Abstract

Electoral rules determine how voters’ preferences are aggregated and translated into political representation, and their design can lead to the election of representatives who represent broader or narrower constituencies. This project examines how single- and two-round elections in Brazil affect municipal mayoral races using a regression discontinuity design. Two-round elections use two rounds of voting to elect a winner, ensuring the winner obtains at least 50% of the vote. Theoretically, this provides incentives for candidates to secure a broader base of support. I show that, in two-round systems, candidates represent a more geographically diverse group of voters, more resources are allocated to public schools, and there is less variance in resources allocated to public schools across the municipality. I find evidence suggesting that these effects are driven more by strategic behavioral responses of candidates, rather than differential entry of candidates into races. These findings suggest that two-round systems lead candidates to secure broader voter bases and subsequently exhibit less political favoritism when implementing policy.

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1. Introduction

There is growing consensus that more inclusive institutions lead to better economic and social outcomes\(^1\). How does this translate into a political system? Even within democracies, there are many ways to structure the political system, which affect the extent to which different groups are represented in the political system. This paper studies how a particular political institution, the electoral rule, leads to the election of representatives who represent broader or narrower groups of voters and affects the manner in which policies are implemented.

I take advantage of a unique policy in Brazil that assigns a municipality’s electoral rule based on a threshold of 200,000 registered voters. Municipalities below this threshold elect their mayor in a single-round election and municipalities above this threshold elect their mayor in a two-round election. Using a regression discontinuity framework that compares municipalities close to the threshold, this paper provides causal empirical evidence that politicians elected under two-round systems secure geographically broader bases of support, provide more resources to public schools, and allocate these resources more equitably.

In a single-round system, voters vote once and the candidate with the most votes wins. In a two-round system, voters first vote and, if no candidate receives a majority, vote a second time between the top two candidates\(^2\). This distinction serves two main purposes. First, two-round systems require winners to attain a vote share above 50\%. Second, the existence of a second round effectively limits the number of candidates (Lizzeri and Persico, 2005). If any one candidate is unlikely to attain a majority, the second round by construction limits the number of candidates. If one candidate emerges as a clear front-runner, she effectively only needs to be concerned with the runner-up, who threatens either a victory in the first round or will be the likely opponent in the second round. Because of these distinctions, two-round systems have been argued to incentivize candidates to secure a broader base of support and legitimize the winner’s position once elected (Bouton, 2013; Bouton and Gratton, 2015)\(^3\). The intuition behind this is that the rules imposed in a two-round system make it more difficult for politicians to win with policies that appeal to a narrow group of voters.

\(^1\)This is most strongly argued in the literature on elite capture, which emphasizes how groups holding disproportionate power undermine reforms that benefit broader constituencies. See Acemoglu and Robinson (2008), Acemoglu et al. (2014), and Bardhan and Mookherjee (2006).

\(^2\)This is the case in Brazil and most countries with two-round systems. In a small number of countries, variants of the two-round system are implemented.

\(^3\)While not a focus of this paper, there is also a large literature arguing that two-round systems allow voters to vote more sincerely in the first round (see Bouton et al., 2019 for a review) and to better communicate their policy preferences to candidates (Piketty, 2000).
To the extent that politicians commit to their campaign promises, the policies that politicians offer in order to win the election may translate into economic consequences. This paper tests the hypothesis that electoral rules affect the public goods that are provided and the manner in which these are allocated across the electorate. When electoral rules make it more difficult for politicians to win with a narrow constituency, this reduces their incentives to provide public goods supported by a narrow constituency once in office.

Two-round systems are the most widely used rule in democratic presidential elections: 64.0% of elections used the two-round system between 2000 and 2010 (Bormann and Golder, 2013 and Figure 1). Together, single- and two-round systems account for 86.7% of elections in this period. Despite the prevalence of single- and two-round systems, causally identifying their impacts is difficult. Electoral rules are often chosen with economic or political interests in mind or implemented in conjunction with other reforms (Cusack et al., 2007). By utilizing a regression discontinuity framework, this study causally identifies the electoral and economic consequences of single- and two-round systems.

To guide the empirical analysis, I propose a model of electoral competition to build intuition and explain why two-round systems create incentives for politicians to engage broader groups of voters, provide more government resources, and allocate resources differently. I adapt a standard probabilistic voting model where candidates offer policy proposals that (i) specify the overall size of the government budget and (ii) target government resources to specific localities within a municipality, as in Genicot et al. (2018). These policy proposals are announced prior to the election and, in a two-round system, are binding between rounds. In these elections, the top two candidates must contend with a small, third candidate, who is non-strategic and commits to allocating all resources to a single locality.

In the model, two-round elections lead to different outcomes because the second round raises the marginal return for the top two candidates to allocate resources to localities. In a two-round election, candidates must attain at least 50% of the vote to win, whether in the first or second round, which raises the value of each vote. As a result, candidates (i) promise a higher overall budget. In addition, candidates in a single-round election face low incentives to allocate resources to the locality dominated by the third candidate. In contrast, in a two-round election, the top two candidates in the first round must look ahead to the possibility of a second round, where the third candidate will not be present. As a result, candidates (ii) promise more resources to the locality that the third candidate appeals to, even if they are unlikely to attract those votes in the first round. However, in two-round systems, candidates may promise more or less resources to the other localities, resulting in
an ambiguous effect on overall inequality in government resources.

I obtain three main empirical results. First, candidates in two-round elections receive broader geographical support. Using each candidate’s vote count at each polling station, I measure the geographic distribution of voters for specific candidates in the first round in two ways: (i) indices of voter concentration to quantify the overall level at which voters are geographically concentrated, and (ii) the standard deviation of candidates’ vote shares to quantify a candidate level measure of geographic concentration. In two-round municipalities, voters are less geographically concentrated, corresponding to a reduction that is $27.4 - 45.6\%$ of the average level of concentration in single-round municipalities. The decrease in concentration is only among the top two candidates, indicating that the electoral rule mainly affects the candidates with a chance of winning. I show that this is not driven by the increased number of candidates in two-round elections. These results suggest that two-round elections lead to greater inclusiveness: elected candidates represent a geographically broader constituency. In turn, I find inclusiveness along another dimension: voters are more engaged in the political process. While turnout is unaffected, as turnout is mandatory in Brazil, I find that the number of blank and invalid ballots is significantly lower in two-round elections.

Second, once in office, politicians elected under two-round systems provide and allocate public goods differently. I find effects both on the level and distribution of municipal resources. I look at the provision of a local public good that can be geographically targeted and which is completely under the jurisdiction of the municipality: municipal education. To quantify provision, I measure the level of resources present in public schools in the municipality. I find that (i) public schools in two-round municipalities are $0.057 - 0.081$ percentiles higher in the national distribution of resources, and (ii) the standard deviation of resources across schools is lower. Schools with the fewest resources in the municipality benefit the most from these additional resources. When politicians secure broader bases of support, they provide more public goods and distribute these resources more evenly across the municipality.

Third, I find evidence that educational outcomes are improved in two-round municipalities. Specifically, drop-out rates are lower and literacy rates are higher among cohorts who attended elementary school during the election. I find limited evidence that two-round municipalities experience improvements along more downstream economic indicators. Two-

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4The effect of the electoral rule on the number of candidates is known as Duverger’s Law, which states that single-round plurality elections will lead to a two-party system, while a two-round majority system will lead to a multi-party system. This prediction has been formalized, and sometimes challenged, in recent literature (Bouton, 2013; Bouton and Gratton, 2015; Callander, 2005; Cox, 1997; Fujiwara, 2011; Osborne and Slivinski, 1996).
round municipalities have fewer households considered low income, but there are no significant improvements in average income, employment, or night lights. These results suggest that electoral rules have short term impacts on direct policy outcomes, but limited effects on more downstream economic outcomes.

Turning to mechanisms, I do not find that two-round elections cause differential selection of candidates. More specifically, I do not find that different types of candidates enter the races nor do different types of candidates win the elections. Candidates in two-round elections are not observably different in terms of demographic characteristics, place of birth, educational attainment, and previous occupation. Winners also do not differ along these observable characteristics. More candidates enter the race in two-round elections – many of these additional candidates are represented by smaller parties and have ran in previous elections. However, these candidates are not more likely to win the election.

I find suggestive evidence that the effects of two-round elections are driven by strategic behavioral responses of candidates. I rule out that candidates’ different strategic behavior is caused by different reelection incentives. Instead, I find that different outcomes come from candidates adopting different strategies during the campaign, in line with the model’s predictions. First, in two-round elections, geographic concentration decreases between the first and second round, suggesting that candidates adopt strategies between rounds to consolidate their voter bases. Second, candidates in two-round elections finance their campaigns differently: they rely less on donations from corporations. To the extent that corporations represent narrower swaths of the electorate, this suggests that candidates in two-round elections adopt different strategies and that these strategies appeal more broadly to individuals rather than corporations. These findings suggest that candidates in two-round elections offer different policy platforms and build more geographically diverse constituencies. When their supporters are less geographically concentrated, mayors allocate public goods in a less geographically concentrated manner.

This study builds on a large, mostly theoretical literature studying the role of electoral rules on political incentives. These studies document how different rules impact electoral accountability (Persson et al., 2003) and personal vote-seeking (Carey and Shugart, 1993).

There is empirical evidence that candidates qualifying for the second round rally votes from supporters of the candidates eliminated after the first round. Pons and Tricaud (2018) find in France that the qualification of a third candidate in the second round reduces the votes for the top two candidates, indicating that when the third candidate is not present in the second round (as is always the case in Brazil), the top two candidates capture votes from supporters for the third placed candidate.

See Persson and Tabellini (2003, 2004) for a review and discussion of other consequences of electoral rules.
Importantly, these studies highlight how electoral rules incentivize politicians to appeal to broader groups of voters (Myerson, 1993), provide public goods with broader benefits (Lizzieri and Persico, 2001, 2005; Persson and Tabellini, 1999), and target public spending to specific groups of voters (Genicot et al., 2018; Milesi-Ferretti et al., 2002). With the exception of Lizzieri and Persico (2005), these studies do not compare single- to two-round systems. In Lizzieri and Persico (2005), politicians in two-round systems provide public goods with broader benefits at a higher rate because the second round effectively limits the number of candidates. This paper provides a theoretical framework to examine how public goods provision differs between single- and two-round systems, and subsequently tests these predictions empirically.

This paper adds to a growing empirical literature providing causal evidence on the impacts of local electoral rules. These studies, which compare proportional and single-round systems in addition to single- and two-round systems, have measured the impact on electoral outcomes and fiscal expenditures (Chamon et al., 2018; Cipullo, 2019; Eggers, 2013; Fujiwara, 2011; Pellicer and Wegner, 2013). Chamon et al. (2018) and Fujiwara (2011) also study the Brazilian context. Of particular interest are Bordignon et al. (2016), who compare single- and two-round systems in Italian municipalities and find that municipalities under two-round systems exhibit more policy moderation, as measured by the volatility across elections of a municipal tax rate. In contrast to Bordignon et al. (2016), I study not only an aggregate policy outcome, the overall level of public goods provision, but also the allocation of this policy across the electorate. This paper’s contribution is to provide evidence that electoral rules have economic consequences, both on the level of public goods provision and how these public goods are distributed.

More broadly, this paper connects to a literature examining inequalities in the allocation of state resources. A large literature documents the role of political factors in creating these inequalities, in particular how politicians politically favor certain subgroups such as those of the same ethnicity or partisanship. A key insight that emerges from this literature is that the extent to which politicians practice political favoritism is reduced when political institutions are stronger, elections are more competitive, and citizens are more broadly engaged in the electoral process (Burgess et al., 2015; Fujiwara and Wantchekon, 2013; Hodler and Raschky, 2014). Notably, Golden and Min (2013) emphasize the importance of policy responsiveness to voter preferences. Electoral rules serve as a key channel through which voter preferences are translated into policy outcomes. The final contribution of this paper is to demonstrate the role of another factor in political favoritism, the electoral rule, and the incentives it creates for politicians to broaden their appeal.
The remainder of this paper is organized as follows. Section 2 presents a theoretical framework for single- and two-round systems. Section 3 describes the context and section 4 describes the empirical strategy. Section 5 presents the results on electoral and economic outcomes. Section 6 discusses the results and mechanisms. Section 7 concludes.

2. Theoretical framework

I present a stylized model to illustrate how two-round elections create incentives for politicians to secure a broader base of support and provide public goods differently. My model of electoral competition adapts a standard probabilistic voting model and follows the setup in Genicot et al. (2018) by allowing for targeting of government interventions to specific localities within a municipality. I extend this model by (i) introducing a third non-strategic candidate who appeals to a single locality, (ii) allowing candidates to exert effort to increase the municipal budget, and (iii) adapting it to the context of single- and two-round elections.

The intuition is that two-round elections perform two functions. First, the winner must attain a vote share above 50%. This makes it difficult for politicians who appeal to a minority of the electorate to gain enough votes to win the election. This also raises the marginal value of every vote and results in candidates exerting more effort to increase the overall government budget. Second, the existence of a second round effectively limits the number of candidates. Candidates who expect to gather enough first round votes to qualify for the second round but less than the 50% to win in the first round must act as if a second round will occur where only one other candidate will stand. This incentivizes candidates to offer policy proposals that appeal to all localities, even to localities that are likely to vote for another candidate in the first round. While this effect runs counter to a large literature documenting the positive impacts of political competition, in a single-round election, higher electoral competition incentivizes candidates to appeal to narrower groups and ignore other voters.

My model predicts that two-round elections lead to different outcomes because candidates adapt different campaign strategies by offering policy proposals that appeal to a broader group

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8 A theoretical literature argues that higher electoral competition has the negative effect of incentivizing candidates to focus on narrower groups. Myerson (1993) shows that candidates offer more unequal campaign promises when electoral competition increases in elections using rank-scoring rules. Lizzeri and Persico (2005) extend this model to other electoral rules and introduce a public good, finding a negative effect of political competition on the equality of campaign promises and public good provision.
of voters. However, two-round elections may also lead to different outcomes by (i) causing different types of candidates to enter the race or (ii) causing different types of candidates to win the election. While I do not model candidates’ entry decisions, I test for these alternative mechanisms in the empirical analysis. I find evidence suggesting that different outcomes in two-round elections are mostly driven by candidates’ strategic responses.

2.1. The environment

Consider an election with three politicians and $J$ localities within a municipality. Politicians are indexed by $c \in \{A, B, C\}$ and localities are indexed by $j \in \{1, 2, \ldots, J\}$ where $J \geq 3$. Each locality has a continuum of voters of mass $1/J$.

Prior to election day, politicians simultaneously announce a platform $q^c = \{q^c_1, q^c_2, \ldots, q^c_J\}$ and $G^c$. $q^c$ describes the amount of the government budget to be allocated to each locality. $G^c$ describes the total government budget. The politician’s budget constraint is:

$$\sum_{j=1}^{J} q^c_j \leq G^c$$

Since each locality has the same number of voters, each voter receives the same fraction of the government budget allocated to their locality. I assume without loss of generality that voters care about the total amount allocated to their locality, $q^c_j$. To promise a certain budget, politicians face a cost that is quadratic in the size of the budget:

$$\frac{1}{2} \kappa (G^c)^2$$

for a constant $\kappa$. Platforms are binding for politician between rounds and after the election.\(^9\)

To make solving a three-candidate model more tractable, I assume that the third candidate $C$ is a non-strategic candidate with the following platform\(^{10}\):

$$q^C = \{0, 0, \ldots, 0, G^C\}$$

\(^9\)This is not unrealistic as the time between rounds is often short compared to the length of the campaign. In Brazil, the second round is three weeks after the first round. Nevertheless, this assumption can be slightly relaxed, as long as there is some continuity between the two rounds. First, if voters’ second round vote depends on a candidate’s policy proposal in both rounds. Second, if candidates can change their policy proposals between rounds but are constrained in the extent to which their proposals can change.

\(^{10}\)I assume that $G^C$ is the highest offer in locality $J$, or that candidate $A$ and $B$’s equilibrium allocations to $J$ are smaller than $G^C$. See Appendix A.5.
There are several ways to interpret candidate $C$. In my model, because voters are partitioned into geographic localities, $C$ is a candidate whose supporters are all located in the same geographic area. However, my model easily translates into other interpretations of candidate $C$. For example, $C$ may be a candidate whose supporters share a common trait and vote for her due to descriptive representation. These traits can include geography but also other dimensions such as age or race. Another possibility is that $C$ is a single-issue candidate who attracts voters who only care about that issue. In any of these cases, $C$ should be viewed as a small candidate and $A$ and $B$ as front-runners in relation to $C$. This also empirically matches elections in Brazil. Third placed candidates receive on average 11.9% of the vote and the vote spread between the second and third placed candidate is on average 23.8%.

Following Genicot et al. (2018), voters in locality $j$ have preferences $u_j(q_j)$ over government spending. The function $u_j(\cdot)$ is strictly increasing and concave in $q_j$. In addition to the policy component of voters’ preferences, there is an individual shock $v_i$ and a municipality shock $\delta$ towards candidate $A$ which are independently and uniformly distributed:

$$v_i \sim U \left[ -\frac{1}{2\psi}, \frac{1}{2\psi} \right] \quad \delta \sim U \left[ -\frac{1}{2\gamma}, \frac{1}{2\gamma} \right]$$

$v_i$ captures idiosyncratic voter preferences towards candidate $A$. $\delta$ captures any political dimensions that swing voters in the municipality as a whole towards candidate $A$, such as economic shocks or popularity shocks.

Voters cast a ballot for the politician who offers them the highest payoff. In localities $j \in \{1, \cdots, J-1\}$, or where candidate $C$ has not invested, this amounts to voting for either $A$ or $B$.\footnote{Since $u_j(\cdot)$ is strictly increasing, candidates $A$ and $B$ will invest a non-zero amount in these localities and voters will always vote for either $A$ or $B$.} In locality $J$, or where candidate $C$ is dominant, voters randomize between voting for $C$ with probability $1 - \alpha$ and either for $A$ or $B$ with probability $\alpha$, depending on whether $A$ or $B$ offers the higher payoff, where $0 < \alpha < 1$.\footnote{Assuming $\alpha > 0$ performs two functions. First, it guarantees that candidate $C$ always gains strictly less than $1/3$ in vote share and so never has the most votes. Note that $C$ will also never have the most votes if $J > 3$. Second, it guarantees a non-zero first order condition for locality $J$ in the single-round election, which allows a direct comparison between the single- to the two-round election. This assumption can be relaxed and will yield the same predictions, see Appendix A.6.}

Thus, in general, voters will vote for $A$ if and only if:

$$u_j(q_j^B) \leq u_j(q_j^A) + v_i + \delta \tag{2.1}$$
In localities $j \in \{1, \cdots, J - 1\}$, all voters for whom this is true vote for $A$. In locality $J$, a fraction $\alpha$ of voters for whom this is true vote for $A$. I assume that the marginal utility of locality $J$ relative to that of the other localities, or $u'_j(q)/u'_j(q)$, is not too large.

The electoral rules follow those in Brazil. In a single-round system, the candidate with the most votes wins. In a two-round system, if no candidate attains more than 50% of the vote in the first round, the second round occurs with the top two candidates.

2.2. Preliminaries

2.2.a. Vote shares with three candidates. First, I derive candidates’ vote shares when three candidates are present. This applies to single-round elections and the first round of two-round elections.

Condition (2.1) corresponds to voters for whom $v_i \geq u_j(q_j^B) - u_j(q_j^A) - \delta$, which allows me to calculate each candidate’s vote share in each locality. As in Genicot et al. (2018), I assume that there are voters to be swung in every locality. Thus, in locality $j$ during round $t = 1$, candidate $c$’s vote share $\pi_{jt}$ is given by:

$$\begin{align*}
\pi_{jt}^A &= \begin{cases}
\frac{1}{2} + \psi \left( \Delta u_{AB}^j + \delta \right) & \text{if } j \in \{1, \cdots, J - 1\} \\
\alpha \left( \frac{1}{2} + \psi \left( \Delta u_{AB}^j + \delta \right) \right) & \text{if } j = J
\end{cases} \\
\pi_{jt}^B &= \begin{cases}
\frac{1}{2} + \psi \left( \Delta u_{BA}^j - \delta \right) & \text{if } j \in \{1, \cdots, J - 1\} \\
\alpha \left( \frac{1}{2} + \psi \left( \Delta u_{BA}^j - \delta \right) \right) & \text{if } j = J
\end{cases} \\
\pi_{jt}^C &= \begin{cases}
0 & \text{if } j \in \{1, \cdots, J - 1\} \\
1 - \alpha & \text{if } j = J
\end{cases}
\end{align*}$$

where $\Delta u_{cd}^j \equiv u_j(q_j^c) - u_j(q_j^d)$.

Candidates’ total vote share in the municipality $\pi_t^c$ is given by:

$$\pi_t^c = \left( \frac{J - 1 + \alpha}{J} \right) \left( \frac{1}{2} + \psi \delta \right) + \frac{\psi}{J} \left( \sum_{j=1}^{J-1} \Delta u_{AB}^j + \alpha \Delta u_{AB}^J \right)$$

13For localities $j \in \{1, \cdots, J - 1\}$, we also need that $u_j(q_j^A) + v_i + \delta \geq u_j(q_j^C)$. Because $u_j(q_j^B) \geq u_j(0) = u_j(q_j^C)$, condition (2.1) is sufficient for voters to vote for $A$ in these localities.

14Namely, for all $j \in \{1, \cdots, J - 1\}$, $u'_j(q)/u'_j(q) < \frac{1 + \frac{(1-\alpha)\gamma}{\psi_j}}{\alpha + \frac{(1-\alpha)\gamma}{\psi_j}}$, for all positive $q$.

15This assumption states that $0 < \pi_{j1}^A < 1$. See Appendix A.1.
\[
\pi_1^B = \left( \frac{J - 1 + \alpha}{J} \right) \left( \frac{1}{2} - \psi \delta \right) + \frac{\psi}{J} \sum_{j=1}^{J-1} \Delta u_{j}^{BA} + \alpha \Delta u_{j}^{BA} \\
\pi_1^C = \frac{1 - \alpha}{J}
\]

As in Genicot et al. (2018), I assume that all localities are contestable\(^{16}\). Then the probability of attaining a vote share above \(\theta\) is given by:

\[
Pr \left( \pi_1^A \geq \theta \right) = \frac{1}{2} + \frac{\gamma}{\psi} \left[ \frac{1}{2} - \left( \frac{J}{J - 1 + \alpha} \right) \theta + \left( \frac{\psi}{J - 1 + \alpha} \right) \left( \sum_{j=1}^{J-1} \Delta u_{j}^{AB} + \alpha \Delta u_{j}^{BA} \right) \right] \tag{2.2}
\]

\[
Pr \left( \pi_1^B \geq \theta \right) = \frac{1}{2} + \frac{\gamma}{\psi} \left[ \frac{1}{2} - \left( \frac{J}{J - 1 + \alpha} \right) \theta + \left( \frac{\psi}{J - 1 + \alpha} \right) \left( \sum_{j=1}^{J-1} \Delta u_{j}^{AB} + \alpha \Delta u_{j}^{BA} \right) \right] \tag{2.3}
\]

With three candidates, I assume that candidate \(C\) always receives the lowest vote share: \(C\) never wins a single-round election nor makes it to the second round in a two-round election (see Appendix A.3). This simplifies candidate \(A\)'s and \(B\)'s maximization problem, and shuts down the channel where candidate \(C\) poses a different threat to electoral defeat.

2.2.b. Vote shares with two candidates.– Next, I derive vote shares when there are two candidates, \(A\) and \(B\), present (as mentioned, candidate \(C\) never makes it to the second round). This applies to the second round in two-round elections.

Candidate \(A\)'s vote shares in each locality and the municipality as a whole are given by:

\[
\pi_{j2}^A = \frac{1}{2} + \psi \left( \Delta u_{j}^{AB} + \delta \right) \\
\pi_2^A = \frac{1}{2} + \psi \delta + \frac{\psi}{J} \sum_{j=1}^{J} \Delta u_{j}^{AB}
\]

Assuming again that all localities are contestable (see Appendix A.2), the probability that candidate \(A\) attains a vote share above \(\theta\) is given by:

\[
Pr \left( \pi_1^A \geq \theta \right) = \frac{1}{2} + \frac{\gamma}{\psi} \left[ \frac{1}{2} - \theta + \frac{\psi}{J} \sum_{j=1}^{J} \Delta u_{j}^{AB} \right] \tag{2.4}
\]

2.2.c. Candidates’ maximization problem.– For both candidate \(A\) and \(B\), her payoff is 1 if she wins the election and 0 otherwise, minus her effort cost which is incurred during the

\(^{16}\)This assumption states that \(0 < Pr \left( \pi_1^A \geq \theta \right) < 1\) and \(0 < Pr \left( \pi_1^B \geq \theta \right) < 1\). See Appendix A.2.
campaign. Candidates maximize their expected payoff, so this amounts to maximizing the probability of winning minus the effort cost.

### 2.3. Equilibrium strategies in a single-round election

In a single-round election, the probability of winning is the probability of attaining a vote share above \( \frac{1}{2} \left( 1 - \frac{1}{J} \right) \). Using equation (2.2), for candidate A, this is equivalent to solving the following maximization problem:

\[
\max_{G^A, q^A = \{q^A_1, \ldots, q^A_J\}} \frac{1}{2} + \left( \frac{\gamma}{J - 1 + \alpha} \right) \left( \sum_{j=1}^{J-1} \Delta u^A_j + \alpha \Delta u^A_J \right) - \frac{1}{2} \kappa \left( G^A \right)^2 \quad \text{s.t.} \sum_j q^A_j \leq G^A
\]

The first order conditions are:

\[
\left( \frac{\gamma}{J - 1 + \alpha} \right) u'_j(q^A_j) = \lambda_{1R} \quad \text{for } j \in \{1, \ldots, J - 1\} \tag{2.5}
\]

\[
\left( \frac{\gamma}{J - 1 + \alpha} \right) \alpha u'_j(q^A_j) = \lambda_{1R} \quad \text{for } j = J \tag{2.6}
\]

\[
\kappa G^A = \lambda_{1R} \tag{2.7}
\]

where \( \lambda_{1R} \) is the Lagrange multiplier of the budget constraint in a single-round system. For localities \( j \in \{1, \ldots, J - 1\} \), equation (2.5) implies that localities with a higher marginal utility (or a higher sensitivity to changes in the electoral platform) are allocated more government spending. Combining equations (2.5) and (2.6), the ratio in marginal utilities between localities is:

between \( j \) and \( j' \): \[
\frac{u'_j(q^A_j)}{u'_j(q^A_j')} = 1 \quad \forall \ j, j' \in \{1, \ldots, J - 1\} \tag{2.8}
\]

between \( j \) and \( J \): \[
\frac{u'_j(q^A_j)}{u'_J(q^A_J)} = \alpha \quad \forall \ j \in \{1, \ldots, J - 1\} \tag{2.9}
\]

Since \( u_j(\cdot) \) is strictly increasing and strictly concave and \( u'_j(q)/u'_j(q) \) is not too large, equation (2.9) yields the following prediction:

**Prediction 2.10.** In a single-round system, in equilibrium, candidates promise less resources to locality \( J \) in comparison to the other localities. In other words, for all \( j \in \{1, \ldots, J - 1\} \), we have that \( q^A_j > q^A_J \).
2.4. Equilibrium strategies in a two-round election

In a two-round election, the probability of winning is the probability of attaining a vote share above $\frac{1}{2}$ in the first round and, if a second round occurs, of attaining a vote share above $\frac{1}{2}$ in the second round:

$$Pr(A \text{ wins in 1st round}) + Pr(\text{second round occurs}) \cdot Pr(A \text{ wins 2nd round})$$

$$= Pr \left( \pi_A^1 \geq \frac{1}{2} \right) + \left( 1 - Pr \left( \pi_A^1 \geq \frac{1}{2} \right) - Pr \left( \pi_B^1 \geq \frac{1}{2} \right) \right) \cdot Pr \left( \pi_A^2 \geq \frac{1}{2} \right)$$

Using equations (2.2), (2.3), and (2.4), this corresponds to the following maximization:

$$\max_{G^A, q^A} \left\{ \frac{1}{2} + \frac{\gamma}{\psi} \left[ \frac{1}{2} \left( \frac{\alpha - 1}{J - 1 + \alpha} \right) + \left( \frac{\psi}{J - 1 + \alpha} \right) \left( \sum_{j=1}^{J-1} \Delta u_{j}^{AB} + \alpha \Delta u_{J}^{AB} \right) \right] \right\}$$

$$+ \left[ \frac{\gamma}{\psi} \left( \frac{1 - \alpha}{J - 1 + \alpha} \right) \left[ \frac{1}{2} + \frac{\gamma}{J} \sum_{j=1}^{J} \Delta u_{j}^{AB} \right] - \frac{1}{2} \kappa (G^A)^2 \right\}$$

s.t. $\sum_j q^A_j \leq G^A$

The first order conditions are:

$$\left( \frac{\gamma}{J - 1 + \alpha} \right) \left( 1 + \frac{(1 - \alpha) \gamma}{\psi J} \right) u'(q^A_j) = \lambda_{2R} \quad \text{for } j \in \{1, \ldots, J - 1\} \quad (2.11)$$

$$\left( \frac{\gamma}{J - 1 + \alpha} \right) \left( \alpha + \frac{(1 - \alpha) \gamma}{\psi J} \right) u'(q^A_j) = \lambda_{2R} \quad \text{for } j = J \quad (2.12)$$

$$\kappa G^A = \lambda_{2R} \quad (2.13)$$

where $\lambda_{2R}$ is the Lagrange multiplier of the budget constraint in a two-round system. Combining equations (2.11) and (2.12), the ratio in marginal utilities between localities is:

between $j$ and $j'$:

$$\frac{u'_j(q^A_j)}{u'_{j'}(q^A_{j'})} = 1 \quad \forall \quad j, j' \in \{1, \ldots, J - 1\} \quad (2.14)$$

between $j$ and $J$:

$$\frac{u'_j(q^A_j)}{u'_{J}(q^A_{J})} = \frac{\alpha + \frac{(1 - \alpha) \gamma}{\psi J}}{1 + \frac{(1 - \alpha) \gamma}{\psi J}} \quad \forall \quad j \in \{1, \ldots, J - 1\} \quad (2.15)$$

As in the single-round system, since $u_j(\cdot)$ is strictly increasing and strictly concave and $u'_J(q)/u'_J(q)$ is not too large, equation (2.15) yields the following prediction:
Prediction 2.16. In a two-round system, in equilibrium, candidates promise less resources to locality $J$ in comparison to the other localities. In other words, for all $j \in \{1, \cdots, J-1\}$, we have that $q^A_j > q^A_J$.

2.5. Comparing single- to two-round systems

In this section, I compare three outcomes under the single- and the two-round system: (i) politician’s allocations to localities, (ii) politician’s choice of the overall budget, and (iii) overall inequality in the allocation of resources. To simplify notation, denote the equilibrium allocations and overall budget for candidate $A$ as $q^{1R}_j$ and $G^{1R}$ (for single-round) and $q^{2R}_j$ and $G^{2R}$ (for two-round).

Prediction (2.17) describes how the allocation of resources to each locality differs between single- and two-round systems.

Prediction 2.17. Candidates promise more to locality $J$ in a two-round system than in a single-round system. Candidates’ promises to the other localities in a two-round system compared to a single-round system is ambiguous. In other words, $q^{1R}_J < q^{2R}_J$ and $q^{1R}_j \leq q^{2R}_j$ for all $j \in \{1, \cdots, J-1\}$.

The change in allocations to the localities where candidate $C$ has promised 0 to is ambiguous. This will depend on the parameters of the model, the functional form of $u_j(\cdot)$, and the change in the overall budget $G$. Prediction (2.18) describes how the overall government budget promised differs between single- and two-round systems.

Prediction 2.18. The overall government budget promised is higher in two-round systems compared to single-round systems. In other words, $G^{1R} < G^{2R}$.

The proof for predictions (2.17) and (2.18) is in Appendix A.4. When comparing inequality in allocations between the two electoral rules, the outcome of interest is how the allocation of resources to locality $J$, where candidate $C$ has offered the entire government budget, compares to the allocation to the other localities\footnote{My model focuses on the difference in allocations between locality $J$ and the other localities. However, depending on the functional form of $u_j(\cdot)$, it is possible that relative allocations between the other $\{1, \cdots, J-1\}$ localities become more or less unequal in two-round elections. If differences in $u_j(\cdot)$ across the localities are sufficiently small, any changes in inequality between the $\{1, \cdots, J-1\}$ localities will be small relative to changes in inequality caused by changes in locality $J$. In the case that $u_j(\cdot) = u(\cdot)$, then all $\{1, \cdots, J-1\}$}. Prediction (2.19) describes how inequality
in allocations differs between single- and two-round systems.

**Prediction 2.19.** In two-round systems compared to single-round systems, the level of inequality in government resources promised, as measured by the resources promised to locality \( J \) compared to the other localities, is ambiguous. If \( q^1_j > q^2_j \) for all \( j \in \{1, \cdots, J-1\} \), then the level of inequality is lower in two-round systems compared to single-round systems. If \( q^1_j < q^2_j \) for all \( j \in \{1, \cdots, J-1\} \), then the change in the level of inequality is ambiguous.

When candidates in two-round elections offer more to all localities, the change in the level of inequality will depend on whether the increase in resources to the other localities is greater or less than the increase in resources to locality \( J \).

2.5.a. **Discussion.** In a single-round system, the presence of a third candidate who appeals to a single locality leads candidates \( A \) and \( B \) to ignore those voters, as the marginal return to allocating resources there is low. In contrast, the two-round system, while not producing a completely equitable distribution, incentivizes candidates to allocate more resources to that locality. The presence of the second round, where the third candidate is not present, raises the marginal return to allocating resources to that locality. This can be seen when comparing the first order conditions in equations (2.6) and (2.12), where the two-round system has the additional term \((1-\alpha)\gamma J\). As a result, candidates \( A \) and \( B \) solicit more votes from locality \( J \) in a two-round election.

In fact, in a single-round system, candidates face lower incentives to invest in all localities. The marginal return to investing in any locality is higher in two-round elections: compare the first order conditions in equations (2.5) with (2.11) and (2.6) with (2.12). These incentives come from the fact that, in two-round elections, there are two ways to win: by attaining 50% in the first round or winning in the second round with 50%. With higher incentives to invest in all localities, candidates in two-round elections exert more effort to increase the government budget.

While my model partitions the electorate into geographic localities, voters can be partitioned along other dimensions, such as income, race, or ideology. My model easily translates into these other settings, and the predictions yield the same interpretation. First, two-round systems raise the marginal return to allocating resources to groups of voters that are heavily targeted by other candidates. This results in candidates offering campaign promises that localities will receive the same allocation and the only disparity that matters is between \( J \) and the other localities.
also appeal to these voters. Second, candidates face higher incentives to appeal to all voters, leading them to increase the overall government budget.

3. Institutional context

Municipalities in Brazil are autonomous governmental entities with an elected executive (mayors, or prefeitos) and legislative body (a council of legislators, or camara de vereadores). Elections for municipal positions are at large and simultaneously held every four years. Mayors in municipalities with less than 200,000 voters are elected through a single-round system, while in larger municipalities they are elected in a two-round system. In the two-round system in Brazil, the threshold for winning is 50%. If no candidate receives at least 50% of the votes in the first round, then a second round is held 3 weeks later with the top two candidates\textsuperscript{18}. Legislators are elected through an open-list proportional system. Voters cast separate votes for a mayoral candidate and a legislative candidate, or a generic vote for the party. Mayors are limited to serving two consecutive terms while there is no term limit for legislators.

State electoral authorities, the Tribunais Electorais Regionais, register citizens and maintain electoral rolls. Several features of Brazilian elections, mandated either in the federal constitution or by law, facilitate voter turnout on election day. First, voter registration is compulsory and must be completed at least 151 days prior to the election. Second, voting is compulsory for all literate Brazilian citizens between 18-69 years of age\textsuperscript{19}. Third, elections are held on the first Sunday in October, a day when few voters are at work.

The timing of announcement of the electoral rule for mayor has varied. In earlier elections, the electoral rule was announced 3-4 months prior to the election. In more recent elections, the number of registered voters has been regularly published, allowing the electoral rule to be known much earlier.

Brazilian elections are a multi-party system, with over 30 political parties registered in the 2016 municipal elections. Mayoral candidates are associated with a party and often a coalition of parties, which are generally formed prior to the election\textsuperscript{20}. Party and coalition affiliations serve as important linkages to the state and federal levels of government (Brollo

\textsuperscript{18}In my sample, a second round occurs 57% of the time.

\textsuperscript{19}Voters may provide justification to a local electoral judiciary office. Absent this justification, voters who fail to vote must pay a small fine and those who fail to vote for three consecutive elections are prevented from accessing public services, such as obtaining a passport or government loans.

\textsuperscript{20}Seats for the legislative council are allocated based on the number of votes received by candidates or parties in the coalition.
and Nannicini, 2012).

Once elected, mayors have a broad mandate to provide public goods, particularly in education, health, and local infrastructure. Municipal revenue is a combination of inter-government transfers and local revenues. The majority of the municipal budget is represented by inter-government transfers (the average within my sample is 65.6% of the municipal budget). The bulk of these transfers come from the state or federal level (on average, 78.0%), and are either constitutional automatic transfers (Fundo de Participação do Municipios) or discretionary transfers (convênios). Municipalities face considerable flexibility in spending these transfers. Among the automatic transfers, 70% of the funds are unrestricted. While 30% are earmarked, municipalities are only restricted to spending it on health and education.

The allocation of spending on public goods occurs through two main channels. First, the majority of public goods are allocated through the annual budgetary process. Second, mayors and legislators can submit bills requesting specific public works or services. While these actions jointly require approval of the mayor and legislature, mayors retain veto power and wield significant influence over the process.

As a result, mayors are important for both the size of the municipal budget and how municipal funds are allocated. This study focuses on public goods provision in municipal education, for several reasons. First, a large fraction of the municipal budget is allocated towards education spending: in 2012, this represented 30.5% of municipal budgets. Second, municipal education is a fairly geographically localized public good. Third, the provision of elementary education (Ensino Fundamental) is one of the few public goods almost entirely under the jurisdiction of the municipality. For other public goods, municipalities share joint responsibility with the state or federal government.

4. Empirical strategy

4.1. Econometric framework

The threshold rule for mayoral elections provides a natural candidate for a regression discontinuity design (RDD). I exploit the 200,000 registered voter threshold, which determines a municipality’s electoral rule, to estimate the impact of the electoral rule.

Denote $Y_i(0)$ and $Y_i(1)$ as the potential outcome in municipality $i$ if assigned a single-round and two-round system, respectively. Assignment of the electoral rule is determined by the running variable, the number of registered voters $X_i$. The assignment variable $D_i$ takes on
the value of $D_i = 0$ if $X_i < 200,000$ and $D_i = 1$ if $X_i \geq 200,000$.

Following Imbens and Lemieux (2008) and Calonico et al. (2014), to estimate the treatment effect at the discontinuity, I use a local linear regression specification:

$$Y_{it} = \beta_1 D_{it} + \beta_2 X_{it} + \beta_3 X_{it} \cdot D_{it} + \gamma_t + \varepsilon_{it} \quad (4.1)$$

where for municipality $i$ in election year $t$ (each of which is one observation), $X_{it}$ is the running variable, $D_{it}$ is the assignment variable, $\gamma_t$ is an election-year fixed effect, and $Y_{it}$ is the outcome of interest. Equation (4.1) amounts to fitting two linear regressions using election-years close to the left and to the right of the threshold. $\beta_1$ represents the estimate of the local average treatment effect. Standard errors are clustered at the municipality level.

Because the treatment effect is identified only at the threshold, equation (4.1) is estimated using municipalities close to the threshold. The main analysis uses a 50,000 registered voter window, but robustness is provided for other bandwidths as well as bandwidths selected using data driven methods (Calonico et al., 2014 and Imbens and Kalyanaraman, 2012)\(^{21}\).

### 4.2. Identification

In order for $\beta_1$ to represent the causal effect of the electoral rule, the conditional expectation of the potential outcomes must be continuous at the threshold. In the following section, I discuss identification and interpretation of the RDD estimates.

#### 4.2.a. Violations of smoothness.

The first way the smoothness assumption can be violated is if the threshold choice is motivated by political or economic factors. There appears to be little evidence for this. The choice of 200,000 registered voters as the threshold was somewhat arbitrary and mainly reflected practical concerns regarding the cost of holding a second round (Chamon et al., 2018; Fujiwara, 2011). In addition, the 200,000 registered voter threshold was set in the 1988 Federal Constitution and has not changed since then. It is unlikely that politicians chose the threshold anticipating which municipalities would be above or below this threshold in 1996 and later.

A second possibility is if municipalities sort across the threshold. Practically, it is difficult for municipalities to selectively sort since voter registration is mandatory and handled by state

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\(^{21}\)Because there is an extremely skewed right tail of municipality sizes due to a few extremely large municipalities such as Rio de Janeiro and São Paulo, the data-driven methods would sometimes select bandwidths larger than the support. As a result, the optimal bandwidth is calculated on a subset of elections that lies within the support and is symmetrical around the threshold: 0–400,000 voters.
electoral authorities. Visually, there do not appear to be discontinuities in the distribution of registered voters at the threshold (Figure 2). To test this formally, I estimate the size of the discontinuity in the density of the running variable at the threshold (McCrary, 2008). The size of the discontinuity is both small in magnitude (0.169) and insignificant ($p = 0.389$)\(^{22}\).

Third, the smoothness assumption can be violated if other policies also change discretely at the threshold. While a number of policies in Brazil are implemented using thresholds, these are based off population counts and not the number of registered voters. Population and the number of registered voters are highly correlated but do not vary one-to-one (Figure C.1). To the best of my knowledge, there are no other policies at the 200,000 registered voter threshold and most other policy thresholds are far from 200,000 registered voters. Two exceptions are a constitutional amendment in 2000 that places a salary cap for local legislators at 300,000 inhabitants and a constitutional amendment in 2004 that changes the size of the local legislature at 285,714 inhabitants. I address this in two ways. First, I estimate a placebo regression where the electoral rule is assigned at these population thresholds. I show that there are no discontinuities of a similar size in the mayoral electoral outcomes I examine (Tables C.17 and C.18). However, legislator salaries and legislature size can affect economic outcomes, so I do not estimate placebo regressions for my public goods outcomes. Second, I test whether the probability of being above or below these thresholds changes discontinuously at the 200,000 voter threshold. I do not find evidence of a discontinuity (Figure C.2)\(^{23}\), indicating that any effect of these policies is balanced across the threshold.

The last possibility is that potential confounds change discretely at the threshold. I test this by estimating equation (4.1) on pre-treatment characteristics of municipalities. I discuss this in detail in the following section.

4.2.b. Balance on pre-treatment characteristics.— Since the treatment (here, the two-round election) is determined by the number of registered voters, municipalities can move into the treatment group or be treated multiple times\(^{24}\). As a result, I define “pre-treatment” in two ways: 1) prior to the introduction of the electoral system in the 1988 Constitution, and 2) prior to the most recent election the municipality was untreated or prior to 1996 if the

\(^{22}\)Due to the skewed right tail of municipality sizes, the size of the discontinuity was estimated off a sample of municipalities excluding those above the 99.9 percentile of registered voters.

\(^{23}\)The regression discontinuity estimate on the probability of being above the 300,000 resident threshold is $-0.0350$ ($p = 0.735$). The regression discontinuity estimate on the probability of being above the 295,714 resident threshold is $0.0516$ ($p = 0.667$).

\(^{24}\)Municipalities can also move out of treatment. While municipalities do experience population decline, none moves below the 200,000 voter threshold.
municipality was never untreated\textsuperscript{25}. To measure outcomes for (1), I use the 5% population sample of the 1980 census, the most recent census prior to 1988. To measure outcomes for (2), I use outcomes either from the census prior to the most recent year in a single-round system (the 1991, 2000, or 2010 census) or outcomes from the 1991 census, for municipalities which were in a two-round system in 1996.

There is no significant treatment effect on nearly all outcomes measured prior to the 1988 Constitution (Panel A of Table 3) and prior to the most recent election in a single-round system (Panel B of Table 3). The treatment effect is estimated on economic characteristics (unemployment rate, literacy, and income), segregation levels\textsuperscript{26} (along income and demographics), and income inequality. To rule out the concern that there are factors that change discontinuously at the threshold and affect which municipalities move into treatment and length of treatment, I test whether population growth is discontinuous at the threshold. If municipalities that grow at slower rates are more likely to be under the threshold and remain there longer, this poses an issue for causal identification. I do not find that population growth is discontinuous at the threshold.

One exception is a large and significant effect on population density. However, there are several reasons to believe this is a false positive. First, dropping one outlier municipality reduces the coefficient by 38.2%, suggesting that a few municipalities are driving this effect, although the estimate is still significant at the 10% level. My main results are robust to dropping this outlier municipality. In addition, there is no visible discontinuity and the effect disappears at larger bandwidths (Figures C.3 and C.4). Second, the estimate ($p = 0.047$) is not significant after Bonferroni adjusting the significance threshold for the number of hypotheses tested. Third, the regression discontinuity coefficients across the ten outcomes (from the most recent single-round) are not jointly significant ($p = 0.339$).

While it is not clear how an imbalance in population density impacts the economic and political outcomes of interest, this poses an issue if politicians are manipulating the composition and size of the electorate by, say, moving citizens or manipulating municipality borders. This does not appear to be the case for two reasons. First, I find no differences in the

\textsuperscript{25}The earliest electoral data available is 1996, so I cannot observe whether municipalities are treated or untreated prior to 1996. Since there is only one unobserved municipal election after the 1988 Constitution (in 1992) and only 45 municipalities have moved across the 200,000 voter threshold between 1996 and 2016, it is unlikely that many municipalities had their electoral rule change between 1992 and 1996.

\textsuperscript{26}This is calculated using the entropy index (see section 4.4 for detailed calculation), which measures how far each census sector is from equal representation of all groups. This was calculated separately for income and demographics. For income, the groups are defined by bins of income relative to the minimum wage. For demographics, the groups are defined by sex, age, and literacy.
urbanization rate (a difference of 0.065%, where the single-round mean is 95.191%, \( p = 0.943 \)). Second, this effect is seen in 1980, prior to the introduction of the threshold rule (Panel A of Table 3). Third, there is no evidence that changes in municipality area or population growth change discontinuously across the threshold (Panel B of Table 3). Nevertheless, I include population density as a control in all specifications\(^{27}\).

**4.2.c. Testing smoothness.**— I test whether my outcomes of interest vary smoothly around the discontinuity. To do this, I estimate placebo regressions where the electoral rule is assigned at other registered voter thresholds between 170,000 and 230,000 voters. This tests whether the effects I estimate are concentrated at the actual threshold of 200,000 voters. I show that there is no discontinuity in my outcomes at thresholds where the treatment does not change (Figures C.19, C.20, C.21, C.22, and C.23).

**4.2.d. Registered voters as a running variable.**— Since treatment (moving into a two-round election) is determined by the number of registered voters, there are interesting implications for the interpretation of the regression discontinuity estimate.

As discussed above, municipalities can move into treatment or be treated multiple times. While this does not invalidate causal identification, it affects whether the treatment effects I estimate are the result of single or multiple treatments.

To investigate this, I test whether the probability that a municipality’s previous election was a two-round system changes discontinuously at the threshold (Figure C.6). Because the regression discontinuity framework identifies the treatment effect at the threshold, treatment effects should be interpreted as the result of the change in this probability at the threshold. I find that at the 200,000 registered voter threshold, the probability of having previously been treated is zero and there is no discontinuous jump\(^{28}\). As a result, the treatment effects identify the effect of moving into a two-round election for the first time.

**4.2.e. Compliance.**— While not an issue for causal identification, imperfect compliance with treatment can affect the interpretation of the causal estimates (Angrist et al., 1996). In this context, compliance was perfect (Figure C.5). All municipalities below the threshold or

\[^{27}\text{I include it linearly and estimate it separately on both sides of the discontinuity:}\]

\[
Y_{it} = \beta_1 D_{it} + \beta_2 X_{it} + \beta_3 X_{it} \cdot D_{it} + \beta_4 Z_{it} + \beta_5 Z_{it} \cdot D_{it} + \gamma_{it} + \varepsilon_{it}
\]

where \(Z_{it}\) is the municipality’s population density in the most recent census prior to the election.

\[^{28}\text{Because no municipalities move under the threshold, all municipalities under the threshold have 0 probability that the previous election was two-round. The regression discontinuity estimate on the probability of being in a two-round system in the previous election is } -0.00802 \text{ (} p = 0.870 \text{).}\]
where the top candidate received at least 50% held one round. All municipalities above the threshold and where the top candidate did not receive at least 50% held two rounds.

4.3. Data sources

4.3.a. Electoral data.— Data on municipality elections come from Brazil’s electoral authority (Tribunal Superior Eleitoral or TSE). These are available for 6 municipal elections between 1996 and 2016. The electoral data provides information on the candidates running, the party and coalition each candidate belongs to, and votes received. In total, there are 32,767 municipal elections covering 5,568 municipalities.

Electoral results are available for each polling station (seção eleitoral), allowing me to observe at a very fine level the number of votes each candidate receives. I use this to measure the geographic distribution of voters for specific candidates at an overall and at a candidate level. Baseline results use votes from the first round of elections. Results from the first round are used to have similar measures between single- and two-round elections, but results are robust to using votes from the final round (the first round in single-round elections and the second round in two-round elections).

To measure the overall level of geographic concentration of voters, I draw from the racial segregation literature. I use three measures of multigroup concentration: the coefficient of variation, the fractionalization index, and the entropy index. The construction of these indices is discussed in section 4.4. My preferred measure is the coefficient of variation, as it is easily interpreted as the deviation of the composition of voters in each polling station from the composition of voters in the municipality. The fractionalization index and the entropy index measure the extent to which polling stations contain different types of voters. All three indices range from 0 to 1, where values closer to 1 indicate greater concentration of voters.

To measure a candidate level of geographic concentration of voters, I use the standard deviation of a candidate’s vote share across polling stations in the municipality. Intuitively, if a candidate receives support from more areas of the municipality, she should experience less variation in her vote share across polling stations.

4.3.b. Public goods provision in schools.— To measure public goods provision in municipal public schools, I use data provided in the 1997-2016 School Census (Censo Escolar). This census is conducted annually by the research arm of the Ministry of Education, Instituto Nacional de Estudos e Pesquisas Educacionais.

I use the Census to observe the level of resources present in schools offering elementary
education. I calculate a measure of resources present in each school across two categories: equipment and infrastructure. Equipment includes movable elements such as the number of computers and availability of air conditioning (see Table B.1 for the full list). Infrastructure includes immovable elements such as the number of classrooms, type of sanitation, and availability of a library (see Table B.2 for the full list). I construct indices of these resources, separately for equipment and infrastructure, by taking the principal component of these variables and computing the school’s percentile rank within the country in each year.\footnote{The variables collected in the School Census under each category varied from year to year. As a result, this makes it difficult to compare the raw PCA index across years. Calculating a school’s percentile rank across all schools for that year allows comparisons across years.}

4.4. Measuring concentration of voters

To measure the overall geographic concentration of voters, I use the coefficient of variation, the fractionalization index, and the entropy index. These indices and their properties are described in more detail in White (1986) and Reardon and Firebaugh (2002). The indices assume a value of 1 if there is full geographic concentration of voters: each polling station contains voters for only one candidate. The indices assume a value of 0 if there is full geographic dispersion of voters: each polling station contains the same composition of voters as the municipality as a whole. To measure a candidate level geographic concentration of voters, I use the standard deviation in vote shares across polling stations.

In this section, I use the following notation. For polling station $i$ in municipality $m$, $p_{mk}$ is the fraction of voters for candidate $k$ in municipality $m$, $p_{imk}$ is the fraction of voters for candidate $k$ in polling station $i$, $n_{im}$ is the number of voters in polling station $i$, and $N_m$ is the number of voters in municipality $m$.

4.4.a. Overall geographic concentration of voters. The coefficient of variation, $s_m$, is defined as:

$$s_m = \frac{1}{K_m - 1} \sum_{k=1}^{K_m} \sum_{i=1}^{I_m} \frac{n_{im} (p_{imk} - p_{mk})^2}{p_{mk}}$$

(4.2)

This index is interpreted as the square deviation of voter composition in polling stations from voter composition in the municipality. Dividing by the number of candidates $K_m$ keeps the index between 0 and 1. When each polling station has the same composition as the municipality ($p_{imk} = p_{mk}$), the index takes a value of 0.

The fractionalization index, $f_m$, is calculated in two steps. The average fractionalization
within each polling station, $\bar{f}_m$, is defined as:

$$\bar{f}_m = \frac{K_m}{\sum_{k=1}^{K_m} \sum_{i=1}^{I_m} \frac{n_{im}}{N_m} p_{imk} (1 - p_{imk})}$$

(4.3)

The overall fractionalization within the municipality, $\hat{f}_m$, is defined as:

$$\hat{f}_m = \frac{1}{K_m} \sum_{k=1}^{K_m} p_{mk} (1 - p_{mk})$$

(4.4)

The final measure, the fractionalization index, $f_m$, is defined as:

$$f_m = \frac{\hat{f}_m - \bar{f}_m}{\hat{f}_m}$$

(4.5)

Fractionalization is also known as the interaction index and measures the probability that two members within a population chosen at random are from different groups. $f_m$ should be interpreted as the average concentration within polling stations, normalized by the overall level in the municipality to keep the index between 0 and 1. When each polling station has the same concentration as the municipality ($\hat{f}_m = \bar{f}_m$), the index takes a value of 0. When each polling station contains only one type of voter ($\bar{f}_m = 0$), the index takes a value of 1.

The entropy index, $h_m$, is also calculated in two steps. The average entropy within each polling station, $\bar{h}_m$, is defined as:

$$\bar{h}_m = -\frac{1}{K_m} \sum_{k=1}^{K_m} \sum_{i=1}^{I_m} \frac{n_{im}}{N_m} p_{imk} \ln p_{imk}$$

(4.6)

The overall entropy within the municipality, $\hat{h}_m$, is defined as:

$$\hat{h}_m = -\sum_{k=1}^{K_m} p_{mk} \ln p_{mk}$$

(4.7)

The final measure, the entropy index, $h_m$, is defined as:

$$h_m = \frac{\hat{h}_m - \bar{h}_m}{\hat{h}_m}$$

(4.8)

Entropy measures how far the population is from equal representation of all groups. The interpretation and range of values of the entropy index $h_m$ are the same as that of the
fractionalization index $f_m$.

**Candidate level geographic concentration of voters.** The standard deviation in a candidate’s vote share, $\sigma_{mk}$, is defined as:

$$\sigma_{mk} = \left( \frac{1}{I_m - 1} \sum_{i=1}^{I_m} \left( p_{imk} - \frac{1}{I_m} \sum_{i=1}^{I_m} p_{imk} \right)^2 \right)^{1/2} \quad (4.9)$$

**Using only the top two candidates.** In some cases, I calculate the indices using only vote shares from the top two candidates. To do this, I assume only the top two candidates are in the race and use the candidate’s vote share out of the top two. These indices should be interpreted as the geographic distribution of voters for the top two candidates. The advantage of doing this is to keep the number of candidates fixed and ignore potential dilution of votes from lower-placed candidates. This is done when comparing to the second round of two-round elections or to show robustness of my results to the number of candidates. Note that, by construction, the standard deviation of votes for the 1st place candidate $\sigma_{m1}$ is the same as that of the 2nd place candidate $\sigma_{m2}$.

5. The effect of the two-round system

I present three main results. First, candidates in two-round elections receive broader geographical support. Second, once in office, politicians elected under two-round systems provide more resources to schools and distribute these resources more equitably. These results suggest that politicians in two-round systems are represented by a broader group of voters and that this affects how public goods are provided in the municipality. Third, I find that educational outcomes are improved in two-round municipalities.

5.1. The geography of votes

Do candidates in two-round elections secure broader bases of support? I provide evidence that voters are overall less geographically concentrated and that it is the top two candidates who receive support from a geographically broader group of voters.

5.1.a. Geographic concentration of voters. The coefficients on the coefficient of variation, fractionalization index, and entropy index are negative, indicating that voters for specific
candidates are overall less geographically concentrated in two-round elections (Figure 4 and Panel A of Table 6). The composition of voters in polling stations is closer to the composition of voters in the municipality as a whole, indicated by the coefficient of variation, and the composition of voters in polling stations is on average less concentrated, indicated by the fractionalization and entropy indices. Municipalities in two-round systems experience a reduction of 0.0087, 0.0118, and 0.0082 in the coefficient of variation, fractionalization, and entropy of voters, respectively. These coefficients correspond to 45.6%, 43.9% and 27.4%, respectively, of the average level in single-round municipalities in the bandwidth.

Next, I test whether all or only some candidates obtain support from geographically broader constituencies. I find that voters for the top two candidates are less concentrated in two-round systems, but that voters for the third and fourth placed candidates in two-round systems are concentrated similarly to voters of the same-placed candidates in single-round systems (Figure 5 and Panel B of Table 6). The estimates for the top two candidates are similar in magnitude: the first placed candidate experiences a 0.0167 reduction in variance (20.9% of the single-round mean) and the second placed candidate experiences a 0.0142 reduction (18.9% of the single-round mean). The estimates for the third and fourth placed candidates are close to zero and insignificant.

The effects on overall concentration are significantly stronger when using vote shares from the top two candidates only (Table 8). This further indicates that the bases of support of the top two candidates drive the reduced concentration of voters in two-round elections.

These effects are not limited to vote shares in the first round. Using only vote shares from the top two candidates, I compare concentration in single-round elections with concentration in the second round of two-round elections. Voters in the second round are also less geographically concentrated (Panel A of Table 7). I also compare concentration between the first and second round in two-round municipalities. While these estimates are correlational and not causal, concentration in the second round is lower than in the first round, indicating that candidates consolidate their voter bases between rounds (Panel B of Table 7).

5.1.b. Voter engagement.— These results suggest that two-round elections lead to greater inclusiveness, as voters from more diverse geographical areas are being represented. I find inclusiveness along another dimension: voter behavior. More specifically, I find higher rates of voter engagement in two-round elections. While turnout is unaffected (which is expected, as turnout is mandatory in Brazil), the number of blank and invalid ballots is significantly lower.

30I compare the coefficients in Table 6 with Table 8. The p-values for the difference between the estimates are 0.024 (for the coefficient of variation), 0.052 (for fractionalization) and 0.147 (for entropy).
in two-round municipalities (Table 9). The number of blank and invalid ballots plausibly corresponds to dissatisfied or disinterested voters (Gonzales et al., 2019)\(^{31}\). The reduction suggests that voters in two-round elections engage in the electoral process at higher rates.

5.2. The allocation of municipal resources

I next investigate the impact of the two-round system on public goods provision. If politicians secure broader bases of support in two-round elections, they may also provide public goods differently once in office. I provide evidence that two-round elections impact both the level and distribution of municipal resources.

5.2.a. Municipal schools.– Municipal schools in two-round municipalities have, on average, more resources (Figure 10 and Columns 1 and 2 in Table 12). A school in a two-round municipality is, on average, 0.081 percentiles and 0.057 percentiles higher in the national distribution of equipment resources and infrastructure resources, respectively. The coefficient on infrastructure resources is smaller and less significant, which may be because infrastructure is more difficult to manipulate, as allocating new infrastructure, such as gymnasiums, requires significantly more time and capital than allocating equipment, such as computers. This is reflected when looking at the estimates separately by the year in the mayoral term: infrastructure levels are less responsive to the electoral cycle (Column 1 in Table 13).

In addition to differences in the overall levels, there is less variance in the resources present in schools in two-round municipalities (Figure 11 and Columns 1 and 2 in Table 12). The standard deviation in equipment resources is 0.018 percentiles lower in two-round municipalities (15.9% of the single-round mean). Although the estimate on the standard deviation in infrastructure resources is of a similar magnitude (−0.021 percentiles), the difference is not significant.

It is instructive to estimate effects for schools at different parts of the distribution in the municipality. Intuitively, if the variance in resources is lower in two-round municipalities, we should expect to see that schools with the least (most) resources in the municipality have more (less) resources.

I group schools into quartiles, which are defined by first calculating for each school its

\(^{31}\)Ballots can be invalid or blank for a number of reasons. For example, municipalities with higher numbers of illiterate voters will have more blank and invalid ballots (Fujiwara, 2015). Since the illiteracy rate is not discontinuous across the threshold and all municipalities used electronic voting by 2000 (which reduced the number of unintentional errors), I interpret the difference in the number of blank and invalid ballots as voter engagement. Gonzales et al. (2019) provide empirical evidence for this interpretation as they find that forced electoral participation increases the number of blank and invalid ballots cast.
percentile in the municipality distribution prior to the election, and then assigning the school to one of four quartiles. The increased level of resources is concentrated in schools located at the lower end of the distribution (Table 14). Schools at the bottom 25% of the distribution are 0.082 percentiles higher in equipment resources and 0.116 percentiles higher in infrastructure resources. Schools in the second quartile experience positive, but smaller gains – 0.066 percentiles in equipment resources and 0.102 percentiles in infrastructure resources. There is no significant difference in resources at the top of the distribution.

5.3. Downstream outcomes

If mayors provide more public goods and distribute them more equitably, does this translate into downstream economic outcomes? I find, in two-round municipalities, improvements on education outcomes but limited effects on economic outcomes.

5.3.a. Education outcomes.– I measure education outcomes in four ways. Using the School Census, I measure the drop-out, failing, and passing rate in schools in the municipality. Using the 2000 and 2010 Demographic Censuses, I measure the literacy rate among cohorts who were of elementary school age during the electoral term. I find that, in two-round municipalities, drop-out rates are significantly lower, 1.65 percentage points off a baseline of 3.21 percentage points, and literacy rates are significantly higher among elementary cohorts, 1.20 percentage points off a baseline of 91.45 percentage points (Figure 16 and Panel A of Table 17). While the drop-out rates are lower, this does not necessarily lead to improved passing rates or worsened failing rates. These results suggest that differential public goods provision in two-round municipalities lead to some improvements in education outcomes.

5.3.b. Economic outcomes.– If two-round municipalities lead to improved education outcomes, this may result in improved economic outcomes. I find some, but limited, improvements on broader economic outcomes (Panel B of Table 17). Using the 2000 and 2010 Demographic Census, I measure the fraction of low income households, income per capita, and the unemployment rate. These outcomes are measured between 2-10 years after the election. Using the 1997-2013 NOAA night lights series, I measure the mean night lights level in the municipality. I find that the fraction of low-income households is significantly lower. This

\[32\text{The p-values for the difference in the regression discontinuity estimates between schools at the 1st quartile compared to the 4th quartile is 0.057 (for equipment) and 0.038 (for infrastructure).}\]

\[33\text{For the 1996 elections, outcomes are observed 4 years later in the 2000 Demographic Census. For the 2000, 2004, and 2008 elections, outcomes are observed 10, 6, and 2 years later in the 2010 Demographic Census.}\]
may be a false positive as the coefficient is large relative to the mean; controlling for the pre-election level reduces the coefficient to $-1.477$ percentage points ($p = 0.0872$). Coefficients on the other outcomes suggest that two-round municipalities lead to improved economic outcomes (income per capita is higher, unemployment is lower, and night lights is higher) but that this effect is not significant.

There may be several reasons broader economic outcomes do not significantly improve. First, two-round elections do not lead to improved economic outcomes. Second, the public goods and policies that mayors implement have no or limited influence on economic outcomes. Outside of health and education, mayors are also responsible for local infrastructure such as public transportation, urban planning, and public health such as sanitation. It is possible but unlikely that these policies do not influence outcomes such as income and employment. Third, there are no improvements in economic outcomes in the short term. Outcomes such as income and night lights may take more than 2-10 years to improve. Fourth, improvements in economic outcomes are not experienced in aggregate but among certain populations. For example, I find that increased school resources are concentrated in schools at the bottom of the distribution. This may explain the significant effect on the low income rate, which reflects outcomes of the poorest households, and not on more aggregate economic outcomes.

5.4. Robustness of the main results

5.4.a. Bias in measures of concentration.— I address two potential sources of mechanical bias in the concentration indices.

One is the size of the parcels (here, polling stations) used to calculate the indices. The number of voters assigned to each polling station is regulated by the TSE so all polling stations should in principle be of similar size (on average, there are 272 valid votes at each polling station). Empirically, the difference in the number of valid votes at each polling station is small in magnitude (3.605 votes) and insignificant ($p = 0.764$).

A second concern, although potentially a mechanism, is the increased number of candidates in two-round elections (Table 9). While the entropy index and fractionalization measure may be affected by the number of candidates, the direction of bias is not monotonic (White, 1986). Nevertheless, I perform three robustness checks.

First, while the number of candidates is a bad control as it is an endogenous outcome, controlling for the number of candidates does not affect the qualitative results (Table C.7). Second, I simulate the effect of adding an additional candidate to all single-round elections.\footnote{I do this by adding in a last place candidate to each polling station. I assign that candidate the number

34}
For most measures, the estimated bias is small and, for the coefficient of variation, of the wrong sign (the row “Potential bias” in Table 6). However, the bias is substantial for the entropy index. Third, I re-calculate all the outcomes using only the vote shares from the top two candidates, to maintain the same number of candidates across single- and two-round elections. Doing so does not substantially change the results (Table 8).

5.4.b. Calculating the resource index. – The resource index is constructed by taking the first principal component of each school’s resources, then calculating a school’s percentile rank in the national distribution. Using a resource index constructed by taking the z-scores of each school’s resources, then calculating a school’s percentile rank in the national distribution, does not affect the qualitative results (Table C.8).

5.4.c. RDD design. – I investigate the robustness of my results to the regression discontinuity design. First, these results are not driven by the choice of bandwidth, whether fixed or chosen by a data-driven method (Figures C.9 and C.10 for voter concentration outcomes; Figures C.11 and C.12 for municipal school outcomes; Figure C.13 for education outcomes). The estimates maintain similar magnitudes and mostly retain significance for bandwidths out to 150,000 voters, although the estimates for the standard deviation in school resources decline and are not significant at larger bandwidths. Second, dropping controls from the regression, namely population density and election-year fixed effects, does not substantially affect the results, although the results are noisier (Tables C.14, C.15, and C.16).

5.4.d. Placebo tests. – As discussed in section 4.2.a, I do not find that policy thresholds at 300,000 inhabitants and at 285,714 inhabitants confound my results. First, in placebo regressions, I do not find similar effects at these thresholds for the mayoral electoral outcomes (Tables C.17 and C.18). Second, I show that any effects of these policies is balanced across both sides of the threshold (Figure C.2).

I also show that there are no discontinuities at placebo thresholds in registered voters (170,000; 180,000; 190,000; 210,000; 220,000; 230,000), indicating that the outcomes are of votes the average last place candidate receives (1.5%). I take away a proportionate number of votes from the other candidates, to ensure that the total number of votes remains the same. I then calculate the change between the actual value and the simulated value.

35Since the number of inhabitants is not the same as the number of registered voters (nor do they map 1:1), to maintain comparability with the baseline estimates, I use a bandwidth of 125,000 inhabitants. This bandwidth was determined by taking half of the population range of municipalities in my 50,000 voter bandwidth (the smallest municipality is 182,082 inhabitants and the largest at 434,474 inhabitants). Since the salary cap was implemented in 2000, I estimate this using elections after 2000. Since the legislature size was implemented in 2004, I estimate this using elections after 2004.
relatively continuous at places where the treatment does not change (Figures C.19 and C.20 for voter concentration outcomes; Figures C.21 and C.22 for municipal school outcomes; Figure C.23 for education outcomes). The treatment effect is isolated to the actual threshold: there are no estimates with the same size and significance as at the actual threshold.

6. Discussion

In my model, two-round elections lead to different outcomes because candidates adjust their strategies by offering policies that appeal to a broader group of voters. However, there may be other explanations. Namely, different types of candidates may enter two-round elections or different types of candidates may win two-round elections. In the following section, I explore these explanations and provide suggestive evidence that candidates’ strategic behavioral responses explain a larger part of the effect of the two-round system.

6.1. Selection in candidates

Candidates in two-round elections may have a broader group of supporters because different types of candidates enter electoral races. For example, two-round elections may incentivize candidates who are more competent or more relatable to enter. I do not find that candidates in two-round elections are significantly different from candidates in single-round elections along observable characteristics. There is no significant difference on age, sex, educational attainment, or state of birth (Panel A of Table 18). Candidates also do not have different occupational backgrounds (Panel B of Table 18).

A second possibility is that different types of candidates win in two-round elections. I also find no evidence that election winners are observably different along the aforementioned characteristics (Table 19).

I find differences in political affiliation among candidates who enter the elections. There are more candidates from small parties and who previously ran as mayoral candidates in two-round elections (Panel A of Table 20), but they are not more likely to win the election.

36 A third possibility is that voters behave differently in two-round elections, either through turnout or strategic voting. In Brazil, turnout is not a major factor as turnout is mandatory. Regarding strategic voting, Fujiwara (2011) finds that third placed and lower candidates receive higher vote shares in two-round elections and argues that voters behave less strategically in two-round elections. While this paper is not focused on voter behavior, I interpret strategic behavioral responses of candidates as an equilibrium outcome that can arise from the electoral rule directly or indirectly through the electoral rule’s impact on voter behavior.
Candidates with incumbency are less likely to win two-round elections, but this result is not robust to other bandwidths. Since smaller parties are more likely to appeal to narrower electorates, it is unlikely that the identity of the candidate’s party explains the reduced concentration in vote shares.

Small candidates may enter two-round elections for several reasons. First, they may be building support for subsequent elections, which is one reason more candidates with previous campaign experience enter two-round elections. Second, these candidates may be seeking to gain positions in the elected administration. Third, and most interestingly, these candidates may want to influence the top candidates’ platforms. In my model, in the two-round election, the small, third candidate indirectly influences the top candidates’ platforms by leading these candidates to offer policies that appeal to her voters. In reality, the third candidate may influence these policies more directly, either by strategically shaping her own policy or through direct bargaining.

6.2. Strategic behavioral responses by candidates

I find limited evidence that two-round elections cause different types of individuals to enter or win the elections. Instead, I find evidence that is consistent with candidates adjusting their strategies during the election.

6.2.a. Reelection incentives.– I rule out that candidates’ different strategic behaviors is caused by changes in reelection incentives. I do not find a significant difference in the treatment effect on municipal school resources between mayors in their first term (eligible for re-election) or second term (Table 15).

However, it may be the case that term limits are not relevant for mayors in my sample. In Brazil, mayors face strong incentives to reward their supporters after the election, even those who are not eligible for re-election. Municipal mayors are viewed as important local operatives who deliver votes for their parties at the state and federal levels, and it is not uncommon for mayors to seek office themselves at the state and federal levels.38

This suggests that, in line with the model’s predictions, different outcomes in two-round elections come instead from candidates adopting different strategies during the campaign, which I discuss in further detail in the following sections.

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37I define a small party as any party that is not one of the top 5 parties in Brazil by national membership.
38In my sample, 46.2% of mayors stand as candidates in a state or federal election after their term and 83.7% of mayors have stood at this level ever. In larger cities, the position of the municipal mayor is often viewed as a stepping stone for higher office.
6.2.b. Concentration between the first and second round.— In section 5.1, I find that the concentration of voters for the top two candidates decreases between the first and second round of the two-round election. In my model, candidates do not change platforms between rounds. In reality, it is more likely that candidates adjust their strategies but are constrained in the extent to which they can do so. There is empirical evidence that candidates qualifying for the second round rally votes from supporters of the candidates eliminated after the first round (Pons and Tricaud, 2018). The decrease in concentration between rounds suggests that candidates adjust their strategies to rally these voters.

6.2.c. Campaign financing.— For the 2004-2012 elections, I am able to observe one aspect of candidate’s strategies: how the campaigns are financed. I find that candidates in two-round elections receive less donations, both on average (Panel A of Table 21) and between the top two candidates (Panel B of Table 21). While the outcomes are noisy, the effects are strongest for donations from corporations: candidates in two-round elections receive fewer donations from corporations.

These results suggest that candidates in two-round elections run their campaigns differently. For example, candidates may be offering policies that appeal to individuals rather than corporations. To the extent that corporations represent a narrower swath of the electorate, the pattern in donations suggests that candidates in two-round elections adopt strategies to appeal more broadly.

7. Conclusion

A majority of countries use two-round systems to choose their leaders, and an increasing number of countries are adopting this system over time. This paper studies how the electoral rule leads to the election of politicians who represent broader or narrower groups of voters and distribute state resources differently. To identify the effect of the two-round system, I leverage a unique rule in Brazilian municipal elections: municipalities above a threshold of registered voters hold two rounds whereas municipalities below this threshold hold a single round. I find that candidates in two-round municipalities are represented by a geographically broader group

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39 I exclude the 2016 elections from the sample, as a new campaign finance law was passed in 2016 that banned donations from corporations.
40 Donors are classified as corporations or individuals, depending on whether a CPF (individual identification number) or CNPJ (corporate identification number) was filed for the donation.
of voters. Once in office, mayors elected under two-round systems provide more resources to municipal schools and distribute these resources more evenly across schools. I find evidence that downstream educational outcomes are also improved in two-round municipalities.

I present a model to highlight why two-round elections may lead to these empirical results. In my model, the second round raises the marginal return to allocating resources. This creates incentives to (i) increase the government budget and (ii) appeal to voters that candidates in a single-round system would otherwise ignore. The main intuition is that two-round elections perform two functions. First, they require a candidate to attain at least 50% of the vote in order to win. Second, the second round effectively limits the number of candidates to two.

My model proposes that two-round elections lead to different outcomes because candidates adopt different strategies. I find evidence suggesting that two-round systems cause candidates to adjust their behavior rather than cause different types of candidates to enter the races. First, I find evidence indicating that candidates consolidate their bases of support between rounds. Second, candidates in two-round elections adopt more broadly appealing strategies, resulting in fewer corporate donors for their campaigns.

If two-round systems lead to positive outcomes, why is the two-round system not more widely used? The reality is that there are potential trade-offs. First, it may be costly for voters to vote twice in a short span of time. In Brazil, turnout is lower in the second round compared to the first round. Uncovering the reasons for this will help better understand the costs of two-round systems. Second, I find that, in two-round systems, individuals at lower parts of the distribution benefit. As a result, there may be opposition by richer households or the elite to implementing two-round systems. Identifying barriers to adopting more inclusive institutions is crucial to understanding the process of political reform. Lastly, two-round elections may only result in better outcomes when the electorate is composed of many small groups. Brazil is a multi-party system and the average single-round election has 4.6 candidates running. Incentivizing candidates to incorporate smaller groups in the coalition may lead to better outcomes. This may not translate to contexts where the electorate is composed of two large groups. Providing more empirical evidence of the causal effect of two-round systems in different contexts would greatly advance our understanding of electoral systems.
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### Figure 1  Electoral rules around the world

*Single-round plurality* (light red) and *Two-round majority* (dark red) correspond to the single- and two-round system in Brazil. Vertical axis corresponds to the number of countries which held an election within the specified time period under the specified electoral rule. Data encompasses 497 presidential elections across 71 countries with democratic regimes and presidential systems, between 1946-2016. *Source: Bormann and Golder (2013).*
Figure 2  Density of elections around the 200,000 registered voter threshold

Plot includes only elections with between 50,000 and 400,000 registered voters (6.0% of the universe of elections). Size of the discontinuity in the density of elections uses the McCrary test and is estimated off all elections below the 99.9 percentile in size. An “election” is defined as a municipality-election year. Bin sizes are 10,000 voter bins.
Table 3  Regression discontinuity estimates on municipality pre-characteristics

<table>
<thead>
<tr>
<th>Panel A: Characteristics measured prior to the 1988 Constitution</th>
<th>% illiterate</th>
<th>% low income</th>
<th>Unempl. rate</th>
<th>Pop. density</th>
</tr>
</thead>
<tbody>
<tr>
<td>TwoRound</td>
<td>−1.499</td>
<td>−0.751</td>
<td>0.044</td>
<td>−397.678**</td>
</tr>
<tr>
<td></td>
<td>(1.057)</td>
<td>(1.148)</td>
<td>(0.145)</td>
<td>(184.347)</td>
</tr>
<tr>
<td>Single round mean</td>
<td>19.029</td>
<td>50.182</td>
<td>1.978</td>
<td>516.067</td>
</tr>
<tr>
<td>Observations</td>
<td>293</td>
<td>293</td>
<td>293</td>
<td>293</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel B: Characteristics measured prior to most recent single-round</th>
<th>Muni. area change (%)</th>
<th>Pop. growth (%)</th>
<th>Pop. density</th>
<th>Income seg.</th>
<th>Dem. seg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>TwoRound</td>
<td>−0.601</td>
<td>−0.468</td>
<td>−663.035**</td>
<td>−0.003</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>(2.296)</td>
<td>(1.260)</td>
<td>(332.555)</td>
<td>(0.004)</td>
<td>(0.001)</td>
</tr>
<tr>
<td>Single round mean</td>
<td>−3.003</td>
<td>2.863</td>
<td>1,013.396</td>
<td>0.090</td>
<td>0.028</td>
</tr>
<tr>
<td>Observations</td>
<td>231</td>
<td>295</td>
<td>295</td>
<td>231</td>
<td>231</td>
</tr>
</tbody>
</table>

| TwoRound                                                          | 0.014                 | −18.964         | 1.211        | −0.652      | 0.004     |
|                                                                  | (0.590)               | (33.328)        | (2.290)      | (1.114)     | (0.009)   |
| Single round mean                                                | 7.409                 | 646.917         | 36.123       | 11.671      | 0.540     |
| Observations                                                     | 295                   | 295             | 295          | 295         | 295       |

*p < 0.10, **p < 0.05, ***p < 0.01

Panel A: outcomes from the 1980 census. Panel B: outcomes either from the census prior to the most recent election in a single-round system or from the 1991 census. F-stat for all treatment effects in Panel B jointly significant: 1.146 (p = 0.339). Muni. area change is the percentage change in municipality area from the prior census. Pop. growth is the percentage change in population from the prior census. Pop. density is population density, per km². Income seg. and Dem. seg. refer to income and demographic segregation, respectively, of census tracts (measured using the entropy index). Income per capita is average monthly household income per capita, in reais. % low income is the fraction of households earning between 0 and 50% of the minimum wage. Estimation method: Local linear regression with election-year fixed effects and a 50,000 voter bandwidth. Standard errors clustered at the municipality level. Source: 1980, 1991, 2000, and 2010 Demographic Census.
Figure 4  Regression discontinuity plots of overall concentration of voters for specific candidates

Overall concentration of voters for specific candidates, as measured by (a) Coefficient of variation, (b) Fractionalization, and (c) Entropy, using vote counts in polling stations. Vote shares are from the first round. In each panel, each point plots an average value within a 7,500 voter bin. Variables on the vertical axis are residualized by population density and election-year fixed effects. Diameter of the points is proportional to the number of observations. Confidence intervals (dashed lines) represent the 95% confidence intervals of a local linear regression (solid red line) with standard errors clustered at the municipality level.
Figure 5  Regression discontinuity plots of the candidate level concentration in voters

(a) Standard deviation in votes for the 1st place candidate

(b) Standard deviation in votes for the 2nd place candidate

Standard deviation in a candidate’s vote counts across polling stations, for the (a) 1st place and (b) 2nd place candidate. Vote shares are from the first round. In each panel, each point plots an average value within a 7,500 voter bin. Variables on the vertical axis are residualized by population density and election-year fixed effects. Diameter of the points is proportional to the number of observations. Confidence intervals (dashed lines) represent the 95% confidence intervals of a local linear regression (solid red line) with standard errors clustered at the municipality level.
Table 6  Regression discontinuity estimates on the geographic concentration of voters

<table>
<thead>
<tr>
<th></th>
<th>Coefficient of variation</th>
<th>Fractionalization</th>
<th>Entropy</th>
</tr>
</thead>
<tbody>
<tr>
<td>TwoRound</td>
<td>−0.009*** (0.003)</td>
<td>−0.012** (0.005)</td>
<td>−0.008* (0.005)</td>
</tr>
<tr>
<td>Potential bias</td>
<td>0.0008 −0.0002 −0.0923</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single round mean</td>
<td>0.019 0.027 0.030</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>264 264 264</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Panel B: Standard deviation in vote shares for each candidate

<table>
<thead>
<tr>
<th></th>
<th>1st place candidate</th>
<th>2nd place candidate</th>
<th>3rd place candidate</th>
<th>4th place candidate</th>
</tr>
</thead>
<tbody>
<tr>
<td>TwoRound</td>
<td>−0.017** (0.007)</td>
<td>−0.014* (0.008)</td>
<td>−0.005 (0.007)</td>
<td>0.004 (0.004)</td>
</tr>
<tr>
<td>Potential bias</td>
<td>−0.0011</td>
<td>−0.0010</td>
<td>−0.0004</td>
<td>−0.0002</td>
</tr>
<tr>
<td>Single round mean</td>
<td>0.080</td>
<td>0.075</td>
<td>0.042</td>
<td>0.023</td>
</tr>
<tr>
<td>Observations</td>
<td>264</td>
<td>264</td>
<td>251</td>
<td>216</td>
</tr>
</tbody>
</table>

*p < 0.1, **p < 0.05, ***p < 0.01

Panel A: Concentration indices of voters for specific candidates, as measured by coefficient of variation, fractionalization, and entropy of vote counts in polling stations. Panel B: Candidate-level concentration of voters, measured by standard deviation in a candidate’s vote shares (for the 1st-4th place candidate) across polling stations. Potential bias is the simulated effect on the outcome from having an additional candidate in every single-round election. Vote shares are from the first round. Estimation method: Local linear regression with election-year fixed effects and a 50,000 voter bandwidth. Population density included as a control separately across the cutoff. Standard errors clustered at the municipality level.
Table 7  Estimates on the geographic concentration of voters across different rounds of elections

<table>
<thead>
<tr>
<th></th>
<th>Coefficient of variation</th>
<th>Fractionalization</th>
<th>Entropy</th>
<th>Std Dev of 1st place candidate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Panel A: single- versus two-round elections: vote shares from final round</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1st round in single-round compared to 2nd round in two-round)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TwoRound</td>
<td>−0.020**</td>
<td>−0.023***</td>
<td>−0.017***</td>
<td>−0.019**</td>
</tr>
<tr>
<td></td>
<td>(0.008)</td>
<td>(0.008)</td>
<td>(0.006)</td>
<td>(0.009)</td>
</tr>
<tr>
<td>Single round mean</td>
<td>0.036</td>
<td>0.038</td>
<td>0.029</td>
<td>0.088</td>
</tr>
<tr>
<td>Observations</td>
<td>216</td>
<td>216</td>
<td>216</td>
<td>216</td>
</tr>
<tr>
<td><strong>Panel B: two-round elections: vote shares in first versus second round</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1st round in two-round compared to 2nd round in two-round)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2ndRound</td>
<td>−0.012***</td>
<td>−0.012***</td>
<td>−0.010***</td>
<td>−0.013***</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.002)</td>
<td>(0.002)</td>
<td>(0.002)</td>
</tr>
<tr>
<td>First round mean</td>
<td>0.049</td>
<td>0.049</td>
<td>0.037</td>
<td>0.103</td>
</tr>
<tr>
<td>Observations</td>
<td>432</td>
<td>432</td>
<td>432</td>
<td>432</td>
</tr>
</tbody>
</table>

*p < 0.10, **p < 0.05, ***p < 0.01

Coefficient of variation, Fractionalization and Entropy measure the overall concentration of voters for specific candidates, using vote counts in polling stations. Standard deviation of 1st place candidate is the standard deviation in the 1st place candidate’s vote counts across polling stations. All outcomes use only vote shares from the top two candidates. Panel A compares the 1st round results (in single-round elections) with the 2nd round results (in two-round elections) and presents the regression discontinuity estimates. Estimation method: Local linear regression with election-year fixed effects and a 50,000 voter bandwidth. Population density included as a control separately across the cutoff. Standard errors clustered at the municipality level. Panel B compares the 1st round results (in two-round elections) with the 2nd round results (in two-round elections), using the full sample of elections that held two rounds. Estimation method: Standard regression with 2ndround as the regressor and election fixed effects. Standard errors clustered at the municipality level.
Table 8  Regression discontinuity estimates on the geographic concentration of voters, using vote shares from the top two candidates only

<table>
<thead>
<tr>
<th>Coefficient of variation</th>
<th>Fractionalization</th>
<th>Entropy</th>
<th>Std Dev of 1st place candidate</th>
</tr>
</thead>
<tbody>
<tr>
<td>TwoRound</td>
<td>−0.015*</td>
<td>−0.018**</td>
<td>−0.013**</td>
</tr>
<tr>
<td></td>
<td>(0.008)</td>
<td>(0.009)</td>
<td>(0.007)</td>
</tr>
<tr>
<td>Single round mean</td>
<td>0.036</td>
<td>0.038</td>
<td>0.029</td>
</tr>
<tr>
<td>Observations</td>
<td>264</td>
<td>264</td>
<td>264</td>
</tr>
</tbody>
</table>

*p < 0.10, **p < 0.05, ***p < 0.01

Coefficient of variation, Fractionalization and Entropy measure the overall concentration of voters for specific candidates, using vote counts in polling stations. Standard deviation of 1st place candidate is the standard deviation in the 1st place candidate’s vote counts across polling stations. All outcomes use only vote shares from the top two candidates. Estimation method: Local linear regression with election-year fixed effects and a 50,000 voter bandwidth. Population density included as a control separately across the cutoff. Standard errors clustered at the municipality level.

Table 9  Regression discontinuity estimates on other electoral outcomes

<table>
<thead>
<tr>
<th>Turnout</th>
<th>Blank/invalid ballots</th>
<th># candidates</th>
</tr>
</thead>
<tbody>
<tr>
<td>TwoRound</td>
<td>0.006</td>
<td>−3.821**</td>
</tr>
<tr>
<td></td>
<td>(0.008)</td>
<td>(1.670)</td>
</tr>
<tr>
<td>Single round mean</td>
<td>0.843</td>
<td>16.524</td>
</tr>
<tr>
<td>Observations</td>
<td>296</td>
<td>296</td>
</tr>
</tbody>
</table>

*p < 0.10, **p < 0.05, ***p < 0.01

Turnout is the fraction of eligible voters who cast a ballot in the election. Blank/invalid ballots is the sum of ballots (in thousands) that were either blank or voided, and is also equal to turnout minus valid ballots. Estimation method: Local linear regression with election-year fixed effects and a 50,000 voter bandwidth. Population density included as a control separately across the cutoff. Standard errors clustered at the municipality level.
Figure 10  Regression discontinuity plots of the overall level of resources in municipal schools

(a) Equipment, mean level of resources

(b) Infrastructure, mean level of resources

Equipment and Infrastructure are indices constructed by taking the first principal component of a school’s equipment and infrastructure elements, then calculating the school’s percentile in the national distribution. Mean level of resources is the mean index level across schools in the municipality for (a) equipment and (b) infrastructure. In each panel, each point plots an average value within a 7,500 voter bin. Variables on the vertical axis are residualized by population density and election-year fixed effects. Diameter of the points is proportional to the number of observations. Confidence intervals (dashed lines) represent the 95% confidence intervals of a local linear regression (solid red line) with standard errors clustered at the municipality level.
Figure 11 Regression discontinuity plots of the distribution of resources in municipal schools

Equipment and Infrastructure are indices constructed by taking the first principal component of a school’s equipment and infrastructure elements, then calculating the school’s percentile in the national distribution. Standard deviation in resources is the standard deviation in the index across schools in the municipality for (a) equipment and (b) infrastructure. In each panel, each point plots an average value within a 7,500 voter bin. Variables on the vertical axis are residualized by population density and election-year fixed effects. Diameter of the points is proportional to the number of observations. Confidence intervals (dashed lines) represent the 95% confidence intervals of a local linear regression (solid red line) with standard errors clustered at the municipality level.
Table 12  Regression discontinuity estimates on resources in municipal schools

<table>
<thead>
<tr>
<th></th>
<th>Mean level of resources</th>
<th>Standard deviation in resources</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Equipment</td>
<td>Infrastructure</td>
</tr>
<tr>
<td>TwoRound</td>
<td>0.081**</td>
<td>0.057*</td>
</tr>
<tr>
<td></td>
<td>(0.035)</td>
<td>(0.033)</td>
</tr>
<tr>
<td>Single round mean</td>
<td>0.738</td>
<td>0.731</td>
</tr>
<tr>
<td>Observations</td>
<td>820</td>
<td>912</td>
</tr>
</tbody>
</table>

*p < 0.10, **p < 0.05, ***p < 0.01

*Equipment* and *Infrastructure* are indices constructed by taking the first principal component of a school’s equipment and infrastructure elements, then calculating the school’s percentile in the national distribution. The first two columns (*Mean level of resources*) have as the dependent variable the mean index level across schools in the municipality. The last two columns (*Standard deviation in resources*) have as the dependent variable the standard deviation in the index across schools in the municipality. *Estimation method:* Local linear regression with election-year fixed effects and a 50,000 voter bandwidth. Population density included as a control separately across the cutoff. Standard errors clustered at the municipality level.
Table 13  Regression discontinuity estimates on resources in municipal schools, by year in the term

<table>
<thead>
<tr>
<th>Panel A: First year in the electoral term</th>
<th>Mean level of resources</th>
<th>Standard deviation in resources</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Equipment</td>
<td>Infrastructure</td>
</tr>
<tr>
<td>TwoRound</td>
<td>0.077**</td>
<td>0.052</td>
</tr>
<tr>
<td></td>
<td>(0.039)</td>
<td>(0.035)</td>
</tr>
<tr>
<td>Observations</td>
<td>197</td>
<td>227</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel B: Second year in the electoral term</th>
<th>Mean level of resources</th>
<th>Standard deviation in resources</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Equipment</td>
<td>Infrastructure</td>
</tr>
<tr>
<td>TwoRound</td>
<td>0.091**</td>
<td>0.059*</td>
</tr>
<tr>
<td></td>
<td>(0.039)</td>
<td>(0.033)</td>
</tr>
<tr>
<td>Observations</td>
<td>197</td>
<td>228</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel C: Third year in the electoral term</th>
<th>Mean level of resources</th>
<th>Standard deviation in resources</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Equipment</td>
<td>Infrastructure</td>
</tr>
<tr>
<td>TwoRound</td>
<td>0.087**</td>
<td>0.059*</td>
</tr>
<tr>
<td></td>
<td>(0.037)</td>
<td>(0.034)</td>
</tr>
<tr>
<td>Observations</td>
<td>197</td>
<td>228</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel D: Fourth year in the electoral term</th>
<th>Mean level of resources</th>
<th>Standard deviation in resources</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Equipment</td>
<td>Infrastructure</td>
</tr>
<tr>
<td>TwoRound</td>
<td>0.070**</td>
<td>0.059*</td>
</tr>
<tr>
<td></td>
<td>(0.033)</td>
<td>(0.034)</td>
</tr>
<tr>
<td>Bandwidth size</td>
<td>50,000</td>
<td>50,000</td>
</tr>
<tr>
<td>Observations</td>
<td>229</td>
<td>229</td>
</tr>
</tbody>
</table>

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Mayoral terms are for four years. Each panel displays the estimate separately for the 1st year (Panel A), 2nd year (Panel B), 3rd year (Panel C) and 4th year (Panel D) of the term. Equipment and Infrastructure are indices constructed by taking the first principal component of a school’s equipment and infrastructure elements, then calculating the school’s percentile in the national distribution. The first two columns (Mean level of resources) have as the dependent variable the mean index level across schools in the municipality. The last two columns (Standard deviation in resources) have as the dependent variable the standard deviation in the index across schools in the municipality. Estimation method: Local linear regression with election-year fixed effects and a 50,000 voter bandwidth. Population density included as a control separately across the cutoff. Standard errors clustered at the municipality level.
Table 14  Regression discontinuity estimates on resources in municipal schools, for schools at different quartiles in the municipal distribution

<table>
<thead>
<tr>
<th></th>
<th>1st quartile</th>
<th>2nd quartile</th>
<th>3rd quartile</th>
<th>4th quartile</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Panel A: Equipment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TwoRound</td>
<td>0.082**</td>
<td>0.066*</td>
<td>0.069*</td>
<td>0.038</td>
</tr>
<tr>
<td></td>
<td>(0.035)</td>
<td>(0.037)</td>
<td>(0.042)</td>
<td>(0.029)</td>
</tr>
<tr>
<td>Single round mean</td>
<td>0.652</td>
<td>0.733</td>
<td>0.781</td>
<td>0.856</td>
</tr>
<tr>
<td>Observations</td>
<td>700</td>
<td>728</td>
<td>760</td>
<td>748</td>
</tr>
<tr>
<td><strong>Panel B: Infrastructure</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TwoRound</td>
<td>0.116**</td>
<td>0.102**</td>
<td>0.056</td>
<td>0.013</td>
</tr>
<tr>
<td></td>
<td>(0.046)</td>
<td>(0.047)</td>
<td>(0.035)</td>
<td>(0.021)</td>
</tr>
<tr>
<td>Single round mean</td>
<td>0.540</td>
<td>0.689</td>
<td>0.814</td>
<td>0.914</td>
</tr>
<tr>
<td>Observations</td>
<td>776</td>
<td>764</td>
<td>784</td>
<td>780</td>
</tr>
</tbody>
</table>

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Equipment and Infrastructure are indices constructed by taking the first principal component of a school’s equipment and infrastructure elements, then calculating the school’s percentile in the national distribution. Dependent variables are the mean index level of equipment (Panel A) and infrastructure (Panel B) elements, separately by quartiles. Quartiles are defined by the school’s percentile in the municipal distribution in the year prior to the election. Estimation method: Local linear regression with election-year fixed effects and a 50,000 voter bandwidth. Population density included as a control separately across the cutoff. Standard errors clustered at the municipality level.
Table 15  Regression discontinuity estimates on resources in municipal schools, by possibility of re-election

<table>
<thead>
<tr>
<th></th>
<th>Mean level of resources</th>
<th>Standard deviation in resources</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Equipment</td>
<td>Infrastructure</td>
</tr>
<tr>
<td>TwoRound</td>
<td>0.113**</td>
<td>0.088**</td>
</tr>
<tr>
<td></td>
<td>(0.047)</td>
<td>(0.045)</td>
</tr>
<tr>
<td>TwoRound * FirstTerm</td>
<td>-0.034</td>
<td>-0.018</td>
</tr>
<tr>
<td></td>
<td>(0.033)</td>
<td>(0.029)</td>
</tr>
<tr>
<td>Single round mean</td>
<td>0.738</td>
<td>0.731</td>
</tr>
<tr>
<td>Bandwidth size</td>
<td>50,000</td>
<td>50,000</td>
</tr>
<tr>
<td>Observations</td>
<td>789</td>
<td>789</td>
</tr>
</tbody>
</table>

*p < 0.10, **p < 0.05, ***p < 0.01

Heterogeneous treatment effects by re-election incentives. *FirstTerm* is a dummy indicating whether the mayor is a first-term mayor (eligible for re-election). *Equipment* and *Infrastructure* are indices constructed by taking the first principal component of a school’s equipment and infrastructure elements, then calculating the school’s percentile in the national distribution. The first two columns (*Mean level of resources*) have as the dependent variable the mean index level across schools in the municipality. The last two columns (*Standard deviation in resources*) have as the dependent variable the standard deviation in the index across schools in the municipality. Estimation method: Local linear regression with election-year fixed effects and a 50,000 voter bandwidth. Population density included as a control separately across the cutoff. Standard errors clustered at the municipality level.
Figure 16  Regression discontinuity plots of municipal education outcomes

![Diagram](image)

(a) Drop-out rate

(b) Elementary literacy rate

Drop-out rate is from the School Census. It is the mean rate across schools in the municipality. Elementary literacy rate is from the 2000 and 2010 Demographic Census. It is the literacy rate of cohorts who are of elementary school age during the mayoral term. In each panel, each point plots an average value within a 7,500 voter bin. Variables on the vertical axis are residualized by population density and election-year fixed effects. Diameter of the points is proportional to the number of observations. Confidence intervals (dashed lines) represent the 95% confidence intervals of a local linear regression (solid red line) with standard errors clustered at the municipality level.
Table 17  Regression discontinuity estimates on municipal education and economic outcomes

<table>
<thead>
<tr>
<th></th>
<th>Drop-out rate</th>
<th>Failing rate</th>
<th>Passing rate</th>
<th>Elem. literacy rate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TwoRound</strong></td>
<td>-1.649**</td>
<td>-0.747</td>
<td>2.330</td>
<td>1.199*</td>
</tr>
<tr>
<td></td>
<td>(0.667)</td>
<td>(1.115)</td>
<td>(1.459)</td>
<td>(0.710)</td>
</tr>
<tr>
<td><strong>Single round mean</strong></td>
<td>3.211</td>
<td>8.645</td>
<td>88.283</td>
<td>91.445</td>
</tr>
<tr>
<td><strong>Observations</strong></td>
<td>909</td>
<td>908</td>
<td>909</td>
<td>177</td>
</tr>
</tbody>
</table>

Panel B: Economic outcomes

<table>
<thead>
<tr>
<th></th>
<th>Low income rate</th>
<th>Income per capita</th>
<th>Unemployment rate</th>
<th>Night lights</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TwoRound</strong></td>
<td>-5.186*</td>
<td>64.667</td>
<td>-0.964</td>
<td>2.715</td>
</tr>
<tr>
<td></td>
<td>(3.079)</td>
<td>(61.782)</td>
<td>(0.635)</td>
<td>(3.306)</td>
</tr>
<tr>
<td><strong>Single round mean</strong></td>
<td>27.929</td>
<td>762.417</td>
<td>9.815</td>
<td>22.527</td>
</tr>
<tr>
<td><strong>Observations</strong></td>
<td>177</td>
<td>177</td>
<td>177</td>
<td>763</td>
</tr>
</tbody>
</table>

*p < 0.10, **p < 0.05, ***p < 0.01

Panel A: Municipal education outcomes. Drop-out rate, Failing rate, and Passing rate are from the School Census. They are the mean rate across schools in the municipality and should add up to 1 in each school. Elem. literacy is from the 2000 and 2010 Demographic Census. It is the literacy rate of cohorts who are of elementary school age during the mayoral term. Panel B: Municipal economic outcomes. Low income rate, Income per capita, and Unemployment rate are from the 2000 and 2010 Demographic Census. Low income rate is the fraction of households earning between 0 and 50% of the minimum wage. Income per capita is the average monthly household income per capita, in reais. Night lights is from the 1997-2013 NOAA night lights series. It is the mean night lights level in the municipality. Estimation method: Local linear regression with election-year fixed effects and a 50,000 voter bandwidth. Population density included as a control separately across the cutoff. Standard errors clustered at the municipality level.
### Table 18  Regression discontinuity estimates on candidate characteristics

#### Panel A: Demographic characteristics of candidates

<table>
<thead>
<tr>
<th></th>
<th>Age</th>
<th>Female</th>
<th>Univ. degree</th>
<th>Born same state</th>
</tr>
</thead>
<tbody>
<tr>
<td>TwoRound</td>
<td>0.470</td>
<td>−0.065</td>
<td>−0.045</td>
<td>−0.070</td>
</tr>
<tr>
<td>(1.514)</td>
<td>(0.040)</td>
<td>(0.048)</td>
<td>(0.049)</td>
<td></td>
</tr>
</tbody>
</table>

Single round mean

<table>
<thead>
<tr>
<th></th>
<th>Age</th>
<th>Female</th>
<th>Univ. degree</th>
<th>Born same state</th>
</tr>
</thead>
<tbody>
<tr>
<td>49.955</td>
<td>0.129</td>
<td>0.796</td>
<td>0.784</td>
<td></td>
</tr>
<tr>
<td>264</td>
<td>263</td>
<td>263</td>
<td>263</td>
<td></td>
</tr>
</tbody>
</table>

Observations 264 263 263 263

#### Panel B: Previous occupation of candidates

<table>
<thead>
<tr>
<th></th>
<th>Public sector</th>
<th>Technical</th>
<th>Business</th>
</tr>
</thead>
<tbody>
<tr>
<td>TwoRound</td>
<td>−0.008</td>
<td>0.014</td>
<td>0.017</td>
</tr>
<tr>
<td>(0.063)</td>
<td>(0.059)</td>
<td>(0.025)</td>
<td></td>
</tr>
</tbody>
</table>

Single round mean

<table>
<thead>
<tr>
<th></th>
<th>Public sector</th>
<th>Technical</th>
<th>Business</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.466</td>
<td>0.388</td>
<td>0.047</td>
<td></td>
</tr>
<tr>
<td>263</td>
<td>263</td>
<td>263</td>
<td></td>
</tr>
</tbody>
</table>

Observations 263 263 263

*p < 0.10, **p < 0.05, ***p < 0.01

Outcomes are the average characteristics of candidates in elections. Panel A contains demographic characteristics. Univ. degree is the fraction of candidates whose highest educational attainment is university or higher. Born same state is the fraction of candidates who were born in the same state as the election. Panel B contains the industry of candidates’ stated previous occupation. Public sector includes occupations such as elected positions, judiciary, and workers in public administration. Technical includes occupations such as scientists, technicians, and artists. Business includes occupations such as administrative positions, workers in commerce and services, and business owners. Estimation method: Local linear regression with election-year fixed effects and a 50,000 voter bandwidth. Population density included as a control separately across the cutoff. Standard errors clustered at the municipality level.
Table 19  Regression discontinuity estimates on characteristics of the winner

<table>
<thead>
<tr>
<th></th>
<th>Age</th>
<th>Female</th>
<th>Univ. degree</th>
<th>Born same state</th>
</tr>
</thead>
<tbody>
<tr>
<td>TwoRound</td>
<td>0.160</td>
<td>−0.027</td>
<td>0.023</td>
<td>−0.041</td>
</tr>
<tr>
<td></td>
<td>(2.763)</td>
<td>(0.087)</td>
<td>(0.100)</td>
<td>(0.071)</td>
</tr>
<tr>
<td>Single round mean</td>
<td>51.608</td>
<td>0.112</td>
<td>0.832</td>
<td>0.789</td>
</tr>
<tr>
<td>Observations</td>
<td>264</td>
<td>263</td>
<td>263</td>
<td>263</td>
</tr>
</tbody>
</table>

**Panel B: Previous occupation of winners**

<table>
<thead>
<tr>
<th></th>
<th>Public sector</th>
<th>Technical</th>
<th>Business</th>
</tr>
</thead>
<tbody>
<tr>
<td>TwoRound</td>
<td>−0.088</td>
<td>0.069</td>
<td>0.059</td>
</tr>
<tr>
<td></td>
<td>(0.137)</td>
<td>(0.131)</td>
<td>(0.044)</td>
</tr>
<tr>
<td>Single round mean</td>
<td>0.534</td>
<td>0.348</td>
<td>0.043</td>
</tr>
<tr>
<td>Observations</td>
<td>263</td>
<td>263</td>
<td>263</td>
</tr>
</tbody>
</table>

Outcomes are the characteristics of the candidate who won the election. **Panel A** contains demographic characteristics. *Univ. degree* is an indicator for whether the winner’s highest educational attainment is university or higher. *Born same state* is an indicator for whether the winner was born in the same state as the election. **Panel B** contains the industry of candidates’ stated previous occupation. *Public sector* includes occupations such as elected positions, judiciary, and workers in public administration. *Technical* includes occupations such as scientists, technicians, and artists. *Business* includes occupations such as administrative positions, workers in commerce and services, and business owners. **Estimation method:** Local linear regression with election-year fixed effects and a 50,000 voter bandwidth. Population density included as a control separately across the cutoff. Standard errors clustered at the municipality level.
Table 20  Regression discontinuity estimates on political affiliation of candidates

<table>
<thead>
<tr>
<th>Previous candidacy</th>
<th>Incumbency</th>
<th>Small party</th>
<th>PT party</th>
<th>Governor’s party</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TwoRound</strong></td>
<td>0.539**</td>
<td>−0.182</td>
<td>0.721**</td>
<td>0.038</td>
</tr>
<tr>
<td></td>
<td>(0.259)</td>
<td>(0.155)</td>
<td>(0.334)</td>
<td>(0.100)</td>
</tr>
<tr>
<td><strong>Single round mean</strong></td>
<td>1.652</td>
<td>0.752</td>
<td>2.535</td>
<td>0.636</td>
</tr>
<tr>
<td><strong>Observations</strong></td>
<td>263</td>
<td>263</td>
<td>296</td>
<td>296</td>
</tr>
</tbody>
</table>

Panel B: Winner only

<table>
<thead>
<tr>
<th>TwoRound</th>
<th>−0.144</th>
<th>−0.201*</th>
<th>−0.008</th>
<th>−0.022</th>
<th>−0.012</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(0.130)</td>
<td>(0.115)</td>
<td>(0.127)</td>
<td>(0.094)</td>
<td>(0.120)</td>
</tr>
<tr>
<td><strong>Single round mean</strong></td>
<td>0.621</td>
<td>0.410</td>
<td>0.369</td>
<td>0.187</td>
<td>0.242</td>
</tr>
<tr>
<td><strong>Observations</strong></td>
<td>263</td>
<td>263</td>
<td>296</td>
<td>296</td>
<td>263</td>
</tr>
</tbody>
</table>

*p < 0.10, **p < 0.05, ***p < 0.01

Previous candidacy is whether the candidate ran in a previous mayoral election. Incumbency is whether the candidate held the position of mayor in a previous term. Small party is any party that is not one of the top 5 parties, by national membership. PT party is whether the candidate is from the Partido dos Trabalhadores. Governor’s party is whether the candidate is from the party of the incumbent state governor. Dependent variables are either the number of candidates with that characteristic (Panel A) or an indicator for the winner having that characteristic (Panel B). Estimation method: Local linear regression with election-year fixed effects and a 50,000 voter bandwidth. Population density included as a control separately across the cutoff. Standard errors clustered at the municipality level.
Table 21  Regression discontinuity estimates on campaign donations

<table>
<thead>
<tr>
<th>Panel A: Average donations per candidate</th>
<th>Donation amounts received by candidates</th>
<th>Total</th>
<th>From individuals</th>
<th>From corporations</th>
</tr>
</thead>
<tbody>
<tr>
<td>TwoRound</td>
<td>-0.225</td>
<td>-0.491</td>
<td>-0.673</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.286)</td>
<td>(0.310)</td>
<td>(0.404)</td>
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</tr>
<tr>
<td>Single round mean</td>
<td>12.844</td>
<td>10.742</td>
<td>11.782</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>154</td>
<td>154</td>
<td>154</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel B: Total donations among top two candidates</th>
<th>Donation amounts received by candidates</th>
<th>Total</th>
<th>From individuals</th>
<th>From corporations</th>
</tr>
</thead>
<tbody>
<tr>
<td>TwoRound</td>
<td>-0.074</td>
<td>-0.614</td>
<td>-1.023</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.335)</td>
<td>(0.492)</td>
<td>(0.541)</td>
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<tr>
<td>Single round mean</td>
<td>14.053</td>
<td>11.717</td>
<td>12.846</td>
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<tr>
<td>Observations</td>
<td>154</td>
<td>154</td>
<td>154</td>
<td></td>
</tr>
</tbody>
</table>

*\(p < 0.10\), **\(p < 0.05\), ***\(p < 0.01\)

Panel A: Outcomes are log average donation levels, in reais, received by candidates (total donations in the election divided by the number of candidates). Panel B: Outcomes are log total donations, in reais, received by the top two candidates. Donors identified as Individual and Corporation depending on whether the donor provided a CPF (individual identification number) or CNPJ (corporate identification number). Estimation method: Local linear regression with election-year fixed effects and a 50,000 voter bandwidth. Population density included as a control separately across the cutoff. Standard errors clustered at the municipality level.
A. Theory Appendix

A.1. Swing-able voters

For $0 < \pi_{j_1}^A < 1$, we need that:

$$u_j(q_j^B) - u_j(q_j^A) - \delta \in \left(-\frac{1}{2\psi}, \frac{1}{2\psi}\right)$$

or that there are swing-able voters in the locality. Let $u(y)$ be the largest possible utility coming from the allocation of government resources. This assumption is satisfied if:

$$\delta \in \left(u(y) - u(0) - \frac{1}{2\psi}, u(y) - u(0) + \frac{1}{2\psi}\right)$$

$$\iff \frac{1}{2\gamma} + u(y) - u(0) < \frac{1}{2\psi}$$

In other words, that swings in municipality vote shares are smaller than the variation in individual preferences. Note that this implies that $\gamma > \psi$ since $u(y) - u(0) > 0$.

A.2. Contestability of localities

For equations (2.2) and (2.3) to be non-degenerate, ie. $0 < Pr(\pi_1^A \geq \theta) < 1$, we need that:

$$\frac{1}{\psi} \left[ -\frac{J}{J - 1 + \alpha} \theta - \frac{1}{2} - \left(\frac{\psi}{J - 1 + \alpha}\right) \left(\sum_{j=1}^{J-1} \Delta u_{j}^{AB} + \alpha \Delta u_{j}^{AB}\right) \right] \in \left(-\frac{1}{2\gamma}, \frac{1}{2\gamma}\right)$$

$$\frac{1}{\psi} \left[ \frac{1}{2} - \left(\frac{J}{J - 1 + \alpha}\right) \theta + \left(\frac{\psi}{J - 1 + \alpha}\right) \left(\sum_{j=1}^{J-1} \Delta u_{j}^{BA} + \alpha \Delta u_{j}^{BA}\right) \right] \in \left(-\frac{1}{2\gamma}, \frac{1}{2\gamma}\right)$$

which corresponds to the following condition for the first round:

$$\theta \in \left(\frac{J - 1 + \alpha}{J}, \left(\frac{-\psi}{2\gamma} + \frac{1}{2}\right), \left(\frac{J - 1 + \alpha}{J}\right) \left(\frac{\psi}{2\gamma} + \frac{1}{2}\right)\right) \quad \text{(A.1)}$$
For equation (2.4) to be non-degenerate, ie. $0 < Pr\left(\pi_2^A \geq \theta \right) < 1$, we need that:

$$
\frac{1}{\psi} \left[ \theta - \frac{1}{2} - \frac{\psi}{J} \sum_{j=1}^{J} \Delta u_{j}^{AB} \right] \in \left( -\frac{1}{2\gamma}, \frac{1}{2\gamma} \right) \\
\frac{1}{\psi} \left[ \frac{1}{2} - \theta + \frac{\psi}{J} \sum_{j=1}^{J} \Delta u_{j}^{BA} \right] \in \left( -\frac{1}{2\gamma}, \frac{1}{2\gamma} \right)
$$

which corresponds to the following condition for the second round:

$$
\theta \in \left( -\frac{\psi}{2\gamma} + \frac{1}{2}, \frac{\psi}{2\gamma} + \frac{1}{2} \right) \quad (A.2)
$$

**Claim A.3.** $\frac{1}{2} \left( 1 - \frac{1-\alpha}{J} \right)$ satisfies condition (A.1).

Both the upper and lower inequalities are satisfied because:

$$
-\frac{\psi}{2\gamma} + \frac{1}{2} < \frac{1}{2} < \frac{\psi}{2\gamma} + \frac{1}{2}
$$

**Claim A.4.** $\frac{1}{2}$ satisfies condition (A.1).

Note that the lower inequality is satisfied:

$$
\left( \frac{J - 1 + \alpha}{J} \right) \left( -\frac{\psi}{2\gamma} + \frac{1}{2} \right) < \frac{1}{2}
$$

because $\frac{J - 1 + \alpha}{J} < 1$ and $-\frac{\psi}{2\gamma} + \frac{1}{2} < \frac{1}{2}$.

I next show that the upper inequality is satisfied. The upper inequality is equivalent to:

$$
\frac{1}{2} < \left( \frac{J - 1 + \alpha}{J} \right) \left( \frac{\psi}{2\gamma} + \frac{1}{2} \right)
$$

$$
\iff J > (1 - \alpha) \left( \frac{\gamma + \psi}{\psi} \right)
$$

which is true so long as $J$ is large enough and $\gamma/\psi$ is not too large.

**Claim A.5.** $\frac{1}{2}$ satisfies condition (A.2).
Both the upper and lower inequalities are satisfied because:

\[-\frac{\psi}{2\gamma} + \frac{1}{2} < \frac{1}{2} < \frac{\psi}{2\gamma} + \frac{1}{2}\]

**A.3. C never makes it to the second round**

For C to never make it to the second round, the probability that candidates A and B attain vote shares above candidate C’s must be 1, ie. \(\pi_1^C\) does not satisfy condition (A.1):

\[
\frac{1-\alpha}{J} \leq \left(\frac{J-1+\alpha}{J}\right) \left(-\frac{\psi}{2\gamma} + \frac{1}{2}\right) \quad \text{or} \quad \frac{1-\alpha}{J} \geq \left(\frac{J-1+\alpha}{J}\right) \left(\frac{\psi}{2\gamma} + \frac{1}{2}\right)
\]

The first inequality is equivalent to:

\[
J \geq (1-\alpha) \left(\frac{2\gamma}{\gamma - \psi} + 1\right)
\]

The second inequality is equivalent to:

\[
J \leq (1-\alpha) \left(\frac{2\gamma}{\gamma + \psi} + 1\right)
\]

The first inequality is much more likely to be satisfied, which is true so long as \(J\) is large enough and \(2\gamma/(\gamma - \psi)\) is not too large.

**A.4. Comparing single- to two-round elections**

I first establish three corollaries.

**Corollary A.6.** \(\frac{u'_j(q_j^{1R})}{u'_j(q_j^{2R})} G^{2R}_{1R} > 1\) for all \(j \in \{1, \ldots, J\}\).

**Proof.** For \(j \in \{1, \ldots, J-1\}\), combining the first order conditions in equations (2.5), (2.7), (2.11), and (2.13), we have that:

\[
\frac{u'_j(q_j^{1R})}{u'_j(q_j^{2R})} G^{2R}_{1R} = 1 + \frac{(1-\alpha)\gamma}{\psi J} > 1
\]

For \(j = J\), combining the first order conditions in equations (2.6), (2.7), (2.12), and (2.13),
we have that:
\[
\frac{u_j'(q_j^{1R})}{u_j'(q_j^{2R})} G^{2R} = 1 + \frac{(1 - \alpha)\gamma}{\alpha \psi J} > 1
\]

\[\square\]

**Corollary A.7.** \[
\frac{u_j'(q_j^{1R})}{u_j'(q_j^{2R})} < \frac{u_j'(q_j^{1R})}{u_j'(q_j^{2R})}
\]

**Proof.** Comparing the ratio of marginal utilities in equations (2.9) and (2.15), the ratio is smaller in the single-round system compared to the two-round system:
\[
\frac{u_j'(q_j^{1R})}{u_j'(q_j^{2R})} < \frac{u_j'(q_j^{2R})}{u_j'(q_j^{1R})} \iff \alpha < \alpha + \frac{(1 - \alpha)\gamma}{1 + \frac{(1 - \alpha)\gamma}{\psi J}}
\]

which is true because \(\alpha < 1\).

\[\square\]

**Corollary A.8.** If \(q_j^{1R} > q_j^{2R}\) for one \(j \neq J\) then \(q_j^{1R} > q_j^{2R}\) for all other \(j \in \{1, \cdots, J - 1\}\).

**Proof.** If \(q_j^{1R} > q_j^{2R}\), then \(u_j'(q_j^{1R}) < u_j'(q_j^{2R})\) because \(u_j(\cdot)\) is strictly concave. The first order conditions (2.8) and (2.14) establish that the marginal utilities between all \(j, j' \in \{1, \cdots, J - 1\}\) are equal. Then we must have that \(u_j'(q_j^{1R}) < u_j'(q_j^{2R})\) and that \(q_j^{1R} > q_j^{2R}\).

\[\square\]

**A.4.a.** Proof of allocations in locality \(J\).– I prove that \(q_j^{1R} < q_j^{2R}\).

**Proof.** I prove by contradiction. Assume that \(q_j^{1R} \geq q_j^{2R}\). Then \(u_j'(q_j^{1R}) \leq u_j'(q_j^{2R})\). By corollary A.6, we must have that \(G^{2R} > G^{1R}\). To satisfy the budget constraint, we must have that \(q_j^{1R} < q_j^{2R}\) for some \(j \neq J\) and, by corollary A.8, for all \(j \neq J\). Then \(u_j'(q_j^{1R}) > u_j'(q_j^{2R})\). However, this violates corollary A.7, and so we must have \(q_j^{1R} < q_j^{2R}\).

\[\square\]

**A.4.b.** Proof of overall budget.– I prove that \(G^{1R} < G^{2R}\).

**Proof.** I prove by contradiction. Assume that \(G^{1R} \geq G^{2R}\). Since \(q_j^{1R} < q_j^{2R}\), to satisfy the budget constraint, we must have that \(q_j^{1R} > q_j^{2R}\) for some \(j \neq J\) and, by corollary A.8, for all \(j \neq J\). Then \(u_j'(q_j^{1R}) < u_j'(q_j^{2R})\). However, this violates corollary A.6, and so we must have \(G^{1R} < G^{2R}\).

\[\square\]
A.4.c. Proof of allocations in other localities.– I show that $q^1_R \leq q^2_J$.

Proof. From the first order conditions (2.7) and (2.13) and since $G^1 < G^2$, we have that $\lambda_1 < \lambda_2$. Then, from the first order conditions (2.5) and (2.11), for $j \in \{1, \ldots, J-1\}$:

$$\frac{u_j'(q^1_J)}{u_j'(q^2_J)} < 1 + \frac{(1-\alpha)\gamma}{\psi J} \Rightarrow \frac{u_j'(q^1_J)}{u_j'(q^2_J)} \geq 1$$

which implies that $q^1_J \leq q^2_J$. \qed

A.5. Candidate C’s budget

In general, for every set of utility functions $\{u_1(\cdot), \ldots, u_J(\cdot)\}$, there exists a $G^C$ such that $G^C$ is the highest offer in locality $J$. I show this for the case where $u_j(\cdot) = \beta J \ln(\cdot)$ and for the two-round election (since $q_J$ is higher in a two-round election).

The first order conditions with respect to $q_J$ and $G$ are:

$$\frac{\gamma}{J - 1 + \alpha} \left(\alpha + \frac{(1-\alpha)\gamma}{\psi J}\right) \frac{\beta J}{q_J} = \lambda_2$$

$$\kappa G = \lambda_2$$

We can write $G$ as a function of $q_J$:

$$G = \frac{1}{\kappa J - 1 + \alpha} \left(\alpha + \frac{(1-\alpha)\gamma}{\psi J}\right) \frac{\beta J}{q_J}$$

Since $q_J < q_j$ for all $j \neq J$ (prediction (2.16)), then $q_J < G/J$, implying:

$$q_J < \left(\frac{1}{\kappa J - 1 + \alpha} \left(\alpha + \frac{(1-\alpha)\gamma}{\psi J}\right) \beta J\right)^{1/2} \equiv \Gamma$$

So long as $G^C > \Gamma$, then candidate C’s allocation to locality $J$ will be the highest offer there. This will be true so long as $\kappa$ or $J$ is large enough and $\gamma/\psi$ is not too large.
A.6. Relaxing the assumption that $\alpha > 0$

Assume $\alpha = 0$ so that candidate $C$ receives all the votes in locality $J$. Then vote shares in the first round, or when all 3 candidates are present, are given by:

\[ \pi_A^1 = \left( \frac{J-1}{J} \right) \left( \frac{1}{2} + \psi \delta \right) + \frac{\psi}{J} \sum_{j=1}^{J-1} \Delta u_{j}^{AB} \]

\[ \pi_B^1 = \left( \frac{J-1}{J} \right) \left( \frac{1}{2} - \psi \delta \right) + \frac{\psi}{J} \sum_{j=1}^{J-1} \Delta u_{j}^{BA} \]

\[ \pi_C^1 = \frac{1}{J} \]

and the probability of attaining a vote share above $\theta$ is given by:

\[ Pr(\pi_A^1 \geq \theta) = \frac{1}{2} + \frac{\gamma}{\psi} \left[ \frac{1}{2} - \left( \frac{J}{J-1} \right) \theta + \left( \frac{\psi}{J-1} \right) \sum_{j=1}^{J-1} \Delta u_{j}^{AB} \right] \]

\[ Pr(\pi_B^1 \geq \theta) = \frac{1}{2} + \frac{\gamma}{\psi} \left[ \frac{1}{2} - \left( \frac{J}{J-1} \right) \theta + \left( \frac{\psi}{J-1} \right) \sum_{j=1}^{J-1} \Delta u_{j}^{BA} \right] \]

Vote shares for the second round with candidates $A$ and $B$ are the same as when $\alpha > 0$.

A.6.a. Equilibrium strategies in a single-round election.– The single-round maximization is:

\[ \max_{G^A, q^A = \{q_1^A, \ldots, q_j^A \}} \frac{1}{2} + \frac{\gamma}{J-1} \sum_{j=1}^{J-1} \Delta u_{j}^{AB} - \frac{1}{2} \kappa (G^A)^2 \quad \text{s.t.} \quad \sum_j q_j^A \leq G^A \]

The first order conditions are:

\[ \frac{\gamma}{J-1} u'(q_j^A) = \lambda'_{1R} \quad \forall \ j \in \{1, \ldots, J-1\} \]

\[ \kappa G^A = \lambda'_{1R} \]

where $\lambda'_{1R}$ is the Lagrange multiplier of the budget constraint in a single-round system when $\alpha = 0$. There is no first-order condition with respect to $q_j^A$, as it does not enter the maximization. I show that in equilibrium, the optimal strategy is to allocate $q_j^A = 0$.

Say $q_j^A > 0$. Consider the following deviation: $\left(q_j^A\right)' = q_j^A - \epsilon$ and $\left(q_k^A\right)' = q_k^A + \epsilon$ for some $k \neq J$ and $\epsilon > 0$. Candidate $C$'s vote share is unchanged, so the threshold for winning
remains \( \frac{1}{2} \left( 1 - \frac{1}{J} \right) \). The net change in the probability of winning is given by:

\[
\left[ \frac{1}{2} + \frac{\gamma}{J-1} \left( \Delta \left( u^A_k \right)' + \sum_{j \neq k, J} \Delta u^A_j \right) \right] - \left[ \frac{1}{2} + \frac{\gamma}{J-1} \left( \Delta u^A_k + \sum_{j \neq k, J} \Delta u^A_j \right) \right]
\]

\[
= \frac{\gamma}{J-1} \left[ u_k \left( q^A_k \right)' - u_k \left( q^A_k \right) \right] > 0
\]

where the last line follows because \( \epsilon > 0 \) and \( u_k(\cdot) \) is strictly increasing. There is a deviation which strictly increases the probability of winning. As a result, any \( q^A_j > 0 \) cannot be optimal so the optimal strategy is to allocate \( q^A_J = 0 \).

**A.6.b. Equilibrium strategies in a two-round election.** The two-round maximization is:

\[
\max_{G^A, q^A = \{q^A_1, \ldots, q^A_J\}} \left( \frac{1}{2} + \frac{\gamma}{\psi} \left[ \frac{1}{J-1} \left( \frac{1}{J-1} \right) \left( \psi \sum_{j=1}^{J-1} \Delta u^A_j \right) \right] \right)
\]

\[
+ \frac{\gamma}{\psi} \left( \frac{1}{J-1} \left( \frac{\gamma}{J} \sum_{j=1}^{J} \Delta u^A_j \right) \right) - \frac{1}{2} \kappa \left( G^A \right)^2 \quad \text{s.t.} \quad \sum_j q^A_j \leq G^A
\]

The first-order conditions are:

\[
\left( \frac{\gamma}{J-1} \right) \left( 1 + \frac{\gamma}{\psi} \right) u'(q^A_j) = \lambda'_{2R} \quad \text{for } j \in \{1, \ldots, J-1\}
\]

\[
\left( \frac{\gamma}{J-1} \right) \left( \frac{\gamma}{J} \right) u'(q^A_j) = \lambda'_{2R} \quad \text{for } j = J
\]

\[
\kappa G^A = \lambda'_{2R}
\]

where \( \lambda'_{2R} \) is the Lagrange multiplier of the budget constraint in a two-round system when \( \alpha = 0 \).

From this, we can see that \( q^A_j > 0 \). Thus, \( q^A_1 < q^A_J \), and prediction (2.17) holds.

Similarly, \( G^{1R} < G^{2R} \). Assume not. To satisfy the budget constraint, we need that \( q^A_j > q^A_J \) for some \( j \neq J \) and by extension all \( j \neq J \). Then \( u'_j(q^A_j) < u'_j(q^A_J) \). However, then \( \frac{u'_j(q^A_J)}{u'_j(q^A_J)} G^{2R} < 1 \) which violates the first order conditions. Thus, \( G^{1R} < G^{2R} \) and prediction (2.18) holds.

We also have that \( q^A_j \leq q^A_1 \). From the first order conditions, we have that \( \frac{u'_j(q^A_1)}{u'_j(q^A_1)} < 1 + \frac{\gamma}{\psi} \) and so \( q^A_j \leq q^A_1 \). Predictions (2.17) and (2.19) then follow.
B. Data Appendix

B.1. Variables from the *Censo Escolar*

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Table B.2  Variables used to construct the infrastructure index

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C. Additional Figures and Tables

Figure C.1  Relationship between municipality population and number of registered voters

The vertical axis is municipality population in the most recent census prior to the election. Plot includes only elections with between 50,000 and 400,000 registered voters (6.0% of the universe of elections).
Figure C.2  Regression discontinuity plots of the probability of falling above/below other policy thresholds

(a) Threshold: 300,000 inhabitants

(b) Threshold: 285,714 inhabitants

The vertical axis is the fraction of elections above (a) the 300,000 resident threshold and (b) the 285,714 resident threshold. At 300,000 residents, a salary cap for municipal legislators comes into effect. At 285,714 residents, the size of the legislature changes. In each panel, each point plots an average value within a 7,500 voter bin. Diameter of the points is proportional to the number of observations. Confidence intervals (dashed lines) represent the 95% confidence intervals of a local linear regression (solid red line) with standard errors clustered at the municipality level.
Figure C.3  Regression discontinuity plots of pre-treatment population density

Population density measured (a) in the 1980 census or (b) in the census prior to the most recent year in a single-round system or in the 1991 census (b). In each panel, each point plots an average value within a 7,500 voter bin. Diameter of the points is proportional to the number of observations. Confidence intervals (dashed lines) represent the 95% confidence intervals of a local linear regression (solid red line) with standard errors clustered at the municipality level.
Figure C.4  Regression discontinuity coefficients on pre-treatment population density at different bandwidths

(a) Measured prior to the 1988 Constitution

(b) Measured prior to the most recent single-round

Population density measured (a) in the 1980 census or (b) in the census prior to the most recent year in a single-round system or in the 1991 census. The thicker vertical lines represent the 90% confidence interval and the thinner vertical lines represent the 95% confidence interval. Estimation method: Local linear regression with the specified voter bandwidth and election-year fixed effects. Standard errors clustered at the municipality level. *Source:* 1980, 1991, 2000, and 2010 Demographic Census.
Figure C.5  Compliance with treatment assignment

The vertical axis is the fraction of elections that held two rounds of elections. The horizontal axis is the vote share of the top candidate in the first round. Municipalities below the 200,000 registered voter threshold (and thus should always hold one round) are denoted by red circles. Municipalities above the 200,000 registered voter threshold (and thus should hold two rounds if no candidate receives 50% in the first round) are denoted by blue triangles. Bin sizes are 10% vote share bins.
Figure C.6  Regression discontinuity plot of probability of treatment in the previous election

The vertical axis is the probability that the previous election was a two-round election. The horizontal axis is the number of registered voters in the current election. In each panel, each point plots an average value within a 7,500 voter bin. Diameter of the points is proportional to the number of observations. Confidence intervals (dashed lines) represent the 95% confidence intervals of a local linear regression (solid red line) with standard errors clustered at the municipality level. Note that because all observations to the left of the threshold are 0, there are no standard errors.
Table C.7  Regression discontinuity estimates on the geographic concentration of voters, with number of candidates as a control

<table>
<thead>
<tr>
<th>Panel A: Concentration indices of voters for specific candidates</th>
</tr>
</thead>
<tbody>
<tr>
<td>TwoRound</td>
</tr>
<tr>
<td>TwoRound</td>
</tr>
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</tr>
<tr>
<td>Single round mean</td>
</tr>
<tr>
<td>Observations</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel B: Standard deviation in vote shares for each candidate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st place candidate</td>
</tr>
<tr>
<td>TwoRound</td>
</tr>
<tr>
<td></td>
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<tr>
<td>Single round mean</td>
</tr>
<tr>
<td>Observations</td>
</tr>
</tbody>
</table>

*p < 0.10, **p < 0.05, ***p < 0.01

Panel A: overall concentration of voters for specific candidates, as measured by concentration indices (coefficient of variation, fractionalization, and entropy) of vote counts in polling stations. Panel B: candidate-level concentration of voters, measured by standard deviation in a candidate’s vote shares (for the 1st-4th place candidate) across polling stations. Vote shares are from the first round. Estimation method: Local linear regression with election-year fixed effects and a 50,000 voter bandwidth. Population density included as a control separately across the cutoff. Number of candidates included as a control. Standard errors clustered at the municipality level.
Table C.8  Regression discontinuity estimates on resources in municipal schools, using z-scores

<table>
<thead>
<tr>
<th></th>
<th>Mean level of resources</th>
<th>Standard deviation in resources</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Equipment</td>
<td>Infrastructure</td>
</tr>
<tr>
<td>TwoRound</td>
<td>0.079**</td>
<td>0.069*</td>
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<tr>
<td></td>
<td>(0.033)</td>
<td>(0.037)</td>
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<tr>
<td>Single round mean</td>
<td>0.724</td>
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<tr>
<td>Observations</td>
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<td>912</td>
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*p < 0.10, **p < 0.05, ***p < 0.01

*Equipment* and *Infrastructure* are indices constructed by taking the z-score of a school's equipment and infrastructure elements, then calculating the school’s percentile in the national distribution. The first two columns (Mean level of resources) have as the dependent variable the mean index level across schools in the municipality. The last two columns (Standard deviation in resources) have as the dependent variable the standard deviation in the index across schools in the municipality. Estimation method: Local linear regression with a 50,000 voter bandwidth. Standard errors clustered at the municipality level.
**Figure C.9**  Regression discontinuity coefficients on overall concentration of voters for specific candidates at different bandwidths

Overall concentration of voters for specific candidates, as measured by (a) *Coefficient of variation*, (b) *Fractionalization*, and (c) *Entropy*, using vote counts in polling stations. Vote shares are from the first round. The thicker vertical lines represent the 90% confidence interval and the thinner vertical lines represent the 95% confidence interval. *Estimation method*: Local linear regression with election-year fixed effects and with the specified voter bandwidth. Population density included as a control separately across the cutoff. Standard errors clustered at the municipality level.
Figure C.10  Regression discontinuity coefficients on the candidate level concentration in voters at different bandwidths

Standard deviation in a candidate’s vote counts across polling stations, for the (a) 1st place and (b) 2nd place candidate. Vote shares are from the first round. The thicker vertical lines represent the 90% confidence interval and the thinner vertical lines represent the 95% confidence interval. Estimation method: Local linear regression with election-year fixed effects and with the specified voter bandwidth. Population density included as a control separately across the cutoff. Standard errors clustered at the municipality level.
Figure C.11  Regression discontinuity coefficients on overall level of resources in municipal schools at different bandwidths

(a) Equipment, mean level of resources

(b) Infrastructure, mean level of resources

*Equipment* and *Infrastructure* are indices constructed by taking the first principal component of a school’s equipment and infrastructure elements, then calculating the school’s percentile in the national distribution. *Mean level of resources* is the mean index level across schools in the municipality for (a) equipment and (b) infrastructure. The thicker vertical lines represent the 90% confidence interval and the thinner vertical lines represent the 95% confidence interval. *Estimation method:* Local linear regression with election-year fixed effects and with the specified voter bandwidth. Population density included as a control separately across the cutoff. Standard errors clustered at the municipality level.
Figure C.12  Regression discontinuity coefficients on distribution of resources in municipal schools at different bandwidths

(a) Equipment, standard deviation in resources
(b) Infrastructure, standard deviation in resources

*Equipment* and *Infrastructure* are indices constructed by taking the first principal component of a school’s equipment and infrastructure elements, then calculating the school’s percentile in the national distribution. *Standard deviation in resources* is the standard deviation in the index across schools in the municipality for (a) equipment and (b) infrastructure. The thicker vertical lines represent the 90% confidence interval and the thinner vertical lines represent the 95% confidence interval. *Estimation method:* Local linear regression with election-year fixed effects and with the specified voter bandwidth. Population density included as a control separately across the cutoff. Standard errors clustered at the municipality level.
Figure C.13  Regression discontinuity coefficients on municipal education outcomes at different bandwidths

(a) Drop-out rate

(b) Elementary literacy rate

Drop-out rate is from the School Census. It is the mean rate across schools in the municipality. Elementary literacy rate is from the 2000 and 2010 Demographic Census. It is the literacy rate of cohorts who are of elementary school age during the mayoral term. The thicker vertical lines represent the 90% confidence interval and the thinner vertical lines represent the 95% confidence interval. IK and MSERD bandwidths not shown for Elementary literacy rate, as the bandwidth chosen was larger than the support. Estimation method: Local linear regression with election-year fixed effects and with the specified voter bandwidth. Population density included as a control separately across the cutoff. Standard errors clustered at the municipality level.
### Table C.14  Regression discontinuity estimates on the geographic concentration of voters, without controls

#### Panel A: Concentration indices of voters for specific candidates

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<th>Coefficient of variation</th>
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<th>Entropy</th>
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<td><strong>TwoRound</strong></td>
<td>−0.008**</td>
<td>−0.010**</td>
<td>−0.007</td>
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<td></td>
<td>(0.003)</td>
<td>(0.004)</td>
<td>(0.005)</td>
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<td><strong>Single round mean</strong></td>
<td>0.019</td>
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#### Panel B: Standard deviation in vote shares for each candidate

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<th>3rd place candidate</th>
<th>4th place candidate</th>
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<tr>
<td><strong>TwoRound</strong></td>
<td>−0.012*</td>
<td>−0.011</td>
<td>−0.003</td>
<td>0.005</td>
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<td>(0.006)</td>
<td>(0.008)</td>
<td>(0.006)</td>
<td>(0.005)</td>
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<tr>
<td><strong>Single round mean</strong></td>
<td>0.080</td>
<td>0.075</td>
<td>0.042</td>
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*p < 0.10, **p < 0.05, ***p < 0.01

**Panel A**: overall concentration of voters for specific candidates, as measured by concentration indices (coefficient of variation, fractionalization, and entropy) of vote counts in polling stations. **Panel B**: candidate-level concentration of voters, measured by standard deviation in a candidate’s vote shares (for the 1st-4th place candidate) across polling stations. Vote shares are from the first round. **Estimation method**: Local linear regression with a 50,000 voter bandwidth. Standard errors clustered at the municipality level.
Table C.15  Regression discontinuity estimates on resources in municipal schools, without controls

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<td>0.068*</td>
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<td>(0.035)</td>
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*p < 0.10, **p < 0.05, ***p < 0.01

Equipment and Infrastructure are indices constructed by taking the first principal component of a school’s equipment and infrastructure elements, then calculating the school’s percentile in the national distribution. The first two columns (Mean level of resources) have as the dependent variable the mean index level across schools in the municipality. The last two columns (Standard deviation in resources) have as the dependent variable the standard deviation in the index across schools in the municipality. Estimation method: Local linear regression with a 50,000 voter bandwidth. Standard errors clustered at the municipality level.

Table C.16  Regression discontinuity estimates on municipal education outcomes, without controls

<table>
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<tr>
<th></th>
<th>Drop-out rate</th>
<th>Failing rate</th>
<th>Passing rate</th>
<th>Elem. literacy</th>
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<tr>
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<td>−1.340*</td>
<td>−0.051</td>
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<td>(0.755)</td>
<td>(1.167)</td>
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<td>Single round mean</td>
<td>3.211</td>
<td>8.645</td>
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*p < 0.10, **p < 0.05, ***p < 0.01

Drop-out rate, Failing rate, and Passing rate are from the School Census. They are the mean rate across schools in the municipality and should add up to 1 in each school. Elem. literacy is from the 2000 and 2010 Demographic Census. It is the literacy rate of cohorts who are of elementary school age during the mayoral term. Estimation method: Local linear regression with a 50,000 voter bandwidth. Standard errors clustered at the municipality level.
Table C.17  Placebo regression discontinuity estimates on the geographic concentration of voters, at 300,000 inhabitant threshold

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<tr>
<td>Single round mean</td>
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<tr>
<td>Observations</td>
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<table>
<thead>
<tr>
<th>Panel B: Standard deviation in vote shares for each candidate</th>
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<td>1st place candidate</td>
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<tr>
<td>TwoRound</td>
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<td></td>
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<tr>
<td>Single round mean</td>
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<td>Observations</td>
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</table>

\*p < 0.10, \*\*p < 0.05, \*\*\*p < 0.01

At 300,000 inhabitants, a 2000 constitutional amendment placing a cap on local legislator salaries comes into effect. Panel A: overall concentration of voters for specific candidates, as measured by concentration indices (coefficient of variation, fractionalization, and entropy) of vote counts in polling stations. Panel B: candidate-level concentration of voters, measured by standard deviation in a candidate’s vote shares (for the 1st–4th place candidate) across polling stations. Vote shares are from the first round. Includes only elections after 2000. Estimation method: Local linear regression with election-year fixed effects and a 125,000 inhabitant bandwidth. Population density included as a control separately across the cutoff. Standard errors clustered at the municipality level.
Table C.18  Placebo regression discontinuity estimates on the geographic concentration of voters, at 285,714 inhabitant threshold

<table>
<thead>
<tr>
<th></th>
<th>Coefficient of variation</th>
<th>Fractionalization</th>
<th>Entropy</th>
</tr>
</thead>
<tbody>
<tr>
<td>TwoRound</td>
<td>0.004</td>
<td>0.005</td>
<td>0.007∗</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.004)</td>
<td>(0.004)</td>
</tr>
<tr>
<td>Single round mean</td>
<td>0.019</td>
<td>0.024</td>
<td>0.027</td>
</tr>
<tr>
<td>Observations</td>
<td>423</td>
<td>423</td>
<td>423</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>1st place candidate</th>
<th>2nd place candidate</th>
<th>3rd place candidate</th>
<th>4th place candidate</th>
</tr>
</thead>
<tbody>
<tr>
<td>TwoRound</td>
<td>0.005</td>
<td>0.003</td>
<td>0.009∗</td>
<td>0.006</td>
</tr>
<tr>
<td></td>
<td>(0.005)</td>
<td>(0.006)</td>
<td>(0.005)</td>
<td>(0.004)</td>
</tr>
<tr>
<td>Single round mean</td>
<td>0.075</td>
<td>0.071</td>
<td>0.040</td>
<td>0.022</td>
</tr>
<tr>
<td>Observations</td>
<td>424</td>
<td>423</td>
<td>400</td>
<td>331</td>
</tr>
</tbody>
</table>

*p < 0.10, **p < 0.05, ***p < 0.01

At 285,714 inhabitants, a 2004 constitutional amendment changing the size of the local legislature comes into effect. *Panel A:* overall concentration of voters for specific candidates, as measured by concentration indices (coefficient of variation, fractionalization, and entropy) of vote counts in polling stations. *Panel B:* candidate-level concentration of voters, measured by standard deviation in a candidate’s vote shares (for the 1st–4th place candidate) across polling stations. Vote shares are from the first round. Includes only elections after 2004. *Estimation method:* Local linear regression with election-year fixed effects and a 125,000 inhabitant bandwidth. Population density included as a control separately across the cutoff. Standard errors clustered at the municipality level.
Figure C.19  Regression discontinuity coefficients on overall concentration of voters for specific candidates at different thresholds

Overall concentration of voters for specific candidates, as measured by (a) Coefficient of variation, (b) Fractionalization, and (c) Entropy, using vote counts in polling stations. Vote shares are from the first round. The thicker horizontal lines represent the 90% confidence interval and the thinner horizontal lines represent the 95% confidence interval. Estimation method: Local linear regression with election-year fixed effects and a 50,000 voter bandwidth. Population density included as a control separately across the cutoff. Standard errors clustered at the municipality level.
Figure C.20  Regression discontinuity coefficients on the candidate level concentration in voters at different thresholds

Standard deviation in a candidate’s vote counts across polling stations, for the (a) 1st place and (b) 2nd place candidate. Vote shares are from the first round. The thicker horizontal lines represent the 90% confidence interval and the thinner horizontal lines represent the 95% confidence interval. *Estimation method:* Local linear regression with election-year fixed effects and a 50,000 voter bandwidth. Population density included as a control separately across the cutoff. Standard errors clustered at the municipality level.
Figure C.21  Regression discontinuity coefficients on overall level of resources in municipal schools at different thresholds

*Equipment* and *Infrastructure* are indices constructed by taking the first principal component of a school’s equipment and infrastructure elements, then calculating the school’s percentile in the national distribution. *Mean level of resources* is the mean index level across schools in the municipality for (a) equipment and (b) infrastructure. The thicker horizontal lines represent the 90% confidence interval and the thinner horizontal lines represent the 95% confidence interval. *Estimation method:* Local linear regression with election-year fixed effects and a 50,000 voter bandwidth. Population density included as a control separately across the cutoff. Standard errors clustered at the municipality level.
Figure C.22  Regression discontinuity coefficients on distribution of resources in municipal schools at different thresholds

(a) Equipment, standard deviation in resources

(b) Infrastructure, standard deviation in resources

Equipment and Infrastructure are indices constructed by taking the first principal component of a school’s equipment and infrastructure elements, then calculating the school’s percentile in the national distribution. Standard deviation in resources is the standard deviation in the index across schools in the municipality for (a) equipment and (b) infrastructure. The thicker horizontal lines represent the 90% confidence interval and the thinner horizontal lines represent the 95% confidence interval. Estimation method: Local linear regression with election-year fixed effects and a 50,000 voter bandwidth. Population density included as a control separately across the cutoff. Standard errors clustered at the municipality level.
Figure C.23  Regression discontinuity coefficients on municipal education outcomes at different thresholds

Drop-out rate is from the School Census. It is the mean rate across schools in the municipality. Elementary literacy rate is from the 2000 and 2010 Demographic Census. It is the literacy rate of cohorts who are of elementary school age during the mayoral term. The thicker horizontal lines represent the 90% confidence interval and the thinner horizontal lines represent the 95% confidence interval. Estimation method: Local linear regression with election-year fixed effects and a 50,000 voter bandwidth. Population density included as a control separately across the cutoff. Standard errors clustered at the municipality level.