Polling Place Location and the Costs of Voting

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Abstract

Surprisingly little is known about the location of polling places across the United States and their effect on turnout. Current estimates of the effect of a mile increase in distance to the polling location on turnout range from large estimates of a 14.5 percentage points (p.p.) reduction in turnout to a null effect. The question of how this cost of voting affects traditionally disenfranchised groups of voters remains. We acquire voter registration, voting history data, and polling locations for over 15 million voters from Pennsylvania and Georgia to fill this gap. We find small average effects of a voter's distance to the polling place on turnout, but considerable heterogeneity. A one mile increase in distance to polling place decreases the likelihood of voting up to 0.99 p.p. on average, but by up to 28 p.p. among those who take public transport to work. The availability of no excuse vote by mail may help to attenuate the reduction in turnout caused by distance to polling place.

JEL Classification: D72, H70, K16
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1 Introduction

The 2020 U.S. elections have set the public's eyes on the influence of electoral design on turnout. State and local government decisions regarding early voting, (Kaplan and Yuan (2020)), mail-in voting (Meredith and Endter (2016); Lockhart et al. (2020); Thompson et al. (2020)), and at-poll voting requirements (Highton (2017); Cantoni and Pons (2019)) can each potentially have important consequences for voter participation. Even small changes to the convenience or cost of voting can determine whether or not someone votes, especially in large elections (Gomez et al. (2007); Braconnier et al. (2017)).

This paper focuses on a particular cost of voting: the distance from a voter's home to their polling place. Distance to the polling place is an essential determinant of voting behavior to study for three reasons. First, this cost of voting cannot be eliminated, unless we remove polling places altogether. Despite the rise in convenience voting, three-quarters of voters still chose to vote at polls on election day in the 2018.[1] Even during the pandemic of the 2020 election cycle, 34 million voters were not able to vote by mail without a state-approved excuse.[2] Second, the distance to polling place is unevenly distributed among the population of eligible voters. If a particular group faces higher costs of voting such that they are less likely to vote, then politicians may ignore their interests (Avery (2015); Martin (2003)). In particular, it is important to understand if the distance to polling place varies systematically by race of eligible voters, given the history of voter suppression in the United States. The locations of polling places may also advantage one political party over another. Third, the distance between voters and their polling place is an outcome of electoral design. State and local lawmakers determine how to divide a state into precincts and where to locate a polling place within precincts. A detailed understanding of how polling place locations affect voter participation can potentially lead to efficiency gains in the processes of reprecincting and choosing polling locations.

Existing estimates of the effect of distance to polling places on voting vary widely. Three papers use a causal identification strategy.[3] Most recently, Cantoni (2020) uses a border discontinuity approach, which exploits the fact that residents on either side of a voting precinct border are similar, but differ in their polling place. Using data from

[1] Election Administration and Voting Survey: 2018 Comprehensive Report. `https://www.eac.gov/sites/default/files/eac_assets/1/6/2018_EAVS_Report.pdf` Retrieved November 11, 2020.

[2] `https://www.washingtonpost.com/graphics/2020/politics/vote-by-mail-states/` "At least 84% of American voters can cast ballots by mail in the fall", *The Washington Post*. Retrieved September 25, 2020.

[3] Other published studies on the distance to polling place find a negative association with turnout. Dyck and Gimpel (2005) find that distance to polling place is associated with lower turnout and more mail-in voting in a study of Clark County, Nevada. Haspel and Gibbs Knotts (2005) find a negative and non-linear relationship in an Atlanta mayoral election.

nine urban municipalities in Massachusetts and Minnesota, Cantoni finds large effects: a mile increase in distance to polling place reduces turnout by 8 to 14.5 percentage points. Clinton et al. (2019) use a panel of voters from North Carolina to study how voting behavior changes as polling places change over time. They find no effect of distance to polling place on turnout: as distance to a polling place increases, voters substitute to early voting such that there is no overall change in turnout. Finally, Brady and McNulty (2011) study precinct consolidations in Los Angeles County using matching methods. They find smaller effects: a mile increase in distance to the polling place reduces turnout by 4 percentage points. Several studies find an additional fixed cost associated with a change in polling place location (Clinton et al. (2019), Yoder (2018)).

Determining whether the effect of a mile increase in distance to polling place on turnout is closer to null or negative 14.5 percentage points is critical. To put the existing estimates in perspective, Thompson et al. (2020) estimate that the impact of implementing state-wide voting by mail raises turnout by about 2.1 percentage points. Enos and Fowler (2016) find that presidential campaigns increase turnout by up to 8 percentage points. Last, Kaplan and Yuan (2020) find that an additional day of early voting raises turnout by 0.22 percentage points. If the true effect of distance to polling place is in line with the upper bound found in Cantoni (2020), then a mile increase in distance to polling place could be compensated by 2 months and 6 days of early voting.

These findings underscore the need for a more comprehensive view of polling places in the United States. It could be that the range of results reflect heterogeneous effects, given that each study uses data from a different location. Moreover, we know that there are large location and election-specific effects on voting behavior (Cantoni and Pons (2019)). However, there is also no overlap in methodologies used across studies, making comparisons difficult.

To help fill this gap, we collect information about the distance to polling place and turnout for over 15 million voters in two large and diverse states, Pennsylvania and Georgia. To estimate the effect of distance to polling place on voting behavior, we use the border discontinuity approach of Cantoni (2020). We choose to replicate the methodology from Cantoni (2020) because the identifying assumptions are plausible and so that we can compare the results. This approach relies on the assumption that voters who live near to precinct borders are similar, except that they are assigned to different polling places and thus face different distances to the polling place. Any factors possibly correlated with turnout should be continuous across the border, whereas the distance to a polling place is discontinuous at the border. We use a sample of voters who live within 0.05 miles (about 160 feet or 80 meters) of a voting precinct border and we only use precinct borders that do not overlap with other important boundaries like

those for school districts, towns, or legislative districts. The remaining voting precinct borders play no role other than determining where people vote on election day.

We find that, on average, a one mile increase in the distance to polling place decreases the likelihood of voting at polls by 0.45 to 1.72 percentage points (p.p.), increases the likelihood of mail-in voting take up by 0.11 to 1.91 p.p and decreases total likelihood of voting from null results to 0.99 p.p. . However, the average effect masks significant heterogeneity. The analysis of the two large states allows us to explore heterogeneous effects according to demographic characteristics, economic variables, party affiliation, and mobility patterns. We find that means of transportation is a particularly important interacting variable. In areas where a large share of the population relies on public transportation to commute to work, a one mile increase in distance to polling place decreases turnout by up to 28%. This is on par with the existing estimates from urban areas in Massachusetts and Minnesota. In general, we find that the large differences in average estimates in our study compared to Cantoni (2020) and others is likely driven by contextual factors and heterogeneous effects.

Our results suggest that the importance of polling place locations for voter participation will vary depending on the constituency affected. If the affected population largely owns cars and drives to work, then a one mile increase in distance to a polling place will have no meaningful effect. On the other hand, a small change to a polling place in an area where people walk to work can have significant effects on turnout.

Our findings highlight some important lessons for studies of polling places in the future. First, although our average effect size is relatively small, even small effects could amount to large changes in turnout in aggregate. As a simple thought experiment, suppose polling places were relocated so that everyone was one mile further from a polling place. We would observe a decrease of 0.7 p.p. in turnout in Pennsylvania. This margin is equivalent to the margin by which Trump won that state in 2016 and is close to the margin by which Biden won in 2020.

Pennsylvania and Georgia also offer two comparison points for electoral design. Pennsylvania requires an excuse for a registered voter to vote by mail (absentee voting) and offers no early voting, while Georgia does not require any excuse for voting by mail and does have early voting. In Georgia, we find that no-excuse mail-in voting is likely important for mitigating the cost of travelling to a polling place. A longer distance to the polling place makes a voter in Georgia less likely to vote at polls and more likely to vote by mail. In Pennsylvania, by contrast, very few voters appear to be able to substitute to mail-in voting when they are deterred by the distance to the polling place. The overall effect of distance to polling place on turnout is larger in Pennsylvania than in Georgia.

In recent years, decisions to close or move polling places have come under increased

scrutiny due to concerns over voter suppression.[4] Related to these concerns, recent studies show that Black voters are more likely to experience longer waiting times at polls (Chen et al. (2019)) and are more likely to have their mail-in ballots rejected (Enrijeta Shino and Smith (2020)). In Georgia, where we have data about the race of registered voters, we find that Black voters tend to live slightly closer to polling places on average. Importantly, we do not find large differences across racial groups in terms of sensitivity to distance to polling place. Similarly, there does not appear to be a significant difference in the way that Republicans and Democrats respond to distance to the polling place. Our findings suggest that some of the concern over polling place closures in recent years may have been misplaced. In particular, most of the polling place closures in the past decade in Georgia occurred in rural areas where there is likely to be a smaller impact of increasing the distance to the polls among voters.[5] Small changes to the location of urban polling places are likely to have a greater impact on turnout and should be evaluated carefully by election commissions.

2 Institutional Background

We study the 2018 primary and general elections in Pennsylvania and Georgia. From 2012 to 2018, the number of registered voters in Pennsylvania increased from 8.5 to 8.6 million[6] while in Georgia it grew from 6 to 6.9 million [7]. In many states, including Pennsylvania and Georgia, 2018 was a year of historically high turnout for a midterm election (58% and 53 % of registered voters cast ballots compared to 43% and 37% in 2014 respectively). However, turnout was much lower for the primary elections (12% for Pennsylvania and 17% for Georgia).

Pennsylvania and Georgia differ in a number of election policies. In Pennsylvania, voting happens only on election day; there is no early voting. In contrast, Georgia offers the possibility of early voting up to three-weeks before election day. In Pennsylvania, only people who cannot vote in person may use an absentee ballot provided they offer an excuse (prior to 2020). In contrast, Georgia offers no-excuse absentee ballots, where any voter may request a mail-in ballot online. Although we do not have the ability to assess these policies with only two states, they are potentially important for understanding any substantive differences in our findings for Pennsylvania and Georgia.

Both states are divided into voting precincts. An accessible location within each

[4] "The Georgia Governor's Race Has Brought Voter Suppression Into Full View", *The Atlantic*. Retrieved Novermber 6, 2018. "Republican Voter Suppression Efforts Are Targeting Minorities, Journalist Says", *NPR*. Retrieved October 23, 2018.

[5] "Voting precincts closed across Georgia since election oversight lifted" *Atlanta Journal-Constitution*. Retreived November 11, 2020.

[6] Voter Registration Statistics from Pennsylvania's Department of State

[7] Voter Registration Statistics from Georgia's Secretary if State Office

precinct, typically a school, library, police station, or church, is chosen as the polling place location by local election commissions. Importantly for our identification strategy, each voter may only vote in person at the polling place for the precinct in which they reside. Election Day Polls are open from 7am to 8pm in Pennsylvania, while Election Day Polls are open from 7am to 7pm in Georgia. If a registered voter has voted before in Pennsylvania, they do not need to bring identification. On the other hand, Georgia has more strict voter ID laws that require Georgia residents to show photo identification when voting in person.

3 Data Collection

From the Pennsylvania Department of State and Georgia Secretary of State, we obtain voter registration files, which include a unique voter identification, address, and voting precinct for each registered voter within the state. Through the voter ID, this information can be merged with voter history files, which records whether or not each registered voter voted in each election as well as their method of voting (at polls or absentee).

We obtain the locations of polling places from Georgia's Secretary of State's website and from Pennsylvania's state-run polling place look-up website.[8] Next, we geocode the polling place locations and registered voter addresses using the Address Locator provided by ArcGIS.[9] The distance to polling place for each individual is measured as the Euclidian distance in miles between the voter's address and the polling place address.

It is important to note that we only observe addresses for registered voters. At the individual level, we are only able to estimate the effect of distance to polling place on voting, conditional on an individual already being registered to vote. Since distance to polling place may also affect the likelihood that an individual registers, this may introduce selection bias. Hence, to complement our analysis, we estimate the effect of distance to polling place on the likelihood that an eligible voter votes, by aggregating to the Census block level. Blocks are the smallest statistical area used by the Census, corresponding to roughly the size of a city block. At the block level, we have information on the voting age population, a proxy for voting eligibility, from the 2010 Census. The main outcome of interest is turnout: the total votes per voting age population. Cantoni similarly aggregates to the block-level, noting that the benefit of avoiding selection bias

[8] Accessed at `https://www.pavoterservices.pa.gov/Pages/PollingPlaceInfo.aspx` and `https://sos.ga.gov/index.php/elections`

[9] This address locator uses interpolation to locate addresses, meaning it has the latitude and longitude of the endpoints of every street. It then interpolates the latitude and longitude of the specific address based on the street endpoints.

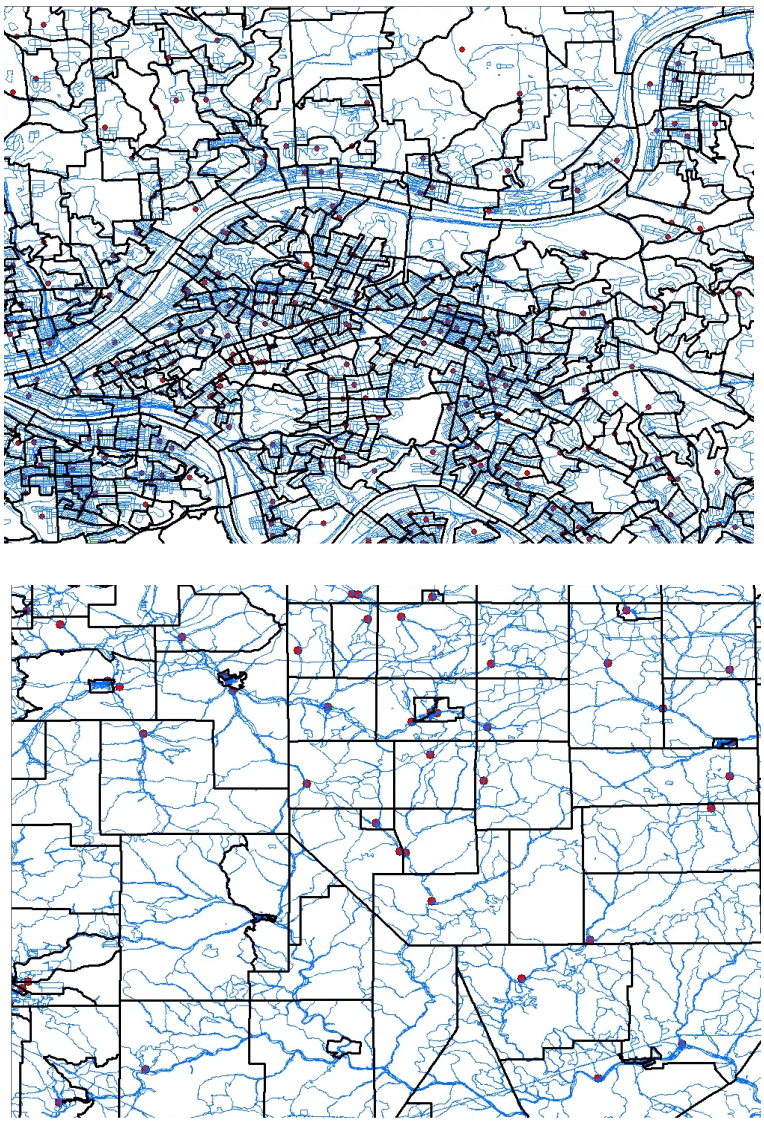
comes at the cost of less precise measurement of distance.[10] Here, the loss in precision is not as important, since we have a large number of blocks. Additionally, blocks are small so that there is little variation in distance to polling place within a block (the average standard deviation of distance to polling place within a block is 0.1 miles or 160 meters).

To aggregate the data to the block level, we assign each registered voter to the census block that contains their geolocated address. Distance to polling place at the block level is measured as the average distance to polling place for all registered voters in the block. To give a sense of the the geography and scale of blocks relative to precincts, Figure 1 shows voting precincts, census blocks, and polling places in an urban and rural area.

Finally, the block-level data is merged with census data on race, ethnicity, gender and age using block identifiers. Other covariates of interest that may be correlated to both turnout and distance to polling place include include car ownership, mode of travel to work and commute time, income, and unemployment. These variables are available at the block-group-level and tract-level from the American Community Survey (2006-2010 five-year estimates). We assign the block-group or tract average to each block within the statistical area. Variable definitions, units of observations, and data sources are described in more detail in Appendix A.1.

[10] Cantoni also pairs this analysis with analysis at the parcel-level. A parcel is a unit of land, typically containing one household. We don't have parcel data for important parts of Pennsylvania (e.g., Philadelphia) nor Georgia. The benefit of Parcel-level analysis is that the measurement of distance is more precise. The drawback is that there is no data on the voting age population, so parcels are assumed to have roughly the same voting age population.

Figure 1: Maps of Precincts, Census Blocks, and Polling Places



Note: The upper map is in Pittsburgh (population 302,407) and the lower map is in Jefferson County (population 43,804). Bold black lines are precinct boundaries. Thin blue lines are Census block boundaries. Red dots are Poling Place Locations. Both maps are roughly 75 square miles (194 square kilometers).

4 Empirical Framework

4.1 Identification Strategy

We estimate the effect of the distance to polling place voting at the poll and by absentee ballot. The identification strategy exploits discontinuities at the borders of voting precincts (called Voting Tabulation Districts by the Census). Intuitively, two neighbors who live on opposite sides of a voting precinct border should be comparable in dimensions related to voting, but differ in where they go to vote.

We first apply this methodology using the individual-level dataset to estimate the effect of distance to polling place on the likelihood of voting, conditional on being a registered voter. Each individual is assigned to the nearest voting precinct border and is only included in the sample if they reside within 0.05 miles (161 feet or 81 meters) of the voting precinct border. Additionally, we restrict attention to segments of voting precinct borders that to do not overlap with other important boundaries that would cause residents to sort on either side of the border. Voting precinct boundaries included in our sample do not overlap with school district boundaries, town or county boundaries, nor boundaries for state or federal congressional districts. Figures 2 and 3 show the voting precinct border segments that are included and excluded in the samples for Georgia and Pennsylvania.

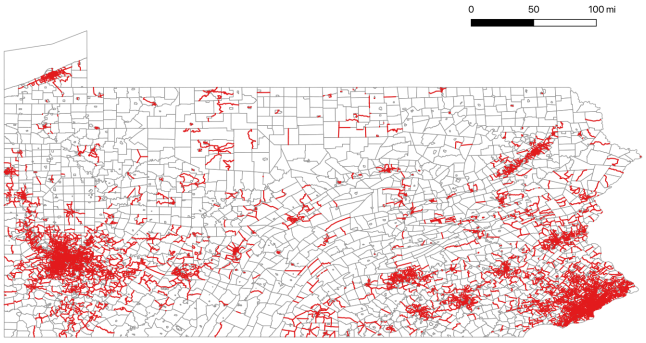


Figure 2: Pennsylvania

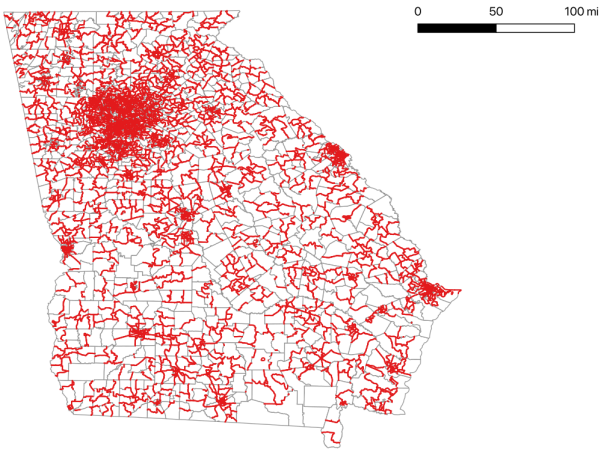


Figure 3: Georgia

We use a similar estimation strategy with the block-level dataset to estimate the effect of the distance to polling place on turnout, unconditional on registration. Each block is assigned to the nearest voting precinct border and is only included in the sample if it's centroid is within 0.2 miles (1056 feet or 322 meters) of the voting precinct border. Conditioning on the block's centroid distance to the border allow us to only consider those blocks where most of their population lives closer to the border.

To limit noise due to imprecise geocoding, we use only blocks where the total votes are less than the 2010 voting age population (as in Cantoni) and where the average distance to polling place is less than 10 miles. Finally, we discard borders where the nearest blocks include both rural and urban areas since these blocks are unlikely to satisfy identifying assumptions. This selection leaves us with $1,787,734$ voters, $111,782$ blocks and $9,921$ borders in Pennsylvania and $524,675$ voters, $35,137$ blocks and $3,945$ borders in Georgia. On average, each border has 355 voters and 27 blocks in Pennsylvania and 358 voters and 22 blocks in Georgia.

The main empirical specification can be written as follows:

$$vote_i = \delta_{s(i)} + \beta distance_i + \mathcal{P}_i'\rho + \mathcal{X}_{b(i)}'\iota + \epsilon_i \tag{1.A}$$

where $vote_i$ indicates whether or not registered voter i voted.[11] $\delta_{s(i)}$ is a fixed effect for a segment of a precinct border, where each voter i is assigned to a unique segment $s(i)$. $distance_i$ is the distance (measured in miles) between a voter's residence and polling place. The specification includes individual-level controls ($\mathcal{P}_i$) and block-level controls ($\mathcal{X}_b(i)$).

At the block-level, the estimating equation is:

$$turnout_b = \delta_{s(b)} + \beta distance_b + \mathcal{X}_b'\iota + \epsilon_b \tag{1.B}$$

where $turnout_b$ is the percent of voting-age population in block b that votes.

The identifying assumption in both of our specifications is that all unobservable factors affecting voting behavior are uncorrelated with distance across and along border lines, conditional on observables.

Following Cantoni (2020), we relax this identifying assumption with a second set of estimating equations that include county-specific controls for latitude and longitude:

$$vote_i = \delta_{s(i)} + \beta distance_i + \alpha_{c(i)} lat_i + \gamma_{c(i)} lon_i + \mathcal{P}_i'\rho + \mathcal{X}_{b(i)}'\iota + \epsilon_i \tag{2.A}$$

$$turnout_b = \delta_{s(b)} + \beta distance_b + \alpha_{c(b)} lat_b + \gamma_{c(b)} lon_b + \mathcal{X}_{b(i)}'\iota + \epsilon_b \tag{2.B}$$

This less parsimonious model means that the effect is identified using only the discontinuities in distance to polling place at the border. The identifying assumption is that any variables that affect turnout, apart from distance, are continuous at all points of the precinct border. Because voters on either side of the border are assigned

[11] For ease of interpreting small coefficients, we have $vote_i$=100 if voter i votes and $vote_i = 0$ if voter i does not vote.

to different polling places, there is a discontinuity in $distance_i$ at the border.

At the block level we separately estimate equations 1.B and 2.B with the following covariates: percent voting age population, percent Democrat, percent Republican, percent Black, percent Hispanic, median household income, percent without a high school diploma, percent who walk to work, and indicators for travel time to work being less than 5 minutes and travel time to work is more than 60 minutes).At the individual level we estimate equations 1.A and 2.A with the the same block-level covariates and with indicators for the voter being a registered Democrat, for being a registered Republican, for being between the ages of 30-49, 50-65, or 65 and up, and if the voter is female.

4.2 Summary Statistics and Balance test

In 2018, there were 7,014 polling places in Pennsylvania and 2,340 polling places in Georgia. Voters on average live 0.93 miles away from their polling place in Pennsylvania and 1.66 miles in Georgia. For 2018 general election, the turnout was is 59% of registered voters in Pennsylvania and 55% of registered voters in Georgia. Voting by mail in Georgia is much higher than in Pennsylvania, where an excuse is required for an absentee ballot. In Georgia, 29.76 percent of those registered to vote choose vote by mail whereas only 2.23 did the same in Pennsylvania. Within each state, the shares of voters registered Democrat and Republican are similar. However we find different percentages of registered voters for each party between states. This difference is due to differences in the information provided by the voter registration files. While Pennsylvania offers party last registered, Georgia only offers party last voted. In terms of other demographic characteristics, we find that Georgia and Pennsylvania are similar except with respect of the share of black voters where Georgia's is larger (30% vs 11%).

Comparing our regression sample with that of the whole state, we find some differences. Urban areas are over-represented in our sample. There is a large proportion of our sample that is found in urban areas (87-98%) vs (75-80%). However, there are sufficient segments in rural areas within each state sample in order to detect differences between urban and rural areas (210 segments (5%) in Pennsylvania and 1380 segments (34 %) in Georgia). Our sample also contains more black registered voters, and poorer voters. Full summary statistics are reported in Appendix 6

Investigating how distance to polling place varies across each state, we regress distance to polling place on political, demographic, and socioeconomic variables in Appendix 7. In both states, polling places tend to be farther away from Republicans, white individuals, and individuals without a high school diploma. After including border fixed effects and county-latitude/longitude controls, most of the correlations are statistically insignificant. However, we still observe two correlations at the individual level being statistically significant (age 30 to 49 and age 50 to 64 indicators at the

95% confidence level) in Pennsylvania and two in Georgia (Democrat indicator at the 99% and republican indicator at the 90% confidence level). Considering variables that are aggregated at the block, block-group, and tract level we only find 3 statistically significant correlations for Georgia and none for Pennsylvania. These are percent Black and cars per household at the 90% confidence level, and Percent Hispanic at the 95% confidence level. We include these and other variables for all individual and block level regressions.

5 The Effect of Distance to Polling Place

We begin with a discussion on the average effect of distance to polling place on likelihood of voting in Pennsylvania (Table 1) and in Georgia (Table 2). We report the coefficient on distance to polling place for several outcomes: likelihood of voting at polling places, by absentee ballot, and overall likelihood of voting for both primary and general elections in 2018. In each table, Panel A reports coefficients from estimating the outcomes with controls and precinct fixed effects only, Panel B reports coefficients from estimating equation 1.A, and Panel C reports coefficients from estimating equation (2.A).

In Panel A of each table, we observe small but statistically significant correlations between distance to polling place and the likelihood of voting at polls. A one mile increase in distance to polling place is associated with a decrease in at poll voting of 0.96 p.p. and 0.43 p.p. in at poll voting for both primary and general elections respectively in Pennsylvania. In Georgia, the estimated coefficients on at poll voting is larger. The larger coefficients for at poll voting in Georgia, however, are compensated for in part by a larger positive association between distance to polling place and the likelihood of absentee absentee voting. The responses in total likelihood of voting range from -0.97 to -0.34 p.p. for primary and general elections in Pennsylvania and from -0.02 to 0.28 p.p. for primary and general elections in Georgia. Note that the positive coefficient in the general elections is due to the large take up of mail-in ballots, and does not remain statistically significant in our causal estimates in Panels B and C.

In Panel B of Tables 1 and 2, including border fixed effects yields coefficients that are larger in magnitude. In Pennsylvania, we observe that a one mile increase in distance to polling place is associated with a decrease in at poll voting of 1.35 p.p. in primary elections and 1.23 p.p. in general elections. In Georgia, a one mile increase in distance to polling place is associated with a decrease in at poll voting of 0.46 p.p. in the primary election and 1.71 p.p. in the general election. Compared to Panel A, these estimates have increased in magnitude from 50% to 75%.

As before, the larger effects on at poll voting in Georgia are compensated for in

Table 1: The effect of distance to polling place on likelihood of voting: Pennsylvania

	Panel A: OLS with Precinct FE and Controls					
	Primary Election			General Election		
	At Poll	Absentee	Total	At Poll	Absentee	Total
Distance (miles)	-0.9691***	-0.0051	-0.9742***	-0.4393***	0.0986***	-0.3407***
	(0.0536)	(0.0082)	(0.0548)	(0.0648)	(0.0168)	(0.0666)
N	6922990	6922990	6922990	6949983	6949983	6949983
y variable mean	18.31	0.38	18.69	56.43	2.15	58.58
R^2	0.059	0.007	0.061	0.057	0.011	0.065
	Panel B: Border FE with Controls					
	Primary Election			General Election		
	At Poll	Absentee	Total	At Poll	Absentee	Total
Distance (miles)	-1.3523***	0.1177*	-1.2346***	-1.2255***	0.2326***	-0.9929***
	(0.2261)	(0.0611)	(0.2190)	(0.2786)	(0.0808)	(0.2669)
N	1529592	1529592	1529592	1534873	1534873	1534873
y variable mean	16.15	0.33	16.48	51.57	1.60	53.17
R^2	0.072	0.028	0.074	0.075	0.027	0.083
	Panel C: Border FE with Controls and County-Lat./Lon.					
	Primary Election			General Election		
	At Poll	Absentee	Total	At Poll	Absentee	Total
Distance (miles)	-1.3476***	0.1201*	-1.2274***	-1.1533***	0.2322***	-0.9211***
	(0.2325)	(0.0623)	(0.2247)	(0.2766)	(0.0816)	(0.2640)
N	1529592	1529592	1529592	1534873	1534873	1534873
y variable mean	16.15	0.33	16.48	51.57	1.60	53.17
R^2	0.072	0.029	0.074	0.075	0.028	0.083

Note: Distance to polling place measured in miles. Likelihood of voting is measured as a percentage points (separately for votes cast at polling places, through absentee ballots, and total). All regressions include Border Fixed Effects (Border FE). County-Lat./Lon. refers to latitude and longitude controls, interacted with county fixed effects. The additional controls are: Democrat indicator, Republican indicator, age 30-49 indicator, age 50-64 indicator, age 65 and up indicator, female indicator, population, voting age population, percent Black, percent Hispanic, median household income, percent without a high school diploma, percent that walk to work, and indicators for whether travel time to work is less than 5 minutes or greater than 60 minutes. Standard errors clustered at the border level are reported in parentheses.

Table 2: The effect of distance to polling place on likelihood of voting: Georgia

	Panel A: OLS with Precinct FE and Controls					
	Primary Election			General Election		
	At Poll	Absentee	Total	At Poll	Absentee	Total
Distance (miles)	-0.2614***	0.2403***	-0.0211***	-1.1373***	1.4199***	0.2826***
	(0.0229)	(0.0227)	(0.0030)	(0.0572)	(0.0665)	(0.0556)
N	5999708	5999708	5999708	5999708	5999708	5999708
y variable mean	12.14	4.55	16.70	25.52	29.52	55.05
R^2	0.677	0.243	0.980	0.033	0.135	0.161
	Panel B: Border FE with Controls					
	Primary Election			General Election		
	At Poll	Absentee	Total	At Poll	Absentee	Total
Distance (miles)	-0.4572***	0.4379***	-0.0193	-1.7106***	1.8681***	0.1575
	(0.0753)	(0.0755)	(0.0156)	(0.1794)	(0.1935)	(0.1939)
N	445881	445881	445881	445881	445881	445881
y variable mean	11.45	4.12	15.57	24.61	27.36	51.97
R^2	0.694	0.249	0.979	0.049	0.156	0.188
	Panel C: Border FE with Controls and County-Lat./Lon.					
	Primary Election			General Election		
	At Poll	Absentee	Total	At Poll	Absentee	Total
Distance (miles)	-0.4677***	0.4458***	-0.0219	-1.7159***	1.9143***	0.1984
	(0.0773)	(0.0770)	(0.0155)	(0.1836)	(0.2018)	(0.2020)
N	445881	445881	445881	445881	445881	445881
y variable mean	11.45	4.12	15.57	24.61	27.36	51.97
R^2	0.694	0.250	0.979	0.050	0.158	0.189

Note: Distance to polling place measured in miles. Turnout is measured as the number of votes per voting-age population (separately for votes cast at polling places, through absentee ballots, and total). All regressions include Border Fixed Effects (Border FE). County-Lat./Lon. refers to latitude and longitude controls, interacted with county fixed effects. The additional controls are: Democrat indicator, Republican indicator, population, voting age population, percent Black, percent Hispanic, median household income, percent without a high school diploma, percent that walk to work, and indicators for whether travel time to work is less than 5 minutes or greater than 60 minutes. Standard errors clustered at the border level are reported in parentheses.

part by larger positive effects of distance to polling place on absentee voting. In Georgia, an increase of a mile of distance to polling place causes absentee likelihood of voting to increase by 0.12 percentage points during the primary election and 1.86 percentage points during the general election. These effects are 3.7 to 8 times larger in magnitude than in Pennsylvania (for the primary and general election, respectively). It is important to remember that Pennsylvania and Georgia differ in their requirements for voting by mail in the 2018 election. Pennsylvania requires voters who request absentee ballots to provide an excuse while Georgia does not. In Georgia, the estimates are consistent with a larger share of voters substituting to mail-in voting when at poll voting becomes too inconvenient, compared to Pennsylvania. Still, there is an overall negative effect of distance to polling place on likelihood of voting overall, even in Georgia.

Pennsylvania's response in total likelihood of voting ranges from 1.23 p.p. in the primary election to 0.99 p.p. in the general election. In Georgia we observe small and not statistically significant effects on total likelihood of voting ranging from 0.02 for the primary election and 0.16 for the general election.

The addition of individual's latitude and longitude interacted with county-fixed effects in Panel C does little to change point estimates compared to those in Panel B. The estimates in Panel C suggest that the overall effect of a mile increase in distance to polling place on likelihood of voting in a general election is a 0.99 p.p. reduction in Pennsylvania with no change in Georgia.

Now we turn to look at the effects of a mile increase on turnout, unconditional on voter registration, using the block-level analyses. We follow the same structure as for Tables 1 and 2 in Tables 8 and 9. We find very similar patterns to those found in the individual level regressions across all Panels. The similarity in results from individual-level and block-level analyses suggests that the selection of registered voters in the individual-level analysis does not affect estimates. Put differently, it is unlikely that distance to polling place has a large effect on a voter's decision of whether or not to register to vote. This may be because registering to vote is an infrequent and relatively low-cost action that takes place before polling places are known.

Focusing on Panel B as we did for the individual level estimates, we find that a one mile increase in distance to polling place is associated with a decrease of at polls turnout from 0.5 to 0.6 p.p. for primary and general elections in Pennsylvania. As before, Georgia's effects are larger ranging from 0.59 to 2.1 p.p. from primary and general elections.

The block level estimates present the same patterns of take up in absentee voting as the individual level estimates. These patterns feature Georgia's estimates varying from 0.47 to 1.2 p.p. in primary and general elections while Pennsylvania's estimates

range from 0.035 to 0.21 p.p. . Georgia's estimates are again 13.42 to 5.7 times larger than those in Pennsylvania for primary and general elections respectively possibly highlighting the institutional differences in excuse requirements to vote by mail.

Focusing on total turnout, the block level estimates find small but significant estimates for general elections. Pennsylvania has the same point estimate for both primary and general elections, a decrease of 0.47 p.p. of turnout (not significant for general election). Georgia's has an insignificant 0.14 negative effect in total turnout but a significant 0.86 p.p negative effect in total turnout. In contrast with the individual level estimates, we find that the take up in mail-in voting isn't large enough to mitigate the effects at polls for Georgia's general election.

Across all specifications, the estimates of the average effect of distance to polling place on overall turnout in Georgia and Pennsylvania are an order of magnitude smaller than those estimated in Cantoni (2020). The estimates from Pennsylvania are closer to those in Brady and McNulty (2011), whereas the null estimates in Georgia coincide with findings in Clinton et al. (2019). In order to reconcile these differences, we check to see if estimates vary within Pennsylvania and Georgia, depending on the context. We first estimate effects in cities and counties separately, and then explore heterogeneous effects.

First, we construct a sample of blocks in Georgia and Pennsylvania that are more similar to the urban census blocks studied in Cantoni. Cantoni analyzes the Boston, Massachusetts area and Minneapolis, Minnesota. Compared to the statewide Pennsylvania and Georgia samples, the census blocks in these areas are higher in population, income, and education. We pool all census-block level data and estimate a propensity score for the likelihood of being in Massachusetts or Minnesota. We use a logit specification and the covariates used in Cantoni (population, income, race, car ownership, and education). Then, we construct a matched sample by selecting the blocks with the highest propensity score so that we have a sample size roughly equivalent to that of Cantoni. For comparability, we consider voting for general elections in midterm years (2018 in Georgia and Pennsylvania, 2014 in Massachusetts and Minneapolis).

Table 3 reports the border fixed effects estimates for full state samples (columns 1 and 2), for the matched samples (column 3) and for the urban areas in Massachusetts and Minnesota (column 4). Point estimates in the matched sample in the full samples. Although the point estimates in the matched sample are still smaller than those estimated in the Boston area and in Minneapolis, the standard errors are larger such that we can not reject the point estimate from the MA sample based in estimates in either matched sample. Overall, this analysis suggests that the effects of distance on turnout are specific to both the setting and electoral design, such that estimates based on small areas are unlikely to generalize to larger areas or to other states.

Table 3: Comparing state samples to urban areas: Border fixed effects regressions

	State Samples		Matched Sample	Urban Areas
	(1) GA	(2) PA	(3) GA and PA	(4) MA and MN
Distance to polling place (mi)	-0.733***	-0.562***	-4.494	-5.435**
	(0.135)	(0.122)	(3.504)	(2.484)
N	84171	165082	1538	1694
y variable mean	54.002	47.584	60.253	38.229
R^2	0.250	0.294	0.478	0.595

Note: The Urban Areas sample is provided by Cantoni (2020) and include data from the Boston, Massachusetts area (MA) and Minneapolis, Minnesota area (MN). The dependent variable is turnout in the 2018 midterm election for Georgia (GA) and Pennsylvania (PA), and the dependent variable is turnout in the 2014 midterm election for MA and MN. All regressions include border fixed effects and covariates. Standard errors clustered at the segment level are reported in parentheses.

Next, in Table 4, we estimate equation 1.A separately for the three largest cities in our data: Philadelphia, Pittsburgh, and Atlanta. Across all three cities, estimates follow a similar pattern as the average effects across the state, but voters in these urban areas are significantly more sensitive. A mile increase in distance to polling place is associated with a decrease in turnout in the general election of 2.62 p.p. in Philadelphia and 0.614 p.p. in Pittsburgh. As in the rest of Pennsylvania, there is no evidence of substitution into absentee voting to moderate these negative effects on turnout. In Atlanta, Georgia, the effects of distance to polling place are similarly amplified compared to the rest of the state. A mile increase in distance leads to a decrease in turnout of 3.16 p.p. and an increase in absentee voting of 3.28 p.p., such that the overall effect on turnout is null. These findings underscore the fact that sensitivity to distance to the polling place and the effect on overall turnout depend greatly on contextual factors, likely including aspects of electoral design (i.e., access to mail-in ballots). In the next section, we focus on demographic characteristics that may help to explain the heterogeneity in our estimates across geographic areas.

Table 4: Comparing city samples: Philadelphia, Pittsburgh, and Atlanta

	Panel A: Philadelphia					
	Primary Election			General Election		
	(1) At Poll	(2) Absentee	(3) Total	(4) At Poll	(5) Absentee	(6) Total
Distance (miles)	-2.163***	-0.014	-2.177***	-2.728***	0.113	-2.615***
	(0.520)	(0.026)	(0.521)	(0.645)	(0.070)	(0.638)
N	658435	658435	658435	661231	661231	661231
y variable mean	16.26	0.19	16.45	52.61	1.13	53.74
R^2	0.119	0.016	0.122	0.090	0.021	0.098
	Panel B: Pittsburgh					
	Primary Election			General Election		
	(1) At Poll	(2) Absentee	(3) Total	(4) At Poll	(5) Absentee	(6) Total
Distance (miles)	-0.780***	0.035	-0.745***	-0.736***	0.122*	-0.614**
	(0.203)	(0.029)	(0.196)	(0.269)	(0.068)	(0.277)
N	587367	587367	587367	588804	588804	588804
y variable mean	20.22	0.58	20.79	58.38	2.52	60.90
R^2	0.100	0.019	0.105	0.074	0.022	0.086
	Panel C: Atlanta					
	Primary Election			General Election		
	(1) At Poll	(2) Absentee	(3) Total	(4) At Poll	(5) Absentee	(6) Total
Distance (miles)	-0.894***	0.876***	-0.017	-3.163***	3.284***	0.121
	(0.142)	(0.141)	(0.023)	(0.361)	(0.392)	(0.375)
N	587402	587402	587402	587402	587402	587402
y variable mean	11.55	4.58	16.13	23.30	29.83	53.12
R^2	0.676	0.251	0.975	0.023	0.181	0.188

Note: The Philadelphia sample includes all of Philadelphia county. The Pittsburgh sample includes all of Allegheny county. The Atlanta sample includes all of Fulton county. Distance to polling place measured in miles. Turnout is measured as the number of votes per voting-age population (separately for votes cast at polling places, through absentee ballots, and total). All regressions include Border Fixed Effects (Border FE). County-Lat./Lon. refers to latitude and longitude controls, interacted with county fixed effects. The additional controls are: Democrat indicator, Republican indicator, population, voting age population, percent Black, percent Hispanic, median household income, percent without a high school diploma, percent that walk to work, and indicators for whether travel time to work is less than 5 minutes or greater than 60 minutes. Standard errors clustered at the border level are reported in parentheses.

6 Heterogeneous Effects

The average effects may hide underlying differences in the responses by different demographic groups, economic groups, and political groups. Understanding the different sensitivities to distance to polling places among various groups is important from an electoral design standpoint as it can lead to uneven representation in the electoral process. Hence, we turn to observe how different groups respond to changes in distance to polling place.

We consider separately categorical variables that summarize demographic characteristics like age, education, gender, and race at the individual level. For each covariate of interest, we estimate equation 1.A using sub-samples based on a set of mutually exclusive categories.

6.1 Individual Level

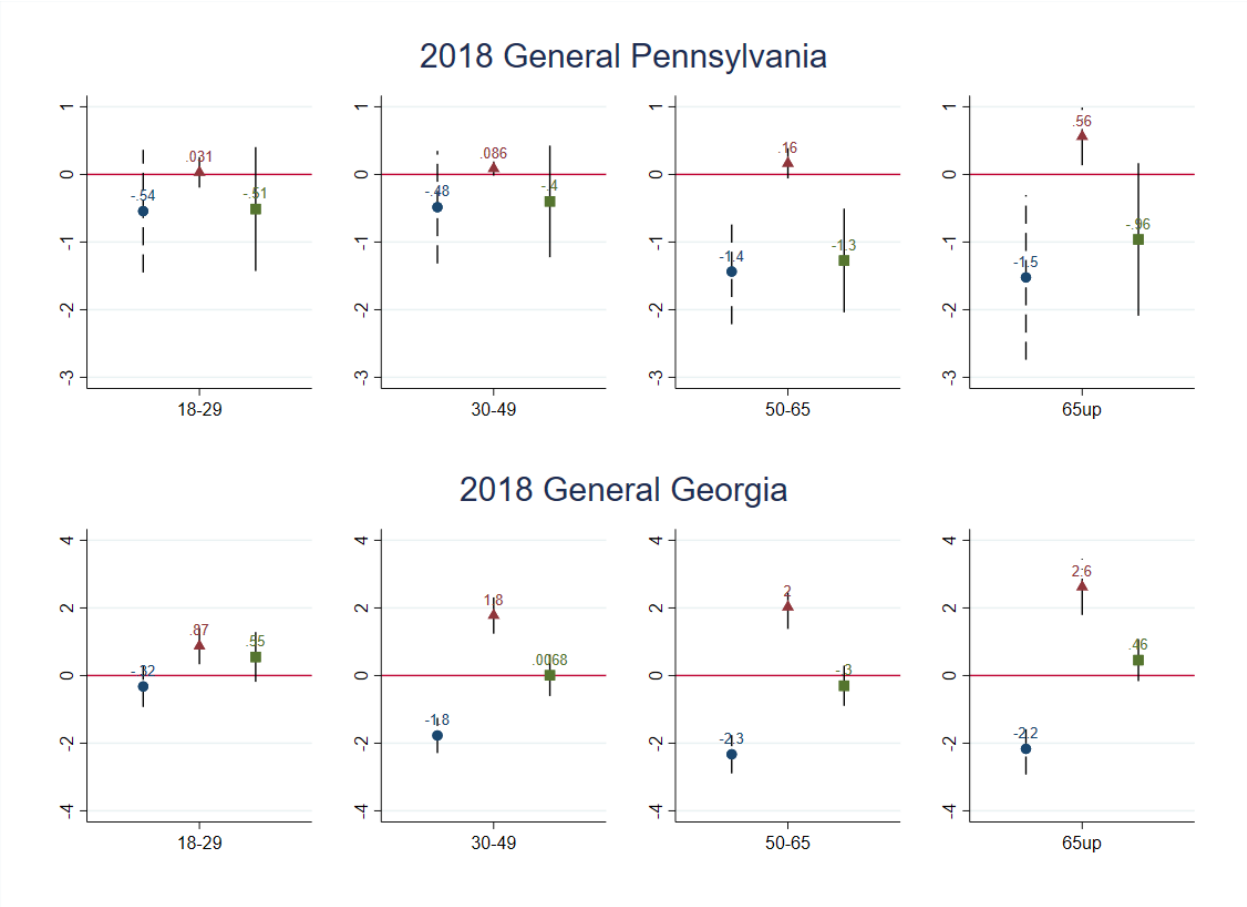
In Figure 4 we report the effects of an increase in the distance to the polling location by age group. One might expect to observe higher effects on individuals in the 18 to 29 age category due to habit formation (Fujiwara, Meng, and Vogl, 2013). However, older individuals in the 50 to 64 and 65 and up age categories seem to be more sensitive to distance to polling place .

We observe that in Pennsylvania, voters between the ages of 50 to 64 and 65 and up seem to respond more to changes in distance than younger voters. We find a statistically significant effect at polls for those of age 50 or higher ranging from a decrease of 1.4 p.p. to 1.5 p.p. and we only find an effect in total likelihood at voting for those 50 to 65 years old. The coefficient size of the effect absentee voting for those 65 and up is larger than that of the other age categories.

In Georgia the patterns of response follow the same as the average effects with null results on overall likelihood of voting but large effects both at polls and in take up of mail-in voting. In Georgia, the effects both at polls and absentee voting grow as the age category increases. All voters but those between the ages of 18 to 29 years old face a decrease in their likelihood of voting at polls with effects slightly larger than Pennsylvania. This points to the fact that older voters are more sensitive to changes in distance than young voters. The magnitudes of the estimates of the increase in the likelihood of voting absentee are very similar to those of the decrease of the at polls just reversed. In both Pennsylvania and Georgia, those 65 and up present statistically significant and positive effects in the likelihood of voting absentee. This could be evidence that those who have valid excuses, look to vote absentee when facing an increase in the distance to their polling place.

Gender differences in turnout behavior may lead us to expect significant differences

Figure 4: The effect of distance to polling place on likelihood of voting: by Age



Note: Distance to polling place measured in miles. Likelihood of voting is measured as a percentage points (separately for votes cast at polling places, through absentee ballots, and total). All regressions include Border Fixed Effects (Border FE). County-Lat./Lon. refers to latitude and longitude controls, interacted with county fixed effects. The additional controls are: Democrat indicator, Republican indicator, age 30-49 indicator, age 50-64 indicator, age 65 and up indicator, female indicator, population, voting age population, percent Black, percent Hispanic, median household income, percent without a high school diploma, percent that walk to work, and indicators for whether travel time to work is less than 5 minutes or greater than 60 minutes. Standard errors clustered at the border level are reported in parentheses.

in the effects of changes in the cost of voting. Since the 1980 to 2016, the gender gap in turnout has varied between 4 and 11 percentage points[12]. Estimates in figure 5 show small differences in the reactions to an increase of a mile in distance to polling place. In Pennsylvania, we find that the point estimates of the effect of distance on voting at polls and on overall likelihood of voting are marginally larger for female voters than that of male voters. In Georgia, both female and male voters decrease their likelihood of voting at polls by nearly the same point estimate (1.8 and 1.6 p.p.) and increase their likelihood of voting absentee by roughly the same amount (2 and 1.8 p.p.) when faced with an increase of a mile of distance to their polling place. It appears that there is no significant difference in the total likelihood of voting between male and female voters.

Race has been a focus when analyzing the cost of voting. Concerns of voter disenfranchisement stem from observations such that African-Americans have longer waiting times (Chen et al. (2019)) and are often subject to gerrymandering practices (Cameron et al. (1996)). Previous papers like Cantoni (2020) find that areas with higher percentage of minorities respond more to changes in distance than those with less percentage of minorities.

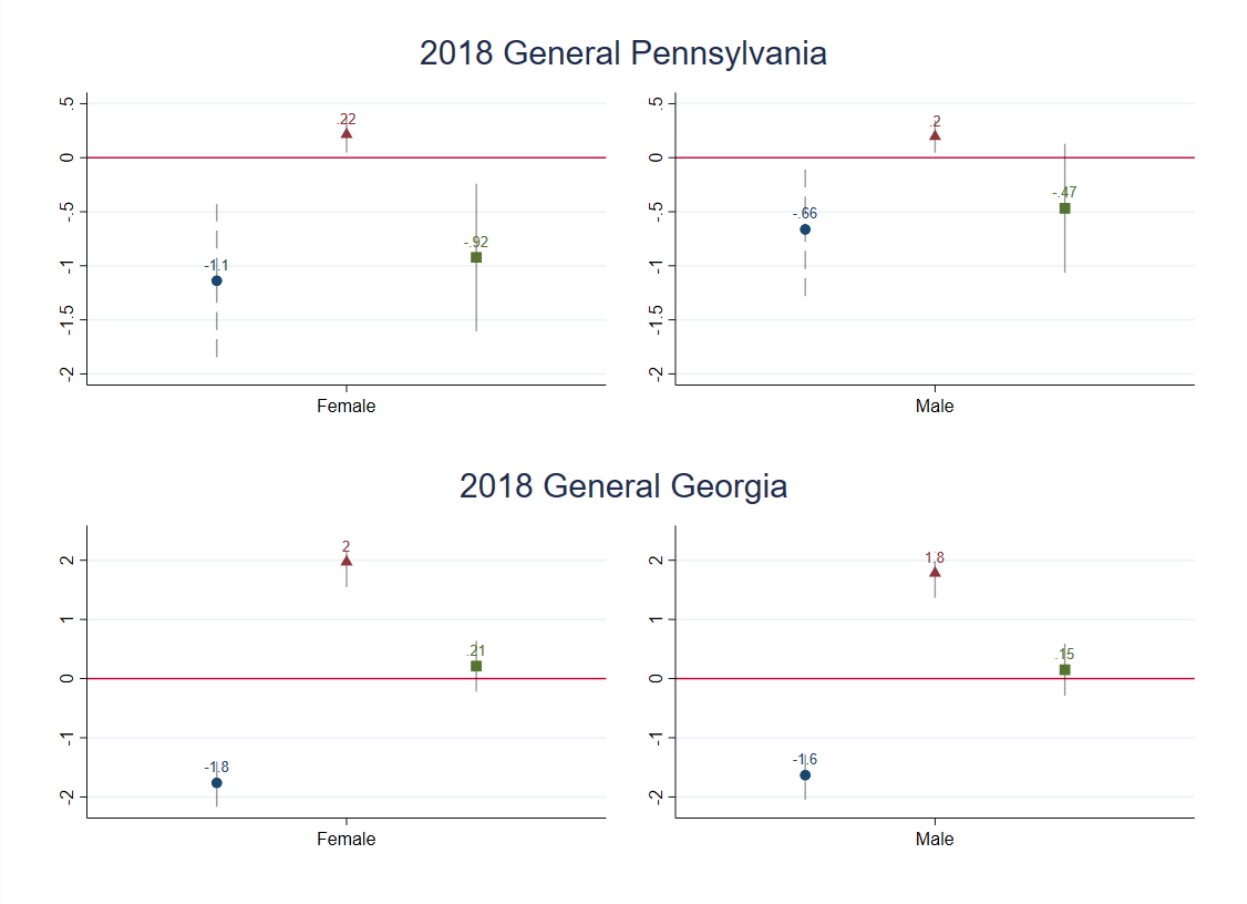
We explore differences with respect to race using the information provided in the voter registration files form Georgia. In figure 6, we find that Black non-Hispanic voters do not react too differently to distance to polling place compared to white non-Hispanic voters. In the general election, the point estimates for White non-Hispanic voters are slightly smaller than those of Black non-Hispanic voters for at polls likelihood of voting (1.7 vs 2.2 p.p.), slightly larger mail-in voting likelihood (2.1 vs 1.7 p.p.) but not statistically different. We find that Hispanic voters don't react to changes in distance in their likelihood at polls but they increase their likelihood of voting absentee. We don't observe the same pattern for Hispanics voters in primary elections.

Surprisingly we observe that the effects of an increase in the distance to the polling place aren't affecting racial groups too differently. However, we can't exclude the possibility of discrimination in other sections of the voting process such as longer wait times or having their mail-in ballots rejected more often (Enrijeta Shino and Smith (2020)). Substitution into mail in ballots may itself be more costly for historically disenfranchised groups.

Differences in the effects of an increase in the cost of voting by political affiliation could create incentives for officials to modify polling locations in order to manipulate vote shares in elections. In particular, a disproportionately negative effect to an increase of a mile in distance on turnout among voters registered for one party could motivate the opposition to reallocate polling places if the effects on their own voters were small

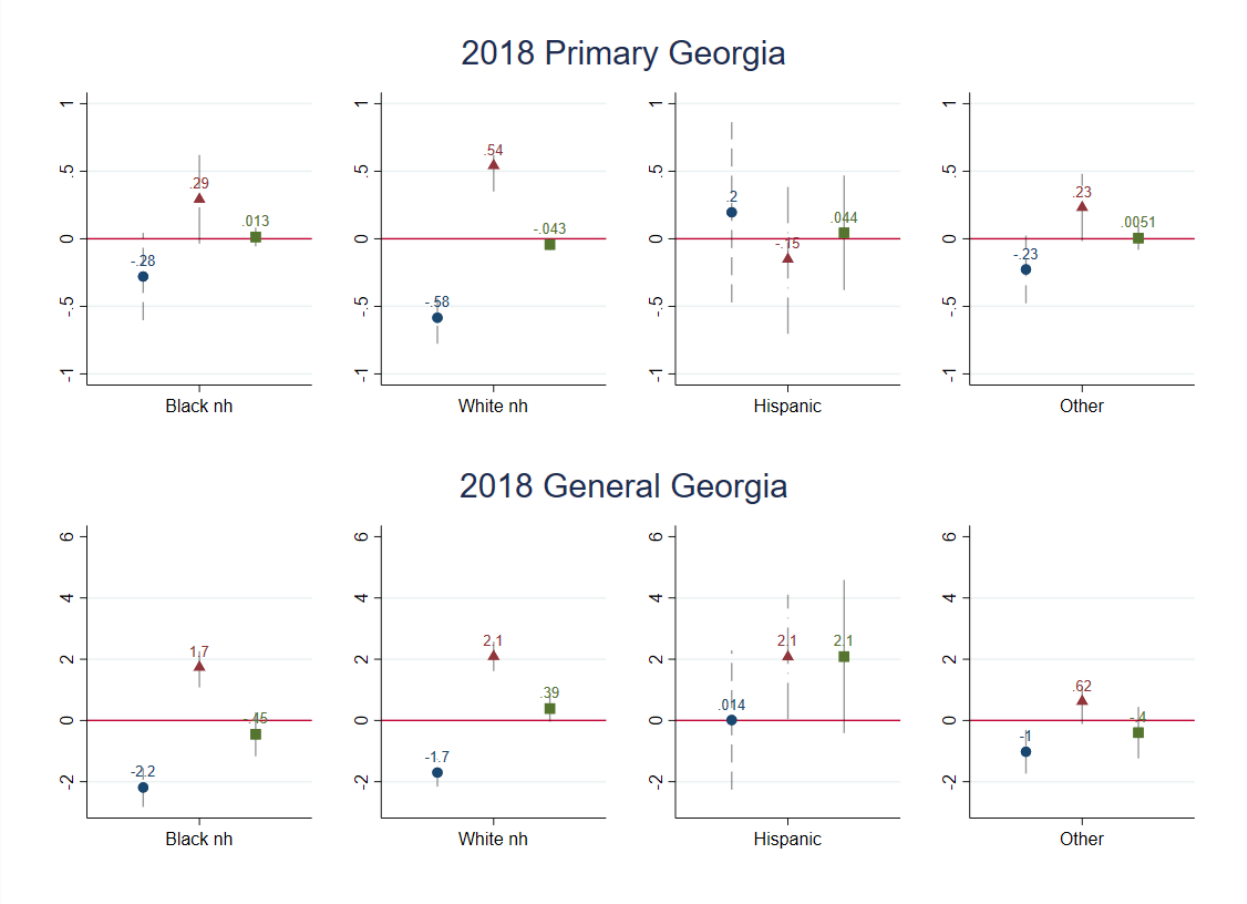
[12] "The Gender Gap". www.cawp.org. 2017. Retrieved September 5, 2018.

Figure 5: The effect of distance to polling place on likelihood of voting: by Gender



Note: Distance to polling place measured in miles. Likelihood of voting is measured as an indicator (separately for votes cast at polling places, through absentee ballots, and total). All regressions include Border Fixed Effects (Border FE). County-Lat./Lon. refers to latitude and longitude controls, interacted with county fixed effects. The additional controls in Panels B and C are: democrat indicator, republican indicator, population, voting age population, percent black, percent hispanic, median household income, percent without a high school diploma, percent that walk to work, and indicators for whether travel time to work is less than 5 minutes or greater than 60 minutes. Standard errors clustered at the border level are reported in parentheses.

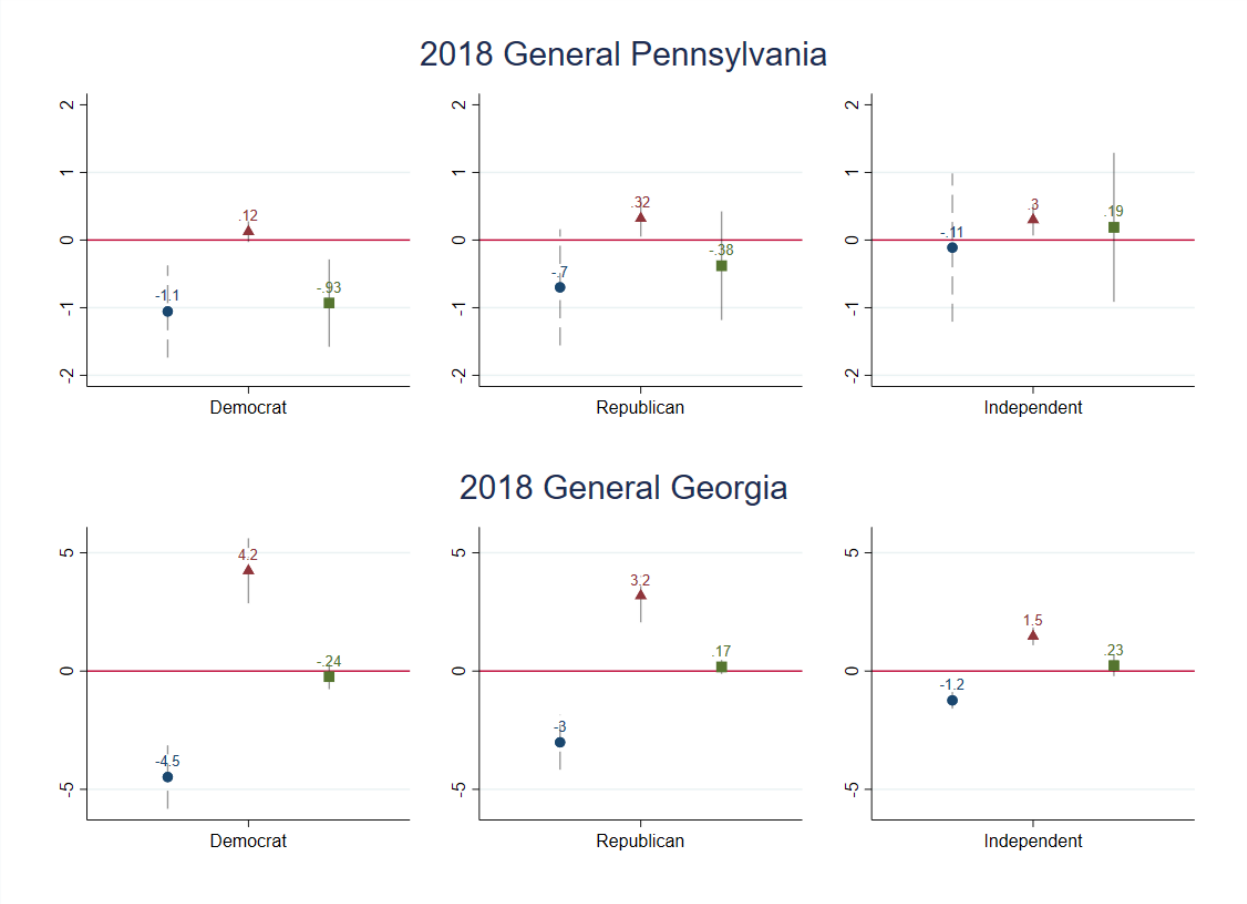
Figure 6: The effect of distance to polling place on likelihood of voting: by Race



Note: Distance to polling place measured in miles. Likelihood of voting is measured as an indicator (separately for votes cast at polling places, through absentee ballots, and total). All regressions include Border Fixed Effects (Border FE). County-Lat./Lon. refers to latitude and longitude controls, interacted with county fixed effects. The additional controls in Panels B and C are: democrat indicator, republican indicator, population, voting age population, percent black, percent hispanic, median household income, percent without a high school diploma, percent that walk to work, and indicators for whether travel time to work is less than 5 minutes or greater than 60 minutes. Standard errors clustered at the border level are reported in parentheses.

to null effects.

Figure 7: The effect of distance to polling place on likelihood of voting: by Party Affiliation



Note: Distance to polling place measured in miles. Likelihood of voting is measured as an indicator (separately for votes cast at polling places, through absentee ballots, and total). All regressions include Border Fixed Effects (Border FE). County-Lat./Lon. refers to latitude and longitude controls, interacted with county fixed effects. The additional controls in Panels B and C are: democrat indicator, republican indicator, population, voting age population, percent black, percent hispanic, median household income, percent without a high school diploma, percent that walk to work, and indicators for whether travel time to work is less than 5 minutes or greater than 60 minutes. Standard errors clustered at the border level are reported in parentheses.

Making use of the party registration information we explore the effects of an increase of distance to the polls on the likelihood of voting. In both Pennsylvania and Georgia we find the point estimates at polls to be for voters registered as democrats (4.5 p.p.) while the smallest ones are for those registered as independents (1.2 p.p.). Although we can't reject the null that the effects in overall likelihood of voting are the same for voters registered as republicans and democrats, we observe that in Pennsylvania and Georgia the point estimate for democrats is roughly 50% larger than that of republicans. In

Georgia, we find that those registered as democrats or republicans are more likely to respond to changes in distance at polls and in mail-in ballots take up by more than 1.5 p.p. than those registered as independents.

6.2 Block Level

When looking for heterogeneous effects at the block level, we run the following specification:

$$turnout_b = \delta_{s(b)} + \mathcal{C}_b'\gamma + distance_b \cdot \mathcal{C}_b'\beta + \mathcal{X}_b'\iota + \epsilon_b \tag{1}$$

Where $\mathcal{C}_i$ refers to a set categorical variables. We look at blocks with a higher percentage of voters at different income groups, education levels, mode of transportation to work, and length of time to work. We report each coefficient on $distance_i$ using coefficient plots. Detailed results from these regressions are reported in the appendix. For each interaction effect, we report estimated coefficients for Pennsylvania and Georgia general elections. Results for primary elections show similar patterns and are reported in Appendix A.4.

Looking at differences in responses to a change in distance to the polling place by block characteristics, we find no significant differences when looking at income groups, and length of time to work. In the next section we discuss results by educational attainment, income brackets, and way of transport to work.

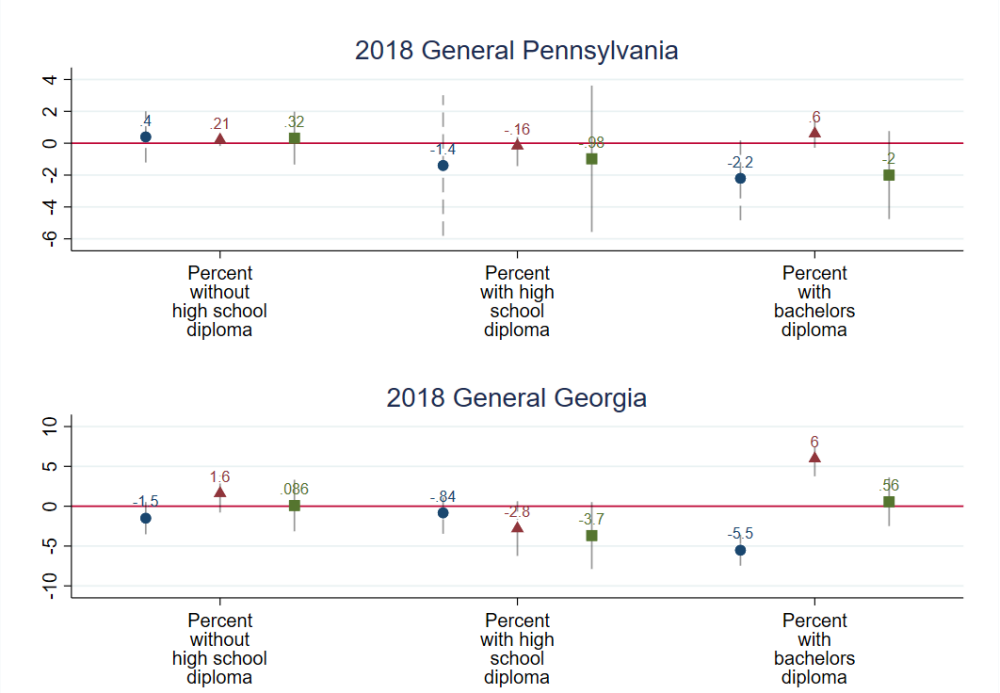
We turn to analyze how blocks with higher percentage of citizens at distinct levels of educational attainment react to changes in distance to their polling location in figure 8. Engrossing, we find small significant effects of a change in distance to the polling location for blocks with higher percentage of voters have at least a college degree in Georgia in turnout at polls but not effect in total turnout. In Pennsylvania, we don't find any significant on turnout at polls, absentee or total.

We find that in Georgia, blocks where more of their voters have at least a bachelors degree, when faced with a higher cost of voting at polls, mostly decide to vote absentee. The differences in the effects at polls and absentee voting could come from lower costs of switching into absentee voting. Perhaps blocks where more of their voters haven't finished college, faced higher difficulties coping with the intricate procedures of filing the forms to obtain absentee ballots, or are less informed on how to engage with the process.

Blocks would decrease turnout at polls from 2.2 to 5.5 p.p. when faced with an increase of a mile in distance to their polling location if their percentage of voters who had at least a bachelors degree would increase from 0 to 100 percent. As mentioned

before, this large decrease in at polls turnout is tampered by an increase of absentee voting from 0.6 p.p to 6 p.p when faced by the same change as before which in turn yields null to small effects in total turnout. In Georgia, the response to a mile increase in distance to the polling location for blocks with a higher percentage of voters with a college degree is significantly different from blocks with a higher percentage of voters of other educational attainment levels.

Figure 8: The effect of distance to polling place on turnout: by Educational Attainment



Note: Standard errors clustered at the boundary level.The additional controls are: percent Voting Age Population, percent Democrat, percent Republican, percent Black, percent Hispanic, Median Household Income, percent without a High School Diploma, percent Walk to Work, Travel Time to Work is less than 5 minutes, and Travel Time to Work is more than 60 minutes.

Concerns about representation also emerge when considering the poor. Without being able to voice their votes, they could loose access to crucial government programs which offer relief and opportunities. Government programs such as the supplemental Nutrition Assistance Program (SNAP), more commonly known as "Food Stamps"[13], Earned Income Tax Credit (EITC) among others are directly beneficial for the poor[14].

Motivated to explore more the interactions between income and changes in the distance to the polling location, we compare areas with high number of voters in

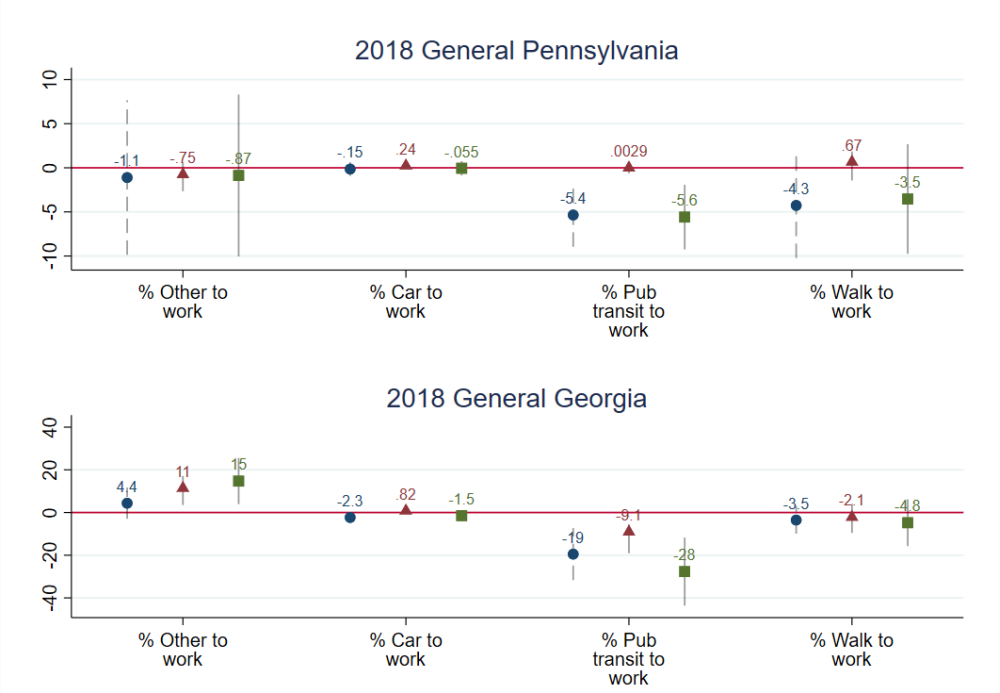
[13]Jolliffe et al. (2019) finds that America's poorest gained from SNAP and it helped prevent hardship in some periods, notably during the 2008-11 financial crisis.

[14]Neumark and Wascher (2001) find that the EITC helps families rise above poverty-level earnings, primarily by inducing labor market entry in families that initially do not have an adult worker.

different income brackets. We find no evidence that blocks with more voters at distinct income brackets react differently to changes in the distance to the polling place.

A natural question that comes to mind when investigating the cost of an increase in the distance to the polling location is: How does it vary with transportation patterns? Luckily the US Census provides information on the ways voter use everyday to get to work. When deciding where to place a polling location, perhaps the boards need to pay close attention to where is the nearest highway, pedestrian accessibility, parking or where is the closest bus stop.

Figure 9: The effect of distance to polling place on turnout: by Way of transport to Work



Note: Standard errors clustered at the boundary level.The additional controls are: percent Voting Age Population, percent Democrat, percent Republican, percent Black, percent Hispanic, Median Household Income, percent without a High School Diploma, percent Walk to Work, Travel Time to Work is less than 5 minutes, and Travel Time to Work is more than 60 minutes.

Our results seem to indicate that paying attention to nearby public transportation routes would be important. In both Pennsylvania and Georgia, we find that the largest effects in at polls and total turnout are found for blocks who have a higher percentage of voters who take public transport to work. These estimates are 8 to 10 times larger than the average effect found in section 4. We find that an increase of a mile of distance to the polling place would decrease at polls turnout by 5.4 p.p. in Pennsylvania and 19 p.p. in Georgia if the percentage of those who take public transport would grow from 0 to 100 percent. To grasp the magnitude of these effects, if all the blocks would go from

having zero of its residents to 100 percent of its residents using public transit to work, we would observe a drop in turnout that is at least twice as large as the vote margins of Maine, Nevada, Minnesota, New Hampshire, Michigan, Pennsylvania, Wisconsin and, Florida in the 2016 election.

7 Non-linear Effects

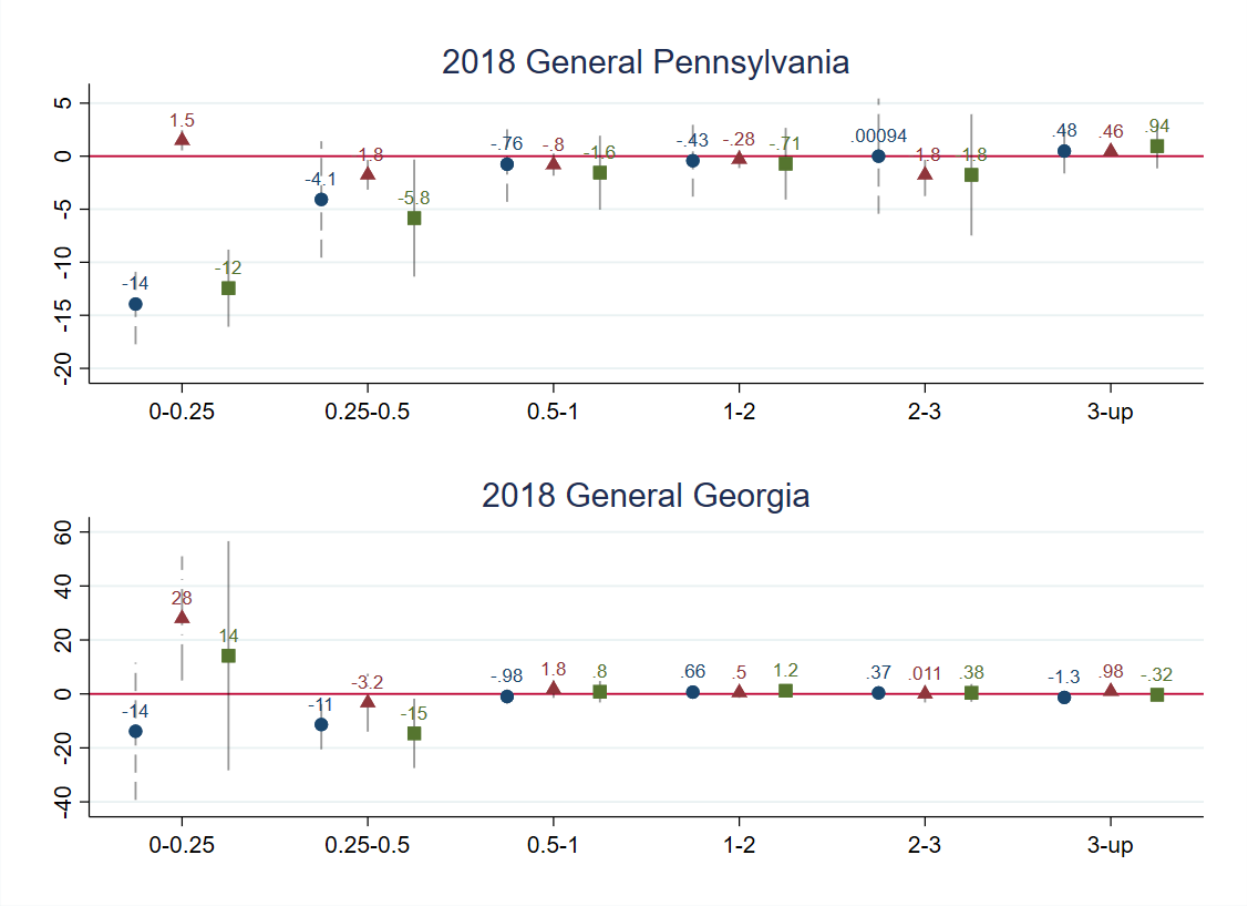
In this section we turn to explore the non-linear nature of our effects. We isolate the effects of distance in intervals of different widths. We run the following specification:

$$vote_i = \delta_{s(i)} + \gamma\ D_i + \beta\ D_i \cdot dist_i + \rho \mathcal{P}_i + \iota\ \mathcal{X}_b(i) + \epsilon_i \tag{2}$$

The variable D_i refers to a vector of indicator variables that take value 1 when the distance by block i is in the range and 0 elsewhere. The ranges are: [0,0.25), [0.25,0.5), [0.5,1), [1,2), [2,3), and [3,10]. We report in the plot below the β vector of coefficients from the interactions between the distance range indicator and the distance variable.

In figure 10 we find the results for general elections. We observe that in both Pennsylvania and Georgia, the majority of the effect happens at the short distances and then tampers off. We find the largest point estimates for those who face distances up to half a mile, with decreases in turnout at polls of 14 p.p. in Pennsylvania and Georgia. These show that although the average effects we find in our main results are small, they mask great non-linearities in the responses to changes in distance to the polling place. These non-linearities are also different across states where we see that substituting into absentee voting helps mitigate the strong reactions in Georgia but not in Pennsylvania.

Figure 10: The effect of distance to polling place on likelihood of voting: Non-linear General Elections



Note: Distance to polling place measured in miles. Likelihood of voting is measured as an indicator (separately for votes cast at polling places, through absentee ballots, and total). All regressions include Border Fixed Effects (Border FE). County-Lat./Lon. refers to latitude and longitude controls, interacted with county fixed effects. The additional controls in Panels B and C are: democrat indicator, republican indicator, population, voting age population, percent black, percent hispanic, median household income, percent without a high school diploma, percent that walk to work, and indicators for whether travel time to work is less than 5 minutes or greater than 60 minutes. Standard errors clustered at the border level are reported in parentheses.

8 Conclusion

Among the many costs of voting, some are easy to control or ban (polling taxes) and others are impossible to control (bad weather). The distance to the polling place is both inherent to the voting process and is subject to regulation. However, we know very little about how distance to polling place affects voter participation. This paper is another step toward informing the policy debate on the distributional effects of changes in the distance to polling places.

The results highlight some important lessons for studies of polling places in the future.First, these results highlight the importance of using a large dataset to study costs of voting in large elections. It is important to have the power to estimate very small effects, since these can add up to meaningful changes in aggregate. In the 2020 presidential election, the margin of victory for Joe Biden was less than one percentage point in both Georgia and Pennsylvania. A mile change (slightly less than one standard deviation in distance) for all voters would decrease turnout by up to 0.99 p.p. in Pennsylvania and would shift voting from in-person to mail-in voting in Georgia. Having a state-wide dataset also allows for meaningful descriptive statistics of the distribution of polling places and allows us to explore the effects by different characteristics of the population.

We find that the sensitivity to distance to polling palace varies across settings and for different demographic groups. Although our average effect sizes in Pennsylvania and Georgia are an order of magnitude smaller than those found in a previous comparable study in urban areas, we find that heterogeneous effects can explain these discrepancies. In particular, in areas where people rely on public transportation for commuting, voters are most sensitive to polling place location. A one mile increase in distance to polling places is associated with an 5.6 to 28 p.p. decrease in total turnout. These findings may point to the need of facilitating easier access to polling places for those that rely on public transport. Older voters are also more sensitive and more likely to substitute to mail-in voting. In Georgia, male voters seem to be more sensitive to changes in distance while we don't observe the same pattern in Pennsylvania. We do not find any statistically significant differences in the sensitivity to polling place location by race or ethnicity.

The findings in this paper can help election commissions that face costly tradeoffs in choosing how many polling places to open and where to place them. For instance, closing or moving polling places in areas where voters have access to car transportation is less costly than closing or moving polling places in areas with heavy reliance on public transportation. Every ten years, following the U.S. Census, state and local officials determine the boundaries of voting precincts, a process known as "reprecincting". This paper suggests that these decisions are not without consequences. Currently, precincts

are designed to have equal population size so that polling places each serve a similarly sized constituency. With the more nuanced understanding of when voters choose mail-in ballots over voting in person or choose to abstain from voting, election commissions may have an opportunity to reduce costs of voting or make costs of voting more equal across the population.

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A Appendix

A.1 Data

Table 5: Variable Definitions, Units of Observation, and Data Sources

Variable	Definition	Unit of Observation	Source
Turnout	Votes per voting age population	Block	PA Secretary of State
Distance to Polling Place	Miles from block interior centroid to polling place	Block	Computed value
Race, Ethnicity, Gender, Age	Percent of population in demographic group	Block	2010 Census
Car Ownership	Number of cars per housing units	Block-group	2006-2010 ACS
Way to Work	Percent of workers 16 and older using mode of transportation to work	Block-group	2006-2010 ACS
Time to Work	Time to work among workers 16 and older who do not work from home	Block-group	2006-2010 ACS
Median Income	Median household income for the past 12 months	Block-group	2006-2010 ACS
Home Ownership	Percent of households owning home	Block-group	2006-2010 ACS
Education	Percent of population older than 25 belonging to education group	Block-group	2006-2010 ACS
Unemployment	Percent of labor force unemployed	Tract	2006-2010 ACS

A.2 Summary Statistics

Table 6: Summary Statistics

	All Pennsylvania		Regression sample		All Georgia		Regression sample	
	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
Turnout, 2018 primary at polls	18.41	38.75	16.32	36.96	12.30	32.85	11.44	31.83
Turnout, 2018 primary absentee	0.38	6.16	0.33	5.75	4.60	20.95	4.13	19.89
Turnout, 2018 primary	18.79	39.06	16.65	37.26	16.90	37.48	15.57	36.26
Turnout, 2018 general at polls	56.79	49.54	52.01	49.96	25.79	43.75	24.72	43.14
Turnout, 2018 general absentee	2.23	14.78	1.65	12.75	29.76	45.72	27.40	44.60
Turnout, 2018 general	59.03	49.18	53.66	49.87	55.55	49.69	52.12	49.96
Democrat	0.48	0.50	0.64	0.48	0.08	0.27	0.09	0.28
Republican	0.38	0.49	0.22	0.41	0.09	0.28	0.06	0.25
Independent	0.14	0.35	0.14	0.35	0.83	0.37	0.85	0.36
Distance (miles)	0.93	3.72	0.39	0.51	1.66	2.70	1.33	1.27
Demographics								
Population	145.70	220.38	148.89	199.18	337.02	465.12	297.38	420.33
Voting Age Population	115.55	190.53	119.88	176.74	244.13	332.47	222.41	308.81
Percent urban	0.80	0.40	0.98	0.13	0.75	0.43	0.87	0.34
Percent Black	0.11	0.23	0.27	0.35	0.30	0.33	0.37	0.35
Percent Hispanic	0.05	0.11	0.08	0.16	0.07	0.11	0.07	0.11
Poverty Rate	0.12	0.13	0.19	0.18	0.14	0.13	0.17	0.16
Median hh Income (10k USD)	5.86	2.89	4.77	2.68	5.85	2.89	5.69	3.14
Way to work								
% Car to work	0.85	0.17	0.71	0.23	0.90	0.09	0.87	0.12
% Walk to work	0.04	0.09	0.07	0.12	0.01	0.04	0.02	0.05
% Pub transit to work	0.06	0.12	0.16	0.18	0.02	0.06	0.04	0.08
% Bike to work	0.00	0.02	0.01	0.03	0.00	0.01	0.00	0.01
Time to work								
% time to work 0-5min	0.04	0.05	0.03	0.05	0.03	0.04	0.02	0.04
% time to work 5-60min	0.88	0.08	0.88	0.10	0.88	0.08	0.89	0.08
% time to work 60min plus	0.08	0.08	0.09	0.09	0.10	0.08	0.09	0.08
Observations	8245003		1765162		6980226		523064	

Table 7: Distance Prediction

	Pennsylvania			Georgia		
	(1) All Individual	(2) Blocks in Border FE Sample	(3) Blocks in Border FE Sample	(4) All Individuals	(5) Blocks in Border FE Sample	(6) Blocks in Border FE Sample
Democrat	-0.049***	0.000	0.000	-0.089***	-0.015***	-0.017***
	(0.008)	(0.001)	(0.001)	(0.017)	(0.004)	(0.004)
Republican	0.047***	0.001	0.002	-0.074**	-0.011*	-0.012*
	(0.011)	(0.001)	(0.001)	(0.034)	(0.007)	(0.006)
Population	-0.001	-0.000	-0.000	0.000	0.000	0.000
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Age 18 to 29	-0.042***	0.005**	0.005**	0.008	0.004	0.002
	(0.010)	(0.002)	(0.002)	(0.014)	(0.008)	(0.007)
Age 30 to 49	-0.039***	0.005**	0.005**	0.024	-0.003	-0.003
	(0.008)	(0.002)	(0.002)	(0.017)	(0.007)	(0.007)
Age 50 to 64	0.002	0.003	0.003	0.040***	0.001	0.000
	(0.006)	(0.002)	(0.002)	(0.012)	(0.006)	(0.006)
Female	-0.015**	0.000	0.000	-0.016***	-0.002	-0.002
	(0.006)	(0.001)	(0.001)	(0.004)	(0.001)	(0.001)
Voting Age Population	0.001	0.000	0.000	-0.000	0.000	0.000
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Percent Black	-0.091	-0.004	-0.004	-0.450***	-0.070	-0.081*
	(0.065)	(0.026)	(0.026)	(0.111)	(0.045)	(0.041)
Percent Hispanic	1.416	0.020	0.024	-0.594***	-0.183**	-0.127**
	(1.110)	(0.026)	(0.026)	(0.144)	(0.072)	(0.063)
Median hh Income (10k USD)	-0.006	0.003	0.001	-0.053***	0.008	0.011
	(0.013)	(0.003)	(0.003)	(0.012)	(0.010)	(0.009)
Poverty Rate	-0.098	-0.004	-0.008	-0.457**	0.073	0.076
	(0.203)	(0.037)	(0.036)	(0.214)	(0.114)	(0.103)
Cars per Household	0.804***	0.005	0.017	0.880***	0.124**	0.088*
	(0.177)	(0.021)	(0.016)	(0.183)	(0.060)	(0.047)
Percent without high school diploma	0.365***	-0.016	-0.017	1.540*	-0.106	-0.084
	(0.096)	(0.026)	(0.026)	(0.900)	(0.122)	(0.112)
% Walk to work	-0.230*	-0.027	-0.019	-0.729	-0.199	-0.363
	(0.131)	(0.036)	(0.035)	(0.724)	(0.343)	(0.296)
% time to work 0-5min	-1.677***	-0.103	-0.096	-2.580***	-0.118	0.122
	(0.401)	(0.090)	(0.085)	(0.715)	(0.293)	(0.260)
Black nh				-0.028*	-0.004	-0.003
				(0.016)	(0.004)	(0.004)
Hispanic				-0.022***	-0.002	-0.002
				(0.008)	(0.006)	(0.006)
White nh				0.028**	-0.003	0.000
				(0.013)	(0.005)	(0.004)
County FE	X			X		
Border FE		X	X		X	X
County-Lat/Long			X			X
N	4924711	1101629	1101629	6015607	445077	445077
y variable mean	0.91	0.37	0.37	1.66	1.34	1.34
R^2	0.019	0.748	0.758	0.099	0.830	0.847

A.3 The Effect of Distance to Polling Place on Turnout

Table 8: The effect of distance to polling place on turnout: Pennsylvania

	Panel A: OLS with Precinct FE and Controls					
	Primary Election			General Election		
	At Poll	Absentee	Total	At Poll	Absentee	Total
Distance to polling place	-0.6460***	-0.0043	-0.6505***	-0.5936***	0.2250***	-0.4380**
	(0.1389)	(0.0209)	(0.1424)	(0.1977)	(0.0549)	(0.2052)
N	173573	174702	173567	165936	174604	165913
y variable mean	16.34	0.35	16.67	45.87	1.94	47.57
R^2	0.177	0.053	0.179	0.255	0.112	0.270
	Panel B: Border FE with Controls					
	Primary Election			General Election		
	At Poll	Absentee	Total	At Poll	Absentee	Total
Distance to polling place	-0.4864***	0.0350	-0.4731***	-0.6016**	0.2078***	-0.4731*
	(0.1732)	(0.0325)	(0.1788)	(0.2550)	(0.0590)	(0.2618)
N	108708	109338	108706	104530	109279	104518
y variable mean	15.72	0.34	16.04	44.55	1.73	46.08
R^2	0.280	0.102	0.281	0.355	0.177	0.371
	Panel C: Border FE with Controls and County-Lat./Lon.					
	Primary Election			General Election		
	At Poll	Absentee	Total	At Poll	Absentee	Total
Distance to polling place	-0.4791***	0.0477	-0.4524**	-0.6058**	0.2323***	-0.4741*
	(0.1747)	(0.0294)	(0.1779)	(0.2584)	(0.0582)	(0.2653)
N	108708	109338	108706	104530	109279	104518
y variable mean	15.72	0.34	16.04	44.55	1.73	46.08
R^2	0.283	0.103	0.283	0.357	0.179	0.373

Note: Distance to polling place measured in miles. Turnout is measured as the number of votes per voting-age population (separately for votes cast at polling places, through absentee ballots, and total). All regressions include Border Fixed Effects (Border FE). County-Lat./Lon. refers to latitude and longitude controls, interacted with county fixed effects. The additional controls in Panels B and C are: population, voting age population, percent registered Democrat, percent registered Republican, percent Black, percent Hispanic, median household income, percent without a high school diploma, percent that walk to work, and indicators for whether travel time to work is less than 5 minutes or greater than 60 minutes. Standard errors clustered at the border level are reported in parentheses.

Table 9: The effect of distance to polling place on turnout: Georgia

	Panel A: OLS with Precinct FE and Controls					
	Primary Election			General Election		
	At Poll	Absentee	Total	At Poll	Absentee	Total
Distance to polling place	-0.4316***	0.1555***	-0.2701***	-0.8066***	1.0935***	0.2472
	(0.0757)	(0.0548)	(0.0990)	(0.0949)	(0.1170)	(0.1569)
N	87852	88332	87718	86499	85553	84538
y variable mean	13.60	5.66	19.09	25.36	29.11	54.00
R^2	0.143	0.101	0.144	0.193	0.184	0.178
	Panel B: Border FE with Controls					
	Primary Election			General Election		
	At Poll	Absentee	Total	At Poll	Absentee	Total
Distance to polling place	-0.5935***	0.4661***	-0.1389	-2.0821***	1.2319***	-0.8558**
	(0.1772)	(0.1363)	(0.1981)	(0.2735)	(0.3058)	(0.4035)
N	32752	32933	32708	32269	32005	31655
y variable mean	13.51	5.23	18.55	25.52	27.45	52.56
R^2	0.524	0.335	0.607	0.320	0.370	0.377
	Panel C: Border FE with Controls and County-Lat./Lon.					
	Primary Election			General Election		
	At Poll	Absentee	Total	At Poll	Absentee	Total
Distance to polling place	-0.5911***	0.4878***	-0.1225	-2.2828***	1.5376***	-0.8430**
	(0.1869)	(0.1382)	(0.2084)	(0.2799)	(0.3100)	(0.4215)
N	32752	32933	32708	32269	32005	31655
y variable mean	13.51	5.23	18.55	25.52	27.45	52.56
R^2	0.533	0.349	0.614	0.331	0.384	0.386

Note: Distance to polling place measured in miles. Turnout is measured as the number of votes per voting-age population (separately for votes cast at polling places, through absentee ballots, and total). All regressions include Border Fixed Effects (Border FE). County-Lat./Lon. refers to latitude and longitude controls, interacted with county fixed effects. The additional controls in Panels B and C are: population, voting age population, percent registered Democrat, percent registered Republican, percent Black, percent Hispanic, median household income, percent without a high school diploma, percent that walk to work, and indicators for whether travel time to work is less than 5 minutes or greater than 60 minutes. Standard errors clustered at the border level are reported in parentheses.

A.4 Heterogeneous Effects: Individual Level

Table 10: The effect of distance to polling place on likelihood of voting: by Age

	Age 18-29					
	General Pennsylvania			General Georgia		
	At Poll	Absentee	Total	At Poll	Absentee	Total
Distance (miles)	-0.5428	0.0309	-0.5120	-0.3240	0.8727***	0.5487
	(0.4629)	(0.1155)	(0.4673)	(0.3094)	(0.2758)	(0.3747)
N	246636	246636	246636	114752	114752	114752
y variable mean	41.06	1.48	42.53	20.31	14.71	35.02
R^2	0.105	0.077	0.116	0.061	0.124	0.139
	Age 30-49					
	General Pennsylvania			General Georgia		
	At Poll	Absentee	Total	At Poll	Absentee	Total
Distance (miles)	-0.4848	0.0862	-0.3986	-1.7721***	1.7789***	0.0068
	(0.4242)	(0.0535)	(0.4210)	(0.2663)	(0.2762)	(0.3129)
N	396102	396102	396102	156859	156859	156859
y variable mean	49.42	0.88	50.29	27.28	22.62	49.90
R^2	0.102	0.032	0.107	0.071	0.140	0.178
	Age 50-64					
	General Pennsylvania			General Georgia		
	At Poll	Absentee	Total	At Poll	Absentee	Total
Distance (miles)	-1.4366***	0.1636	-1.2730***	-2.3287***	2.0268***	-0.3019
	(0.3975)	(0.1139)	(0.3914)	(0.2884)	(0.3300)	(0.3038)
N	256849	256849	256849	103039	103039	103039
y variable mean	62.43	1.36	63.80	27.03	36.01	63.04
R^2	0.101	0.057	0.108	0.094	0.176	0.220
	Age 65 up					
	General Pennsylvania			General Georgia		
	At Poll	Absentee	Total	At Poll	Absentee	Total
Distance (miles)	-1.5232**	0.5613***	-0.9619*	-2.1668***	2.6221***	0.4552
	(0.6215)	(0.2175)	(0.5749)	(0.3892)	(0.4242)	(0.3166)
N	200687	200687	200687	70427	70427	70427
y variable mean	64.42	3.68	68.10	22.18	45.94	68.12
R^2	0.104	0.082	0.103	0.134	0.203	0.265

Note: Distance to polling place measured in miles. Likelihood of voting is measured as a percentage points (separately for votes cast at polling places, through absentee ballots, and total). All regressions include Border Fixed Effects (Border FE). County-Lat./Lon. refers to latitude and longitude controls, interacted with county fixed effects. The additional controls in Panels B and C are: democrat indicator, republican indicator, population, voting age population, percent black, percent hispanic, median household income, percent without a high school diploma, percent that walk to work, and indicators for whether travel time to work is less than 5 minutes or greater than 60 minutes. Standard errors clustered at the border level are reported in parentheses.

Table 11: The effect of distance to polling place on likelihood of voting: by Gender

	Female					
	General Pennsylvania			General Georgia		
	At Poll	Absentee	Total	At Poll	Absentee	Total
Distance (miles)	-1.1381***	0.2151**	-0.9230***	-1.7630***	1.9728***	0.2098
	(0.3612)	(0.0857)	(0.3480)	(0.2068)	(0.2173)	(0.2193)
N	600505	600505	600505	240919	240919	240919
y variable mean	55.07	1.74	56.81	25.44	29.32	54.76
R^2	0.098	0.044	0.107	0.057	0.184	0.196
	Male					
	General Pennsylvania			General Georgia		
	At Poll	Absentee	Total	At Poll	Absentee	Total
Distance (miles)	-0.6636**	0.1960**	-0.4676	-1.6324***	1.7829***	0.1505
	(0.3146)	(0.0765)	(0.3042)	(0.2103)	(0.2127)	(0.2246)
N	499769	499769	499769	204158	204158	204158
y variable mean	51.21	1.51	52.72	23.64	25.07	48.71
R^2	0.121	0.036	0.133	0.071	0.189	0.236

Note: Distance to polling place measured in miles. Likelihood of voting is measured as a percentage points (separately for votes cast at polling places, through absentee ballots, and total). All regressions include Border Fixed Effects (Border FE). County-Lat./Lon. refers to latitude and longitude controls, interacted with county fixed effects. The additional controls in Panels B and C are: democrat indicator, republican indicator, population, voting age population, percent black, percent hispanic, median household income, percent without a high school diploma, percent that walk to work, and indicators for whether travel time to work is less than 5 minutes or greater than 60 minutes. Standard errors clustered at the border level are reported in parentheses.

Table 12: The effect of distance to polling place on likelihood of voting: by Party Affiliation

	Democrat					
	General Pennsylvania			General Georgia		
	At Poll	Absentee	Total	At Poll	Absentee	Total
Distance (miles)	-1.0557***	0.1237	-0.9320***	-4.4799***	4.2396***	-0.2402
	(0.3479)	(0.0782)	(0.3295)	(0.6845)	(0.7004)	(0.2679)
N	733063	733063	733063	40212	40212	40212
y variable mean	55.23	1.63	56.87	31.30	65.24	96.54
R^2	0.093	0.041	0.104	0.151	0.155	0.101
	Republican					
	General Pennsylvania			General Georgia		
	At Poll	Absentee	Total	At Poll	Absentee	Total
Distance (miles)	-0.6993	0.3194**	-0.3798	-3.0107***	3.1848***	0.1741
	(0.4383)	(0.1367)	(0.4096)	(0.5906)	(0.5735)	(0.1516)
N	228128	228128	228128	27928	27928	27928
y variable mean	56.29	2.00	58.29	39.18	57.88	97.06
R^2	0.131	0.060	0.142	0.243	0.253	0.150
	Independent					
	General Pennsylvania			General Georgia		
	At Poll	Absentee	Total	At Poll	Absentee	Total
Distance (miles)	-0.1119	0.2999**	0.1880	-1.2394***	1.4690***	0.2296
	(0.5591)	(0.1191)	(0.5624)	(0.1791)	(0.1912)	(0.2258)
N	139083	139083	139083	376937	376937	376937
y variable mean	38.33	1.06	39.39	22.82	21.07	43.90
R^2	0.138	0.079	0.147	0.043	0.082	0.084

Note: Distance to polling place measured in miles. Likelihood of voting is measured as a percentage points (separately for votes cast at polling places, through absentee ballots, and total). All regressions include Border Fixed Effects (Border FE). County-Lat./Lon. refers to latitude and longitude controls, interacted with county fixed effects. The additional controls in Panels B and C are: democrat indicator, republican indicator, population, voting age population, percent black, percent hispanic, median household income, percent without a high school diploma, percent that walk to work, and indicators for whether travel time to work is less than 5 minutes or greater than 60 minutes. Standard errors clustered at the border level are reported in parentheses.

Table 13: The effect of distance to polling place on likelihood of voting: by Race

	Black nh					
	Primary Georgia			General Georgia		
	At Poll	Absentee	Total	At Poll	Absentee	Total
Distance (miles)	-0.2795*	0.2926*	0.0130	-2.1880***	1.7390***	-0.4490
	(0.1648)	(0.1674)	(0.0353)	(0.3236)	(0.3365)	(0.3675)
N	165509	165509	165509	165509	165509	165509
y variable mean	10.93	3.83	14.76	22.35	27.46	49.81
R^2	0.710	0.264	0.984	0.050	0.225	0.233
	White nh					
	Primary Georgia			General Georgia		
	At Poll	Absentee	Total	At Poll	Absentee	Total
Distance (miles)	-0.5845***	0.5419***	-0.0426**	-1.7016***	2.0909***	0.3893*
	(0.0983)	(0.0979)	(0.0209)	(0.2330)	(0.2444)	(0.2181)
N	201672	201672	201672	201672	201672	201672
y variable mean	13.93	5.24	19.18	28.23	30.58	58.82
R^2	0.682	0.267	0.979	0.078	0.181	0.212
	Hispanic					
	Primary Georgia			General Georgia		
	At Poll	Absentee	Total	At Poll	Absentee	Total
Distance (miles)	0.1960	-0.1517	0.0442	0.0137	2.0739**	2.0876
	(0.3400)	(0.2810)	(0.2163)	(1.1593)	(1.0348)	(1.2753)
N	13927	13927	13927	13927	13927	13927
y variable mean	5.03	1.11	6.14	24.93	16.97	41.90
R^2	0.826	0.330	0.970	0.194	0.260	0.262
	Other					
	Primary Georgia			General Georgia		
	At Poll	Absentee	Total	At Poll	Absentee	Total
Distance (miles)	-0.2269*	0.2320*	0.0051	-1.0211***	0.6228*	-0.3983
	(0.1280)	(0.1270)	(0.0443)	(0.3633)	(0.3777)	(0.4281)
N	63969	63969	63969	63969	63969	63969
y variable mean	6.43	2.02	8.45	19.01	19.27	38.28
R^2	0.740	0.265	0.965	0.091	0.190	0.217

Note: Distance to polling place measured in miles. Likelihood of voting is measured as a percentage points (separately for votes cast at polling places, through absentee ballots, and total). All regressions include Border Fixed Effects (Border FE). County-Lat./Lon. refers to latitude and longitude controls, interacted with county fixed effects. The additional controls in Panels B and C are: democrat indicator, republican indicator, population, voting age population, percent black, percent hispanic, median household income, percent without a high school diploma, percent that walk to work, and indicators for whether travel time to work is less than 5 minutes or greater than 60 minutes. Standard errors clustered at the border level are reported in parentheses.

Table 14: The effect of distance to polling place on likelihood of voting: Non Linear

	Border FE and additional Controls - PA						Border FE and additional Controls - GA					
	Pri AP	Pri AB	Pri Tot	GE AP	GE AP	GE Tot	Pri AP	Pri AB	Pri Tot	GE AP	GE AB	GE Tot
Distance (miles) × 0-0.25	-19.1311***	0.3360	-18.7950***	-13.9391***	1.4960***	-12.4431***	-7.6937	4.3408	-3.3529	-13.8364	27.9785**	14.1421
	(1.6261)	(0.3582)	(1.5760)	(1.9338)	(0.4887)	(1.8546)	(7.6584)	(2.8965)	(9.2750)	(12.9771)	(11.7451)	(21.6592)
Distance (miles) × 0.25-0.5	-6.0887***	-0.4566	-6.5453***	-4.0775	-1.7584**	-5.8359**	-10.7280***	-0.7928	-11.5208**	-11.3745**	-3.2485	-14.6230**
	(2.0439)	(0.3618)	(2.0592)	(2.7990)	(0.7133)	(2.8152)	(4.0542)	(2.1163)	(4.7229)	(4.6832)	(5.4733)	(6.5545)
Distance (miles) × 0.5-1	-2.5651**	-0.2704	-2.8355**	-0.7594	-0.7965	-1.5558	-1.2078	1.3792**	0.1714	-0.9777	1.7752	0.7975
	(1.2537)	(0.2564)	(1.2575)	(1.8066)	(0.5352)	(1.7793)	(1.0928)	(0.6656)	(1.3819)	(1.3752)	(1.6695)	(2.0275)
Distance (miles) × 1-2	-2.0384*	-0.1095	-2.1479*	-0.4281	-0.2829	-0.7110	-0.2019	-0.2829	-0.4849	0.6564	0.5040	1.1604
	(1.1727)	(0.2160)	(1.1767)	(1.7273)	(0.4272)	(1.7241)	(0.5826)	(0.4131)	(0.7441)	(0.7521)	(0.9944)	(1.0600)
Distance (miles) × 2-3	-3.0072	-0.3569	-3.3640	0.0009	-1.7612*	-1.7603	-0.1934	-0.7349	-0.9283	0.3731	0.0108	0.3839
	(1.9372)	(0.8912)	(2.3086)	(2.7730)	(1.0220)	(2.9168)	(0.9269)	(0.6228)	(1.1237)	(1.1092)	(1.6316)	(1.6838)
Distance (miles) × 3-up	0.9093	0.1772*	1.0865*	0.4814	0.4583**	0.9397	-0.5265**	0.3157*	-0.2108	-1.3087***	0.9842***	-0.3245
	(0.6087)	(0.0921)	(0.5964)	(1.0776)	(0.2070)	(1.0654)	(0.2400)	(0.1691)	(0.2770)	(0.3268)	(0.3598)	(0.3638)
N	1765507	1765507	1765507	1772498	1772498	1772498	523065	523065	523065	523065	523065	523065
y variable mean	16.32	0.33	16.65	52.00	1.66	53.66	11.44	4.13	15.57	24.72	27.40	52.12
R^2	0.049	0.030	0.050	0.062	0.027	0.069	0.039	0.033	0.050	0.042	0.060	0.069

Note: Standard errors are clustered at the border level. County-Lat/Long refers to latitude and longitude controls, interacted with county fixed effects. The additional controls in Panel C are: percent Voting Age Population, percent Democrat, percent Republican, percent Black, percent Hispanic, Median Household Income, percent without a High School Diploma, percent Walk to Work, Travel Time to Work is less than 5 minutes, and Travel Time to Work is more than 60 minutes.

A.5 Heterogeneous Effects: Block Level

Table 15: The effect of distance to polling place on turnout: by Educational Attainment

	Pennsylvania			Georgia		
	(1) GE AP	(2) GE AB	(3) GE Total	(4) GE AP	(5) GE AB	(6) GE Total
Percent without high school diploma	-10.339***	-1.554***	-11.629***	-13.491***	-3.050	-16.845***
	(1.472)	(0.369)	(1.532)	(2.474)	(2.380)	(3.497)
Percent with high school diploma	-9.930***	-1.380*	-11.772***	-13.501***	-0.212	-13.723***
	(2.464)	(0.750)	(2.573)	(2.513)	(2.774)	(3.918)
Percent with bachelors diploma	0.000	0.000	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)	(.)	(.)
Mean Distance to Polling Place × % without high school diploma	0.397	0.213	0.321	-1.503	1.618	0.086
	(0.820)	(0.198)	(0.848)	(1.033)	(1.227)	(1.651)
Mean Distance to Polling Place × % with high school diploma	-1.399	-0.160	-0.976	-0.837	-2.804	-3.681*
	(2.252)	(0.651)	(2.342)	(1.341)	(1.750)	(2.141)
Mean Distance to Polling Place × % with bachelors diploma	-2.206	0.600	-1.999	-5.526***	5.970***	0.560
	(1.342)	(0.453)	(1.409)	(0.991)	(1.131)	(1.560)
N	101036	105618	101025	30392	30162	29830
y variable mean	44.60	1.73	46.13	25.88	27.51	52.98
R^2	0.359	0.180	0.375	0.326	0.379	0.384

Note: Standard errors clustered at the boundary level.The additional controls are: percent Voting Age Population, percent Democrat, percent Republican, percent Black, percent Hispanic, Median Household Income, percent without a High School Diploma, percent Walk to Work, Travel Time to Work is less than 5 minutes, and Travel Time to Work is more than 60 minutes.

Table 16: The effect of distance to polling place on turnout: by by Income Categories

	Pennsylvania			Georgia		
	(1) GE AP	(2) GE AB	(3) GE Total	(4) GE AP	(5) GE AB	(6) GE Total
Mean Distance to Polling Place	-1.949	0.676	-1.930	0.312	0.766	0.537
× <15k	(1.894)	(0.631)	(1.919)	(1.655)	(2.024)	(2.753)
Mean Distance to Polling Place	2.872	0.420	3.142*	-2.708*	-0.238	-2.297
× 15-30k	(1.784)	(0.416)	(1.810)	(1.505)	(1.878)	(2.408)
Mean Distance to Polling Place	-0.739	0.182	-0.342	-2.839	-2.760	-6.732**
× 30-50k	(1.993)	(0.480)	(2.074)	(1.991)	(2.236)	(3.006)
Mean Distance to Polling Place	-1.088	-0.163	-1.180	-0.967	2.276	1.984
× 50-100k	(1.581)	(0.374)	(1.699)	(1.402)	(1.672)	(2.062)
Mean Distance to Polling Place	-3.763	0.537	-3.753	-6.254***	7.575***	1.545
× 100-200k	(2.504)	(0.597)	(2.695)	(2.281)	(2.506)	(3.554)
Mean Distance to Polling Place	1.220	-1.233	1.021	-3.006	2.504	-1.217
× >200k	(4.706)	(1.427)	(4.975)	(3.914)	(5.561)	(6.458)
N	101036	105618	101025	30392	30162	29830
y variable mean	44.60	1.73	46.13	25.88	27.51	52.98
R^2	0.360	0.180	0.375	0.326	0.379	0.384

Note: Standard errors clustered at the boundary level.The additional controls are: percent Voting Age Population, percent Democrat, percent Republican, percent Black, percent Hispanic, Median Household Income, percent without a High School Diploma, percent Walk to Work, Travel Time to Work is less than 5 minutes, and Travel Time to Work is more than 60 minutes.

Table 17: The effect of distance to polling place on turnout: by Way to Work

	Pennsylvania			Georgia		
	(1) GE AP	(2) GE AB	(3) GE Total	(4) GE AP	(5) GE AB	(6) GE Total
% Other to work	2.684	0.330	3.282	1.704	-6.362	-2.627
	(3.623)	(0.827)	(3.771)	(6.788)	(6.398)	(9.832)
% Car to work	6.119***	-0.251	6.317***	6.549	1.635	9.251
	(2.252)	(0.558)	(2.351)	(4.635)	(4.225)	(6.952)
% Pub transit to work	7.055***	0.502	7.735***	17.158**	1.359	19.009*
	(2.646)	(0.627)	(2.764)	(7.461)	(5.804)	(10.114)
% Walk to work	0.000	0.000	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)	(.)	(.)
Mean Distance to Polling Place	-1.107	-0.752	-0.869	4.359	11.451***	14.708***
× % Other to work	(4.470)	(0.971)	(4.684)	(3.722)	(4.060)	(5.517)
Mean Distance to Polling Place	-0.148	0.238**	-0.055	-2.319***	0.816*	-1.457***
× % Car to work	(0.397)	(0.096)	(0.411)	(0.349)	(0.418)	(0.534)
Mean Distance to Polling Place	-5.355***	0.003	-5.591***	-19.485***	-9.077*	-27.673***
× % Pub transit to work	(1.837)	(0.321)	(1.867)	(6.212)	(5.088)	(8.125)
Mean Distance to Polling Place	-4.268	0.667	-3.539	-3.524	-2.146	-4.787
× % Walk to work	(3.045)	(1.075)	(3.173)	(3.251)	(3.777)	(5.590)
N	101036	105618	101025	30392	30162	29830
y variable mean	44.60	1.73	46.13	25.88	27.51	52.98
R^2	0.359	0.180	0.374	0.326	0.378	0.383

Note: Standard errors clustered at the boundary level.The additional controls are: percent Voting Age Population, percent Democrat, percent Republican, percent Black, percent Hispanic, Median Household Income, percent without a High School Diploma, percent Walk to Work, Travel Time to Work is less than 5 minutes, and Travel Time to Work is more than 60 minutes.

Table 18: The effect of distance to polling place on turnout: by Time to Work

	Pennsylvania			Georgia		
	(1) GE AP	(2) GE AB	(3) GE Total	(4) GE AP	(5) GE AB	(6) GE Total
% time to work 0-5min	-3.093	-0.852	-3.876	3.023	7.223	10.273
	(3.934)	(0.807)	(4.173)	(5.815)	(6.022)	(8.785)
% time to work 5-15min	-5.206**	-0.302	-5.122**	-0.892	2.831	1.151
	(2.248)	(0.446)	(2.320)	(4.207)	(4.261)	(6.465)
% time to work 15-30min	-6.743***	-0.156	-6.843***	-2.430	-1.889	-3.960
	(2.081)	(0.454)	(2.145)	(4.114)	(3.976)	(6.109)
% time to work 30-60min	-3.506	-0.087	-3.440	-4.382	1.063	-3.920
	(2.169)	(0.412)	(2.220)	(4.380)	(4.520)	(6.690)
% time to work 60min plus	0.000	0.000	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)	(.)	(.)
Mean Distance to Polling Place	-2.221	1.681	0.106	-2.983	-2.968	-5.393
× % time to work 0-5min	(5.600)	(1.163)	(6.024)	(3.724)	(3.937)	(4.980)
Mean Distance to Polling Place	1.026	0.129	0.620	-0.643	0.870	-0.010
× % time to work 5-15min	(1.455)	(0.276)	(1.510)	(1.170)	(1.358)	(1.796)
Mean Distance to Polling Place	0.904	0.432*	1.209	-3.471***	1.825	-1.489
× % time to work 15-30min	(1.037)	(0.247)	(1.083)	(1.098)	(1.390)	(1.704)
Mean Distance to Polling Place	-3.036**	0.122	-2.850**	-1.089	1.573	0.428
× % time to work 30-60min	(1.268)	(0.255)	(1.302)	(1.234)	(1.428)	(1.880)
Mean Distance to Polling Place	-4.840*	-1.115	-5.243*	-5.127*	-0.004	-4.988
× % time to work 60min plus	(2.608)	(0.771)	(2.707)	(3.010)	(3.303)	(4.449)
N	101036	105618	101025	30392	30162	29830
y variable mean	44.60	1.73	46.13	25.88	27.51	52.98
R^2	0.359	0.180	0.374	0.326	0.377	0.383

Note: Standard errors clustered at the boundary level.The additional controls are: percent Voting Age Population, percent Democrat, percent Republican, percent Black, percent Hispanic, Median Household Income, percent without a High School Diploma, percent Walk to Work, Travel Time to Work is less than 5 minutes, and Travel Time to Work is more than 60 minutes.