Improving access to voting with optimized matchings

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ABSTRACT

Research on political representation has traditionally focused on the design of electoral systems. Yet there is evidence that voting costs result in lower turnout and undermine voters' confidence in the electoral system. Election administrators can selectively manipulate participation costs for different individuals and groups, leading to biased electoral outcomes. Quantifying the costs of voting and designing fair, transparent and efficient rules for voter assignment to polling stations are important for theoretical and practical reasons. Using analytical models, we quantify the differential costs of participation faced by voters, which we measure in terms of distance to polling stations and wait times to cast a vote. To estimate the model parameters, we use real-world data on the 2013 midterm elections in Argentina. The assignment produced by our model cut average voting time by more than 27%, underscoring the inefficiencies of the current method of alphabetical assignment. Our strategy generates better estimates of the role of geographical and temporal conditions on electoral outcomes.

1. Introduction

Scholarly work on political representation mainly focuses on problems associated with electoral system and ballot design. However, the location and administration of polling stations have sizable effects on electoral outcomes (Alvarez et al., 2008, p. 248). Hurdles to participation increase the opportunity costs of voting, which results in lower turnout (Dyck and Gimpel, 2005) and undermines confidence in the electoral system (Claassen et al., 2008). There is now robust evidence that distance to polling stations and waiting in line to vote impose real costs on voters and discourage political participation (Dyck and Gimpel, 2005; Stewart III and Ansolabehere, 2015). Yet voting costs are not evenly distributed across the electorate. In the US, for instance, racial minorities tend to experience longer voting times than white voters (Stewart III, 2012), and urban voters travel less but wait longer to vote (Stewart III and Ansolabehere, 2015). Hence varying voting costs results in disenfranchisement, affecting political representation. As Lijphart (1997, p. 2) eloquently puts it: "low voter turnout means unequal and socioeconomically biased turnout."

These insights have piqued academic interest in issues associated with electoral administration. Decisions by authorities in charge of planning and administering elections affect the distance and wait time faced by different groups of voters (Haspel and Knotts, 2005, p. 560). These choices could be subjected to opportunistic political manipulation by those authorities, facilitating access to the ballot of their supporters and making it more difficult for their opponents to cast a vote (Nagler, 1991; Brady and McNulty, 2011). Given existing evidence that the costs of voting vary significantly across individuals of different socioeconomic status, matching voters to polling stations has become a politically salient and controversial problem (Stewart III, 2012; Herron and Smith, 2016).

Providing electoral administrators with transparent rules for voter assignment and resource allocation has important implications for the functioning of the electoral process, the fundamental pillar of democratic governance.[1] The usual recommendation to reduce voting costs is to better allocate resources across polling stations. However, electoral authorities lack a clear benchmark on how to allocate those resources in an efficient, objective and fair way. Our paper aims at filling that void.

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[1] "The use of automated districting procedures is at least able to ensure that systematic distortions of the electoral outcome are avoided, and, denying political parties the opportunity to manipulate districts, they can be very useful to provide fair district maps." (Ricca et al., 2013, p. 250).

Employing tools of mathematical programming, we develop a modeling strategy for optimal voter assignment to polling stations, reducing voting costs as defined by the total time needed to vote (sum of travel and wait times).

The main differences between our approach and previous studies that apply quantitative methods to electoral problems are twofold: first, we consider the relocation of polling stations together with the assignment of voters to polling places; and, second, we focus on the combination of travel and waiting time as a measure of the total time needed to vote. While similar approaches have been considered in the past, earlier work did not address the problems of assigning polling stations and voters to polling places simultaneously. Allen and Bernshteyn (2006) define regression models to predict voter turnout; based on queueing theory results, they propose a simple heuristic for redistributing polling stations between a set of precincts with the aim of minimizing the maximum expected wait time among those precincts. Orford et al. (2011) consider statistical models of voter turnout and perform a correlation study between distances to polling stations, among other variables, to assess the effect of polling stations' locations. Yang et al. (2013) analyze the problem of redistributing polling stations between a set of precincts, but unlike our method they apply an "equity" criterion defined as the difference between the maximum and minimum expected waiting times among those precincts. Herron and Smith (2016) develop a simulation model that can be used to analyze the effect of different numbers of stations within the same polling place. By explicitly considering distances between voters' residences and polling stations, we can compute a reliable estimate of the travel time of each voter. As mentioned earlier, we also account for waiting time at the voting station, as estimated by a queueing theory model.

Our modeling framework allows us to quantify the costs of voting, as given by the two components of voting time, under different voter assignment scenarios. First, we develop a benchmark model to match voters to polling stations that satisfies fundamental principles of efficiency and objectivity. We use this benchmark to quantify the costs of participation under the voter allocation rule in Argentina. The current election design assigns voters to polling places within a territorial subunit of the broader electoral district in alphabetical order. While seemingly innocuous, this alphabetical assignment rule does not internalize the varying voting costs—resulting from travel distance to polling stations and wait times—for different voters within those subunits.

Using voter-to-polling-station assignment data in one territorial subunit of the city of Buenos Aires, we document large differences in total voting time when the current electoral system is compared to the optimized assignment. We find that minor changes in voter assignment to polling stations resulting from our model lead to sizable variation in the expected costs of voting, as measured by travel and wait times. On average, the assignment that results from the benchmark model reduces the average total voting time by more than 27% with respect to the current official assignment. We also develop alternative models that either vary the capacity of polling places, relocate polling stations, or both. For each of these alternatives, we compare the resulting total voting time to the assignments used in Argentina, and discuss the expected impact on voting outcomes. The reductions in travel and wait times arising from the implementation of our linear programming approach are significant. There is ample evidence that even small changes in total voting time can have a significant impact on participation rates (McNulty et al., 2009) and on perceptions about the legitimacy of the electoral process (Spencer and Markovits, 2010; Gerber et al., 2013). Although the efficiency gains could have significant effect in elections like those in Argentina where voting is mandatory, the gains are likely to be even more important under different electoral rules, in particular where voting is not mandatory.[2] Assessing the impact of implementing more efficient voter assignment rules on electoral outcomes—including turnout and representation—under different electoral rules is a

potentially fruitful and important area for a more rigorous empirical evaluation.

The rest of this paper is divided into six sections. Section 2 places our contribution in the context of the extant literature; Section 3 describes the current official assignment process of voters to polling stations used in Argentinean elections and the matching problem variants that will be solved; Section 4 introduces the proposed voter-matching models, beginning with the benchmark assignment version, which we use to document the extra participation costs experienced by voters under the current system; Section 5 discusses the methodologies for obtaining and processing the data on queues and waiting times at the polling places and the voters' geographical location data; Section 6 implements the models and analyzes the results; and finally, Section 7 presents our closing comments and conclusions.

2. Related literature

Voting is one of the central features of democratic governance. In theory the individual decision to vote is affected by expected benefits and costs of turning out (Downs, 1957; Riker and Ordeshook, 1968; Aldrich, 1993). The rational voter hypothesis has been criticized because it fails to explain the levels of voting. Since the probability of casting a decisive vote is negligible, any small cost of participation would lead to abstention.[3] However, we do observe that many individuals vote systematically, suggesting that political participation is not solely based on self interest (Palfrey and Rosenthal, 1983, 1985; Aldrich, 1993; Green et al., 1994).[4] In any event, the rational voter model provides important insights that explain participation at the margin (Aldrich, 1993; Blais et al., 2000; Bhatti, 2012). The choice to participate in an election varies across voters according to individual characteristics, including interest and motivation. Hence, even in highly salient elections, a large number of potential voters abstain, indicating that civic-mindedness is far from universal and that voting costs could affect political participation. Hurdles to participation also play an important role in other major perspectives on the individual and group level determinants of voting (Gomez et al., 2007).[5] In all of these perspectives, distance to polling stations and wait time increase the opportunity costs of voting, resulting in lower turnout (Dyck and

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[2] Mandatory voting is likely to result in higher turnout rates (Singh, 2011, 2015; Carlin and Love, 2013). Yet, as documented in the literature on election management, holding motivation to vote and constraints constant (including the expected cost of not voting), the reduction in participation costs should result in a higher likelihood of voting. We discuss this conjecture further in footnote 2 below. Anecdotally, we observe stark differences in turnout rates in primary, midterm and presidential elections in Argentina, USA and elsewhere. The Chilean case presents an interesting example: turnout rates dropped substantially (from about 85% to 40%) after Chile moved from mandatory voting for all voters who registered voluntarily, to voluntary voting with universal registration (Contreras et al., 2016).

[3] In the rational voter model the probability of voting is a function of the utility an eligible voter gets from casting her vote. We can denote the probability that individual i turns out as an increasing function of U_v, the utility she derives from voting: $\pi_i = f(U_v)$. The utility of voting, $U_v = f(pB, c)$, can be defined in terms of the material and psychological benefits B that the voter expects to receive when her candidate of choice wins the election, the probability p that her vote will be decisive, and the costs c of participating in the electoral process. The costs of voting include the resources required to acquire information about candidates and political issues, and the time it takes to cast a vote. Under general conditions, the utility of voting is increasing with the benefits B and decreasing with the cost of participation c. As the number of voters increases, the probability p of any single vote being pivotal becomes negligible. To the extent that voting is costly, a rational voter is likely to sit an election out.

[4] We can further decompose the voter benefits into selfish ones (benefits accrued directly by the voter) and social ones (indirect benefits to others that the voter internalizes). If solely motivated by selfish benefits, the individual calculus would result in a lower probability of turning out as the number of voters increases. Social benefits, on the other hand, could result in a higher probability of voting even as the number of voters goes up (see Edlin et al., 2007).

[5] These perspectives place emphasis on socio-economic status (Almond and Verba, 2015; Verba and Nie, 1987), or group level conditions affecting voter mobilization (Rosenstone and Wolfinger, 1978; Rosenstone et al., 1993).