# Does Distance Matter? Evaluating the Impact of Drop Boxes on Voter Turnout

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*Objective.* This article examines the impact that reducing the distance to a voter's nearest ballot drop box has on turnout. *Methods.* The placement of five new ballot drop boxes was randomized among six potential sites identified based on similar criteria. The randomization of the five boxes across the six sites created natural Treatment (those sites that received a new box) and Placebo (the site that did not receive a new box) groups. We then employed a difference-in-difference design to determine whether voters in the Treatment group were more likely to vote in the 2017 general election compared to those in the Placebo group. *Results.* We find that a decrease of one mile to the nearest drop box increased the probability of voting by 0.64 percent. *Conclusion.* Our finding indicates that drop boxes have a positive effect on voter turnout and that decreasing the distance to these boxes can lead to an increased likelihood of voting.

Voter turnout in the United States lags behind most other developed democracies. In a 2018 report by the Pew Research Center, the United States ranked 26th of 32 developed countries in turnout (DeSilver, 2018). In no national election since 1968 has the voting eligible turnout (VEP) been above 62.5 percent (McDonald, 2018). Midterm and off-year elections experience even lower turnouts; for example, in Washington State, VEP turnout in the 2016 presidential election was 65.7 percent, but for the 2014 midterm election it was only 43.1 percent (McDonald, 2018).

One popular approach for increasing voter turnout in the United States is to increase the ease of voting. Indeed, research shows that reducing the barriers to voting leads to increased turnout, and though these effects are rarely large, in a country with relatively low levels of turnout, even small changes are important (Stein and Garcia-Monet, 1997; Gimpel and Schuknecht, 2003; Brady and McNulty, 2011). No-excuse absentee voting, early voting, and vote by mail (VBM) all represent different measures voting jurisdictions are taking to make voting easier and to increase voter participation. Of these, VBM removes the most barriers to voting. In VBM jurisdictions, voters do not need to request an absentee ballot, as they do with no-excuse absentee voting; instead, all registered voters receive and can return their ballot through the mail.

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While the effect of VBM provisions on voter turnout has been studied extensively, little research exists on the impact of providing citizens in VBM jurisdictions with the alternative option of voting via drop boxes. Drop boxes are large, secure boxes where voters can drop off their ballots instead of mailing them in. All VBM states (currently Washington, Colorado, and Oregon) require some provision for voting via drop boxes, and experience with these boxes shows that many voters choose them over the mail. For instance, in Washington State, 57 percent of the 3.4 million votes cast in the 2016 general election were placed in one of the state's 314 drop boxes (Washington Secretary of State, 2017b). Drop boxes provide some potential advantages for voters over the mail in option. First, one can vote without the expense or inconvenience of acquiring a postage stamp. Second, some may find drop boxes to be a more trustworthy or secure way to vote as they reduce the number of hands through which a ballot passes before it is counted. For these reasons, drop boxes may encourage more people to vote by making the process both easier and more secure. The presence of drop boxes, often placed in high traffic areas and embossed with bold pro-voting graphics,[1] may also increase voting by serving as a visual reminder.

The decline of traditional in-person precinct voting, and the increasing range of voting practices now common across the United States, makes it especially important to understand the relative impact these alternatives have on voting behavior. One important question within VBM states, and in states considering a move to a VBM system, is the extent to which drop boxes should be made available to voters. While they have already proven popular, they are also expensive to install and maintain. A recent law passed by the Washington State Legislature requiring counties to install about 220 additional drop boxes across the state has been met with resistance from county officials who are responsible for funding their installation (Cornfield, 2018).

One prior investigation found that increasing the number of boxes and reducing the distance to the nearest drop box location had a noticeable effect on turnout in primaries and off-year elections, and a small effect during general elections. Collingwood et al. (2018) examined a large expansion in the number of boxes in King County, Washington. They found that reducing the distance between a voter and the nearest box by 1 standard deviation below the mean distance increased the likelihood of voting by less than 1 percentage point in the 2016 general election, and by 1.5 percentage points in the 2015 general election. However, for the 2015 and 2016 primaries, it increased at 4 and 2 percentage points, respectively. This study is the only one to date that we are aware of to examine the impact of drop boxes on voting behavior. However, the design of this study leaves open the possibility that the relationship detected was not a causal one.

This study builds on the King County study by analyzing the effect of an expansion in the number of drop boxes in Washington State's second largest county, Pierce County. Prior to the 2017 general election, Pierce added five additional drop boxes, increasing the countywide total from 30 to 35. Compared with the analysis of King County, where the number of drop boxes grew from 10 to 43, this study examines the effect of a smaller increase in drop boxes and an expansion that received much less publicity than did King County's expansion. Unlike that one, which targeted nearly the entire county, the additional boxes in Pierce were directed at specific communities within the county. Also, unlike King County, the present study is set in a county where new drop boxes are not the novelty they were in King, as for the last seven years a large share of Pierce County's voters have used them to return their ballots.

[1] In Washington State, they often feature quotes from famous individuals encouraging civic participation. For instance, one in Pierce County, Washington includes this Alice Walker quote: "The most common way people give up their power is by thinking they don't have any."

More importantly, our study employs a stronger methodology to establish the causal link between distance to drop box and the propensity to vote. In the Collingwood et al. (2018) study, election officials determined the new locations for the 33 additional drop boxes; these decisions are what allowed the authors to capture variation in voters' proximity to drop boxes over time and to analyze the relationship between these changes and voting behavior. Unfortunately, this method also left no way to ensure that the selection of sites was independent of underlying trends in turnout. Thus, the increase in turnout that study measures could possibly be due to changes in voting behavior correlated with the locations of the new boxes, rather than to the new boxes themselves. Without a true random design, one cannot be sure if the correlation between distance to drop box and voting is truly causal.

Our study, by contrast, uses an experimental design that more convincingly identifies drop boxes' causal effect on voting. Pierce County election officials had identified six sites as potential locations for a new box. According to county officials, all six sites had equally strong cases for a new box based both on nearby residents' proximity to other drop boxes, their turnout rates, and other criteria used to identify potential locations by the Pierce County Auditor. Yet the county only had resources to install five boxes. Working with county election officials, we randomly selected one of the six potential sites to *not* receive a new drop box for the 2017 general election. This unselected site became our "Placebo" location, and the other five become our "Treatment" locations. Voters near the Placebo location act as a control group against which we can compare the behavior of voters near the Treatment locations. Since the Placebo location was chosen randomly from among similar sites, we can be more confident that the observed effects are due to the installation of new boxes rather than to underlying trends in unobservable characteristics of voters.

## Background

Demographically, voters in the United States tend to be older, more educated, and wealthier; much research in political science finds that who votes influences the design and implementation of policies and the allocation of public spending. Accordingly, increasing not just turnout, but participation among low-propensity populations is important for the representativeness of American democracy (Griffin and Newman, 2007; Martin, 2003; Gilens, 2012; Bartels, 2009; Wolfinger and Rosenstone, 1980).

Voting laws and policies are enacted and enforced primarily at the state rather than the federal level. Voting practices in the United States, accordingly, vary by locale. While some states have imposed greater restrictions on voting through stricter voter ID laws, many others have sought to reduce or eliminate geographic distance or other barriers to voting to increase voter turnout. No-excuse absentee voting, early voting, Election Day voting centers, and VBM laws have all been enacted to reduce barriers to participation with the hope that higher turnout rates would result. Thirty-two states and the District of Columbia currently allow no-excuse absentee voting, where anyone can request an absentee ballot without disclosing the reason for this request (National Council of State Legislatures, 2020). In 2012, the Pew Research Center estimated that 36 percent of voters, or more than 46 million people, cast their ballots in some way other than through a traditional polling location (Desilver and Geiger, 2016). Between 2000 and 2012, the number of ballots cast by mail increased from 10 to 20 percent (Green and Ueyama, 2015). Research finds that institutional factors and distance to voting locales can reduce the likelihood of voting

(Dyck and Gimpel, 2005; Brady and McNulty, 2011; Gimpel and Schuknecht, 2003), especially among low-propensity voting populations (Barreto, Nuno, and Sanchez, 2009; Rosenstone and Hansen, 1993).

Three states have gone the furthest to reduce barriers to voting by eliminating polling stations altogether and moving entirely to a VBM system. Washington, Colorado, and Oregon now conduct all elections by mail and all registered voters receive a ballot, which they can return by mail or deposit into a secure drop box.[2] Prior research on the effect VBM has had on turnout finds that it can increase voter turnout, although the effect has been dependent on the type of election, demographic group, and the novelty of VBM (Gronke et al., 2008; Gronke and Miller, 2012; Hamilton, 1988; Jeffe and Jeffe, 1990; Karp and Banducci, 2000; Kousser and Mullin, 2007; Magleby, 1987; Mutch, 1992; Southwell and Burchett, 1997, 2000; Southwell, 2016). Many of these studies have found that VBM has the largest impact in nonpresidential elections where turnout is low. In terms of representation, Southwell and Burchett (1997) found that VBM did increase participation among nontraditional voters (Southwell and Burchett, 1997), but other studies found that turnout increased most among demographic groups already inclined to vote (Karp and Banducci, 2000; Stein and Vonnahme, 2008).

While VBM eliminates some impediments to voting, it may not reduce them all, and could inadvertently create new ones. Some voters may be concerned about sending their ballot to election officials through a third party (the USPS), and via a delivery system not designed to ensure the security and safety of their ballot. Many VBM jurisdictions currently require voters to stamp their own ballot in order to return it through the Postal Service, though this recently changed in Washington State. While perhaps a minor cost, this could reduce the likelihood of voting, especially if individuals do not have postage on hand. The need for a stamp could prove an impediment especially to low-propensity and young voters. According to the 2016 Survey of the Performance of American Elections, the top reason for using a drop box among registered voters in Washington was because it added safety and privacy for their ballot (39 percent). The second most common reason given was not needing a stamp (35 percent), followed by the convenience of drop box location (25 percent).

It is perhaps these concerns that explain why all VBM states have some drop box requirement. Oregon has over 300 such boxes and in 2017 Washington State had 371 (Washington State Secretary of State, 2017c). These boxes are available 24/7, and voters can drop their ballot in them any time during an approximate two-week window before Election Day. Moreover, they are typically placed in high traffic areas such as shopping malls, transit stops, libraries, and government offices. When available, drop boxes prove to be a popular way to vote. In Washington State's 2016 general election, more than 50 percent of statewide ballots were returned via these drop boxes; in Pierce County that year, more than 60 percent were.

[2]While Oregon, Washington, and Colorado are the only states that conduct elections entirely by mail, some states like California allow voters to use this as an alternative to in-person voting. The California Voter's Choice Act (SB 450) of 2016 allows counties to conduct VBM elections if a set of conditions are satisfied (California Secretary of State, n.d.). Currently 15 counties have implemented the program, which sends a mail-in ballot to every registered voter, though they still have the option to vote in person. Beginning in 2019, all mail-in ballots in California also include prepaid postage (California Secretary of State, 2019). Based on an executive order from Governor Gavin Newsom, the November 2020 general election will be the first time California conducts an election entirely by mail due to concerns related to the coronavirus pandemic, though it is unclear at this point whether this will lead California to transition to an VBM-only system such as Washington, Oregon, or Colorado in the future (California Secretary of State, 2020).

Yet despite their popularity, little attention has been paid to whether drop boxes improve turnout in VBM jurisdictions. The one exception is Collingwood et al.'s (2018) study in King County, Washington. They found that a very large expansion of drop boxes (from 10 to 43) increased voter turnout and, more importantly, that the distance between a voter and the nearest drop box location helped explain a voter's likelihood of voting. The greatest effect that was identified was for primary and off-year elections, with the location of drop boxes having little effect on voting during the presidential election.

As noted earlier, an important shortcoming of this study was that the placement of new drop boxes in King County was not random, and thus their location may not have been exogenous to underlying trends in voter behavior. If King County officials targeted areas for drop boxes based on expected changes in turnout, then it would be difficult to separate out the effect of drop boxes on turnout from characteristics of voters near where these drop boxes were installed. The results thus may not accurately identify the impact of these boxes on the decision to vote, with the estimates either overstating or understating their true effect.

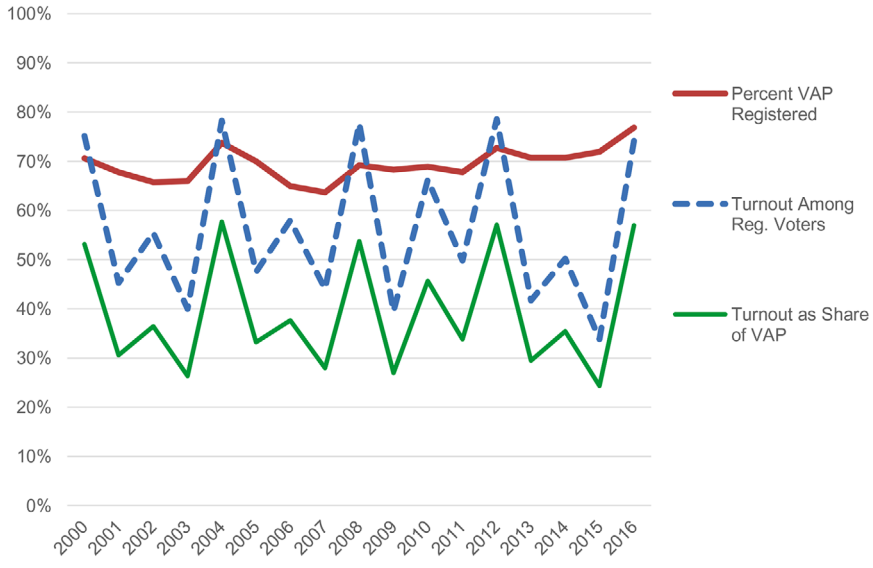
In this study, we address this shortcoming by randomizing the placement of five new drop boxes in Pierce County, Washington among six predetermined locations, all of which were identified by election officials using the same selection criteria. As described in greater detail below, this experimental design allows us to identify the causal effect of drop boxes by comparing the voting behavior of voters near our Placebo box with those near the five new drop boxes, the latter constituting our Treatment group. Even if Pierce County officials had chosen the potential locations based on expected changes in turnout, a comparison between those in our Treatment group with those in the Placebo group removes this potential source of bias since the selection criteria for the new boxes was similar across all six locations. In the Collingwood et al. (2018) study, the selection process was not controlled for, meaning that the increases in turnout seen could have resulted from factors other than the decrease in distance to the nearest box.

Policymakers in VBM states have increasingly relied on drop boxes for vote delivery, under the assumption that the greater availability of these boxes will improve turnout, yet there have not been many empirical studies of this to date. In 2017, the Washington State Legislature passed a law mandating that counties expand the number of drop boxes, stipulating that each county maintain at least one box for every 15,000 voters, with additional requirements for the dispersion of these boxes. This new law is requiring counties across the state to install an additional 220 new boxes (Washington State Secretary of State, 2017c). Each box costs an estimated $10,000, with additional costs for maintenance and ballot collection, which makes assessing their effectiveness in increasing turnout important (Cornfield, 2018). If they do not increase the likelihood of voting, then costly expansions in the number of boxes may not be merited. As more states look for ways of increasing turnout, understanding the effect of VBM and the location of drop boxes is important, and Colorado, Oregon, and Washington serve as important test cases.[3]

[3]With the same motive of encouraging more to vote, in 2018 Washington Governor Jay Inslee authorized the funding of stamped ballots for the 2018 primary and general elections (Blethen, 2018). This will cost taxpayers an estimated $2 million per year. Future work should examine the effect that stamped ballots have on drop box usage since the lack of a stamp was the second most popular reason people gave for using drop boxes. However, the security of the boxes was the most popular reason for using them as opposed to mailing one's ballot, which suggests that they will remain popular with voters. VBM states, and those with a hybrid system like California, also have an interest in encouraging voters to use drop boxes since this could reduce the cost associated with prepaid postage, though it is unclear at this stage how the savings in postage would balance with the costs of maintaining the boxes.

FIGURE 1

Pierce County, Washington Voting Statistics, 2000–2016.




DATA SOURCE: Washington State Secretary of State's Office (2017a).

### *Pierce County and Drop Boxes*

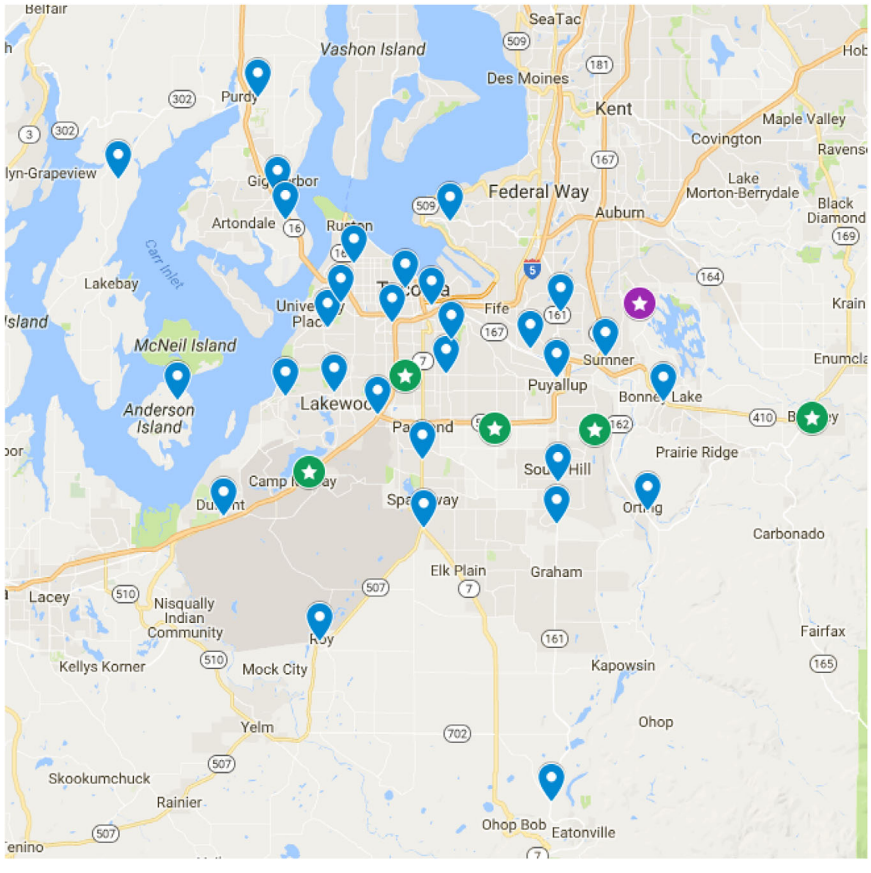
With over 800,000 residents, Pierce County has the second largest population in Washington behind King County. The county seat is Tacoma, with more than 200,000 residents, and Tacoma is Pierce's largest city. Over the last few decades, Pierce has been transitioning to a service-based economy, and a large share of its residents commute to jobs in neighboring King County. The county encompasses the Port of Tacoma and the Joint Base Lewis-McChord military base, both of which form important components of the local economy. Compared with King County, Pierce residents live in more suburban locales, are less racially diverse, face longer commutes, are more likely to be in the military, and vote less frequently.

In terms of elections, Pierce has over 500,000 registered voters (Washington State Secretary of State, 2017c). As Figure 1 shows, over the last two decades, the share of the voting-age population (VAP) registered to vote has ranged from 65 to 75 percent.[4] Turnout, defined as the share of registered voters who cast a ballot, is typically around 75 percent during presidential elections, between 50 and 65 percent during midterm elections, and ranges from 35 to 50 percent during off-year elections (Figure 1). In the 2017 general election, turnout was only 28.6 percent, putting Pierce in second place for the lowest countywide turnout in Washington State, though turnout statewide that year was only 37.1 percent (Washington State Secretary of State, 2017c).

[4]Registration and turnout rates measured using voting-age population as the denominator will tend to understate these rates when compared to calculations using eligible voters as the denominator, as the VAP will include felons and noncitizens ineligible to vote (McDonald, 2018). While the voting-eligible population would give a more accurate assessment of registration and turnout rates, VEP statistics were not available from the Washington Secretary of State's office or the Pierce County Auditor.

FIGURE 2

Location of All Drop Boxes in Pierce County (2017).




NOTE: Green stars are Treatment boxes; purple star is Placebo box.

In 2018, Pierce County had 35 drop boxes. The oldest three drop boxes date to 2009. In 2011, Pierce County became a VBM jurisdiction, and that year added 16 new boxes. Since then, at least one box has been added each year, with the largest number of new boxes (five boxes) installed in 2017. These five boxes brought the countywide total to 35. Pierce boxes are all open 24/7 beginning 18 days before an election. Since 2014, over 50 percent of the votes cast in Pierce County have come through one of these drop boxes.

Figure 2 shows the location of the county's 35 drop boxes, and also shows the location of the one Placebo box used in this study. According to Pierce County documents (Rooney, 2018), new drop box sites are chosen based on the following criteria:

1. proximity to population centers and density, number of ballot drop-off users, and major traffic corridors;
2. familiarity of locations for a majority of the population;
3. access to public transportation routes;
4. accessibility features of the sites for voters with disabilities;
5. availability of parking and adequate traffic flow;

6. ability to maintain consistent locations for all countywide elections;
7. ability to partner with a public organization with community ties; these partners include transit centers, park and ride lots, police stations, city halls, libraries, and fire stations; and
8. socioeconomic indicators such as income and ethnicity.

In 2017, the county used these criteria to identify six priority locations for new boxes. However, the county only had funds for five, and thus permitted us to randomly select one of these six to serve as our Placebo location, or drop box. Because of the recent expansion, 98 percent of all registered voters in Pierce now live within five miles of one of these drop boxes.

## Data and Methodology

To identify individuals in our Treatment and Placebo groups, we began with a file containing information on all registered voters in Pierce County made available to us by the Pierce County Auditor's Office. We contracted with a nationally known voter file vendor (L2 Political) for information on when voters registered to vote, their age, gender, voting history, and sociodemographic indicators including income and race/ethnicity.[5]

To identify individuals in both our Treatment and Placebo groups, we calculated the distance between every Pierce County voter's home address and each of the county's 35 ballot drop boxes, plus the one Placebo drop box.[6] We assigned voters to the Treatment group if their nearest drop box in 2017 was one of the five newly installed ones. We assigned voters to the Placebo group if their closest drop box would have been the Placebo drop box, had it actually been installed. The Treatment group contains 55,835 voters while the Placebo group contains 10,607 voters. Pierce County voters who were not in the Placebo or Treatment groups are not included in our analysis to ensure we are measuring the effect of the decrease in distance resulting from the installation of the new boxes for those in the Treatment group. Table 1 presents summary statistics for both Treatment and Placebo groups; for reference, it also includes information on the balance of Pierce County voters.

We define our study's "treatment" to be the change in the proximity to one's nearest drop box as a result of the 2017 expansion. We measure this change as the difference between the number of miles to a Treatment voter's nearest drop box prior to 2017 and the number of miles to the nearest drop box in 2017.[7] By definition, this change in distance for all individuals in the Treatment group is greater than zero, and is zero for those in Placebo group since the distance to their nearest drop box did not change. We can thus measure the effect of the individual decrease in distance to the nearest drop box as a result of the new installations, as well as ensure that any changes in likelihood of voting are due to the change in distance. In 2017, individuals in the Treatment group were an average of 1.31 miles closer to a drop box than they had been in 2016, which we predict will increase

[5]The determination of each individual voters' race/ethnicity and income by L2 Political is based on a combination of surname, neighborhood characteristics, and other private consumer data, so the match is an estimate and not necessarily exact.

[6]These distances are calculated "as the crow flies." This procedure also maintains the assumption that individuals interact with the ballot drop box closest to their home address. This may not be the case and is an important question for future study.

[7]For simplicity, we estimate our models using the absolute value of the change in distance. A large positive value indicates a large decrease in distance to the nearest drop box.

TABLE 1

Summary Statistics

| Placebo Group, $n = 10{,}598$ | Mean | *SD* | Min | Max |
|---|---|---|---|---|
| Voter turnout | 0.47 | 0.50 | 0 | 1 |
| Δ*Distance* | 0.00 | 0.00 | 0.00 | 0.00 |
| Age | 48.85 | 16.18 | 18 | 99 |
| East and South Asian | 0.05 | 0.21 | 0 | 1 |
| European | 0.87 | 0.33 | 0 | 1 |
| Hispanic and Portuguese | 0.05 | 0.22 | 0 | 1 |
| Black | 0.00 | 0.05 | 0 | 1 |
| Other | 0.03 | 0.16 | 0 | 1 |
| Income | $111,318.30 | $48,053.06 | $6,000.00 | $250,000.00 |
| Female | 0.51 | 0.50 | 0 | 1 |
| **Treatment Group, $n = 55{,}756$** | **Mean** | ***SD*** | **Min** | **Max** |
| Voter turnout | 0.43 | 0.50 | 0 | 1 |
| Δ*Distance* | 1.31 | 1.43 | $9.30 \times 10^{-6}$ | 7.32 |
| Age | 49.10 | 17.68 | 18 | 100 |
| East and South Asian | 0.04 | 0.20 | 0 | 1 |
| European | 0.86 | 0.34 | 0 | 1 |
| Hispanic and Portuguese | 0.06 | 0.24 | 0 | 1 |
| Black | 0.01 | 0.11 | 0 | 1 |
| Other | 0.02 | 0.14 | 0 | 1 |
| Income | $79,648.86 | $41,822.70 | $6,000.00 | $250,000.00 |
| Female | 0.53 | 0.50 | 0 | 1 |
| **All Other Voters, $n = 353{,}267$** | **Mean** | ***SD*** | **Min** | **Max** |
| Voter turnout | 0.47 | 0.50 | 0 | 1 |
| Δ*Distance* | 0.00 | 0.00 | 0.00 | 0.00 |
| Age | 49.28 | 17.38 | 18 | 100 |
| East and South Asian | 0.04 | 0.19 | 0 | 1 |
| European | 0.86 | 0.34 | 0 | 1 |
| Hispanic and Portuguese | 0.06 | 0.24 | 0 | 1 |
| Black | 0.01 | 0.12 | 0 | 1 |
| Other | 0.02 | 0.15 | 0 | 1 |
| Income | $84,439.30 | $44,482.47 | $6,000.00 | $250,000.00 |
| Female | 0.53 | 0.50 | 0 | 1 |

NOTE: The calculations above only include voters for whom all sociodemographic data were available.

their likelihood of voting, based on existing research. The Placebo group was identified as a potential new location by the Pierce County Auditor using the same criteria as that used for the Treatment group but they did not receive a box. We therefore predict there will be no change in the likelihood of someone in the Placebo group voting in the 2017 election.

As shown in Table 1, over the last three general elections (2015, 2016, and 2017), an average of 47 percent of those individuals in the Placebo group voted, while in the Treatment group, an average of 43 percent voted, indicating that the Treatment group consisted of voters with a slightly lower propensity to vote ($p = 0.000$). Table 1 also shows some differences in sociodemographic characteristics between our Treatment and Placebo groups. The Placebo group had a significantly higher average income ($p = 0.00$), fewer East and South Asians voters ($p = 0.00$), fewer Europeans ($p = 0.00$), and fewer Hispanic ($p = 0.00$) and black ($p = 0.00$) voters.

Ideally, the randomization process described above would have produced Treatment and Placebo groups that were similar in terms of their observed characteristics.[8] Since that is not the case, we control for differences in sociodemographic characteristics in our model between the two groups, as these demographic characteristics are often found to be associated with voting behavior. To do this, we estimate the treatment effect of the drop box expansion using a difference-in-difference model. We compare changes in voting among the Treatment group with changes in voting among the Placebo group and control for differences in the level of voter turnout caused by individual characteristics. The year fixed-effects included in the model capture changes due to year-specific voting patterns. This is shown in Equation (1):

$$Vote_{i,t} = \alpha_0 + \alpha_1 \Delta Distance_i + \alpha_2 Year\ 2017_t + \alpha_3 \Delta Distance_i \times Year\ 2017_t + \gamma_i + \tau_t + \varepsilon_{i,t}. \quad (1)$$

- $Vote_{i,t}$ equals 1 if individual $i$ who was registered to vote in year $t$ (=2015, 2016, or 2017) cast a ballot in that year's general election, and 0 otherwise.
- $\Delta Distance_i$ represents the change in distance to the nearest drop box experienced by individual $i$ following the 2017 expansion.
- $Year\ 2017_t$ is equal to 1 if the observation is from the 2017 general election, after the ballot drop box expansion.
- $\gamma_i$ and $\tau_t$ are individual and year fixedeffects, respectively.

The average treatment effect of the ballot drop box expansion is captured by $\alpha_3$, the coefficient on the interaction between $\Delta Distance_i$ and $Year\ 2017_t$. This coefficient quantifies the average difference between individuals in the Treatment and Placebo groups regarding changes in their likelihood to vote between 2017 and the two prior election years. If drop boxes increase turnout, this coefficient will be positive and statistically significant; if they do not increase turnout, this coefficient will be 0.

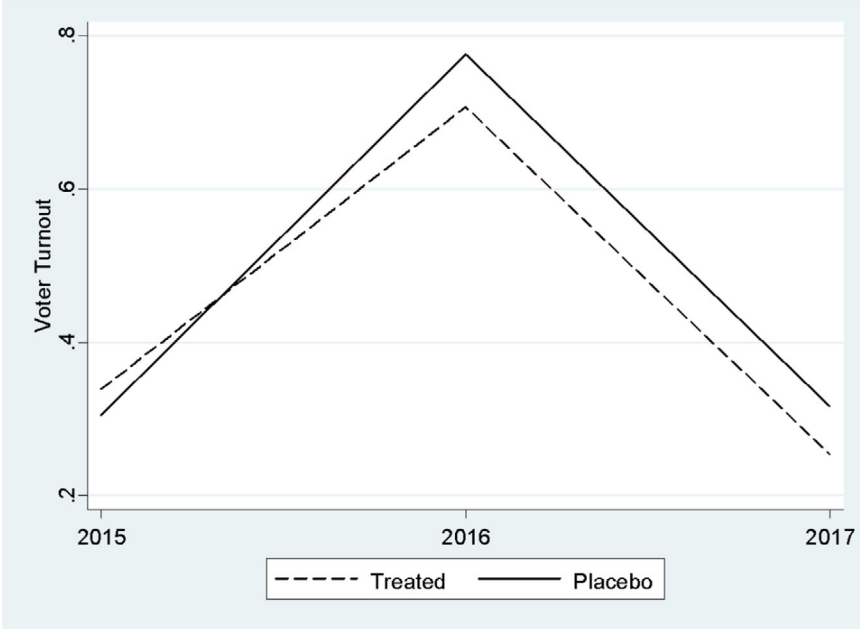
Because the dependent variable ($Vote_{i,t}$) is binary, the most appropriate functional form to estimate Equation (1) would seem to be a conditional (or fixed effects) logit model. Instead, we use a linear probability model (LPM) to estimate the effect of the drop box expansion because a conditional logit estimator would eliminate all individuals in the sample who either always vote or never vote. This would constitute 47 percent of our sample. Employing the LPM avoids this reduction in sample size, and the biases introduced by it. Moreover, since our purpose is to estimate marginal rather than overall effects, using an LPM rather than a conditional logit should not bias our estimates. To ensure these assumptions are correct, we did estimate Equation (1) using a conditional logit and found that the results were very similar to those for an LPM when we place the equivalent 47 percent restriction on the sample size. However, the results were very different from our unrestricted LPM, indicating, we believe, the selection bias that the conditional logit model introduces because of who it drops from the study.

Before estimating a difference-in-difference model, we must first ensure that the data satisfy the so-called parallel trends assumption. That is, the Treatment and Placebo groups must exhibit similar trends in voting if the ballot drop box expansion had not occurred.

[8]Since characteristics such as income, ethnicity, and gender can be controlled for in our empirical model, it is actually more important that these groups are similar in dimensions that would be difficult to measure. Our randomization process still ensures that these groups are similar in terms of the criteria used by the Pierce County Auditor to select sites for drop boxes, as outlined in the "Pierce County and Drop Boxes" section.

FIGURE 3

Treated Versus Placebo General Election Voter Turnout Trends




If on the other hand, turnout in the Treatment group had already been rising relative to the Placebo group prior to the new the box installations, this would make it difficult to attribute any higher turnout among the Treatment group to the new drop boxes rather than to longer term trends. Figure 3 shows the mean levels of voter turnout for the Placebo and Treatment groups in the 2015, 2016, and 2017 general elections.

As shown, the Treatment and Placebo groups display similar trends. If anything, the Placebo group exhibited faster growth in voter turnout between 2015 and 2016. As an additional check, we estimated Equation (1) with 2016 (incorrectly) assumed to be the treatment year. If this resulted in a positive and statistically significant coefficient on $\alpha 3$, this would also provide evidence that the parallel trends assumption did not hold and would overstate the causal effect of the 2017 drop box expansion on turnout. Table A1 presents the results of this analysis. As shown there, we find no significant difference in the change in voter turnout between the Placebo and Treatment groups between years 2015 and 2016. This validates our parallel trends assumption and our empirical methodology.

## Results

Table 2 presents the estimated magnitude of the effect of individual characteristics, year, and distance to drop box on the likelihood of voting. Column 1 in Table 2 reports estimates that include the individual fixedeffect ($\gamma_i$), as in Equation (1).[9] The first row shows

[9]The full set of parameter estimates are reported in Table A2. Note that the parameters other than 3, while interesting in their own right, are not relevant for this study.

TABLE 2

Treatment Effects Derived from LPM Difference-in-Difference Model

| | (1) Base Model | | (2) By Socio-Demographic Group | |
|---|---|---|---|---|
| Treatment Effects | Coefficient | *p*-Value | Coefficient | *p*-Value |
| Main effect | 0.0064*** | (0.0000) | 0.0131 | (0.2399) |
| Age 26–31 | | | −0.0018 | (0.7641) |
| Age 32–37 | | | −0.006 | (0.3097) |
| Age 38–43 | | | −0.0072 | (0.2459 |
| Age 44–49 | | | −0.0034 | (0.5819) |
| Age 50–54 | | | −0.0014 | (0.8273) |
| Age 55–59 | | | −0.0029 | (0.6536) |
| Age 60–65 | | | −0.002 | (0.7405) |
| Age 66–72 | | | 0.0031 | (0.6041) |
| Age 73+ | | | 0.0015 | (0.7855) |
| Income $35,832–$51,000 | | | −0.0123** | (0.0219) |
| Income $51,041–$60,881 | | | −0.0161*** | (0.0067) |
| Income $60,999–$72,000 | | | −0.0101** | (0.0350) |
| Income $72,064–$77,860 | | | 0.0013 | (0.8427) |
| Income $77,875–$85,624 | | | −0.0117** | (0.0192) |
| Income $85,702–$96,000 | | | −0.0189*** | (0.0004) |
| Income $96,081–$115,340 | | | −0.0261*** | (0.0000) |
| Income $116,000–$131,000 | | | −0.0125** | (0.0183) |
| Income $132,000 | | | −0.0164*** | (0.0042) |
| Female | | | −0.0005 | (0.8246) |
| European | | | 0.0086 | (0.3738) |
| Hispanic and Portuguese | | | 0.0067 | (0.5564) |
| Black | | | 0.0214 | (0.3196) |
| Other | | | 0.0017 | (0.8991) |
| Observations | 184,927 | | 184,927 | |
| $R^2$ | 0.3419 | | 0.3452 | |
| Number of individuals | 66,354 | | 66,354 | |

NOTE: The omitted age decile is 18–25. The omitted income decile is $6,000–$35,768. The omitted ethnicity category is "East and South Asian." Marginal effects for specific sociodemographic groups are found by adding the group's coefficient to the "Main effect" coefficient.
*Robust *p*-values are in parentheses: ***$p < 0.01$; **$p < 0.05$; $p < 0.1$.

the effect of a reduction in distance to the nearest drop box from the 2017 drop box expansion on those in the Treatment group. Decreasing a voter's distance to the nearest drop box by one mile increased the likelihood of voting by 0.64 percentage points.[10]

Individuals in the Placebo and Treatment groups vary by age, income, and ethnicity/race, differences, which our analysis controls for. An important question is whether individuals with certain sociodemographic characteristics are more likely to vote when drop boxes are closer to them. To examine this question, we interacted $\Delta Distance_i \times Year\ 2017_t$ with markers of voters' age, income, gender, and ethnicity. The magnitude and statistical significance of these interaction terms will tell us if these groups responded differently to the drop box expansion. This is important for determining whether drop

[10]As a robustness check, we reestimated the model, including an additional interaction term for those who did not vote in the 2015 general election. We were interested to see if the effect of the drop box would be greater for this group. We find no significant difference in the treatment effect for this group versus the rest of the estimation sample. The results are presented in Table A3.

TABLE 3

Simulated Treated Versus Untreated Turnout for the 2017 General Election

| Condition | Vote Probability | 95% CI Upper Bound | 95% CI Lower Bound |
|---|---|---|---|
| Untreated | 0.2610352 | 0.2615345 | 0.260536 |
| Treated | 0.2688985 | 0.269411 | 0.2683861 |

NOTE: "Untreated" indicates simulated turnout among our estimation sample assuming none of the ballot drop boxes were installed before the 2017 general election. "Treated" indicates simulated turnout among our estimation sample assuming all individuals experienced a reduction in their distance to the nearest drop box equal to the mean value among our treatment group (1.31 miles).

boxes disproportionately encourage different types of voters to vote. Column 2 in Table 2 presents the estimated main treatment effect ($\alpha_3$) as well as the interaction terms for each sociodemographic group.

For age and income, all individuals were split into deciles, with the boundaries determined by the composition of the Treatment and Placebo groups. For example, for age, the bottom decile serves as our reference, and this youngest 10 percent of individuals in our data set are between the ages of 18 and 25. The insignificance of the interaction terms in Table 2, Column 2, indicates that there were no differences in the treatment effect by age group, holding income, gender, and ethnicity/race constant.

To examine treatment effects by income (with the bottom decile of $6,000–$35,768 being the reference group), we find statistically significant differences in treatment effect by income. The negative, statistically significant coefficient on all but one income category indicates that the treatment effect is smaller at higher levels of income. There is not an apparent pattern in treatment effect by income, except that all groups but one (the sixth decile) have a noticeably smaller treatment effect. For example, for the sixth decile, the −0.0117 coefficient indicates that the treatment effect among those in the reference decile ($6,000–$35,768) is 1.17 percentage points higher than it is among those in this decile, holding age, gender, and ethnic/racial background constant.

Turning to the last two sociodemographic categories, we find no difference between men and women in turnout effect, nor do we find differences based on the racial/ethnic markers, or age. This contrasts with the findings in Collingwood et al. (2018), which found that the expansion of drop boxes in King County had a larger effect on older voters in both general and primary elections, and a smaller effect on female voters in primary elections.

The findings in Table 2, Column 2, illustrate how drop box effects differ (or not) by age, income, gender, or race/ethnicity, holding other sociodemographic characteristics constant. However, to predict individuals' actual voting behavior requires accounting for the combined effect of these separate characteristics. We illustrate this by simulating the effect of new drop boxes on the propensity to vote. We compare two scenarios: first, we use the estimates from Column 2 to simulate turnout if every voter in our sample had experienced a 1.31 mile decrease (the average in our Treatment group) in the distance to the nearest drop box before the 2017 general election. Second, we do the same thing only we simulate turnout with no voters in our sample having experienced a change in their distance to the nearest drop box. As Table 3 shows, we estimate that if no one in our sample had experienced a decrease in the distance to their nearest drop box, turnout for the 2017 general election among our Treatment and Placebo groups would have been 26.1 percent. If everyone were instead 1.31 miles closer to their nearest drop box, we predict a turnout of

26.9 percent, for an increase of 0.8 percentage points, which would equal approximately 1,128 voters. This hypothetical simulation is another way of portraying the magnitude of the effect drop box expansions have on turnout that we find.

## Conclusion

Compared with findings in King County (Collingwood et al., 2018), this study adds stronger evidence of the effect additional drop boxes can have on voter turnout. The experimental design of our study allows us to compare voting behavior between voters randomly chosen to experience a decrease in the distance to their nearest drop box with others chosen to have no such decrease based on similar criteria. This method allows us to more convincingly distinguish the effect of drop box proximity from other potential explanations of voting choices. Overall, we find that the 2017 expansion of drop boxes in Pierce County, which had 55,835 registered voters now located closer to a drop box, increased the likelihood to vote in the 2017 general election by 0.64 percent for each one-mile reduction in distance to the nearest box. While this change does not seem particularly large, it does suggest that drop boxes have a positive effect on voter turnout. To put the estimate in context, we also simulated a hypothetical scenario where everyone in our sample had experienced a 1.31 mile decrease in the distance to their nearest drop box. Based on our findings, we estimate the difference in turnout between these two hypothetical scenarios to be 26.9 percent versus 26.1 percent in the 2017 general election, or a difference of 0.8 percentage points. Based on the turnout in the 2017 general election, this would represent approximately 1,128 additional voters. Within the context of the low turnout in Pierce County in 2017, and compared with alternative ways election officials have tried to encourage voting, this effect is not negligible.

These findings on the effect of drop boxes are noteworthy in that, unlike King County, in this study drop boxes were already commonly used and therefore the results should not be muddied by the novelty of new boxes. Moreover, identifying a Placebo group of voters to compare our Treatment group with significantly strengthens our confidence in accurately describing the causal effects of drop boxes. Our findings, together with those of Collingwood et al. (2018) in neighboring King County, affirm the positive effects that drop boxes have on voter turnout in Washington State. This is significant considering the resistance the mandated expansion in the number of boxes faced from elected officials, who sometimes questioned the utility of these boxes in a VBM state (Cornfield, 2018). The findings of both our study and Collingwood et al.'s (2018) research suggest that these boxes may very well be worth the cost to the state and provides empirical evidence for the benefits of drop boxes, as well as trying to make these boxes as close and convenient to voters as possible.

Interventions meant to increase turnout, such as drop box expansions, will be moderated by the type of election, the content of the ballot, and the specific characteristics of the voter, as well as geography. There is still a lot of research to be done on the effects of drop boxes in VBM states, such as whether rural counties also see an increase in turnout as a result of expansion and whether drop boxes continue to have a positive effect on turnout when stamped ballots are provided. With Washington having tried a new stamped ballot system for the 2019 election and for all elections going forward, it remains to be seen if drop boxes will retain their popularity and effect on voting if postage is no longer required. Yet even with postage-paid ballots, it is very likely that a significant number of voters will continue to see drop boxes as the most secure and convenient option for returning their

ballot. While 35 percent of voters reported using a drop box because they lacked a stamp, 64 percent reported using them because of their safety or convenience. This suggests that drop boxes will continue to have a positive effect on voter turnout, even if Washington and other states transition to prestamped ballots.

We also believe more work is needed to better understand how the population interacts with ballot drop boxes. Our analysis assumes that voters are most likely to use the drop box closest to their home. It could be that voters use the drop box closest to their workplace or school rather than their home. It is also important to understand how the availability of a new drop box interacts with voters' preferred mode of transportation (walking, biking, or driving), their awareness of drop boxes, and their current distance from their closest drop box. Understanding these relationships could help policymakers target drop box expansions in communities where they are likely to have the greatest effect.

## Appendix

TABLE A1

Treatment Effects with Placebo Intervention Years

| | (1)<br>Year 2016 |
|---|---|
| Main effect (Placebo year) | −0.002 |
| | (0.199) |
| Observations | 184,927 |
| $R^2$ | 0.342 |
| Number of individuals | 66,354 |
| Individual fixed effects | Yes |

NOTE: Robust *p*-values are in parentheses: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

TABLE A2

Full LPM Difference-in-Difference Model Results

| | (1)<br>Base Model | (2)<br>By Sociodemographic Group |
|---|---|---|
| *Year* 2017 × Δ*Distance* | 0.0064*** | 0.0131 |
| | (0.0000) | (0.2399) |
| Age 26–31 | | 0.0103 |
| | | (0.4079) |
| Age 32–37 | | 0.0298* |
| | | (0.0986) |
| Age 38–43 | | 0.0691*** |
| | | (0.0020) |
| Age 44–49 | | 0.1207*** |
| | | (0.0000) |

*Continued*

TABLE A2

Continued

| | (1) Base Model | (2) By Sociodemographic Group |
|---|---|---|
| Age 50–54 | | 0.1775*** |
| | | (0.0000) |
| Age 55–59 | | 0.1919*** |
| | | (0.0000) |
| Age 60–65 | | 0.1875*** |
| | | (0.0000) |
| Age 66–72 | | 0.1600*** |
| | | (0.0000) |
| Age 73+ | | 0.1338*** |
| | | (0.0010) |
| *Year* 2017 × Age 26–31 | | 0.0085 |
| | | (0.3915) |
| *Year* 2017 × Age 32–37 | | −0.0294*** |
| | | (0.0040) |
| *Year* 2017 × Age 38–43 | | −0.0539*** |
| | | (0.0000) |
| *Year* 2017 × Age 44–49 | | −0.0604*** |
| | | (0.0000) |
| *Year* 2017 × Age 50–54 | | −0.0638*** |
| | | (0.0000) |
| *Year* 2017 × Age 55–59 | | −0.0502*** |
| | | (0.0000) |
| *Year* 2017 × Age 60–65 | | −0.0182* |
| | | (0.0859) |
| *Year* 2017 × Age 66–72 | | 0.0192* |
| | | (0.0648) |
| *Year* 2017 × Age 73+ | | 0.0215** |
| | | (0.0316) |
| Age 26–31 × Δ*Distance* | | 0.0017 |
| | | (0.8170) |
| Age 32–37 × Δ*Distance* | | 0.0006 |
| | | (0.9524) |
| Age 38–43 × Δ*Distance* | | −0.0065 |
| | | (0.6076) |
| Age 44–49 × Δ*Distance* | | −0.0196 |
| | | (0.2067) |
| Age 50–54 × Δ*Distance* | | −0.0228 |
| | | (0.1822) |
| Age 55–59 × Δ*Distance* | | −0.0143 |
| | | (0.4387) |
| Age 60–65 × Δ*Distance* | | −0.0135 |
| | | (0.4950) |
| Age 66–72 × Δ*Distance* | | −0.0230 |
| | | (0.2720) |
| Age 73+ × Δ*Distance* | | −0.0300 |
| | | (0.1827) |
| *Year* 2017 × Age 26–31 × Δ*Distance* | | −0.0018 |
| | | (0.7641) |

*Continued*

TABLE A2

Continued

| | (1) Base Model | (2) By Sociodemographic Group |
|---|---|---|
| *Year* 2017 × Age 32–37 × Δ*Distance* | | −0.0060 |
| | | (0.3097) |
| *Year* 2017 × Age 38–43 × Δ*Distance* | | −0.0072 |
| | | (0.2459) |
| *Year* 2017 × Age 44–49 × Δ*Distance* | | −0.0034 |
| | | (0.5819) |
| *Year* 2017 × Age 50–54 × Δ*Distance* | | −0.0014 |
| | | (0.8273) |
| *Year* 2017 × Age 55–59 × Δ*Distance* | | −0.0029 |
| | | (0.6536) |
| *Year* 2017 × Age 60–65 × Δ*Distance* | | −0.0020 |
| | | (0.7405) |
| *Year* 2017 × Age 66–72 × Δ*Distance* | | 0.0031 |
| | | (0.6041) |
| *Year* 2017 × Age 73+ × Δ*Distance* | | 0.0015 |
| | | (0.7855) |
| *Year* 2017 × Income $35,832–$51,000 | | 0.0285*** |
| | | (0.0031) |
| *Year* 2017 × Income $51,041–$60,881 | | 0.0346*** |
| | | (0.0005) |
| *Year* 2017 × Income $60,999–$72,000 | | 0.0129 |
| | | (0.1741) |
| *Year* 2017 × Income $72,064–$77,860 | | −0.0163 |
| | | (0.1142) |
| *Year* 2017 × Income $77,875–$85,624 | | 0.0037 |
| | | (0.7136) |
| *Year* 2017 × Income $85,702–$96,000 | | 0.0073 |
| | | (0.4832) |
| *Year* 2017 × Income $96,081–$115,341 | | 0.0254*** |
| | | (0.0063) |
| *Year* 2017 × Income $116,000–$131,000 | | −0.0097 |
| | | (0.3315) |
| *Year* 2017 × Income $132,000+ × Δ*Distance* | | −0.0070 |
| | | (0.4678) |
| *Year* 2017 × Income $35,832–$51,000 × Δ*Distance* | | −0.0123** |
| | | (0.0219) |
| *Year* 2017 × Income $51,041–$60,881 × Δ*Distance* | | −0.0161*** |
| | | (0.0067) |
| *Year* 2017 × Income $60,999–$72,000 × Δ*Distance* | | −0.0101** |
| | | (0.0350) |
| *Year* 2017 × Income $72,064–$77,860 × Δ*Distance* | | 0.0013 |
| | | (0.8427) |
| *Year* 2017 × Income $77,875–$85,624 × Δ*Distance* | | −0.0117** |
| | | (0.0192) |
| *Year* 2017 × Income $85,702–$96,000 × Δ*Distance* | | −0.0189*** |
| | | (0.0004) |
| *Year* 2017 × Income $96,081–$115,341 × Δ*Distance* | | −0.0261*** |
| | | (0.0000) |

*Continued*

TABLE A2

Continued

| | (1) Base Model | (2) By Sociodemographic Group |
|---|---|---|
| *Year* 2017 × Income $116,000–$131,000 × Δ*Distance* | | −0.0125** |
| | | (0.0183) |
| *Year* 2017 × Income $132,000+ × Δ*Distance* | | −0.0164*** |
| | | (0.0042) |
| *Year* 2017 × Female | | −0.0155*** |
| | | (0.0002) |
| *Year* 2017 × Female × Δ*Distance* | | −0.0005 |
| | | (0.8246) |
| *Year* 2017 × European | | −0.0726*** |
| | | (0.0000) |
| *Year* 2017 × Hispanic | | −0.0548*** |
| | | (0.0000) |
| *Year* 2017 × Black | | −0.0339 |
| | | (0.1581) |
| *Year* 2017 × Other | | −0.0460*** |
| | | (0.0059) |
| *Year* 2017 × European × Δ*Distance* | | 0.0086 |
| | | (0.3738) |
| *Year* 2017 × Hispanic × Δ*Distance* | | 0.0067 |
| | | (0.5564) |
| *Year* 2017 × Black × Δ*Distance* | | 0.0214 |
| | | (0.3196) |
| *Year* 2017 × Other × Δ*Distance* | | 0.0017 |
| | | (0.8991) |
| *Year* 2016 | 0.3977*** | 0.3960*** |
| | (0.0000) | (0.0000) |
| *Year* 2017 | −0.0577*** | 0.0264* |
| | (0.0000) | (0.0682) |
| Constant | 0.3220*** | 0.2300*** |
| | (0.0000) | (0.0000) |
| Observations | 184,927 | 184,927 |
| $R^2$ | 0.3419 | 0.3452 |
| Number of Individuals | 66,354 | 66,354 |
| Individual fixed effects | Yes | Yes |

NOTE: The omitted age decile is 18–25. The omitted income decile is $6,000–$35,768. The omitted ethnicity category is "East and South Asian." Differences in causal effects across sociodemographic groups are indicated by the estimated coefficient on the three-way interaction terms. Robust *p*-values are in parentheses: ***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.

TABLE A3

LPM Difference-in-Difference Results Testing for Differences According to Participation in the 2015 General Election

| | (1)<br>Base Model |
|---|---|
| *Year* 2017 × Δ*Distance* | 0.0083*** |
| | (0.0000) |
| *Year* 2017 × Δ*Distance* × Did Not Vote in 2015 | −0.0014 |
| | (0.5865) |
| *Year* 2017 × Did Not Vote in 2015 | 0.1591*** |
| | (0.0000) |
| *Year* 2016 | 0.3916*** |
| | (0.0000) |
| *Year* 2017 | −0.1589*** |
| | (0.0000) |
| Constant | 0.3279*** |
| | (0.0000) |
| Observations | 184,927 |
| Number of voter_id | 66,354 |
| $R^2$ | 0.3529 |
| Individual fixed effects | Yes |

NOTE: The estimate in the first row (0.0083) is the "main effect" for the whole estimation sample. The estimate for those who did not vote in the 2015 general election is found by adding the "main effect" and the estimate in the third row (−0.0014). Robust *p*-values are in parentheses: ***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.

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