences-in-differences methodology are both applied to show that municipalities that used EV spent more on health, education and public employment compared to the ones that didn't confirming the hypothesis presented in our model.

Key words: Electronic voting; political participation; politically motivated intergovernmental transfers; social public spending.

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1- Introduction

Brazilian redemocratization in the 1990s has significantly increased its government role as a public goods' provider. Part of this phenomenon can be explained by voter enfranchisement biased towards the poor and less educated. The introduction of the electronic voting (EV) system has helped illiterates (or functional illiterates) to cast their votes without affecting educated citizens for which reading the instructions and filling a ballot was a trivial task. Therefore, even though the turnout remained closely the same, the income of the median voter that can actually cast a vote has decreased due to EV, making redistributive policies more likely to be supported.

The discussion about voters' demands has an earlier tradition. Alexis de Tocqueville in his seminal book "Democracy in America" argued that allowing those who do not own property to vote, would increase the proportion of voters who are in favor of income redistribution. Theoretical models have also predicted that an increase in voting participation of poorer voters is positively related to an increase in social spending (Meltzer & Richards (1981), Bugarin & Portugal (2015)). Meltzer & Richards (1983) attempt to confirm empirically their own model prediction. However, by using the income of the median income earner as a proxy for the income of the median voter, they did not take into account that voter turnout is low for the poor. One would make the same mistake in the Brazilian case before the EV introduction because the income of the median voter was smaller than the income of the median voter who could correctly cast a vote.

There are other empirical works confirming Meltzer & Richards (1981) prediction (Lindert (2004), Mueller and Stratmann (2003), Oliveira (2005)). Nonetheless, it has remained a challenge to find an identification strategy to solve the reverse causality problem of regressing directly government spending on voting participation. The more the government spends, the

more likely poor people will participate in the elections to keep the status quo. The present work solves the reverse causality problem and answer the question of how does an increase in political participation or voters' enfranchisement affects government spending.

Although an increase in voting participation in Brazil was expected right after the redemocratization,¹ this was not observed. The high turnout before EV was not reflected in a large number of votes being cast, especially for Representatives that didn't have their names printed in the ballot. The proportional representation system imposes each one of the 27 Brazilian states to act as a multi-member district holding at least 8 and at most 70 seats in congress (lower chamber). As a consequence, the pool of Federal Representatives' candidates to be chosen by a voter is large (this is also the case for State Representatives) making it impractical to print all their names in a ballot so the voter, before EV, had to actually write in a specific blank space on the ballot their candidate's name or respective number in order to cast a valid vote for him (or her). That way, knowing how to read and clearly write was essential to cast a vote. As pointed by Hidalgo (2010), for a country with an electorate's illiteracy rate close to a third, this wasn't a trivial task.

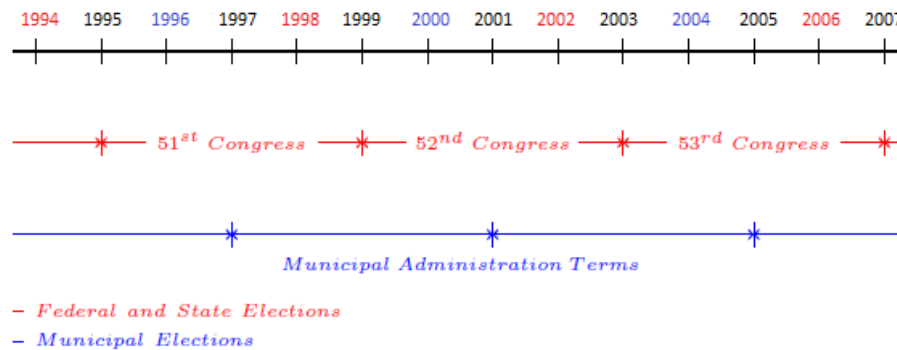
The consolidation of Brazilian democracy, therefore, came with the introduction of electronic voting (EV), which has allowed voters, mainly the poor, to exercise their right to vote (Schneider 2015). The EV was introduced in Brazil in order to make voting easier to all citizens and consequently increase the power of the Brazilian democracy. For instance, in the 1994 elections, before EV, the valid vote to turnout ratio for Federal Representatives was only 58%.

¹ The new constitution of 1988 has granted to all eligible voters the right of a direct, secret, universal and periodic vote. Also, in Brazil voting is mandatory which can help to explain its high turnout of 80% on average.

While in 2002, when EV was already being used in all polling stations in the country this number increased to 92% according to the Supreme Electoral Court, TSE.

In Brazil, there are elections every other year as Figure 1 shows. For instance, in 1994, the federal elections elected the Federal and State Representatives; senators; governors and president. Two years later, the municipal elections elected the municipal representatives and mayors.² EV was first implemented in the 1996 municipal level elections. All municipalities with more than 200,000 eligible voters and the states' capitals used the new technology³. In the 1998 federal elections all Brazilian municipalities with more than 40,500 eligible voters⁴ used the electronic voting system. Finally, in the municipal elections of 2000 and all the following ones every Brazilian voter was able to electronically vote.

Figure 1: Timeline



The main purpose of this work is to associate enfranchisement through EV usage in the 1998 elections, where EV became a feature across Brazil,⁵ to municipal level public spending.

² Both municipal and federal elections grant a four years term to the ones elected (except senator that get an 8 year term). Also, a two years distance separates these two elections.

³ Only 57 municipalities used EV in 1996.

⁴ Four states used the electronic voting for all their municipalities independent of the number of eligible voters and therefore are not part of most data analysis (Rio de Janeiro, Amapá, Alagoas and Roraima).

⁵ In the 1996 municipal elections only a few municipalities were capacitated to use EV.

Therefore, EV is used as an instrument to show how change in enfranchisement (or number of correctly cast votes) affects social spending at the municipal level. The connection between the federal and municipal election is established taking into account how mayors respond to the federal elections in the middle of their terms in office: In order to get reelected,⁶ the mayor which municipality used EV in 1998, is going to respond to the poor voter enfranchisement by increasing public spending.⁷ At the same time, Representatives elected in 1998 will be willing to help mayors from municipalities that used EV through intergovernmental transfers, mostly used in social spending, in exchange for support in the next federal elections as these mayors can now deliver more votes to them. As argued by Novaes (2015), in multi-member districts (Brazilian case), mayors are important brokers for Representatives.

This result should be expected due to the intuition provided by our model, similar to the one constructed by Bugarin & Portugal (2015), which concludes that the optimum amount of public provision is biased toward the preferred policy of the socioeconomic class with higher turnout. The difference is that in our model all voters are necessarily going to show up to vote, since voting is mandatory in Brazil. However, they may not correctly cast their votes. Interestingly, since the EV is not only going to enfranchise voters but it is also going to bias this enfranchisement disproportionately towards the poor, as showed in previous econometric works (Fujiwara, 2015; and Schneider, 2015), the model is going to predict that the provision of public goods should therefore increase because the poor are the ones more likely to demand public goods and at the same time, to be *de facto* enfranchised.

⁶ All mayors were able to try reelection in 2000 since the law granting mayor the possibility for reelection started being effective in 1997, one year after the mayoral election of 1996.

⁷ Since the Federal elections took place in 1998, the mayor was able to respond to it for two years before trying reelection in the municipal elections of 2000.

Besides presenting a model to motivate the empirical analysis, this work is going to rely on two econometric methodologies. Assuming the 1998 municipalities' assignment for EV usage as good as random, this work first estimates a two stage least square regression (using as dependent variable the logarithm of the social public spending) in order to measure the enfranchisement impact on government spending at the municipal level during the last two years of mayoral four years' term (1999 and 2000). EV assignment is used as instrument as it affects valid votes to turnout ratio for representatives without directly affecting social spending. To guarantee that EV usage is the only difference between the compared municipalities, the analysis will be restrained to places where the number of eligible voters is close to 40,500. Municipalities near this cutoff have similar characteristics and vote preferences and any differences between them are given by EV usage only. As municipalities that used EV had an increase on valid votes to turnout ratio close to 20 p.p. and 15 p.p. respectively for federal and state representatives (Fujiwara 2015, Hidalgo, 2010, Schneider, 2015), it should be expected a disproportionately higher amount of public provision in these places.

Secondly, in order to collect a larger sample, as most municipalities (92.3%) had less than 40,500 voters in 1998, a difference-in-differences analysis, taking into account these places, is going to be constructed. To use this methodology, four states that had EV in all their territories are going to be used as the treatment group and the remaining ones will be the control. Our focus will be only on municipalities with less than 40,500 voters in order to avoid heterogeneity between the two groups. The EV's impact on government spending will be found by comparing the differences between the amount of public expenditure on the treatment and control group before the EV usage (last two years of the mayoral term that ended in 1996) and after it (last two

years of the mayoral term that ended in 2000). It should be expected a much larger and significant public spending increase on the municipalities that used EV in 1998.

Besides the introduction, this work is divided as follows: Section 2 presents a literature review on the connection between voting participation and public spending and discusses the EV implementation. Section 3 presents a model to motivate the empirical analysis. Section 4 briefly discusses the data collection. Section 5 presents the 2SLS model and Section 6 the differences-in-differences. Finally, section 7 concludes the work.

2- Background

2.1. Voters' enfranchisement and public spending

Meltzer & Richard (1981) show that voting enfranchisement increases public spending. Using a model of electoral competition, they argue that the median income voter is the one imposing his (or her) preferences on public spending. Moreover, the electoral equilibrium shows that: the poorer the median income voter is, the larger will be his (or her) public spending optimum provision demanded. This result comes from the fact that, the poorer the citizen is, the lower will be his (or her) tax contribution to finance the public provision. Lindert (2004) developed an econometric study using decennial data from OECD countries between 1880 and 1930 to confirm the positive relationship between government size and vote participation. In Latin America, Brown & Hunter (1999) study the relationship between democracy and public social spending using panel data for 17 countries between 1980 and 1992. The authors' conclude that, especially in poor and economic instable countries, democracy increases the allocation of public spending on social programs when compared to dictatorship regimes.

For the United States, Husted & Kenny (1997) make a panel data analysis for 46 American states between 1950 and 1988. During this period, restrictions to vote focused mainly on the poor, such as poll taxes payments and literacy tests, were banned in the country increasing voting participation and, at the same time, decreasing the income of the median voter. Therefore, it should come as no surprise the result found on their study showing that a reduction of 0.2 on the median voter income to the total population income ratio caused an increase of 5 to 12% on public social spending.

Besides the empirical evidence mentioned above, Meltzer & Richard (1981) argument is not consensual. Alesina & Giuliano (2009), for instance, argue that the empirical studies are limited and other aspects such as median voter's social mobility perspective and strength of lobbying groups could reinforce the limits imposed on government intervention in the economy. A possible way to explain the difficulty to find empirical evidence on the relationship between the median's voter income and public spending is given by the fact that the median income of the citizen may not be the same as the median income of those who actually showed up to vote. That is, even if the democracy allows all eligible voters to cast their votes, those who don't vote have their preferences completely ignored. As Mueller & Stratmann (2003) show, there is a positive relationship between turnout and public spending.

Therefore, democracy by itself is not enough to guarantee larger public spending. According to UNDP (2005), between 1990 and 2002, less than 55% of all eligible voters living in a democracy showed up to vote and cast a vote to a candidate (or party). More importantly, those abstaining to vote are more likely to represent the poor (and illiterates). Frey (1971) shows a positive relationship between income and electoral participation in the United States. Greene & Nikolaev (1999) using electoral polls between 1972 and 1993 concluded that electoral

participation monotonically increases with income. Borgonovi et al. (2010) show a positive relationship between education and electoral participation in 15 European countries. In Brazil, Elkins (2000) finds a positive relationship between political concern and education.

Consequently, a lower political participation concentrated on the poor makes the median voter income to be larger than the median citizen income reducing the preferences for public goods given by the electoral equilibrium as argued by Bugarin & Portugal (2015). A solution pointed by these authors is to use mandatory voting.⁸ Jackman (2001) uses the Australia elections to show how mandatory voting increase voting participation (the turnout has increased from 65% to 95% after mandatory voting was imposed in this country). However, mandatory voting by itself cannot guarantee voting participation. As aforementioned, Brazil's case is illustrative. Although the constitution makes it mandatory for all citizens between 18 and 70 years old to vote,⁹ in 1994 for instance, less than 60% of those who showed up to vote (turnout close to 80%) could actually cast a valid vote for a candidate or party to the legislative seats.

2.2 Electronic voting and political participation in Brazil

Electronic voting (EV) was introduced in Brazil in 1996 (municipal elections). All capital cities and municipalities with more than 200,000 voters used EV (total of 57 municipalities). In 1998 (federal elections), not only all municipalities with more than 40,500 voters have used EV, but also all municipalities of Alagoas, Amapá, Roraima and Rio de Janeiro state (in total, 515 municipalities used). As showed in the literature (Hidalgo, 2010; Moraes, 2012; Fujiwara, 2015; and, Schneider, 2015), EV usage is responsible for an increase of 20 p.p. in the valid votes (correctly cast votes) to turnout ratio for federal and state representatives. As mentioned before,

⁸ According to The Economist (2015), 38 countries use or has used mandatory voting in their elections.

⁹ All Brazilian citizens, age 16 and older have the right to vote.

to cast a vote for representative before EV, one should clearly write the name or number of the candidate. It could also be possible to write the name or number of the party, had the voter decided to vote directly to the party instead of one of its representatives. Therefore, knowing how to read in order to understand how to cast a vote and where one should specifically write the name of the candidate in the ballot would be essential to correctly vote in Brazil.

When the new system was introduced, the voter would only need to press the candidate's number on a numerical keyboard (similar to a regular phone keypad commonly used in Brazil according to Hidalgo (2010)) and after verifying the picture of the candidate one was willing to vote for, it would be necessary to press a green button in order to cast the vote.¹⁰ The only way one could not cast a vote, without being on purpose,¹¹ would be to type a candidate's number with no correspondence to any candidate and after reading in the screen "this number is wrong", the voter would have to press the green button anyway. As Hidalgo (2010) points out, the EV was considered a democratic progress since even the illiterates could press a number followed by the green button after seeing their preferred candidates' face on the screen.

The main four works on EV in Brazil are Hidalgo (2010), Moraes (2012), Fujiwara (2015) and Schneider (2015). All these works converge to the fact that EV has increased political participation.¹² The last three works also show, although in different ways, that EV had a larger impact on enfranchisement in municipalities with a larger rate of illiteracy.¹³ Hidalgo (2010), focusing on federal representatives elections, shows that the party ideological choice (from left to

¹⁰ Fujiwara (2015) shows illustrations of the old ballot comparing it to the electronic one. It's also important to notice that the government had made TV advertisement teaching how to vote in the new system and trained people to help voters if something went wrong during the voting process in the Election Day.

¹¹ The voter could not cast a vote on purpose by pressing a white button (blank vote) followed by the green one to confirm it.

¹² By increasing the valid votes to turnout ratio close to 22%.

¹³ Schneider (2015) also shows that EV had a larger impact on enfranchisement in municipalities with lower GDP per capita.

right) suffered only a small effect due to EV that benefitted the right wing parties the most. This counter intuitive result is challenged by Schneider (2015) that taking into account regional clientelistic relationship in Brazil, demonstrated that the left wing parties were actually the ones disproportionately benefitted by the EV introduction.¹⁴ Moraes (2012) studies the increase in electoral competition resulted by the EV usage and Fujiwara (2015) focuses on the public health spending at the state level in Brazil showing that the larger the percentage of voters using EV within a state, the larger the amount of health spending and consequently the better the health outcomes in these places. Differently from Fujiwara (2015), our work relies on municipal level data¹⁵ and shows that not only health, but also public employment, education and the overall municipalities' public expenditures increase due to EV usage. Also, this work shows that the municipal revenue, mostly composed by federal and state transfers, of places that used EV in 1998 disproportionately increased explaining how these municipalities were able to spend more on public goods. Therefore, this work uses a larger sample and also explains the connection between federal representatives and mayors. Finally, it also adds to the literature by testing empirically the predictions of the model presented in the following section.

3 – The effect of electronic vote on the electoral outcome: A political economy model

3.1 Introduction

Section 3 builds a voting model aimed at better understanding the effect of EV on the electoral equilibrium. The model distinguishes to different stages of voters' decision; first, a voter decides whether or not to vote. Next, if the voter decides to vote, then she will decide to which party to vote for.

¹⁴ The different results can be also explained by the usage of differences-in-differences and regression discontinuity design methodology by Schneider (2015) while Hidalgo (2010) uses only the former.

¹⁵ Fujiwara (2015) analyses state level data (27 observations).

A voter's decision to vote is one of the most discussed issues both in Political Sciences and in Economics as well. Indeed, considering that there is a cost associated to voting, a rational agent will choose to vote only if she believes it is reasonably likely that her vote will change the electoral outcome. Chamberlain & Rothschild (1981) prove that under rather general conditions, the probability that a voter will cast the decisive vote in an election between two alternatives (parties) in which there are $2N+1$ voters is of order N^{-1} . Therefore, in large elections the probability of a voter being pivotal is negligible.¹⁶ But then, electoral participation should be reduced, as also suggested in Downs (1957, p. 260-276).

However, actual electoral data show a much higher level of electoral participation, even in countries where voting is not mandatory. For instance, the 2012 US presidential elections showed a record low participation level of 57.4%, which is much higher than social choice theories would predict.

Both experimental and theoretic studies aim at understanding why people vote. Blais & Young (1999) conclude that a feeling of civic duty is a strong factor that makes people vote, based on an experiment conducted by the Canadian Electoral Commission. Schram & Winden (1991) present a theoretic model that also assumes the civic duty motive but adds the issue of group identification and the fact that the larger the number of votes a group obtains, the more it is able to affect public policy as well; it concludes that members of a group will pressure the other members to vote. This second theoretic motive for voting is supported by Schram & Sonnemans (1996)'s experimental study. Edlin, Gelman & Kaplan (2007) present a model in which a citizen's utility has a social component, i.e., she cares about the other citizens' welfare;

¹⁶ According to John Longredan, "[...]the chances of actually influencing an election are about the same as getting hit by lightning" (in Carey, 2008).

the model shows that there will be higher voting participation than when a citizen has the typical selfish utility. Harder & Kronick (2008) stresses that the social environment and the difficulties a citizen faces to vote (due to lack of literacy, for example) affect the willingness to vote. Finally, Feddersen & Sandroni (2006)'s model assumes that citizens care about the aggregate social cost of voting and introduces the concept of “ethical rules” that determine which citizens will vote in equilibrium; that model endogenizes a concept similar to the exogenous concept of civic duty as part of the equilibrium solution.

In the present paper we use the concept of “willingness to vote” as a proxy for all the motives for voting described above. In our model each citizen i has a willingness to vote $v_i \in V \subset \mathbb{R}_+$. The willingness $v_i \geq 0$ represents the utility gain agent i receives when he votes, regardless of the final result of the election. Note that, since the citizen understands that his vote is insignificant, his decision on whether or not to vote depends on the comparison between the cost of voting and his willingness to vote. If the cost is lower than the willingness to vote, the agent will then decide to participate and will vote sincerely, for the party that better represents his preferences.

Hence, our electoral analysis will be divided in two steps. In the first step, each citizen decides whether or not to vote, based on her cost to vote and on her willingness to vote. In the second step, those who decided to vote take their ballots.

3.2. First step: The decision to vote

Primitives of the model

There is a continuum of agents of mass 1, $W = [0,1]$. Each agent $i \in W$ has a type $v_i \in V \subset \mathbb{R}_+$, his willingness to vote. In particular, if $v_i = 0$, then agent i sees no value in voting. The

willingness to vote v_i is a continuous random variable distributed in a non-negative set V according to the distribution $F(v_i)$.

If he decides to vote, citizen i will incur a cost $\kappa_i \in \mathbb{R}_+$. The cost reflects a number of components. Directly, it reflects the displacement costs, the opportunity cost of time, etc. Most importantly, it reflects the cost of gathering the information he needs in order to decide who to vote for, as well as preparing for filling properly the complex voting cell. That is the component that will matter in the present model, since that component may change according to the voting technology, as discussed previously.

General electoral participation

An agent of type v_i and cost κ_i will decide to vote if and only if:

$$v_i - \kappa_i \geq 0. \quad (1)$$

Let $E = \{i \in W \mid v_i - \kappa_i \geq 0\}$ be the set of voting citizens. Then the cardinality of E , $|E|$, corresponds to the proportion of voting citizens. Note that the higher the expected value of the willingness to vote, the higher the overall electoral participation, *ceteris paribus*. More importantly for the present study, the lower the voting costs, the higher the proportion of voting citizens, *ceteris paribus*.

An illustration of the voting costs associated to legal requirements can be found in Brazilian institutions. Before the 1988 Brazilian Constitution voters were required to be literate in order to vote; therefore a poorer, illiterate citizen would have to first learn how to read and write in order to have access to voting. Similarly, before the 1960s several American States

required citizens to pass literacy tests in order to vote; that, in practice, reduced the vote of the colored citizens for whom these tests were typically difficult (Husted & Kenny, 1997).

These examples suggest that poorer citizens tend to have lower electoral participation. Indeed, several empirical studies suggest that this is indeed the case, as reviewed in Bugarin & Portugal (2015). In what follows we include such a friction in the original model.

Different electoral participation by social classes

Suppose now that society is divided in three income classes. The low-income class P is formed of poorer citizens with income y^P . The middle-income class M congregates the middle class with income y^M and the high-income class R is composed of richer citizens with income y^R , where $y^P < y^M < y^R$. A class $J = P, M, R$ has mass $\alpha^J \in [0,1]$ where $\alpha^P + \alpha^M + \alpha^R = 1$.

Suppose now that there is total orthogonality between income and willingness to vote, so that the willingness to vote is distributed in each class according to the same distribution function $F(v_i)$. Furthermore, suppose for simplicity that the all citizens sharing the same income class share the same voting cost, i.e., $\kappa_i = \kappa^J$ for every citizen i class $J, J = P, M, R$. Finally, as discussed before, suppose that the cost of voting is higher for the low-income class, i.e., $\kappa^P > \kappa^M, \kappa^R$.

Therefore, $F(\kappa^J)$ corresponds to the percentage of citizens from class $J = P, M, R$ that gives up voting. Hence, $\alpha'^J = [1 - F(\kappa^J)]\alpha^J$ is the percentage of citizens that belong to class J and vote, $\eta^J = F(\kappa^J)\alpha^J$ is the percentage of citizens that belong to class J and do not vote, and $\alpha^J = \alpha'^J + \eta^J$.

The effect of the electronic vote on each class' electoral participation

Our model allows us to investigate the effect of the electronic vote on the each income class. Suppose that class P , besides being the poorer class, is also the class with lowest literacy levels, so that, it is also the class with highest voting costs with the older voting technology, because it requires memorizing and writing down the candidates' names, as discussed earlier. Then, the percentage of electoral participation will be lower in class P ($\kappa^P > \kappa^M, \kappa^R \rightarrow 1 - F(\kappa^P) < 1 - F(\kappa^M), 1 - F(\kappa^R)$).

What would be the effect of implementing EV? We expect that the EV will create the highest changes precisely in class P that has the highest rate of illiteracy. In that class, the easier voting technology will reduce voting costs, from κ^P to $\tilde{\kappa}^P < \kappa^P$. As for the other classes, that includes citizens better able to read and write and with higher education levels, the effect of EV will be less significant. Hence, for simplicity we assume that EV does not affect the voting costs for the other two classes. Therefore, EV will allow higher participation rates for the poor class without significantly changing the participation rates in the remaining classes.

3.3. Second step: Electoral equilibrium with heterogeneous participation

The basic ideas of the model

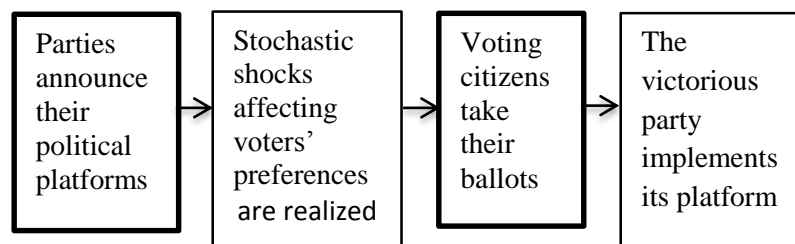
The electoral competition model presented here follows Bugarin & Portugal (2015). Two parties simultaneously announce political platforms. A platform consists of a provision of a public good that will be produced if the party wins the election. Production of the public good is totally funded by taxes to be collected from every citizen according to a single tax rate. Since society is composed of three income classes, all citizens from the same class will have the same preferences for public good provision. Furthermore, since all citizens benefit the same way from

public good consumption but the poorer ones pay fewer taxes for its production, typically the poorer classes prefer more public goods than the rich ones.

A number of citizens in each class do not vote. Those who vote will vote sincerely, for the party that better represents his preferences. Citizens' preferences take into consideration parties' platforms but are also influenced by unpredicted stochastic factors that are orthogonal to the announced platforms. Examples of such factors are sexual scandals or a terrorist attack, among others.

Elections are held in one national electoral district in which each voter has one vote. After the elections, each party is assigned a quantity of seats in the Legislature that corresponds to the percentage of votes it received. After the new Legislature is formed, the party that has a majority of seats (we assume an odd number of seats) implements its campaign platform: taxes are collected and the public good is provided. Figure 1 presents the general form of the game. Note that only the first and the third boxes correspond to agents' decisions. Furthermore, decisions in the third box are straightforward since voting citizens vote sincerely. The details of the electoral competition game and its solution are presented next.

Figure 2 - The electoral competition game



Society is composed of three income classes, as previously described. Two parties $P=A, B$ announce simultaneously a per capita level of provision of a public good, $g_J, J = A, B$, to be implemented by the winning party. Public good production is financed by an income tax collected according to the tax rate τ , common to all agents. All tax-collected resources are used for the public good's provision. Then the government budget constraint is given by the equation below, where $\sum_J(\eta^J + \alpha'^J) y^J = \sum_J \alpha^J y^J = y$ represents the average income of all citizens.

$$\tau \sum_J(\eta^J + \alpha'^J) y^J = \tau y = g \quad (2)$$

A voter's utility has two components: a pragmatic component and an ideological one. This is the most general way of characterizing an economic agent who also has political concerns; for more on this topic, see Ferejohn (1986), Bugarin (1999) and Bugarin (2003). The pragmatic or *economic* part of the utility represents the voter's decisions as a *homo oeconomicus* and depends on the consumption of a private good, as well as the consumption of the public good. Thus, if a citizen of class J has private consumption c^J and public good consumption g , its utility is $c^J + H(g)$ where H is a twice differentiable, strictly increasing, and strictly concave function. In the present model public good provision and the corresponding income tax rate are the result of the electoral process; therefore, the *homo oeconomicus* will choose the highest possible private consumption, i.e., $c^J = (1 - \tau)y^J$, and the resulting pragmatic component of his utility is:

$$(1 - \tau)y^J + H(g). \quad (3)$$

¹⁷ This section and the following section as well draw heavily on Bugarin & Portugal (2015).

Hence, we can write that agent's pragmatic utility as $W^J(g) = (y - g)\frac{y^J}{y} + H(g)$.

Therefore, his preferred public policy is:

$$g^{*J} = (H')^{-1}\left(\frac{y^J}{y}\right), J = P, M, R. \quad (4)$$

Note that $g^{*P} > g^{*M} > g^{*R}$, i.e., the poorer a citizen is, the more favorable he is to public expenditure, as discussed before. This result is well known in the literature and has been carefully formalized in Meltzer & Richard (1981). It explains the increase in the size of governments throughout the 19th and 20th centuries as a consequence of the expansion of suffrage in the consolidating western democracies.

The ideological component of a voter's utility function reflects his concerns as a *homo politicus* and depends on two random variables corresponding to the voter's bias towards party B , or equivalently, party B 's popularity at the time the election is held¹⁸. The first random variable is common to all voters and relates to the realization of a state of nature that affects the entire population. A war, an abrupt change in international oil prices and a countrywide energy crisis are examples of such phenomena. A clear example is the popularity of the U.S. president after the terrorist attack on September 11th, 2001, which increased from 57% in February to 90% in September.¹⁹ We model that process with a random variable δ uniformly distributed on $\left[-\frac{1}{2\psi}, \frac{1}{2\psi}\right]$. The parameter $\psi > 0$ measures the level of sensibility of society to these shocks: the lower the value of ψ , the more those shocks may affect society. To illustrate, price changes in oil may strongly affect the political equilibrium in a country that depends strongly on that product,

¹⁸ Analogous results would obtain if we had set the bias with respect to party A due to the symmetry of the bias.

¹⁹ See "Poll Analyses", Section "Gallup Poll News Service", The Gallup Organization, <http://www.gallup.com>, 09/24/2001.

such as Venezuela, and have much less effect in countries that produce near their internal demand levels, such as Brazil.

The second random variable is particular to each voter i in group J and reflects his personal bias towards party B . It relates to information about relevant politicians on issues that are not consensual in society, such as release of information that a candidate used drugs in his youth; some voters may believe that this fact makes him unsuitable to a political leadership career, others may find no relation whatsoever with his political career, others may even sympathize with the candidate. We model that bias as a random variable σ^{iJ} uniformly distributed on $\left[-\frac{1}{2\phi}, \frac{1}{2\phi}\right]$. Hence, the greater the parameter ϕ , the more homogeneous class J is.

Therefore, if party B wins a majority of seats in the Legislature with platform g^B , voter i in the social class J derives utility:

$$W^J(g^B) + \sigma^{iJ} + \delta. \quad (5)$$

Note that it may be the case that the realization of δ is positive whereas the realized value of σ^{iJ} is negative. Suppose, for example, that the GDP of country increases above expectations, which brings about overall support for the incumbent president's party, but the media releases the news of a sexual scandal in the presidential office, which may affect different voters in different ways.

The solution to the electoral competition game

We solve the game by backwards induction. Suppose party P announces policy g^P , $P = A, B$. Then, voter i in class J prefers party A to party B if and only if:

$$W^J(g^A) > W^J(g^B) + \sigma^{iJ} + \delta. \quad (6)$$

Then, the voter that is exactly indifferent between the two parties in class J corresponds to the realization σ^J of the random variable σ^{iJ} given by the following equation $\sigma^J = W^J(g^A) - W^J(g^B) - \delta$.

Since citizens vote sincerely, the number of votes party A receives is:

$$\pi^A = \sum_J \alpha'^J \cdot \text{Prob} [\sigma^{iJ} \leq \sigma^J] = \sum_J \alpha'^J \left[\sigma^J + \frac{1}{2\phi} \right] \phi = \sum_J \alpha'^J \sigma^J \phi + \frac{\alpha'}{2}. \quad (7)$$

Define $W'(g^A) = \sum_J \alpha'^J W^J(g^A)$ and $W'(g^B) = \sum_J \alpha'^J W^J(g^B)$. Then the probability of victory of party A is:

$$p^A = \text{Prob} \left[\pi^A \geq \frac{\alpha'}{2} \right] = \text{Prob} \left[\delta \leq \frac{1}{\alpha'} [W'(g^A) - W'(g^B)] \right]. \quad (8)$$

The above expression can be rewritten as:

$$p^A = \frac{1}{2} + \frac{\psi}{\alpha'} [W'(g^A) - W'(g^B)]. \quad (9)$$

By symmetry, the probability of victory of party B is:

$$p^B = \frac{1}{2} - \frac{\psi}{\alpha'} [W'(g^A) - W'(g^B)]. \quad (10)$$

Parties choose their announced platforms in order to maximize their probability of winning the election given by (9) and (10). Therefore, party A solves the following problem:

$$\max_{g^A} p^A(g^A, g^B) = \frac{1}{2} + \frac{\psi}{\alpha'} [W'(g^A) - W'(g^B)] \quad (11)$$

Subject to: $0 \leq g^A \leq y$.

Moreover, party B solves a completely similar problem. The solution to this platform announcement simultaneous game yields the same dominant strategy to both parties, given below, where $y' = \frac{\sum_J \alpha'^J y^J}{\sum_J \alpha'^J} = \frac{\sum_J \alpha'^J y^J}{\alpha'}$.

$$g^A = g^B = g^E = (H')^{-1} \left(\frac{y'}{y} \right) \quad (12)$$

Note that income $y' = \frac{\sum_J \alpha'^J y^J}{\sum_J \alpha'^J} = \frac{\sum_J \alpha'^J y^J}{\alpha'}$ is a convex combination of each income class' income, in which the weights are the percentage of citizens in each class that really vote. Therefore, the higher the political participation in one class, the higher the weight parties give to that class' income and, thereby, the closer the equilibrium policy will be to that class' preferred policy.

For the sake of illustration, suppose that $\alpha'^P = \alpha'^M = 0$ and $\alpha'^R > 0$, i.e., only the rich citizens vote. Then, $\alpha' = \alpha'^R$, $y' = y^R$ and $g^E = (H')^{-1} \left(\frac{y^R}{y} \right) = g^{*R}$, so that the platform announced by each party is precisely the one preferred by the rich citizens. This explains again why there was so little redistribution in the past when voting rights were restricted to land owners.

3.4. The effect of electronic voting on the electoral equilibrium

Consider first the electoral equilibrium prior to EV. Recall that $\alpha'^J = [1 - F(\kappa^J)]\alpha^J$, $J = P, M, R$ and $\kappa^P > \kappa^M, \kappa^R$. Then we can write (with the subscript b for “before”) as:

$$y'_b = \frac{\sum_J \alpha'^J y^J}{\alpha'} = \frac{\sum_J [1 - F(\kappa^J)] \alpha^J y^J}{\alpha'} > \sum_J \alpha^J y^J = y. \quad (13)$$

Since $\alpha'^P < \alpha'^M, \alpha'^R$, then it follows that $g_a^E = (H')^{-1}\left(\frac{y'_a}{y}\right) < (H')^{-1}(1)$, i.e., public goods provision before EV is below what it would be if all citizens were voting. This is a direct consequence of the fact that precisely the poor citizens, those who prefer more public goods provision, are the ones who present lowest electoral participation.

Consider now the situation posterior to the introduction of EV. According to our model's hypotheses, κ^M and κ^R remain unchanged, whereas the cost parameter κ^P decreases to $\tilde{\kappa}^P < \kappa^P$. Then, using the subscript a for “after”, we can write:

$$y'_a = \frac{[1-F(\tilde{\kappa}^P)]\alpha^P y^P + [1-F(\kappa^M)]\alpha^M y^M + [1-F(\kappa^R)]\alpha^R y^R}{[1-F(\tilde{\kappa}^P)]\alpha^P + [1-F(\kappa^M)]\alpha^M + [1-F(\kappa^R)]\alpha^R} < \frac{[1-F(\kappa^P)]\alpha^P y^P + [1-F(\kappa^M)]\alpha^M y^M + [1-F(\kappa^R)]\alpha^R y^R}{[1-F(\kappa^P)]\alpha^P + [1-F(\kappa^M)]\alpha^M + [1-F(\kappa^R)]\alpha^R} = y'_b \quad (14)$$

$$\text{But then: } g_a^E = (H')^{-1}\left(\frac{y'_a}{y}\right) > (H')^{-1}\left(\frac{y'_b}{y}\right) = g_b^E.$$

In other words, the new voting technology brings about a reduction in the cost of voting to the poor, which increases their participation and, thereby, increases the weight of their preferences in parties' calculations, thereby increasing the equilibrium provision of public goods.

This is the main conclusion of the present theoretic model. The main theoretic insight is that increasing *de jure* access to voting, by legally extending the suffrage to poorer citizens, is not enough to ensure that the political parties will take these citizens' preferences into account. It is necessary that, in addition to having the right to vote, these citizens really exert that right. Only in the case where poorer citizens do participate strongly in the political arena by voting, will public policy reflect their preferences.

The main point of the present work is that, due to the high cost of voting to poorer, illiterate citizens in Brazil, their preferences were not fully considered until EV technology strongly increased their participation, changing the electoral equilibrium.

The empirical implication of the model and its testable hypotheses are straightforward: if the model does rightfully reflect the real situation, then, we should have observed a significant increase in the provision of public goods in Brazil after the implementation of EV. More specifically, since poorer citizens care more about social policy (health, education, cash transfers, etc.) we should have observed a clear increase in public spending in these areas.

The following sections test these hypotheses confirming that there was indeed a robust increase in social expenditure in Brazil after the advent of EV and that this increase is particularly strong in municipalities with higher numbers of illiterate citizens.

4- Data

The dependent variables are constructed using the municipal level data on public spending available on the Brazilian National Treasury website.²⁰ The selected topics are health, education, public employment, intergovernmental transfers, revenue and expenses. The three first topics are selected to measure the response to enfranchisement on essential social spending areas. Intergovernmental transfers is selected because the Federal and State Representatives have connections with municipalities and disproportionately benefit the ones that are more likely to vote for them by sending these transfers (see Brollo and Nannicini, 2012 for a discussion on politically motivated transfers in Brazil). Also, as discussed in Novaes (2015), mayors act as brokers for Representatives campaigning for them in exchange for financial support. Therefore,

²⁰ All dependent variables are per capita values and deflated using the IGPM index (1994 is the base year).

Representatives would be interested in transferring money to the municipalities with more valid votes to turnout ratio (positively related to EV usage), since the mayor will be able to deliver a larger amount of votes in exchange for these transfers. Finally, total revenue and expenses shows the overall increase in social spending in response to enfranchisement.

As argued before, we are assuming that the mayor responds to the federal elections. To capture this, the average spending in the two years after the federal elections which are also the two years before the municipal ones, is considered. For instance, when the 1998 federal elections are considered, its impact is measured by the average of the municipal public spending between 1999 and 2000. Places that used EV in 1998, and that therefore have extra political participation biased toward the poor, are expected to spend more on public goods provision.

Finally, the independent variables are composed by a dummy to identify EV usage, percentage of votes obtained by the winner mayor in the 1996 municipal elections, a dummy showing if the mayor's party is the same as the current president or governor (for each respective state) coalitions, number of eligible voters (the last three mentioned variables are available at TSE), average household monthly income per capita, percentage of people living in rural areas, illiteracy rate and municipal ideology. The demographic data comes from Ipeadata.²¹ Municipality ideological index is composed by a number, ranging from 0 to 10 (where 0 is extreme left wing and 10 extreme right wing), that is based on the federal representatives elections, the construction of this index can be found at Schneider (2015) and is helpful to explain differences in municipal level spending.

5 - Two Stage Least Square Regression

²¹ The data available are based on the decennial data collected in 1991 and 2000. Therefore, 1991 and 2000 has become a proxy for 1994 and 1998 respectively.

5.1 Estimation Strategy

The natural regression to test the model presented above, would be the following one:

$$\ln Y_m = \alpha + \beta_1 V_m + \beta_2 X_m + \epsilon_m \quad (15)$$

Where $\ln Y_m$ represents the logarithm of the average social spending between 1999 and 2000 at municipality m , V_m the valid votes to turnout ratio for State Representatives in 1998, X_m contains the control variables and the variable ϵ_m contains the error term for each observation. However, two problems may arise. First, the social spending in 1999 and 2000 may be related to past social spending that increased V_m . For instance, suppose the spending in education between 1999 and 2000 is related to the spending in education in the past 10 years. If this is true, then previous spending on education benefit the poor by giving them access to schooling and also help them to be enfranchised as they could cast a vote. The estimated return to enfranchisement would then be biased due to this reverse causality bringing an overestimated β_1 . At the same time, omitted variables such as the measurement of the median voter income may also bias the results. Valid votes by itself may not show poor voter enfranchisement. It could be the case that the municipality has a large valid vote to turnout ratio because most citizens are rich and can therefore cast a vote. This could underestimate our results since large valid votes would show smaller preferences for redistribution.

To solve this problem we estimate the following 2SLS model:

$$V_m = \mu + \pi_1 D_m + \pi_2 X_m + u_m \quad (16)$$

$$\ln Y_m = \delta + \lambda V_m + \Lambda X_m + \epsilon_m \quad (17)$$

Where D_m is a dummy variable indicating whether municipality m used EV. The difference between equations (15) and (17) is that λ measures the impact of the estimated valid votes to turnout in equation (16). Therefore, the instrumented valid votes to turnout in equation (17) impacts social spending only through the enfranchisement brought by EV that is biased toward the poor voters. Since the number of eligible voters is by definition related to EV usage, there are no controls for number of voters. To compensate for this fact, the regressions will be restrained to a small interval close to the cutoff for EV usage (40,500 voters) so the municipalities can be comparable²². The results are presented next.

5.2 Results

Table 1 shows the estimations for a closed interval of municipalities containing between 35,500 and 45,500 voters.²³ An increase of 10 p.p. in the valid votes to turnout ratio increases health spending by 16.5%; public employment by 7.1%; total spending by 9.9%; total revenue by 9.5% and intergovernmental transfer by 14.5%.

Table 1 – 2SLS showing the relationship between the logarithm of social spending on health; education; public employment; total spending ; total revenue and intergovernmental transfers.

VARIABLES	Health	Education	Public Employment	Total Spending	Total Revenue	Intergovernmental Transfers
V_m	1.65701** (0.67242)	0.31883 (0.51915)	0.71356* (0.39163)	0.99146** (0.43733)	0.95113** (0.42643)	1.44933*** (0.37455)
Observations	116	116	115	116	116	116
R-squared	0.55664	0.57222	0.65195	0.61244	0.58296	0.49507

²² Note that municipalities belonging to the four states mentioned earlier (Rio de Janeiro, Amapá, Roraima and Alagoas), used EV even if they had less 40,500 voters.

²³ Increasing the interval to a bandwidth of 15,000 voters increases the significances of the results.

Robust standard errors clustered by Brazilian states are reported in parenthesis. All regressions control for average household monthly income per capita and use state fixed effects. All regressions use a bandwidth of 5,000 voters. The 1%, 5% and 10% level of significance are represented by ***, ** and * respectively.

Although the municipalities are likely to be similar, one can still argue that the results are being driven by the lack of control for population. The next section presents a robustness check to increase the confidence in the presented results.

5.3 Robustness Checks

The robustness check for this section comes from a falsification test that does a series of similar regressions as the ones mentioned above, but using the municipal social spending variables after the 1994 and 2002 elections as dependent variables. As presented in Table 2 (placebo 1994 and placebo 2002 consecutively), these two regressions show no significant effect on social spending due to the EV usage, with exception of two 10% significant result for public employment and intergovernmental transfer. This is expected given that there were no differences on voting systems adopted between the municipalities in the considered years (either no one used EV or every municipality used it).

Table 2 – 2SLS showing the relationship between the logarithm of social spending on health; education; public employment; total spending ; total revenue and intergovernmental transfers.

Placebo 1994

	Health	Education	Public Employment	Total Spending	Total Revenue	Intergovernmental Transfers
VARIABLES						
V_m	25.25326 (33.427)	18.24622 (22.5081)	9.37695 (13.01901)	13.29145 (15.82004)	14.15764 (16.50341)	18.87932 (26.40304)
Observations	116	117	116	116	116	115

Placebo 2002

	Health	Education	Public Employment	Total Spending	Total Revenue	Intergovernmental Transfers
VARIABLES						
V_m	12.31441 (10.37810)	9.93802 (8.54762)	14.84281* (8.46971)	11.89018 (7.99544)	10.02100 (7.58705)	14.09310* (7.78164)
Observations	117	117	117	117	117	117
R-squared	0.40804	0.27263	0.33548	0.40542	0.50687	0.21982

Robust standard errors clustered by Brazilian states are reported in parenthesis. Regressions for the Placebo 1994 control for average household monthly income per capita (for the year of 1991) and regressions for the Placebo 2002 control for the 2002 GDP per capita. All regressions use state fixed effects. All regressions use a bandwidth of 5,000 voters. The 1%, 5% and 10% level of significance are represented by ***, ** and * respectively.

The 2SLS presented above have empirically confirmed the prediction of the model presented in section 3. However, it has some limitations. First, it has a small sample. Second, although the difference between the number of eligible voters is small across municipalities close to the cutoff, the regressions do not control for it due to the high correlation between the number of eligible voters and the instrument, EV usage (correlation close to .70 for the 5,000 bandwidth considered). The differences-in-differences methodology is used next to check the robustness of the results by introducing a large sample analysis.

6 Differences-in-Differences

6.1 Estimation Strategy

An alternative way to test our hypothesis is to use the differences-in-difference (DID) methodology. As mentioned before, this method compares municipalities that used EV (the treatment group) to the ones that didn't (the control group). It then presents the differences in public spending between two periods, before and after the EV usage, within these two groups as

the following regression shows:

$$\log(y_{it}) = \beta_0 X_{it} + \beta_1 (Year * EV) + \beta_3 Year + \beta_4 EV_i + \epsilon_{it}, \quad (18)$$

where $Year_t$ is a dummy variable equal to 1 when $t = 1998$ and EV_i is a dummy variable equal to 1 for municipalities that have used EV. For this estimation we are going to restrict the EV usage to the four states that had electronic voting in all its territory. Therefore, we can have a sample that covers most Brazilian municipalities and that at the same time have on average the same number of voters than the control group has²⁴. The variable X_{it} includes all control variables that vary across time and municipalities (such as average income and number of eligible voters). The dependent variable y_{it} corresponds to the *per capita* social public spending (such as health and education) and ϵ_{it} represents the error term. The coefficient β_1 is the parameter of interest that captures the effect of EV on municipal public spending.

The following assumptions are made about the estimations. First, as the EV was implemented partly in the 1998 federal elections, we assume that the local administrations observe the change in the political participation for these elections and answer to it based on the median voter's choice. Second, we assume that non-observed variables that vary across time are orthogonal to the variable of interest.²⁵ Third, the selection of the four states which used EV in all its territory was not driven by political interests. As Fujiwara (2015) points out: "Two remote states largely covered by the Amazon forest (Amapá and Roraima) were chosen to check the electoral authority's ability to distribute EV in isolated areas, while the states of Rio de Janeiro and Alagoas had areas where the army provided security to election officials, allowing an

²⁴ If we consider all municipalities that have used EV in 1998, our treatment group will have municipalities where the number of eligible voters will vary from 947 to 7,131,342. On the other hand, the control group will have less than 40,500 eligible voters in all its municipalities.

²⁵ See Angrist & Krueger (1999) for a complete discussion on the DID methodology.

opportunity to check the logistics of distributing the electronic devices jointly with the military”. Therefore, there seems to be no political motivation behind the EV usage selection. Fourth, the control and treatment group do not present significant differences due to the EV usage on variables that are not likely to be affected by it. Table 3 presents a balance check to support the argument:

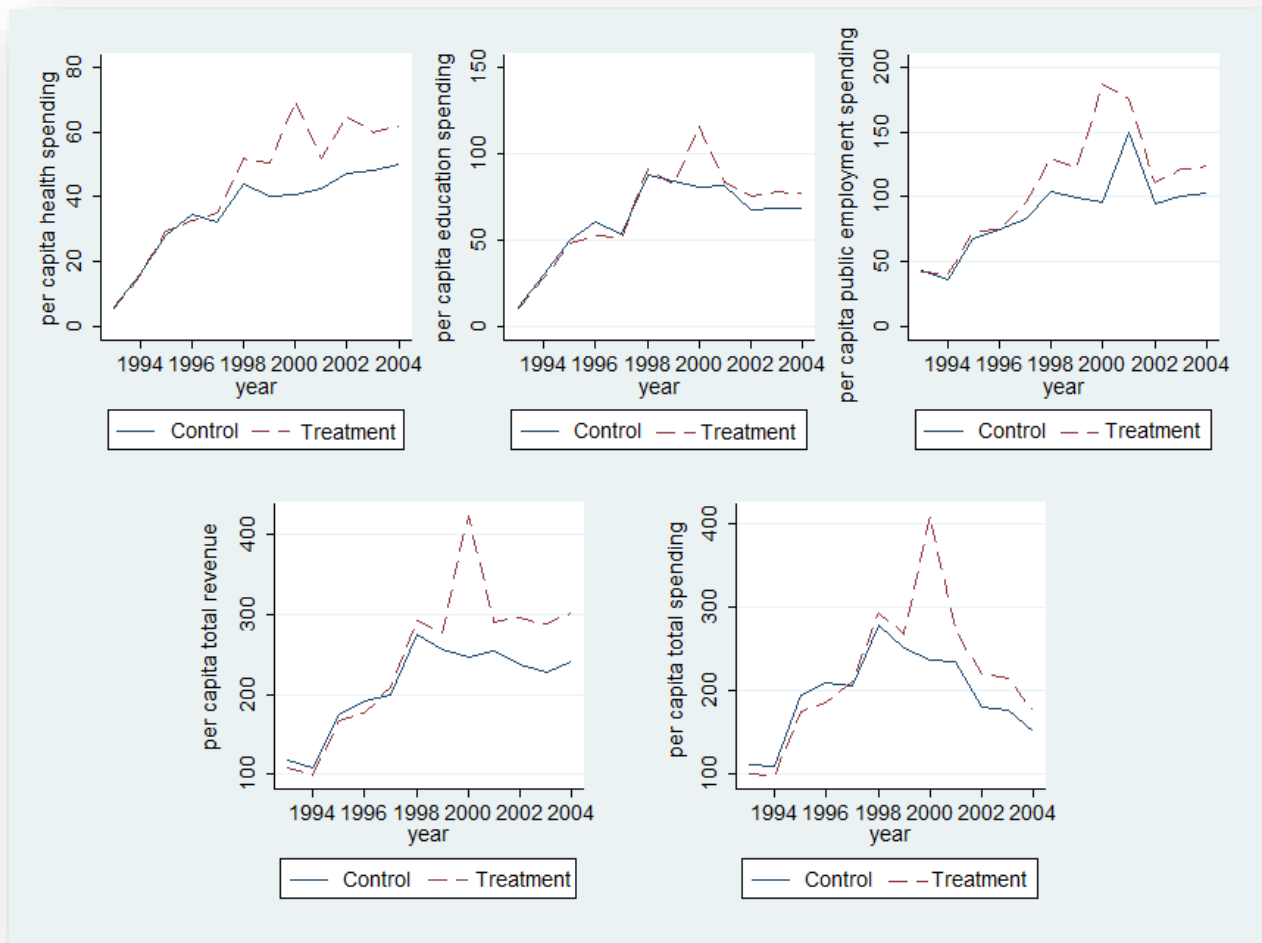
Table 3 – DID estimation showing that the treatment and control group have not changed across periods

VARIABLES	(1) Valid Votes Fed	(2) Valid Votes Est	(3) Rural	(4) Income	(5) Voters	(6) HDI	(7) Illiterates
EV*Year=1998	0.22732*** (0.02517)	0.14187*** (0.02008)	0.02590 (0.02467)	-14.80712 (11.91577)	571.14875 (369.40061)	0.00490 (0.00656)	-1.71777 (1.14854)
Observations	9,760	9,760	10,222	10,222	9,761	10,222	10,222
R-squared	0.48509	0.52506	0.25971	0.61827	0.09146	0.79253	0.75642

All regressions use state fixed effects. Standard errors, clustered by mesoregion, are presented in parenthesis. All regressions are controlled for a dummy identifying EV usage (collinear to the state fixed effects) and a dummy identifying the year of EV usage. Regression (1), (2), (3), (4), (5), (6) and (7) consider the valid votes to turnout ratio for federal representatives; state representatives; percentage of people in the municipality living on rural areas; average income; number of voters; human development index and percentage of illiterate adults. The sample considers municipalities with more than 1245 and less than 40500 voters. *** $p < 0,01$, ** $p < 0,05$, * $p < 0,1$

Table 3 shows that the EV usage is only affecting the valid votes to turnout ratio for federal and state representatives increasing it by 22 and 14 percentage points respectively. This should be expected based on the previously mentioned literature on EV in Brazil. Before testing whether the EV usage is affecting the municipal level of public spending, Figure 4 (below) motivates the DID methodology to be applied.

Figure 4 – Per capita average spending on health; education; public employment, total revenue and total spending (all values are deflated) between 1993 and 2004 comparing the municipalities that used EV in 1998 (treatment) and the ones that didn't (control).



The smallest 10% municipalities have been dropped to attenuate the per capita spending on the smallest municipalities. 4577 municipalities (82% of the total Brazilian municipalities) are covered in this representation.

As it can be observed, between 1999 and 2000 (year of the municipal election) there is a clear increase on public spending (for all variables considered) disproportionately larger on municipalities that used EV in 1998. It is interesting to notice that not only the electoral spending cycle on municipal elections exist (1996, 2000 and 2004), but also that in 1996 it was

disproportionately larger on municipalities that didn't use EV (public employment spending is the only exception) making it stronger the argument that the EV has changed the municipal social spending. In 2004, there is a clear pattern in public spending that is similar for both groups which can be explained by the leveling on political participation in all municipalities brought by the general usage of EV since 2000.

6.2 Results

The DID estimation results are presented in Table 4, Panel A. Columns (1), (2) and (3) show respectively, the results obtained for social spending on health, education and public employment. Columns (4) and (5) take into account, respectively, municipal total spending and revenue. Finally, Column (6) shows the intergovernmental transfers, both national and subnational (state), received by municipalities. EV usage, therefore, is responsible for an increase in the total spending on health, education and public employment respectively by approximately 28, 20 and 22 percent.²⁶ Total spending, revenue and intergovernmental transfers have also increased respectively by approximately 19, 17 and 17 percent.

The intergovernmental transfer variable helps to explain how municipalities can get more revenue in order to spend on social expenditures. As Brollo and Nannicini (2012) argue, these transfers are extremely relevant since it accounts, on average, for 65% of the municipal budget. However, parts of these transfers are constitutional automatic transfers such as the Fundo de Participação dos Municípios - FPM. Therefore, it could be the case that the municipalities that used EV in 1998 were disproportionately favored by the FPM, main source of revenue for small

²⁶ A 28% increase on health spending, for instance, would be equivalent to an increase of 33R\$ (or 16\$) per capita.

municipalities²⁷ and this could be driving our obtained results. The estimates presented in Table 4 control for the amount of money received by the FPM in each municipality which makes the coefficients to get even larger showing evidence that not taking this transfer into account was actually downward biasing the results.

Table 4 - Panel B shows the result for a similar exercise, however, instead of comparing the public spending after the 1994 and 1998 elections, this DID analysis takes into account the elections of 1998 and 2002 and how they do impact municipal social spending. For this counterfactual analysis one should expect the sign of the coefficient (β_1) to be negative since the municipalities that didn't use EV in 1998 are presumably going to catch up after using the new system. Nonetheless, as EV was used by all Brazilian municipalities in 2000, one cannot isolate its impact on public spending as clear as before. After all, one cannot argue that the 2002 elections have enfranchised voters through EV introduction. The result shows that public spending on health was the only variable to get a negative and significant sign. The remaining coefficients that presented significant results were positive, but their magnitudes are much smaller than before.

Table 4 - Estimating the relationship between the logarithm of the municipal spending on public goods (such as health and education) and the EV usage using the DID methodology.

VARIABLES	(1) Health	(2) Education	(3) Public employment	(4) Total spending	(5) Total revenue	(6) Intergovernmental transfers
Panel A: 1995-1996 vs. 1999-2000						
Year = 1998	0.19035*** (0.03103)	0.25594*** (0.02713)	0.22464*** (0.03272)	-0.01611 (0.02367)	0.08540*** (0.02297)	0.20155*** (0.02049)

²⁷ According to IBGE (the Brazilian institute of geography and statistics), municipalities with less than 5,000 citizens, between 1998 and 2000, got on average 57.3% of their revenue from FPM.

EV*Year=1998	0.28761*** (0.08616)	0.20005*** (0.04822)	0.22917** (0.10282)	0.19304*** (0.04435)	0.17864*** (0.04063)	0.17773*** (0.03274)
Observations	8,102	8,124	9,386	6,453	6,453	9,393
R-squared	0.38845	0.53090	0.61788	0.60570	0.63755	0.75195

Panel B: 1999-2000 vs. 2003-2004

Year = 2002	0.20743*** (0.01646)	-0.22121*** (0.02119)	0.03587*** (0.01221)	-0.43345*** (0.01127)	-0.10971*** (0.01208)	-0.00407 (0.00816)
EV*Year=2002	-0.10072** (0.04181)	0.07843* (0.04203)	-0.03454 (0.05620)	0.07165*** (0.02221)	0.07073*** (0.02673)	0.01715 (0.01575)
Observations	8,086	8,095	9,887	6,454	6,454	9,895
R-squared	0.40688	0.46495	0.59696	0.73215	0.67813	0.77356

All regressions use state fixed effects. Standard errors, clustered by mesoregion, are presented in parenthesis. All regressions are controlled for income, number of voters, FPM transfers and a dummy identifying EV usage (collinear to the state fixed effects). Regression (1), (2), (3), (4), (5), and (6) consider the logarithm of per capita municipal spending on health; education; public employment, total spending, total revenue and total intergovernmental current transfers. The sample considers municipalities with more than 1245 and less than 40500 voters. *** $p < 0,01$, ** $p < 0,05$, * $p < 0,1$

Panel A results are close to the one presented in section 5. An interesting exercise can be done by considering Table 3 estimations showing an increase of 14 p.p. in the valid votes to turnout ratio for State Representatives. Plugging this value on Table 1 gives the following result: An increase of 14 p.p. in the valid votes to turnout ratio increases health spending by 23.1%; public employment by 10%; total spending by 13.9%; total revenue by 13.3% and intergovernmental transfer by 20.3%. This exercise brings confidence in the results presented in section 5 and also provides external validity to those estimations.

6.3 Robustness Check

The next analysis shows how intergovernmental transfers are politically motivated. This is important to understand how municipalities that used EV can afford to spend more on social policies. After all, even if the mayor had decided to increase social public spending he (or she) would need to get more revenue. If the intergovernmental transfers in Brazil are politically motivated, as argued by Brollo and Nannicini (2012), then places that have used EV should have access to larger transfers. As argued before, the mayors act as brokers for the federal (and state) representatives which are the ones that have access to these transfers and will benefit the mayors that can help them to get reelected.

Table 5 shows the negative relationship between voting relatively more to the right wing parties and social spending. The interaction variable between municipal ideology and EV usage has a significant effect on total revenue and spending. Both get smaller once the municipality presents larger support for the right wing parties. The variable called share shows how much of the total vote was given to the current mayor, so this variable doesn't change across time. As one can notice, the interaction between this variable and EV usage is positive and significant for education, total spending, total revenue and intergovernmental transfer. Interestingly, this interaction squared is negative for these variables showing negative marginal returns to share of votes. This can be an indication that places where the elections are more contested are the ones where the mayor needs to make a larger effort to be reelected.²⁸ Finally, a dummy indicating if the mayor represents the same party of the governor or the president and his coalition formed

²⁸ Federal or state representatives would be interested in helping the mayor by sending intergovernmental transfers so he (or she) can campaign for them in the federal elections two years later.

after the 1998 elections shows a positive and significant increase in public employment, total spending and intergovernmental transfer only on municipalities that have used EV.

Table 5 - Estimating how the logarithm of the municipal spending on public goods (such as health and education) and transfers are politically motivated.

VARIABLES	(1) Health	(2) Education	(3) Public employment	(4) Total spending	(5) Total revenue	(6) Intergovernmental transfers
Year = 1998	0.19387*** (0.03053)	0.25756*** (0.02781)	0.22251*** (0.03271)	-0.01340 (0.02399)	0.08733*** (0.02339)	0.19951*** (0.02062)
EV*Year=1998	0.26929*** (0.07989)	0.17858*** (0.04753)	0.20476** (0.09719)	0.17286*** (0.03572)	0.16168*** (0.03526)	0.17162*** (0.03057)
Ideology	-0.03823** (0.01675)	-0.02965** (0.01449)	-0.0610*** (0.01603)	-0.02920** (0.01368)	-0.02422* (0.01296)	-0.02605** (0.01053)
EV*ideol.	0.00522 (0.05639)	-0.02738 (0.02677)	-0.03912 (0.03970)	-0.06711** (0.03341)	-0.05798* (0.03330)	-0.00762 (0.02115)
Share	-0.00010 (0.00017)	0.00008 (0.00011)	-0.00008 (0.00015)	0.00040* (0.00023)	0.00041* (0.00023)	0.00017** (0.00007)
EV*Share	0.00090 (0.01629)	0.01907*** (0.00683)	-0.00665 (0.00920)	0.01988** (0.00999)	0.02386** (0.00988)	0.00813* (0.00429)
(EV*Share) ²	0.00001 (0.00016)	-0.0001*** (0.00005)	0.00006 (0.00007)	-0.00014* (0.00007)	-0.00017** (0.00007)	-0.00006 (0.00004)
Coalition	0.00371 (0.01702)	0.01187 (0.00975)	0.01020 (0.01120)	-0.00206 (0.01187)	0.00572 (0.01046)	0.00806 (0.00721)
EV*coalit.	0.14918 (0.11098)	0.07677 (0.04766)	0.13000*** (0.04833)	0.07551* (0.04374)	0.06412 (0.04229)	0.05909* (0.03462)
Observations	8,024	8,045	9,234	6,417	6,417	9,241
R-squared	0.39022	0.53311	0.61820	0.60674	0.63880	0.75077

All regressions use state fixed effects. Standard errors, clustered by mesoregion, are presented in parenthesis. All regressions are controlled for income, number of voters, FPM transfers and a dummy identifying EV usage (collinear to the state fixed effects). Regression (1), (2), (3), (4), (5), and (6) consider the logarithm of per capita municipal spending on health; education; public employment, total spending, total revenue and total intergovernmental current transfers. The sample considers municipalities with more than 1245 and less than 40500 voters. *** p<0,01, ** p<0,05, * p<0,1

Next we focus on two more robustness checks: One to show that the municipal representatives were also affected by the EV usage and another to show that the previous findings are robust to different timing selection. The first robustness check therefore argues that the municipal elections were also affected by the EV usage. Since there was no study showing that the vote for municipal representatives were also impacted by the EV usage, this work used a regression discontinuity design (RDD), as used in the previous literature (Fujiwara, 2015, Schneider, 2015), to show that the same has happened in the municipal elections. The sample selected takes into account the 1996 elections where State Capitals and municipalities that had more than 200,000 voters were able to use it. Since most states, 17 out of 26, have used EV only in one municipality and there were State Capitals with less than 200,000 voters such as Palmas-TO with only 42,313, this work is going to select the São Paulo state to do the RDD analysis. Almost 23% (13 out of 57) of the municipalities that used EV belonged to São Paulo state and there were enough number of municipalities close to the cutoff to be considered²⁹ (not the case for the remaining states). Table 6 shows that there was an increase close to 10 percentage points in the number of valid votes to turnout ratio for municipal representatives due to the EV usage.

Table 6 - Estimating the impact of EV usage on valid votes to turnout ratio for municipal representatives on the municipal elections of 1996.

	Valid Votes to turnout ratio (1)	Valid Votes to turnout ratio (2)	Valid Votes to turnout ratio (3)
VARIABLES			
EV	0.08984***	0.10077***	0.09533***
Observations	24	22	20

²⁹ The balance check considering number of voters and average income shows that the cutoff by itself does not bring differences between the municipalities that used EV and the remaining ones.

R-squared	0.64628	0.77696	0.78335
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Robust standard errors presented in parenthesis. All regressions are controlled for income, number of voters, number of voters minus the cutoff and an interaction between the former variable and EV usage. Regression (1), (2) and (3) consider municipalities with more than 120,000; 130,000 and 140,000 voters. *** p<0,01, ** p<0,05, * p<0,1

Finally, Table 7 shows that the timing chosen for our estimations does not change the significance or sign of our results. This table presents a DID that compares the average of municipalities social spending between 1999 and 2000 (after federal elections) and compare it to the average on social spending between 1997 and 1998 in order to guarantee that the mayor is the same between these two periods. As one can notice, although the coefficients are attenuated, they remain being positive and significant.

Table 7 - Estimating the relationship between the logarithm of the municipal spending on public goods (such as health and education) and the EV usage using the DID methodology, but changing the time framing.

VARIABLES	(1) Health	(2) Education	(3) Public employment	(4) Total spending	(5) Total revenue	(6) Intergovernmental transfers
Year = 2000	0.16315*** (0.01593)	0.21183*** (0.01546)	0.12377*** (0.01379)	0.06551*** (0.00953)	0.12363*** (0.01117)	0.13861*** (0.01010)
EV* Year = 2000	0.21987** (0.09305)	0.11053** (0.04605)	0.11957** (0.04786)	0.13535*** (0.02382)	0.11783*** (0.02588)	0.08779*** (0.02842)
Observations	9,829	9,853	9,878	9,884	9,886	9,886
R-squared	0.44571	0.60489	0.66599	0.72852	0.74811	0.77797

All regressions use state fixed effects. Standard errors, clustered by mesoregion, are presented in parenthesis. All regressions are controlled for income, number of voters, FPM transfers and a dummy identifying EV usage (collinear to the state fixed effects). Regression (1), (2), (3), (4), (5), and (6) consider the logarithm of per capita municipal spending on health; education; public employment, total spending, total revenue and total intergovernmental current transfers. The sample considers municipalities with more than 1245 and less than 40500 voters. *** p<0,01, ** p<0,05, * p<0,1

7 - Conclusion

This paper has shown that voters' enfranchisement in Brazil, concentrated on the poor and illiterates that were being kept from casting their votes before the electronic voting (EV) introduction, have positively impacted the amount of social public spending on health, education and public employment. Also, municipalities total spending and revenue as the intergovernmental current transfers received by them, have all disproportionately increased on municipalities using EV and therefore, presenting larger political participation. This empirical result corroborates our model prediction that suggests larger public provision on municipalities using EV. The main contribution of the present work is therefore to show the consequences of EV on public spending. Finally, this work has also brought additional evidence on political motivated intergovernmental transfer and social public spending.

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