

Waiting to Vote in the 2016 Presidential Election:  
Evidence from a Multi-County Study

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## Abstract

This paper is the result of a nationwide study of polling place dynamics in the 2016 presidential election. Research teams, recruited from local colleges and universities and located in 23 election jurisdictions across the U.S., observed and timed voters as they entered the queue at their respective polling places and then voted. We report results about four specific polling place operations and practices: the length of the check-in line; the number of voters leaving the check-in line once they have joined it; the time for a voter to check-in to vote (i.e., verify voter's identification and obtain a ballot); and the time to complete a ballot. Long lines, waiting times, and times to vote are closely related to time of day (mornings are busiest for polling places). We found the recent adoption of photographic voter ID requirements to have a disparate effect on the time to check-in among white and non-white polling places. In majority white polling places scanning a voter's driver's license speeds up the check-in process. In majority non-white polling locations the effect of strict voter ID requirements increases time to check-in, albeit modestly. The number of persons leaving the check in line before casting a ballot is significantly greater at majority-minority than majority-white polling locations.

Key word: Election administration, voting behavior, polling place operations

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**I. Background**

The photo of a long line of voters waiting to cast ballots is one of the most persistent clichés of Election Day press coverage. This cliché was elevated to a political priority in 2012, when reports of unusually long lines in Florida flooded the airwaves, causing President Barack Obama to comment on them in his election night victory speech, and for him to later appoint a presidential commission to, among other things, make recommendation to avoid such sights in the future.

Waiting to vote is consequential for the health of our democracy. Research has shown that waiting long times to vote lessens voters' confidence that their vote will be counted as they intended (Atkeson and Saunders 2008; Alvarez, Hall and Llewellyn 2008; Bowler et al. 2015). Confidence in the accuracy and legitimacy of election outcomes is foundational to democratic governance. Those who lose elections must believe their loss is fair and true and not a function of how the election was administered.

The issue of renegeing — leaving the check-in line after joining it — has been a controversial, but under-studied, aspect of polling place lines. Studies find that as lines increase, customers are more likely to get frustrated and leave them (Broyle and Cochran 2007). This has obvious negative consequences in retail or social service setting, and even more troubling consequences, if true, in a voting setting, since it suggests one way in which voting turnout might be reduced as a consequence of long lines. Waiting to vote has also been found to be substantially longer for racial and ethnic minorities and low-income voters, depressing subsequent voter turnout among these non-white voters (Pettigrew 2013; Barreto et al 2009).

Much of the published research literature about voting wait times have been studies of single counties (Allen and Bernshtyn (2006), Highton (2006), Edelstein and Edelstein (2010), Spencer and Markovits (2010), and Yang, Fry, and Kelton (2010)). The only nationwide systematic evidence of wait times was contained in answers to questions in the Cooperative Congressional Election Study (CCES) and the Survey of the Performance of American Elections (SPAEE), but the responses have not been used in research that treats wait times as a dependent variable. An important exception is Fortier et al's (2018) study of line lengths during the 2016 election.

The behavior of lines at polling places falls under the academic study of queuing systems, which is a core component of operations research and industrial engineering. In framing its recommendations about reducing congestion at polling places and the long lines that result, the Presidential Commission on Election Administration (PCEA) encouraged election officials to adopt the insights of queuing theory into their planning and Election Day management (PCEA 2016:3)

Queuing theory explains the amount of time a customer waits in a queuing system in terms of three simple factors: arrival rates of customers, the number of positions available to serve customers and the amount of time it takes to serve a customer. Applied to voting, queuing theory suggests that waits to check-in at a precinct grow as the arrival rate of voters increases, the amount of time it takes to check-in a voter increases, and as the number of check-in clerks (or poll book positions) decreases. The same applies to the dynamics that might produce lines at other parts of the voting process, such as in gaining access to a voting booth. However, respondents to the 2016 *Survey of the Performance of American Elections* (Stewart 2016) reported that when they encountered a line at the polling place, 66% of the time it was to check-

in to vote, 16% of the time, it was after checking in, and 16% of the time, it was evenly divided between the two. (The remaining 2% did not remember).

Queuing theory makes it clear that wait times at polling places are location-specific. Therefore, while it is useful to measure wait times using survey research, surveys have their limitations. In particular, it is generally impossible to match survey respondents to the specific polling places where they voted, and therefore it is impossible to study correlations between reported wait times and the specific factors that the queuing literature shows causes lines to grow or shrink. The best that can be done is to identify the spatial distribution of wait times at aggregated geographies and to study variation of wait times in terms of voter demographics and administrative/legal practices in the counties where respondents live. If the power of queuing theory is to be applied to empirical questions about lines at polling places, we need direct observations of polling places practices and operations.

## **II. Literature Review**

A review of the literature identifies three main factors that explain waiting to vote: demographics, operations and policy. We consider each in turn.

### *Demographics*

The demographic factor that has the biggest influence on waiting to vote is race and ethnicity. Using data from the Cooperative Congressional Election Study (CCES) and the Survey of the Performance of American Elections (SPAEE), Stewart (2010) Pettigrew (2013), and Fortier et al (2018) all found that non-white minority groups wait longer than whites to vote. Pettigrew (2013) identifies the racial composition of a neighborhood as a factor for voting wait time. In that study, Pettigrew finds that even when controlling for shifts in turnout and income, there is a strong relationship between race and wait time, specifically for African American voters. Barreto

et al (2009) and Mebane (2004) similarly found that the quality of polling place locations tended to be 'lower' in low-income and minority communities, a condition they found to depress voter turnout.

Stewart (2010) tested the effect of race/ethnicity at the individual and aggregate level, relying upon the 2008 and 2012 SPAE surveys and the 2008 CCES survey. The individual level of analysis refers to the willingness of voters of different demographic characteristics to stand in lines before voting. On the individual level, African American voters and Hispanic voters surveyed were found to have waited longer on average to vote than white voters. The aggregate level of analysis refers to individuals, despite demographic differences, facing long lines as a result of neighborhoods associated with a specific demographic. On the aggregate level, zip codes with greater than 75% non-white populations waited more than twice as long as zip codes with less than 25% non-white populations.

Of the two approaches, aggregate and individual, aggregate level analysis was found to account for the relationship between race and wait times better, in two ways. First, aggregate analysis shows that white voters residing in racially diverse precincts waited twice as long to vote as white voters in racially homogeneous precincts. Second, a fixed effects regression showed that nearly all the individual level differences in wait time could be accounted for by controlling for county and zip code. These findings would suggest that wait times might be related to differences in polling place, staffing, equipment and operations between majority and minority communities, conditions directly related to the operations at polling places.

### *Operations*

The factors examined in the literature related to the operation of polling places include poll workers, ballot length, voting machines, and time of day. Each can have an independent

effect on the waiting time to vote including checking in, casting a ballot, and the likelihood a voter leaves the line.

Spencer and Markovits (2010) studied 30 precincts in California during the 2008 presidential election. They made three interesting discoveries concerning the effectiveness of poll workers. First, the study found that there was a significant increase in the efficiency of the poll workers at polling locations in high-income areas. Each \$10,000 difference in annual median household income translated to an average 11 seconds less time spent in line (Spencer and Markovits 2010).

Second, Spencer and Markovits found that experienced poll workers were no more efficient than inexperienced poll workers. In fact, it was estimated that experienced poll workers took an extra 31 seconds to check-in voters. Two explanations were offered for this finding. Experienced poll workers, who by definition have volunteered for several elections, may have difficulty remembering the voting rules and regulations of the current cycle. Additionally, experienced poll workers may spend more time chatting with the regulars at the polling place.

Third, they found that the increases in the numbers of poll workers at check-in stations resulted in a longer vote line. Two potential explanations were suggested for this finding, the first being more poll workers overall reduces the net amount and quality of training each individual worker gets, which leads to a decrease in efficiency. The other possible explanation is that the tasks at a check-in table are often very simple, and the chance of making an error increases by having more people doing the same task.

Spencer and Markovits also found a significant and positive relationship between voting machines and vote times. Specifically, the study found that when controlling for ballot length, voters took longer to ballot on an electronic (DRE) system than paper ballots. Two potential

explanations were provided for this observation. The first explanation is that paper ballots make it easier to skip over portions of the ballot. While paper ballots allow voter to simply ignore a page, DREs notify voters about incomplete ballots and thus require more time for the voter to navigate through the ballot (see Miller 2013; Miller et al 2015; Nichols and Strizek 1995; Herrnson et al. 2012). Another explanation is that the complex DRE technology caused voters to take a longer amount of time to complete their ballots. To test this explanation, DRE voters in San Mateo County were compared to paper ballot voters in the same county, and it was found that DRE voters spent on average 76% longer to cast their ballots. Spencer and Markovits note the significance of this finding since DRE machines are more expensive than regular paper ballots.

Following the 2012 election, there was a lot of attention paid to the influence that ballot length had on the amount of time it takes to mark a ballot. The Florida legislature extended the length of that state's ballots significantly and voters in other states faced increasing numbers of ballot measures. As a general matter, it is obvious that the most important factor influencing ballot-marking time will be ballot length and structure (i.e. number of referenda, contested offices and the number of candidates on the ballot for specific offices).

Research (Stewart 2016; Fortier et al 2018) suggests that there is significant queuing at precincts before the polls are even open. Lines will be longer in the morning, as a consequence of the pre-opening queuing, than during the midday or evening hours of polling place operations. Consequently, we have reason to expect that time of day (i.e., morning, midday and evening) might have independent effects on waiting to vote.



## *Policy*

A major governmental policy that has been investigated from the perspective of long lines is voter identification requirements. Pettigrew (2013) found voter identification laws affect wait times. That study found that states which require a photo ID experienced an average wait time of 6 to 8 minutes greater than states without these restrictions. The study attributes this finding to a variety of factors including the time spent for voters to locate a valid ID, the time spent for voters who do not have a valid ID to cast a provisional ballot, and the implementation of new voter ID guidelines by states.

It is unclear whether strict photo ID laws should increase or decrease check-in times. On the one hand, the presence of strict photo ID laws increases the number of voters who may cause a delay because they have failed to bring an ID and/or must complete a provisional ballot application. On the other hand, many states with strict ID laws have electronic poll books with or without installed magnetic stripe readers onto their electronic poll books so that driver's license information can be more quickly entered into the search function of the electronic poll book. This latter effect might be observed in majority white precincts where we might expect to observe a higher proportion of persons who have valid driver's licenses.<sup>14</sup> The use of electronic poll books may have a differential effect on check-in times between white and non-white polling locations.

Given the reported longer wait times in states with restrictive voter ID requirements, we expect that states that allow same day voter registration will also have longer lines and wait times to vote. In states with same day voter registration, poll workers and voters take more time to complete the task of registering to vote before voting.

### III. Research Methodology of the Current Study

Research teams, recruited from local colleges and universities and located in 28 election counties and 19 states across the U.S., observed and timed voters as they entered the queue at their respective polling places on November 8, 2016. A common set of protocols was used across all counties participating in data collection (available in the Supplemental Materials).<sup>2</sup> The counties that comprise the dataset for this paper constitute a sample of convenience, because they depend on who responded to the call to participate in the study. The obvious bias induced by this sampling method, compared to drawing a representative sample of voters or polling places, is that counties without a college or university are unlikely to be included in the study. However, as the list of counties in Table 1 makes clear, the counties that were in the study were distributed geographically and across urban, suburban, and rural locations. Thus, while not representative, the collection of precincts is varied enough that important empirical insights can perhaps be gleaned from the data. The counties studied closely approximate the demographic makeup of the 2016 electorate (see Appendix).

[Table 1 about here]

Within counties, polling places were selected randomly by participating faculty (details of random sampling protocol in the Supplemental Materials).<sup>3</sup> The unit of random sampling was the polling place rather than physical location, since multiple polling places may be physically located in a single facility (e.g. library, school, community center). In some cases, multiple polling places were selected at a single location. There were instances where local conditions necessitated deviating from random selection, most often due to difficulty traveling to voting location or wanting to observe campus voting locations. When such circumstances occurred, the

teams were instructed to ensure that selection did not constitute sampling on the dependent variable (e.g. not selecting locations expected to have problems or lines).

The protocol for observing lines and duration of voting were based on studies discussed earlier (Fortier et al 2018; Herron and Smith 2016; Stewart 2015; Spencer and Markovits 2010). Pairs of student-researchers were assigned to observe Election Day polling places for two-hour periods.<sup>4</sup> Researchers were tasked with collecting several pieces of information. One researcher from each two-person team was assigned to count the number of persons in line waiting to check-in to vote at ten minute intervals during the shift (see “Timing of Voting Process” in Appendix). The same researcher was also responsible for counting the number of persons who left the queue after entering the line, which is termed “reneging” in the queuing literature.<sup>5</sup>

The second researcher observed individual voters as they navigated the various tasks associated with voting, checking in, casting the ballot, and scanning the ballot. Individual voters were chosen to be observed in the following way. Upon arriving at the polling place, the second researcher would follow the first person they observed checking-in to vote. Once that person had finished voting (i.e., scanned their ballot or left the electronic voting machine), the researcher would then identify the next person in the check-in line, and repeat the process. The second researcher generally recorded the amount of time (down to the second) it took these voters to check-in, mark their ballot, and scan their ballot (if applicable). This form is available for download from the project website.<sup>6</sup>

Finally, the research team was responsible for filling out a form that described the physical characteristics of the polling place they visited. This form is based on Barreto et al’s (2009) study of polling places with additions based on other research about polling place characteristics (PCEA 2013; Alvarez, Atkeson and Hall 2013; Berger, Meredith and Wheeler

2008; Brady and McNulty 2011; Kropf and Kimball 2013, Schur and Adya 2013; Spencer and Markovits 2010). The observer's form recorded information about the approach to the polling place (visibility from street, ease of parking, etc.), exterior polling place characteristics (quality of surrounding buildings, accessibility of entrance, etc.), interior polling place characteristics (lighting conditions, signage, etc.), polling place operations (number of poll workers, type of voting machines, etc.), and a sketch of the polling place layout. This form is available in the Supplemental Materials.<sup>7</sup> Additional information on polling place demographics, including the proportion of persons over 65 years of age and the racial and ethnic makeup of registered voters in each polling place location were obtained from *Catalist* (2016).<sup>8</sup>

In total, five pieces of information about voters' polling place experience were collected: number in line, the number of arrivals, check-in time (seconds), time to vote (seconds) and persons leaving the line. Two of these measures, check-in time and time to cast a ballot are measured and reported for individual voters. The number of persons in line, arriving in line and leaving the check-in line are measured at the level of the polling place per ten-minute interval.

A total of 9,347 individual voter observations were taken by student researchers at 605 polling place locations in 28 counties and 20 states. As might be expected with a project of this scope, several obstacles required us to limit both our sample of counties and available data for analysis. These obstacles included: comparability among polling places, student access to polling places on Election Day and the training of student researchers and their execution in the field.<sup>9</sup>

One of the 28 counties in our study, Bernalillo County, New Mexico (1,054 voter observations in 68 polling places) uses Election Day vote centers (EDVC) at which voters cast their ballots on Election Day. Vote centers are an alternative to traditional, neighborhood-based

precincts. When a county opts to use vote centers, voters may cast their ballots on Election Day at any vote center in the county, regardless of their residential address (NCSL 2016; Stein and Vonnahme 2008). Voting in the remaining 27 counties took place at Election Day polling precincts, where voters were assigned to vote at one and only one polling location on Election Day. Given this difference, we have chosen not to include Bernalillo County's EDVCs in our analysis.

Student access to polling places was in some instances prohibited, as in the case of Lafayette, Mississippi<sup>10</sup> where state law bars persons unaffiliated with candidates from entering the polling place as a poll watcher. In Lafayette County students were unable to collect data on time to check-in, time to vote and information on the setup and operation of the polling location e.g., number of poll workers, further reducing our sample of voter observations and polling locations to 7,579 voter observations in 528 polling locations. In other instances, students failed to keep track of voters who left the line to enter the polling place, resulting in unreported data on time to vote and cast a ballot. As Table 2 demonstrates the number of valid voter observations decreases as voters moved from arriving at the polling location to entering the polling place and voting. The largest diminution in data collected was for persons leaving the line before they could enter the polling location. The infrequency of this behavior during each two-hour shift (i.e., a mean of .3 person per ten-minute interval) made the student's task of observing persons leaving the line more challenging, accounting for the high incidence of missing data.

#### **IV. Descriptive Statistics**

[Table 2 about here]

Table 2 reports the descriptive statistics for number of persons in line, arriving in line, time to check-in (seconds), time to vote (seconds) and persons leaving the line by time of day. We operationalize the time-of-day by creating three dummy variables for morning, midday and evening. The morning and evening intervals are the first and last three hours of operation respectively. The balance of the day is the midday interval. Starting and ending times were obtained for each county and state and were used to code the three dummy measures for each county. The morning session is the excluded category in the multivariate analyses.<sup>11</sup>

Consistent with previous research (Fortier et al 2018) all of our observational measures of polling place practices and operations are under dispersed (see Figures 1a-d). Voters in our sample of 2016 Election Day polling places experienced an average line of 10 voters every hour when arriving at their polling location. On average, our researchers observed 14 new arrivals at a polling place during each ten-minute interval while less than one voter (.3) left the line during the same time interval. Voters took less than one and half minutes (81 seconds) to check-in and less than four minutes (221 seconds) to cast a ballot.

As expected average line length, arrivals and persons leaving the line are greatest in the morning and decline throughout the day. The average morning queue is nearly three to five times greater than midday or evening. Time to check-in varies little over the course of day, but time to vote (i.e., cast a ballot) increases over the course of the day.

[Table 2 about here]

[Figure 1 about here]

## **V. Multivariate Analysis**

Using better measurement than available in prior research, we evaluate the multivariate correlates of key measures of voting, including wait times, check-in times, time to complete the ballot, and the likelihood that a voter leaves the check-in line rather than waits to vote (i.e., reneges). We estimate models with and without fixed effects for counties and standard errors clustered on polling place location. Fixed effects for counties tests that our hypotheses account for omitted county and state level factors that we are unable to measure at this time. Clustering on the polling place location is needed since the individuals observed at each location are not independent events. Estimating our models with and without fixed effects for counties allows us to differentiate between those covariates that are constant within a county (e.g., use of DRE voting machines, epoll books, same day registration, straight ticket voting and voter ID requirements) and those covariates which vary across polling locations within counties (e.g., racial/ethnic makeup, ballot length and the number of poll workers). Our fixed effects models exclude covariates that do not vary within county enabling us to differentiate polling place practices that local election officials can elect to change from those that are beyond their immediate control.

### *Line length*

We begin the analysis by examining the average number of people in line each hour. As mentioned above, the number of people waiting in line to check-in is likely to be governed most strongly by three factors; the arrival rate of voters, the number of check-in stations available at the precinct, and the time it takes to check-in a voter. In addition, Pettigrew (2017), Stewart (2014), Barreto et al. (2009) and Mebane (2005) report significant under provision of polling stations and staffing at African-American and Hispanic polling places, a condition that can lengthen lines and adversely affect voter turnout among minority voters. We also know the

number of poll workers at each polling location by hour. If equipment and check-in stations are allocated consistently within counties, the number poll workers should be a reasonable surrogate for the number of check-in stations.<sup>12</sup> Observing the relationship between the numbers of poll workers allows us to determine whether staffing is related to length of lines and if this relationship varies across polling place locations as a function of the racial composition of the polling place.

Independent of arrival rates, evidence from the SPAE (Stewart 2016) and other research suggests that there is significant queuing at precincts before the polls are even open.<sup>13</sup> Thus, even once we account for arrival rates and the capacity of precincts to handle these arrivals, lines will be longer in the morning because of the pre-opening queuing.

Table 3 reports estimates of polling line length. The unit of analysis is the average number of persons in line at each polling place location per ten-minute interval. We use an ordinary least squares regression model.

[Table 3 about here]

As expected, lines are longer as the number of arrivals per hour increases. Controlling for arrival rates, lines are also significantly longer in the morning (the omitted category for time of day) and shorter midday and evening. Lines decline in length with a greater number of poll workers. Line lengths do not decline with faster check-in times. These findings remain significant when line length is estimated with fixed effects for counties. There are no statistically significant differences in line length among majority and non-majority white polling places. There is a modest improvement in the explanatory power of the fixed effects model ( $R^2=.310$ ) over the non-fixed effects model ( $R^2=.262$ ), suggesting there maybe county and state level unobserved covariates of average line length to be studied in future research.



Among the repertoire of actions local elections can take, the number of poll workers per voters in line has the most impactful effect on reducing average hourly line length. One addition poll worker per voter in line reduces the average line length by four persons per hour.

### *Check-in times*

Check-in times are driven by three general factors, (1) the amount of business that must be transacted at the check-in station, (2) the ability of the technology (epoll books and poll workers) to handle the transaction quickly, and (3) the ability of the voters to complete the transaction quickly. For instance, in a state that only requires voters to state their name and address when they check-in, with the poll workers checking off the name of the voter, the transaction will probably be faster than in a state that encourages poll workers to update the voter's mailing address as part of the check-in process. Election administrators often comment on the ability of poll workers to comply with all the requirements of the check-in process, claiming that certain types of workers (e.g., older or less-educated workers) are slower than others (younger and better-educated workers).

We are interested in the question of whether same day registration and voter ID laws might influence check-in times. A dummy variable for counties that allow same day and Election Day registration is included in our model of check-in time. To test whether strict photo ID requirements influence check-in times one way or the other, we have included an dummy variable where 1=a photographic ID is required to vote and 0= where a photographic ID is not required to vote in our model of check in time.<sup>14</sup> We have also included the interaction between majority-minority polling places (i.e., 1= 50%+ of voters are non-white, 0=50%+ of voters are white) and a strict photo ID requirement to vote. Our expectation is that in majority-minority polling locations that require a photo ID to vote, check in times will take longer, while in

majority white polling places a photo ID requirement might be expected to shorten check-in times. Finally, we have included the number of poll workers per voters in line and the use of electronic poll books for checking in voters (EAC 2016) as measures of polling place capacity to check-in voters.<sup>15</sup>

Table 4 reports the results of the analysis of check-in times. The estimation technique is ordinary least squares regression without (column 1) and with fixed effects for counties (column 2) and clustering the standard errors on polling place location. The unit of analysis is the individual voter as they waited to check-in to vote. The dependent variable is the average number time (seconds) it took voters to check-in over a one hour period.

The main effect for a photo ID requirement on check in time is significant and negatively signed, indicating that in majority white polling places the effect of requiring a photo ID to vote reduces check in time on average by 40 seconds. This supports earlier speculation that many states with strict ID laws use electronic poll books to check-in voters and have installed card readers into their electronic poll books so that driver's license information can be more quickly entered and processed. Among counties in our sample with a strict photo identification requirement, all use electronic poll books to check-in voters. In majority non-white polling places, where we expect a lower percentage of voters to have a valid photographic ID, a photo ID requirement significantly lengthens the time to check-in by 32 seconds (i.e.,  $-40.1 + 72.2 = 32.1$ ) on average in majority-minority polling places.

Same day registration significantly increases check-in times in states that afford their voters the opportunity to both register and vote at the same time. On average, check-in times increase by nearly a minute (42 seconds) in counties with same day registration.

As expected, check-in time is significantly longer in the morning, but is not significantly shorter during either the midday or evening hours of voting. The number of poll workers has an expected negative and significant effect on check-in time, but this effect is insignificant when estimated with fixed effects for counties. The use of electronic poll books to check-in voters has an unexpectedly significant and positive effect on time to check-in. Since use of electronic poll books does not vary within county this effect may reflect unobserved differences between counties we have not accounted for in our model of within county variation in check in time. A fixed effects model does not provide a remedy because of the invariance within county in the use of electronic poll books. A panel design is more likely to uncover the effect electronic poll books on check in time by identify differences over time in check in times between the same polling places with and without electronic poll books.

Column 2 of table 4 reports the estimates of check in time with fixed effects for counties. This model does not include estimates for same day registration, a photo ID requirement and the use of electronic poll books, since these measures are invariant within counties. Only the racial and ethnic makeup of the polling place (i.e., majority-minority) and voting in the morning (i.e., the constant) have a significant effect on check in time in our model with fixed effects for counties. Time to check in is significantly longer in morning and in majority-minority polling places. The explanatory power of the fixed effects model is a substantially greater ( $R^2=.182$ ) than the model without fixed effects for counties ( $R^2=.08$ ), suggesting the variation in check in time across counties is influenced by unobserved county and state level factors. The persistence of a significant difference in check in time between majority white and majority non-white polling places in the fixed effects model provides further reason to believe a state photo ID requirement is among the state level factors influencing check in time.

[Table 4 about here]

### *Time to mark ballots*

Our model of time to cast a ballot includes the time of day, the use of electronic voting machines (DREs), ballot length, and proportion of persons over 65, which some previous studies (Spencer and Markovits 2010) found to increase wait times to vote. Three measures of the ballot length were collected for each county: the number of candidate contests, the total number of propositions and the total number of choices on the ballots (the number of candidates for all contests and choices for all propositions (i.e., for and against). On average, there were five propositions per ballot, 23 contests for elective office per ballot and 42 candidates and propositions on the ballots for voters to choose from in the counties studied. Given the high inter-correlation among these three measures of ballot structure, we have used the total number of choices (candidates and ballot propositions) as a measure of ballot length. The effect of a larger number of ballot choices on time to vote may be offset by allowing voters to cast a straight ticket vote, choosing to vote for all candidates of one party. Three states in our sample (i.e., Alabama, Pennsylvania and Texas) allowed their voters this option in 2106. We have included a dummy variable for states that allowed their voters to vote a straight ticket where 1= straight ticket ballot option and 0=no straight ticket ballot option.

Table 5 reports the results of time to cast a ballot. The estimation technique is ordinary least squares regression with and without fixed effects for counties and clustering the standard errors on polling place location. As with our estimates of check-in time, the unit of analysis is the individual voter as they were observed completing their ballot. The dependent variable is the average time in seconds to cast a ballot of over a one-hour period.

In the model without fixed effects for counties (column1) time of day, ballot length (i.e., choices) and the opportunity to vote a straight ticket have significant effects on the time a voter takes to cast their ballot. The number of ballot choices has a significant positive effect on the time to vote and the opportunity to vote a straight ticket significantly reduces the time to ballot.

Voting on an electronic voting machine does not have a significant effect on the time to cast a ballot. Previous researchers (Spencer and Markovits 2010) reported that electronic voting machines lengthens the time to vote, in part due to voters' lack of familiarity with electronic voting devices. Our non-finding for this relationship may reveal 2016 voters' greater familiarity and adeptness in operating electronic voting devices than was observed in Spencer and Markovits study of 2008 voters.

The share of persons over 65 is not significantly related to the time to complete a ballot. We suspected that older voters are more experienced voters and more knowledgeable about candidates and issues on the ballot, increasing the speed with which seniors complete their ballot (Holt et al 2013; Glenn and Grimes 1968). This effect for older voters on time to complete their ballot was not confirmed.

Time to cast a ballot is longer in the evening and midday than the morning, a finding that might seem counter intuitive. As reported above, persons who vote in the midday or evening experience shorter lines than those who vote in the morning. We suspect that voters who ballot in the midday and evening take advantage of the shorter time to check in by taking longer to cast their ballot.

When we introduce fixed-effects for counties in our estimate of time to cast a ballot only time of day is significantly related to the time it takes a voter to cast a ballot. The number of ballot choices is insignificant when we control for unobserved county and state level factors that

might influence time to ballot. The option to vote a straight ticket and the use of DRE voting machines are not included in the fixed effects model because these variables are invariant within jurisdictions.

The non-significant coefficient for number of ballot choices in the fixed effects model may reflect a significant degree of under voting i.e., voters who fail to cast a vote for many down ballot for contests, especially as ballot choices and uncontested races increase. We were unable to collect data on ballot completion for a significant number of polling places in our sample. Where available, ballot completion at the county level suggests that that some portion of the variation in time to cast a ballot is likely related to many voters not voting for down ballot contests.<sup>16</sup> This condition might directly or indirectly (through other covariates of polling place operations) effect time to cast a ballot. This possible explanation remains the subject of future studies of polling place practices.

Another explanation for why ballot length might not influence time to vote in the fixed effects model is how straight ticketing voting is related to ballot length and time to vote. In our sample of states with straight ticket voting, the mean number of ballot choices was 50 and average time to vote was nearly three minutes. In states without straight ticket voting the mean number of ballot choices was 40 and average time to vote was nearly four minutes. We suspect the effect of longer ballots on time to vote is mitigated in straight ticket voting states by the opportunity to cast a straight ticket.<sup>17</sup>

Notwithstanding these above explanations, some caution should be taken with concluding that ballot length does not affect time to ballot in the fixed effects model. States and local governments determine what is on the ballot. We cannot establish an accurate estimate that ballot length has ballot-marking time using within county variation in ballot lengths. The

preferred design is time-series cross section in which we can compare the same polling places over time.

[Table 5 about here]

### *Reneging*

To study the correlates of the number of persons leaving the poll place before voting i.e., reneging, we estimated a negative binomial model in which the dependent variable was the average number of voters who left the line before voting at each polling place during ten-minute interval of observation. The independent variables were the number of voters in line and time of day.

In estimating the negative binomial model, it is necessary to account for the influence of line length in two ways. First, and most intuitively, if a voter is standing in a long line, she or he is more likely to doubt the value of waiting to vote, and therefore will be more likely to leave. Second, and less obviously, as the number of people waiting to vote increases, the number of opportunities to observe voters leaving the line increases — even if the voters standing in line are deciding to leave for reasons that have nothing to do with line length. Therefore, it is necessary to account for line-length twice in the model, first as a regular independent variable, and second, as an exposure (or offset) variable. By defining an offset or exposure variable (i.e., the log of the number of persons in line) we are only adjusting for the opportunity an event has to occur. The assumption here is that, for example, every extra voter in line increases the observed voter's probability of leaving the line; at the same time, each additional voter in line is simply an opportunity for someone else to leave. To estimate this effect we take the natural log of line length<sup>18</sup> and add it to both sides of our negative binomial regression model. One important feature of an offset variable is that it is required to have a coefficient of 1. This is because it is

part of the rate. The coefficient of 1 allows us to theoretically move it back to the left side of the equation to turn our count back into a rate. By defining an offset variable, we are adjusting for the opportunity an event might occur, one more voter entering the line, has on incidence of persons leaving the poll place without voting.<sup>19</sup>

Table 6 reports the results of the analysis. In the model without fixed effects for counties (column 1) only time of day (i.e., morning) and the proportion of persons over 65 have a significant effect on the incidence of persons leaving the line to check in to vote. The coefficient for the number of persons in line is significant, but only at the .1 level of significance. Reneging declines significantly as the proportion of persons at the polling location over 65 increases.

The coefficient for the number in line to check-in is *negative*, which on the surface suggests that voters are *less* likely to leave from a long line than from a short line. However, with the presence of the log of persons in line as an offset variable as well, the interpretation of this coefficient is not so straightforward. To illustrate this, we estimated a simple bivariate negative binomial regression model, using number in line as both an explanatory and exposure variable. The coefficient on the explanatory variable again was negative. However, when we graph out the estimated number of reneging voters as a function of line length, the relationship is more interesting. As shown in Figure 2, the predicted number of voters leaving the line increases across the range of one to approximately 100 in line.<sup>20</sup> At that point, the number of voters reneging begins to decline. Keeping in mind that 87% of observations involve a line of 100 or fewer people, in most instances, the relationship between the number reneging and the length of the line is in fact positive. It is only in the very longest lines where voters appear particularly likely to tough it out.



Reneging is significantly less likely to be observed in the morning when lines and waiting times are longer. This non-intuitive finding might have several explanations. First, voters who arrive when the lines are the longest, when the polls open, are typically arriving two hours before work begins. Standing in line for an hour starting at 7:00 a.m. may have different implications for someone trying to get back to work or home to the family. Second, early-morning voters may simply have fewer options than to wait it out.

When we introduce fixed effects for counties (column 2) the coefficient for the number of person in line is positive but only significant at the .1 level. Reneging continues to be greater in the morning, reneging increases in the afternoon, but this effect is significant only at .1 level.

[Table 6 about here]

[Figure 1 about here]

## **V. Conclusion and Discussion**

The purpose of this paper has been to present and analyze data gathered in the first nationwide study of polling place wait times ever conducted. The conclusion to this paper can be divided into two parts, first, issues related to the substantive findings and second, issues related to the study itself.

Our findings confirm much of what we both knew and suspected influences voters' experiences at polling places. Long lines, waiting times and times to vote are closely related to time of day (mornings are busiest for polling places) and the availability of poll workers. The number of poll workers is a significant corrective for long lines and check in time. In both instances, the number of poll workers per voters in line had a significant and negative effect on reducing average line length and time it took to check in voters. Reducing line length with more

poll workers may be important remedy for reducing the number of persons to leave the line before voting. Line length has significant and negative effect on the number of voters who upon arrival at a polling location experience a long line and choose to leave rather than wait in line.

State laws that allow same day voter registration, straight ticket voting and determine the length of the ballot (i.e., number of ballot contests and choices) have significant effects on polling place performance. These findings underscore the limitations local elections officials have in fashioning remedies for long lines and time to check in and vote. A photo ID requirement has a variable effect on check in time, depending on the racial and ethnic makeup of the polling location. At majority white polling locations, the magnetic strip on driver's license speeds up the check-in process when combined with electronic poll books, a practice that is uniform in our sample of counties that require photographic identification to vote. Check-in times are significantly longer in majority non-white polling places in counties that require photographic identification. When we estimate check in times with fixed effects for counties, dropping same day registration and strict photo ID requirements from the model, the coefficient for a majority-minority polling place is significant and positive, indicating there are longer check in times in majority non-white polling places, independent of other unobserved county and state level effects.

Two findings were not anticipated; the insignificant effect electronic balloting machines and the number of ballot choices had on time to cast a ballot. Others have found that electronic voting takes more time to cast a ballot (Spencer and Markovits 2010), a condition explained by voters' lack of familiarity with electronic voting machines. We fail to confirm this finding. We suspect that since their adoption after the 2000 election, voters have become more familiar with and adept at using electronic voting machines. Ballot choices should lengthen the time a voter

takes to cast a ballot, a finding confirmed only in model without fixed effects. We suspect voters are either prepared to navigate a long ballot or simply under vote, in both instances netting no effect on the time to cast a ballot. Straight ticket voting might also explain how voters in counties with longer ballots reduce their time to cast a ballot as well and incidence of uncontested races in which voter choice is limited to just one candidate.

Undertaking this project was no trivial matter, either from the perspective of the faculty members who organized the students or from the organizers, who were responsible for coordinating the effort and gathering (and cleaning) the data. Because only 26 counties were included in this study, and they were not chosen to be representative of the nation, it is not possible to use the results of this study to generalize to the whole nation. Indeed, given the amount of effort necessary to pull off a study of even this magnitude, it seems unlikely that a large-scale study that was representative of the nation's precincts would be possible.<sup>21</sup>

However, because the study was designed to be representative of precincts *within* counties, it seems likely that this study, and studies such as this, will be able to produce results that are more generalizable, at least within certain configurations of election administration.

Substantively, this study has only begun to scratch the surface of hypothesis testing about the role that various covariates play in influencing polling place congestion and the factors that lead to such congestion. The current paper, by-and-large, was confined to covariates that could be generated from the timing and arrivals datasets. Some of the most important factors that are likely to influence things like wait times and voting times need to be measured outside these two data sets. In some cases, these measures can be gleaned from the dataset that coded numerous facts about the polling places that were visited, such as whether electronic poll books were used and how many check-in stations there were. In other cases, we will need to gather data outside

of this study, for instance, measuring the length of ballots and the incidence of under voting. We have already made plans to replicate our study in 2018 and 2020. This will produce a more powerful panel design with which to study and measure of correlates of wait and voting times.

The election of 2012 raised to public consciousness the operation of polling places. It raised the priority that local election officials placed on studying what goes on in their polling places and using the resulting data to improve operations. We hope that this project also demonstrates that political science can contribute to this observational endeavor, as well.

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## Endnotes

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<sup>1</sup> Though a majority of all adults, both White and non-White have a valid driver's license, a much higher proportion of African-Americans (25%) than Whites (8%) do not have a valid driver's license (PolitiFact 2012).

<sup>2</sup> [\(redacted for review\)](#)

<sup>3</sup> (redacted for review)

<sup>4</sup> Practical scheduling constraints of undergraduates often meant that researchers only spent one hour at polling locations. Polling place refers to a single voting district—precinct—and not to multi-district (precinct) polling places.

<sup>5</sup> “Balking” is arriving at a line, but then deciding not to join the line. We did not attempt to collect data about balking.

<sup>6</sup> (redacted for journal review)

<sup>7</sup> (redacted for journal review)

<sup>8</sup> Demographic data on persons over 65 were not available for the five boroughs of New York City were not available.

<sup>9</sup> See Mann et al (2018) for a further discussion of students' evaluation of their research experience.

<sup>10</sup> In Lafayette, Mississippi, students observed 714 voters in line at 7 polling locations.

<sup>11</sup> We also considered other ways to define time-of-day e.g., opening of the polling place to noon, noon to 5PM and 5PM to closing and rejected these operationalization based on other research (Fortier et al. 2018) that reports voter arrivals for the 2016 elections consistent with our measure of time-of-day voting patterns.

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<sup>12</sup> We obtained valid data for the number of check-in stations for less than a third of our sample, necessitating using poll workers as a surrogate measure for the number of check-in stations.

<sup>13</sup> An example of this is contained in the raw data generated by this project. When we calculate the average number of people in line at the earliest recorded times in all the jurisdictions in the study — which is a proxy for when the polls opened in the jurisdiction — the average number of people waiting in line was 18, compared to 11 people in line at all other times.

<sup>14</sup> Source: <http://www.ncsl.org/research/elections-and-campaigns/voter-id.aspx#Laws%20in%20Effect>

<sup>15</sup> EAC reports whether an electronic poll book was used in the county, but not whether a scanning device was also used with the electronic poll book.

<sup>16</sup> We observed countywide ballot drop off to be significant in a number of our jurisdictions. In Dane County, Wisconsin 309,291 ballots were cast for Presidential candidates but only 234,506 votes were cast in the contest for Dane County District Attorney, the last countywide race on the ballot. In Johnson County, Iowa 76,940 votes were cast for President, but only 49,717 votes were cast for county District Attorney. In Richland, South Carolina 337,912 votes were cast for President and only 89,970 votes were cast in the contest for county District Attorney. Finally, in Richmond, Virginia 337,912 ballots were cast for President but only 98,995 cast were cast for the first of several constitutional amendments at the bottom the county-wide ballot.

<sup>17</sup> We do not have data on the incidence of straight ticket voting at our polling place locations. In Texas straight ticket voting ranges between 30%-50% in the state's 10 largest counties (McCullough 2018). In Alabama 65% of voters in the 2018 midterm election cast a straight ticket ballot (Cason 2018). Pennsylvania does not report the number of straight ticket ballots cast at any level of aggregation.

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<sup>18</sup> For lines length of zero, we take the log of 1.1.

<sup>19</sup> The reneging model was calculated with *Stata*15 and the exposure command.

<sup>20</sup> Figure 2 is estimated from a model of persons leaving the line and the number of persons in line.

<sup>21</sup> One factor that has not been mentioned until now is the fact that many state laws prohibit the type of activity necessary to conduct a study such as this. While most states will allow researchers to station themselves at the entrance to polling places, not all do — several require everyone, except for members of the working press, to stay hundreds of feet away from polling places. We have not yet done a complete canvassing of state laws about researcher (or even citizen) access to polling places, our sense is that while most states will allow researchers into polling places with the approval of election officials, very few states allow such access unless the local official approves.

Table 1

Jurisdiction	Observations	Polling places
Los Angeles, CA	320	38
Fairfield, CT	244	11
Orange, FL	254	20
Bibb, GA	175	8
Madison, ID	530	9
Johnson, IA	404	28
Riley, KS	143	16
Fayette, KY	669	43
Suffolk, MA	427	25
Ingham, MI	234	25
St. Louis, MO	870	94
Albany, NY	219	30
Bronx, NY	34	3
Kings, NY	64	5
New York, NY	267	18
Rensselaer, NY	191	19
Saratoga, NY	147	16
Sullivan, NY	6	1
Westchester, NY	158	8
Union, PA	36	7
Richland, SC	316	14
Harris, TX	398	18
Albemarle, VA	222	7
Henrico, VA	314	21
Fairfax, VA		
City and County	598	35
Dane, WI	339	9
Total	7,579	528

Table 2: Mean measures of polling place practices and operations

Variable	Obs.	Mean	Std. Dev.	Min	Max
Arrivals count <sup>1</sup>	7,526	13.8	11.4	0	169
Morning	2,489	17.1	14.1	0	169
Midday	3,642	12.3	9.9	0	164
Evening	1,395	11.7	7.9	0	50
Number in line <sup>1</sup>	7,021	10.9	31.1	0	447
Morning <sup>2</sup>	2,322	22.5	49.6	0	447
Midday	3,425	5.7	12.3	0	133
Evening	1,274	4.2	8.5	0	110
Number leaving line <sup>3</sup>	6,180	.3	.79	0	11
Morning	2,152	.37	.91	0	7
Midday	2,904	.28	.74	0	11
Evening	1,124	.2	.61	0	5
Check-in time (seconds)	7,160	81.1	77.7	1	600
Morning	2,368	85.2	87.6	1	598
Midday	3,394	77.4	168.3	1	2,182
Evening	1,313	83.4	76.4	1	2,082
Time to vote (seconds)	6,954	221.6	161.7	1	2,182
Morning	2,291	212.7	141.1	0	1,503
Midday	3,394	218.3	168.3	1	2,282
Evening	1,269	246.5	175.3	2	2,082

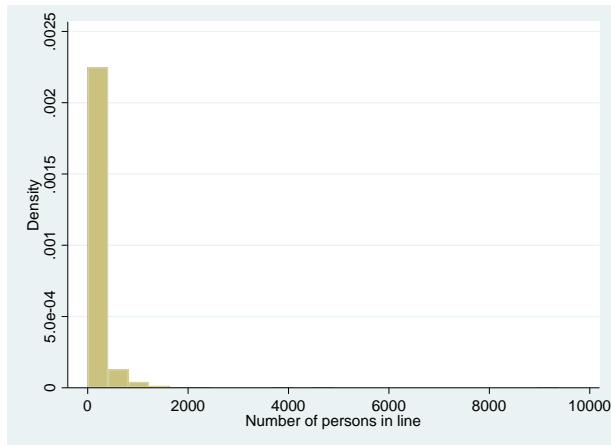
<sup>1</sup> Average number of persons in line per 10-minute interval.

<sup>2</sup> Morning and evening hours are the first and last three hours of polling place operations with the balance of hours of operation defined as midday.

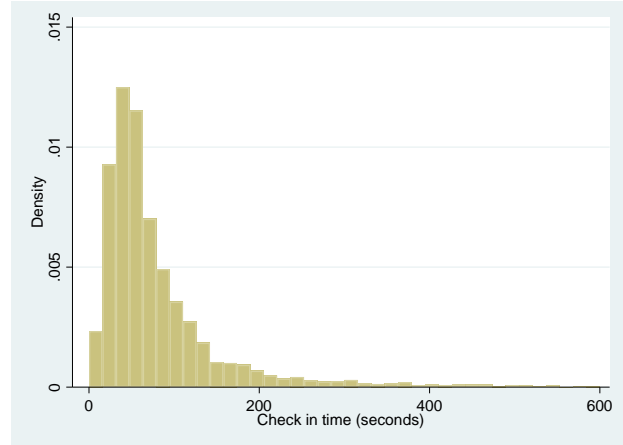
<sup>3</sup> Number of persons per 10-minute interval.

Figure 1: Distribution of hourly measures of polling place practices and operations

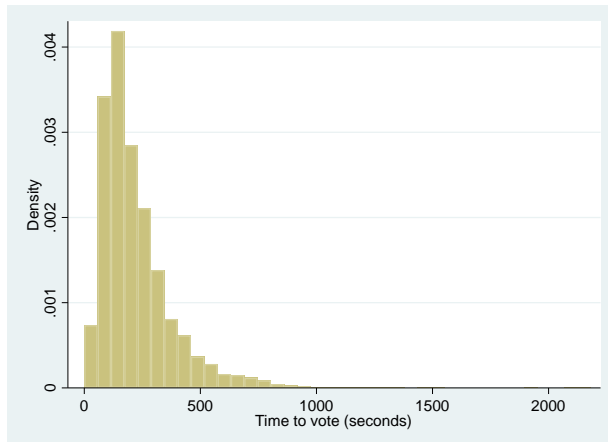
A. Line length



B. Check-in time



C. Time to vote



D. Persons leaving before voting

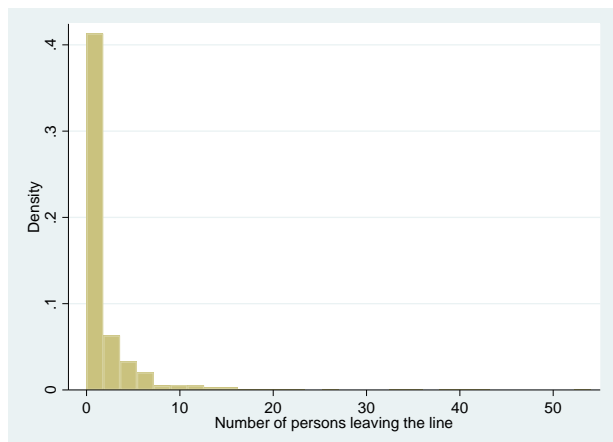


Table 3  
Regression estimates  
of the average number of persons in line<sup>1</sup>

	1	2
Arrival count	0.987*** (0.182)	0.849*** (0.156)
Check in time	-0.0277** (0.0136)	-0.0105** (0.00460)
Poll workers per voter	-3.670*** (0.666)	-3.940*** (0.616)
Midday	-10.14*** (3.618)	-11.22*** (4.000)
Evening	-7.894** (3.054)	-11.51*** (4.096)
Majority minority	-1.079	-0.343
Polling location	(1.945)	(2.068)
Constant	15.86*** (5.088)	16.64*** (4.123)
Observations	5,858	5,858
R <sup>2</sup>	0.262	0.310
Fixed effects counties	-	25

Robust standard errors in parentheses

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

1-Number of persons leaving the line during 10-minute intervals

Table 4  
Regression estimates for time to check-in

	1	2
Midday	-0.901 (4.493)	-2.446 (3.864)
Evening	2.036 (5.533)	3.721 (4.593)
Majority minority polling location	6.197 (5.451)	12.02** (5.779)
Poll workers per voter	-1.837** (0.788)	-0.487 (0.652)
Electronic poll book	23.08*** (4.423)	-

Same day registration	42.39*** (6.976)	-
Photo ID required	-40.08*** (5.977)	-
Photo ID x majority- Minority polling place	72.28** (29.84)	-
Constant	64.09*** (4.188)	98.85*** (7.895)
Observations	5,858	5,858
R-squared	0.082	0.182
Fixed effects counties	-	25

Robust standard errors in parentheses

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

Table 5  
Regression estimates for time to cast a ballot

	(1)	(2)
Midday	17.39** (7.198)	29.08*** (5.542)
Evening	18.20** (8.507)	34.41*** (7.451)
% over 65	-26.75 (40.60)	-47.21 (32.30)
Ballot Choices	2.365*** (0.153)	0.436 (0.688)
DRE voting machine	-4.698 (10.92)	
Straight ticket voting	-79.11*** (13.40)	
Constant	132.7*** (9.918)	356.0*** (56.99)
Observations	6,055	6,055
R-squared	0.196	0.286
Fixed effects counties	-	20

Robust standard errors in parentheses

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



Table 6  
Negative binomial estimates for persons leaving the line<sup>1</sup>

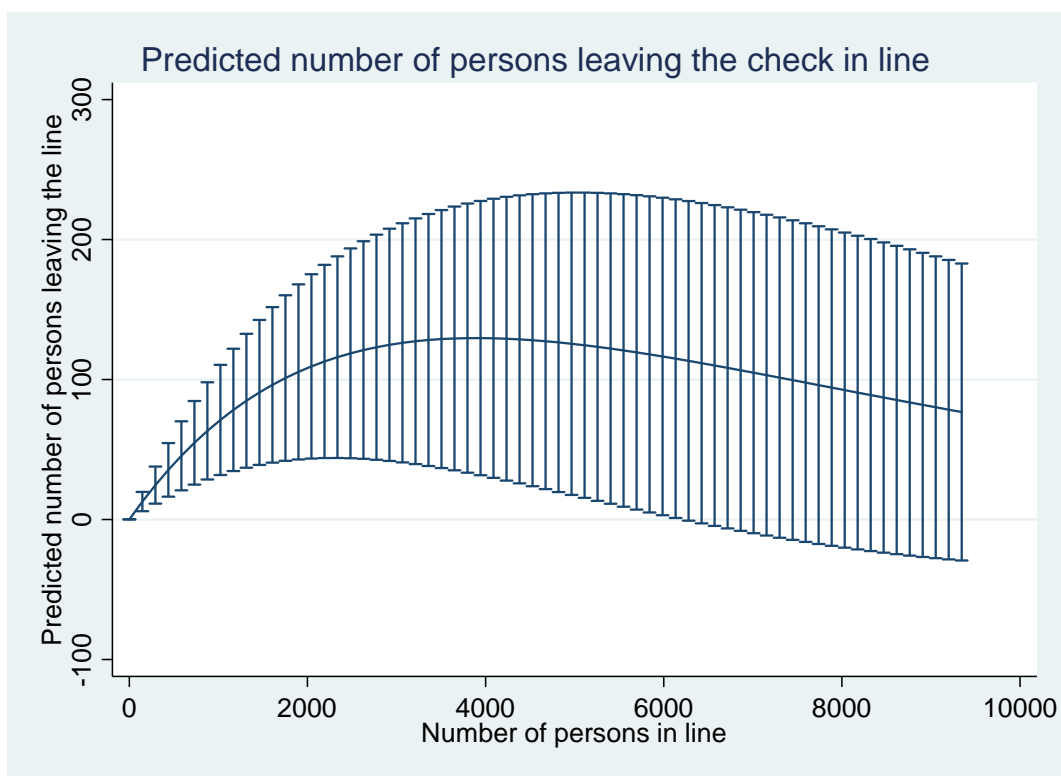
	(1)	(2)
Number in line	-0.00431** (0.00215)	0.00236* (0.00147)
Midday	0.404** (0.199)	0.573*** (0.175)
Evening	0.215 (0.316)	0.461* (0.258)
Log of number in line	1 (exposure)	1 (exposure)
Constant	-0.974*** (0.204)	-1.073** (0.431)
Observations	5,958	5,958
Pseudo R <sup>2</sup>	.010	.060
lnalpha	1.56	1.21
Fixed effects counties	-	25

Robust standard errors in parentheses

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

1-1-Number of persons leaving the line during 10-minute intervals

Figure 2



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## Appendix

### Demographics of Study Jurisdictions and 2016 National Exit Poll

Variable	National <sup>1</sup>	Study Jurisdictions
65 +	16%	20%
White	72%	75%
African-American	12%	14%
Hispanic	11%	7%
Other	4%	3%
College Graduate	50%	41%

1- National Exit Poll, 2016 Presidential Election  
<https://www.cnn.com/election/2016/results/exit-polls>

**Timing of Voting Process**  
(Please write legibly)

Electronic ballot form Bibb County, GA

Jurisdiction: East Macon 3 ← Polling Place: \_\_\_\_\_

Your name: Olivia Moore

Time of Arrival: 7:05 am Time of Departure: 9:07 am

**Instructions:** Use a phone or digital watch/stopwatch that shows seconds to record the exact time for each step in the voting process of individual voters. Please record time as hour : minute : second.

The "Distinguishing Characteristics" column is only to help you keep track of each voter you are timing. It should be a distinctive piece of clothing or other item worn or carried. Please do not use gender, race, age, or other personal/demographic characteristic as voter identification.

Track an individual voter through the entire process, then start with the next voter who arrives at the check-in table.

If you lose track of a voter, or fail to record a particular time, put an **X** in the appropriate spot and then proceed to the next step.

	Distinguishing Characteristics	Check in		Voting	
		Start check-in	Leave table	Start voting	End voting
1	Sun Glasses	7:20:10	7:20:45	7:20:58	7:23:29
2	Purple sweater	7:22:16	7:23:63	7:23:11	7:26:55
3	Pink backpack	7:25:10	X	X	X (A)
4	Mercer	7:32:06	7:32:45	7:33:00	7:37:08
5	green coat	7:36:05	7:36:51	7:37:00	7:41:15
6	Maroon pants	7:40:30	7:41:45	7:41:50	7:45:24
7	hat & glasses	7:41:46	7:42:52	7:43:00	7:47:00
8	Glasses	7:43:47	7:46:30	7:46:47	7:48:06
9	Pink blazer	7:48:55	X	X	X (B)
10	red blazer	7:51:38	7:52:40	7:53:06	7:55:20
11	colorful shoes	7:56:43	7:57:24	7:57:27	8:04:20
12	navy sweater	7:59:47	8:00:21	8:03:30	8:09:42
13	black + white tie	8:01:50	8:02:56	8:03:02	8:07:52

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Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Strict photo ID	7,581	0.12	0.32	0	1
Straight ticket voting	7,581	0.15	0.35	0	1
Majority-minority	7,081	0.16	0.37	0	1
Choices	6,999	42.1	28.7	11	124
% over 65	6,784	0.19	0.09	0.03	0.50
DRE voting machine	7,579	0.28	0.45	0	1
Epoll book	7,579	0.56	0.50	0	1
Morning	7,581	0.32	0.47	0	1
Midday	7,581	0.49	0.50	0	1
Evening	7,581	0.19	0.39	0	1