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 twenty-eight election jurisdictions across the United States, 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 identification (ID) requirements to have a disparate effect on the time to check in among white and nonwhite polling places. In majority-white polling places, scanning a voter's driver's license speeds up the check-in process. In majority nonwhite polling locations, the effect of strict voter ID requirements increases time to check in, albeit modestly.

Keywords

election administration, voting behavior, polling place operations

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 recommendations 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 (Alvarez, Hall, and Llewellyn 2008; Atkeson and Saunders 2007; 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 reneging—leaving the check-in line after joining it—has been a controversial, but understudied, 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 a retail or social service setting, and even more troubling consequences, if true, in a voting setting, as it suggests one way in which voter 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 nonwhite voters (Barreto, Cohen-Marks, and Woods 2009; Pettigrew 2017).

Much of the published research literature about voting wait times has comprised studies of single counties (Allen and Bernshteyn (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 (SPAE), 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 (Bipartisan Policy Center 2013, 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 percent of the time, it was to check in to vote; 16 percent of the time, it was after

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checking in; and 16 percent 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.

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/ethnicity. Using data from the Cooperative Congressional Election Study (CCES) and the Survey of the Performance of American Elections (SPAE), Stewart (2014), Pettigrew (2017), and Fortier et al. (2018) all found that nonwhite 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, Cohen-Marks, and Woods (2009), and Mebane (2005) 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 percent nonwhite populations waited more than twice as long as zip codes with less than 25 percent nonwhite 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 thirty 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 eleven 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 thirty-one 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. In addition, 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 voters 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 Herrnson, Hanmer, and Niemi 2012; Miller 2013; Miller, Tuma, and Woods 2015; Nichols and Strizek 1995). 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 with paper ballot voters in the same county, and it was found that DRE voters spent on average 76 percent longer to cast their ballots. Spencer and Markovits note the significance of this finding as 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 (Fortier et al. 2018; Stewart 2016) 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 preopening 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 that require a photo ID experienced an average wait time of six to eight 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 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.[1] The use of electronic poll books may have a differential effect on check-in times between white and nonwhite 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.

Research Methodology of the Current Study

Research teams, recruited from local colleges and universities and located in twenty-eight election counties and nineteen states across the United States, 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). 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 with 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 these data. The counties studied closely approximate the demographic makeup of the 2016 electorate (see online appendix).

Within counties, polling places were selected randomly by participating faculty (details of random sampling protocol in the Supplemental Materials).[2] The unit

Table 1. List of Counties Studied.

Jurisdiction	Observations	Polling places
Los Angeles, CA	320	38
Fairfield, CT	244	11
Orange, FL	254	20
Bibb, GA	175	8
Bannock, 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 City, VA	598	35
Dane, WI	339	9
Total	7,579	528

of random sampling was the polling place rather than physical location, as 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; Spencer and Markovits 2010; Stewart 2015). Pairs of student-researchers were assigned to observe Election Day polling places for two-hour periods.[3] 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 the online 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.[4]

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.[5]

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, Cohen-Marks, and Woods's (2009) study of polling places with additions based on other research about polling place characteristics (Alvarez, Atkeson, and Hall 2013; Berger, Meredith, and Wheeler 2008; Bipartisan Policy Center 2013; Brady and McNulty 2011; Kropf and Kimball 2011; Schur, Ameri, and Adya 2017; 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.[6] Additional information on polling place demographics, including the proportion of persons over sixty-five years of age and the racial and ethnic makeup of registered voters in each polling place location were obtained from Catalist (2016).[7]

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.

A total of 9,347 individual voter observations was taken by student-researchers at 605 polling place locations in twenty-nine counties and nineteen 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.[8]

Table 2. Mean Measures of Polling Place Practices and Operations.

Variable	Obs.	M	SD	Minimum	Maximum
Arrivals count[a]	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[a]	7,021	10.9	31.1	0	447
Morning[b]	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[c]	6,180	0.3	0.79	0	11
Morning	2,152	0.37	0.91	0	7
Midday	2,904	0.28	0.74	0	11
Evening	1,124	0.2	0.61	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

[a]Average number of persons in line per ten-minute interval.
[b]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.
[c]Number of persons per ten-minute interval.

One of the twenty-nine counties in our study, Bernalillo County, New Mexico (1,054 voter observations in sixty-eight 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 (National Council of State Legislatures [NCSL] 2018; Stein and Vonnahme 2008). Voting in the remaining twenty-eight 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,[9] 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, for example, 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.

Descriptive Statistics

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.[10]
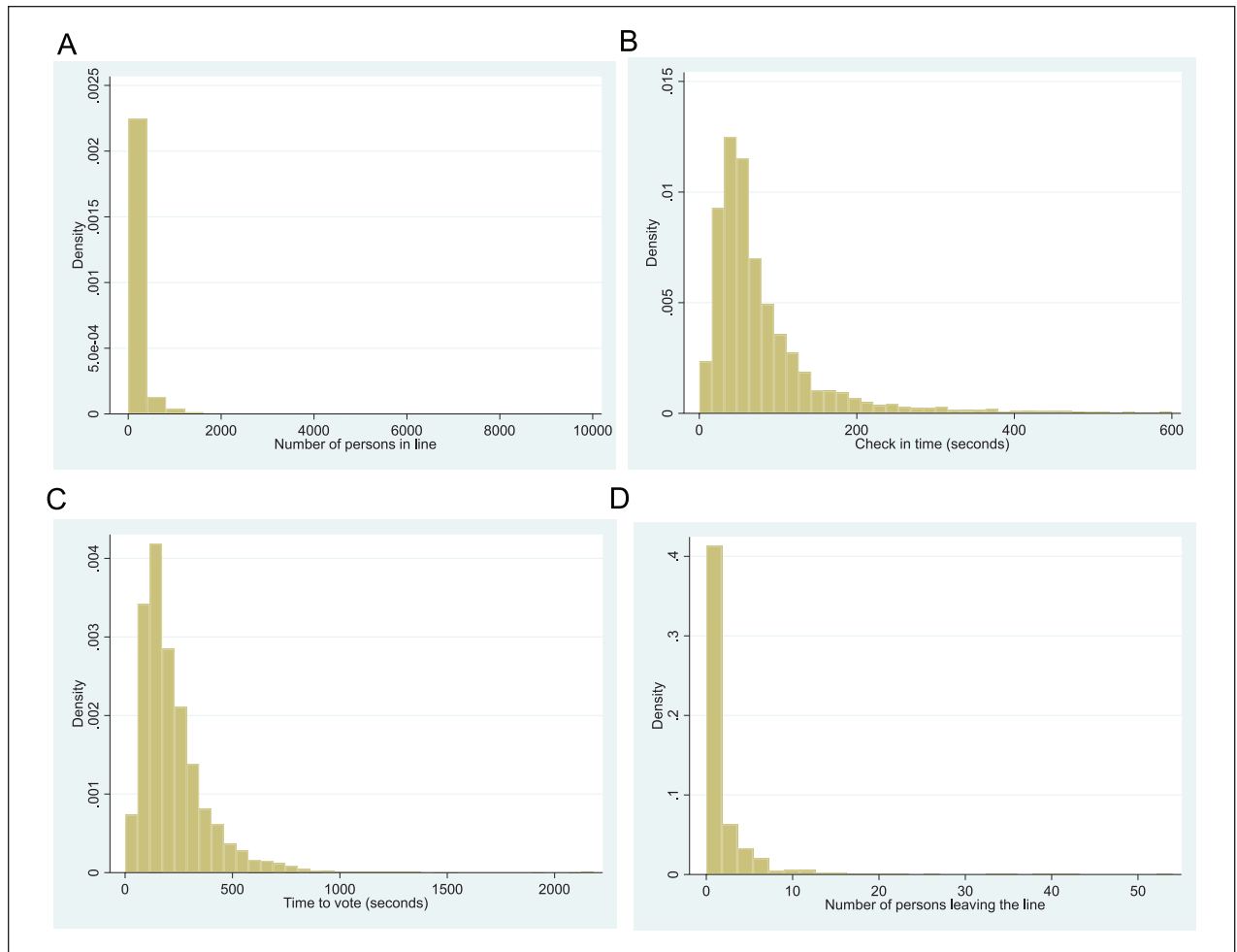
Figure 1. Distribution of hourly measures of polling place practices and operations: (A) Line length, (B) Check-in time, (C) Time to vote, and (D) Persons leaving before voting.

Consistent with previous research (Fortier et al. 2018), all of our observational measures of polling place practices and operations are underdispersed (see Figure 1A–D). Voters in our sample of 2016 Election Day polling places experienced an average line of ten voters every hour when arriving at their polling location. On average, our researchers observed fourteen 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-a-half minutes (eighty-one 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 the day, but time to vote (i.e., cast a ballot) increases over the course of the day.

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 as 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 that 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, Cohen-Marks, and Woods (2009); and Mebane (2005) report significant underprovision 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 of poll workers should be a reasonable surrogate for the number of check-in stations.[11] 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.[12] 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 preopening 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.

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 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 nonmajority-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

Table 3. Regression Estimates of the Average Number of Persons in Line.[a]

	1	2
Arrival count	0.987***	0.849***
	(0.182)	(0.156)
Check-in time	−0.0277**	−0.0105**
	(0.0136)	(0.00460)
Poll workers per voter	−3.670***	−3.940***
	(0.666)	(0.616)
Midday	−10.14***	−11.22***
	(3.618)	(4.000)
Evening	−7.894**	−11.51***
	(3.054)	(4.096)
Majority-minority polling location	−1.079	−0.343
	(1.945)	(2.068)
Constant	15.86***	16.64***
	(5.088)	(4.123)
Observations	5,858	5,858
R^2	.262	.310
Fixed-effects counties	—	25

Robust standard errors in parentheses.
[a]Number of persons leaving the line during ten-minute intervals.
*p < .1. **p < .05. ***p < .01.

(R^2 = .262), suggesting there may be 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 additional 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 a 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.[13] We have also included the interaction between majority-minority polling places (i.e., 1 = *50%+ of voters are nonwhite*, 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 (Election Assistance Commission [EAC] 2016) as measures of polling place capacity to check in voters.[14]

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 forty 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 ID requirement, all use electronic poll books to check in voters. In majority nonwhite 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 thirty-two 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 (forty-two 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

Table 4. Regression Estimates for Time to Check In.

	1	2
Midday	−0.901	−2.446
	(4.493)	(3.864)
Evening	2.036	3.721
	(5.533)	(4.593)
Majority-Minority polling location	6.197	12.02**
	(5.451)	(5.779)
Poll workers per voter	−1.837**	−0.487
	(0.788)	(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 × Majority-Minority polling place	72.28**	—
	(29.84)	
Constant	64.09***	98.85***
	(4.188)	(7.895)
Observations	5,858	5,858
R^2	.082	.182
Fixed-effects counties	—	25

Robust standard errors in parentheses.
*$p < .1$. **$p < .05$. ***$p < .01$.

unexpectedly significant and positive effect on time to check in. Because the 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 of electronic poll books on check in-time by identifying 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, as 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 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-nonwhite 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.

Time to Mark Ballots

Our model of time to cast a ballot includes the time of day, the use of 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, twenty-three contests for elective office per ballot, and forty-two candidates and propositions on the ballots for voters to choose from in the counties studied. Given the high intercorrelation 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 2016. 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 over a one-hour period.

In the model without fixed effects for counties (column 1), 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 lengthen the time to vote, in part, due to voters' lack of familiarity with electronic voting devices. Our nonfinding for this relationship may reveal 2016 voters' greater familiarity and adeptness in operating electronic voting devices than was observed in Spencer and Markovits's study of 2008 voters.

Table 5. Regression Estimates for Time to Cast a Ballot.

	(1)	(2)
Midday	17.39**	29.08***
	(7.198)	(5.542)
Evening	18.20**	34.41***
	(8.507)	(7.451)
% over 65	−26.75	−47.21
	(40.60)	(32.30)
Ballot Choices	2.365***	0.436
	(0.153)	(0.688)
DRE voting machine	−4.698	
	(10.92)	
Straight-ticket voting	−79.11***	
	(13.40)	
Constant	132.7***	356.0***
	(9.918)	(56.99)
Observations	6,055	6,055
R^2	.196	.286
Fixed-effects counties	—	20

Robust standard errors in parentheses. DRE = electronic voting machine.
*$p < .1$. **$p < .05$. ***$p < .01$.

The share of persons over sixty-five 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 (Glenn and Grimes 1968; Holt et al. 2013). 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 counterintuitive. 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 nonsignificant coefficient for number of ballot choices in the fixed-effects model may reflect a significant degree of undervoting, that is, 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 some portion of the variation in time to cast a ballot is likely related to many voters not voting for down ballot contests.[15] This condition might directly or indirectly (through other covariates of polling place operations) affect 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 fifty, and average time to vote was nearly three minutes. In states without straight-ticket voting, the mean number of ballot choices was forty, 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.[16]

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 length has *on* 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.

Reneging

To study the correlates of the number of persons leaving the poll place before voting, that is, 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 a 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

Table 6. Negative Binomial Estimates for Persons Leaving the Line.[a]

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

Robust standard errors in parentheses.
[a]Number of persons leaving the line during ten-minute intervals.
*$p < .1$. **$p < .05$. ***$p < .01$.

voter in line is simply an opportunity for someone else to leave. To estimate this effect, we take the natural log of line length[17] 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.[18]

Table 6 reports the results of the analysis. In the model without fixed effects for counties (column 1) time of day (i.e., morning and midday) and the number of persons in line have a significant effect on the incidence of persons leaving the line to check in to vote. When we introduce fixed effects for counties (column 2) the coefficient for number in line is positive but statistically significant at only the .1 level. Time of day—morning and midday—have a significant effect on the incidence of reneging. Unobserved county and state-wide effects may mitigate the effect of line length on reneging.

In the model without fixed effects for counties 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
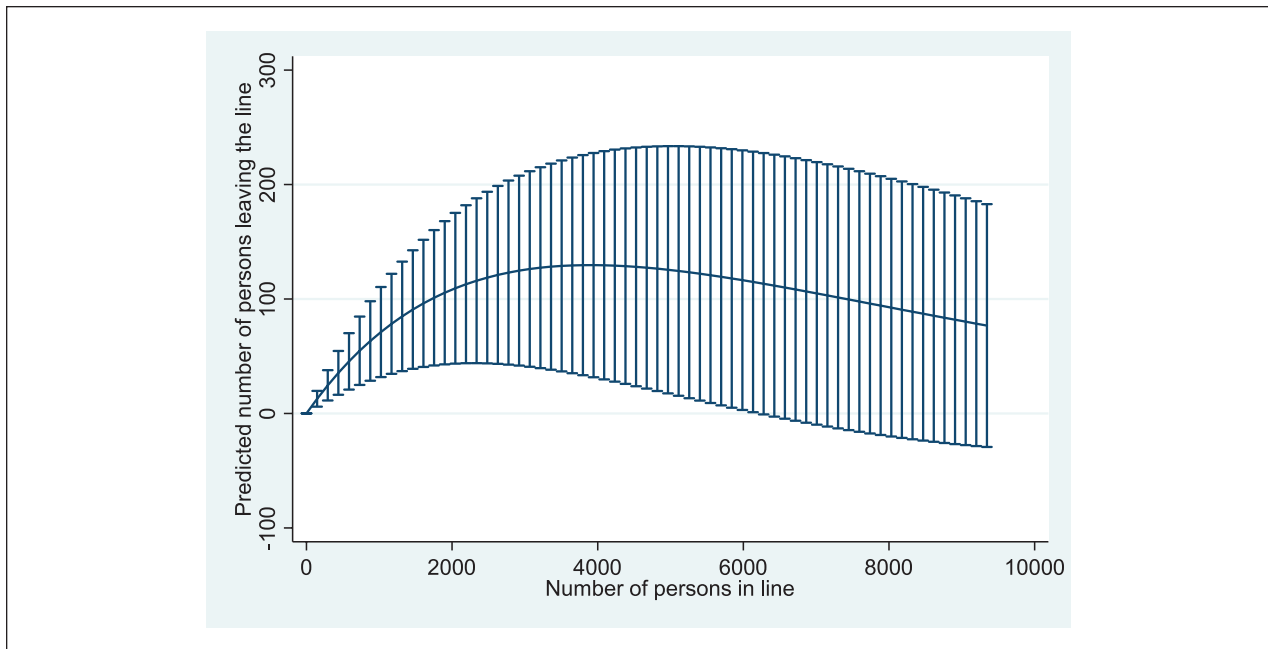
Figure 2. Predicted number of persons leaving the check-in line.

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 one hundred in line.[19] At that point, the number of voters reneging begins to decline. Keeping in mind that 87 percent of observations involve a line of one hundred 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 nonintuitive 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.

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 an important remedy for reducing the number of persons to leave the line before voting. Line length has a 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 licenses 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 ID to vote. Check-in times are significantly longer in majority nonwhite polling places in counties that require photographic ID. 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 nonwhite 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 the model without fixed effects. We suspect voters are either prepared to navigate a long ballot or simply undervote, 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 twenty-six 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.[20]

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 datasets. 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 undervoting. 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 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.

Declaration of Conflicting Interests

Funding

Notes

1. Although a majority of all adults, both white and nonwhite, 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).
2. (redacted for review) https://sites.google.com/view/pollresearch2018/home
3. 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 multidistrict (precinct) polling places.
4. "Balking" is arriving at a line, but then deciding not to join the line. We did not attempt to collect data about balking.
5. https://sites.google.com/view/pollresearch2018/home
6. https://sites.google.com/view/pollresearch2018/home
7. Demographic data on persons over sixty-five were not available for the five boroughs of New York City.
8. See Mann et al. (2018) for a further discussion of students' evaluation of their research experience.
9. In Lafayette, Mississippi, students observed 714 voters in line at seven polling locations.
10. We also considered other ways to define time-of-day, for example, opening of the polling place to noon, noon to 5:00 p.m., and 5:00 p.m. to closing and rejected these operationalizations 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.
11. 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.
12. 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 juris-dictions in the study—which is a proxy for when the polls opened in the jurisdiction—the average number of people waiting in line was eighteen, compared with eleven people in line at all other times.

13. Source: http://www.ncsl.org/research/elections-and-cam-paigns/voter-id.aspx#Laws%20in%20Effect.

14. Election Assistance Commission (EAC) reports whether an electronic poll book was used in the county, but not whether a scanning device was also used with the elec-tronic poll book.

15. 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 countywide ballot.

16. 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 percent and 50 percent in the state's ten largest counties (McCullough 2018). In Alabama, 65 percent 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.

17. For line lengths of zero, we take the log of 1.1.

18. The reneging model was calculated with *Stata*15 and the exposure command.

19. Figure 2 is estimated from a model of persons leaving the line and the number of persons in line.

20. One factor that has not been mentioned until now is the fact that many state laws prohibit the type of activity nec-essary 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, but 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.

Supplemental Material

Supplemental materials and replication materials for this article are available with the manuscript on the *Political Research Quarterly* (*PRQ*) website.

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