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Political participation and the accessibility of the ballot box

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Abstract

Commuting to and from precinct locations can be burdensome, particularly on a busy weekday in congested metropolitan areas when many voters are pressed by the demands of everyday living: work, family and school. Some precinct locations are more accessible than others, and for the less accessible ones, at least some people will feel that the cost to get there outweighs any benefit they may reap in terms of personal satisfaction from having fulfilled a civic obligation. Even after controlling for variables that account for the motivation, information and resource levels of local precinct populations, we find that accessibility does make a significant difference to turnout. The evidence points to a non-linear relationship. Distance imposes its heaviest burden on turnout in suburban precincts in the middle ranges of distance (2–5 miles). In the most rural precincts, where in spite of the distance (6–10 miles), travel routes are direct and relatively unimpeded, turnout rates are higher. We conclude with some policy recommendations that would ease the burden of getting to and from precinct sites on election day.

Introduction

The study of political participation through the act of voting is one of the most thoroughly tilled fields of political behavior research. It is no great surprise that voter turnout has attracted so much attention given its centrality to the theory and practice of democracy. And voting has been the main focus of research primarily because it is a relatively easy form of participation (Verba, Schlozman, & Brady, 1995). Yet in spite of its supposed ease, many in the US never bother to go to the polls — in

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the 1996 election, only 49% of eligible voters bothered to cast ballots, and in 2000 turnout was about 51%. This is a potentially serious problem because if so few people vote, policy outcomes may not be representative of the preferences of the broader community, thereby causing conflict and raising questions about the legitimacy of the political system (Highton, 1997; Tollison & Willett, 1973). Many scholars have worked at pinpointing the sources of low turnout. Among the causes most frequently highlighted are low personal motivation and interest, ignorance and lack of awareness, restrictions placed on registration, the one-sidedness of elections, and the absence of serious mobilization efforts by political parties and candidates (Rosenstone & Hansen, 1993). Our research probes some old reasons for low voter turnout that have rarely been investigated—analyzing the geography and placement of polling locations relative to precinct populations.

Considerable thought and energy continues to be directed at proposals for increasing voter turnout in the United States and other democratic nations. Not surprisingly, the remedies proposed depend entirely upon what causes are identified at the root of the problem. Those pinpointing high levels of cynicism and low levels of motivation sometimes suggest civic and voter education as the solution, but are usually not specific about what form this education should take. Some have recommended the practical step of easing voter registration procedures, and making registration more accessible. From those who believe that what voters really need is someone to mobilize them, comes the recommendation of a stronger role for parties and campaigns; including suggestions aimed at helping increase the level of competition in elections, such as campaign spending reforms aimed at helping challengers.

Our thought is that the ongoing study of participation could benefit by using innovative methodologies to examine the geographic accessibility of precinct polling places both in the United States and abroad. We believe that commuting to and from precinct locations can be burdensome on potential voters, particularly on a busy weekday in congested metropolitan areas when citizens are pressed by the demands of everyday living: work, family and school. Some precinct locations are more accessible than others, and for the less accessible ones, at least *some* people will conclude that the cost to get there outweighs any benefit they may reap in terms of personal satisfaction from having fulfilled a civic obligation.

While few have examined the question of accessibility directly, Stein and Garcia-Monet (1997) found that placing early voting sites in non-traditional locations stimulated participation in Texas. As non-traditional sites, the authors coded supermarkets, convenience stores, shopping malls and mobile units. For every ten nontraditional early voting sites the authors' found a 0.15% increase in the proportion of votes cast early (Stein & Garcia-Monet, 1997, 665; Stein, 1998). One might also hypothesize that burdening the participation of certain populations by placing polling locations in out-of-the-way places is one means unscrupulous, but strategic, authorities use to depress turnout. Regardless of how voting sites are located relative to precinct populations, though, our central hypothesis is that precincts in which the polling locations are more accessible to their underlying populations will exhibit higher turnout levels than those that are more difficult to reach.

Even after controlling for variables that account for the motivation of the population we believe there are good reasons to believe that accessibility may make a significant difference to turnout. Suburban populations are usually better educated than those living in other areas, but recent evidence has pointed to their low turnout, particularly in state and local elections (Gimpel, 1999). We are not naive enough to suggest that accessibility is the overriding variable influencing turnout. And we are well aware of the findings suggesting that rural populations, presumably required to commute long distances to their polling place, exhibit much higher turnout levels than urban ones. Clearly it is unlikely that every citizen would vote even under the most convenient of circumstances and some vote in spite of considerable inconvenience. Most studies have shown that social psychological factors outweigh convenience factors in determining whether voters participate (Katosh & Traugott, 1982; Knack, 1994; 1995; Rosenstone & Hansen, 1993). On the other hand, accessibility, as we are conceiving of it here, has rarely been one of the convenience factors subject to measurement (but see: Stein & Garcia-Monet, 1997). And while increasing the accessibility of precinct locations may not result in a 30 or 40 point rise in participation, we would consider it a significant and policy relevant finding if accessibility made the difference of between 0.3 and 1 point in the level of turnout for every mile or two of distance. If turnout dropped by 1/2 a point for each mile a site was positioned away from a center of population, placing it at five miles of distance would drop turnout by 2.5 percentage points, clearly a significant margin in close elections.

So although a lack of voter interest and motivation may be the major hindrance, we are suggesting that if polling places were more accessible, at least some of those voters of marginal interest and motivation would turn out to vote upon realizing that they might not have to fight the usual nettlesome obstacles on their way. Making voting more convenient involves more than just easing registration laws. Even among those who are registered, many do not presently vote. People who are not registered give different reasons for their lack of registration than the registered do for their failure to turn out (Kelley, Ayres, & Bowen, 1967; Merriam & Gosnell, 1924). Easing registration requirements will not ease the burden of getting to and from the polls on a busy weekday. Parties and candidate mobilization efforts may also matter to turnout, but it does not seem likely that Congress will pass sweeping campaign finance reforms that will help political party building efforts. Nor is it clear that proposed campaign finance reforms, alone, would make for more competitive elections since incumbents have significant advantages other than fundraising.

Contingent valuations of going to vote

Theories that postulate people evaluating the costs of getting to any location based on some general sense of attractiveness or accessibility are useful for our purposes. What costs are people willing to pay in transportation expenses, say, to get to take advantage of public goods such as parks and beaches? The contingent valuation literature within economics has suggested that the value of these public goods can be determined by what people are willing to pay to get to them (Clawson & Knetsch, 1966). Commuting costs, then, are tantamount to entrance fees to access otherwise free public recreational facilities. If economists in this tradition of research do not directly collect data on travel costs, they may construct survey questions designed to elicit a consumer valuation at different hypothetical levels of cost (Bishop & Syme, 1995; Cameron, 1992; Green, 1992; Green, Kahneman, & Kunreuther, 1994; Kahneman & Knetsch, 1992; Portney, 1994).

The analogy from the contingent valuation of natural resources to an application involving the value of voter turnout is not so far fetched, since the act of voting can be viewed as a public good. Specifically, rational choice theory (Downs, 1957) sees political participation as individuals sacrificing the costs of transportation and time for a public good—the election of a particular candidate or party (Blais, 2000; Green & Shapiro, 1994, 47; Struthers & Young, 1989). The value of voting can be revealed indirectly through travel decisions, at least for current voters.

Strictly speaking, however, rational choice theory has a hard time explaining why people vote since any individual's vote is not likely to influence election outcomes. If people are truly acting according to calculations of material self-interest, and they realize that their vote is highly unlikely to sway an election, they would not bother to waste time voting (Downs, 1957; Tullock, 1967). Even if voting costs very little, rational choice theorists have had a hard time predicting the high levels of turnout in most western democracies. Rational choice theorists have an empirical problem unless they expand the notion of utility to encompass concepts of obligation, altruism, psychic gratification or citizen duty (Riker & Ordeshook, 1973). Once these concepts are included, however, rational action can be nearly anything, and self-interest ceases to have much substantive meaning.

Rather than tying the discussion to a particular concept of rational behavior, and embroiling our work in theoretical and empirical controversies we will be unable to resolve, we are willing to admit that people may vote for a variety of reasons, perhaps having little to do with calculations of economic gain. Granted, for a large number of voters, accessibility may not be an issue, and other costs associated with voting may also be negligible. Blais (2000, 86) found that in Quebec, for instance, the majority of voters estimated the cost of voting to be quite small. About two-thirds of the respondents to the Quebec survey said that they didn't think they could do anything better with the time they took to vote (Blais, 2000, 87). But that still leaves the other one-third who apparently did see an opportunity cost to voting. There is likely to be a non-trivial number of voters who do find the costs of voting to be insurmountable given their lack of interest—the cost of getting to and from the polls may outweigh whatever satisfaction they might receive from casting their ballot (Blais & Young, 1996). Through simulations based on Canadian data, Blais found that moving the time involved in voting from 30–45 min reduced turnout by about two percent among regular voters (Blais, 2000, 89). But more importantly, many who never vote overestimate the costs involved, and nonvoters and irregular voters may be more sensitive to issues of cost than those who consistently show up. Perhaps this is why data consistently show lower turnout at polling locations with more restrictive hours of operation (Katosh & Traugott, 1982).

We have both theory and good evidence that for some people costs and perceived costs attached to the act of voting matter enough to discourage turnout. Acknowledging that at least some citizens vote out of a sense of duty, if that sense of duty is sufficiently low, and the costs of getting to and from the voting booth are sufficiently high, they will not bother with voting. Similarly, it is the voters with the lowest levels of civic engagement, partisan enthusiasm or interest in politics for whom accessibility is likely to matter most. Knack (1994) found, for example, that among those with a strong sense of civic duty, rain does not matter to turnout, but bad weather may influence those without a strong sense of civic duty, reducing turnout by several points (see also Merrifield, 1993).

Given that those that derive less utility or psychic gratification from the act of voting are the ones most likely to be affected by the costs imposed by inaccessible precinct locations, the question arises as to whether one should want these voters to be involved in the first place. Perhaps only the most dutiful and civic minded citizens should show up on election day? Arguably, the act of voting ought to be more demanding, not less, because we do not want to increase voting *per se*, we want to increase informed voting.

Our response is that it is unconstitutional to knowingly exclude a portion of the eligible voting population by failing to remove a geographic obstacle that is effectively working as a poll tax. To quote Kelley, Ayres and Bowen:

> ... How much interest should a voter have to qualify him for voting? Enough to stand in line all day? For half a day? For two days? We cannot say, but those who think voting should be limited to the "interested" ought to be prepared to do so." (Kelley, Ayres & Bowen, 1967, 375)

There may be rather ordinary life factors which severely prohibit even civic minded people from exercising their responsibility to vote. Nearly 10% of all US households are composed of single parents with children under the age of 18. The obstacles that a single parent must overcome to reach the polls on a workday—especially one that is difficult to reach—may be too great to permit them the opportunity to vote (Kwan, 1999). And single parent status is only one of many common factors which may complicate the task of reaching the voting booth. Some lack private transportation, others have inordinately long commutes, some live in severely congested areas, and others have physical handicaps. For all of these citizens, increasing the accessibility of polling locations may enable them to fulfill their civic obligation.

The concept of accessibility

Accessibility is a core concept in this study, but it is not normally a concept that is familiar to scholars concerned with elevating turnout. The notion of accessibility we are suggesting here originates mainly from the literature on transportation planning and engineering, and, to a lesser extent, economics. In this framework, accessibility is thought to be the reciprocal of the costs of moving people and goods between points in space. Travel costs are central because the less time and money spent in travel, the more places that can be reached within a certain budget, and the greater the accessibility (Handy & Niemeier, 1997, 1175). As defined by transportation planners, accessibility is a function of *distance* and *impedance*. *Distance* can be defined in Euclidean terms as the shortest means of getting from point A to point B, assuming perfect efficiency in transportation.

Impedance is whatever stands in the way of getting from point A to point B, and can be measured in a variety of ways, such as speed limits, residential density and accompanying traffic congestion, number of major intersections one must traverse on the way, or topographical barriers such as rivers or steep terrain. Distance is not necessarily a problem getting to and from a polling place if there is no impedance. A polling location may be six miles away, but if there is no traffic congestion or other barriers between one's home and the precinct place, distance may not stand as a significant barrier. On the other hand, impedance might not matter much if the distance is so short that overcoming barriers between two points is a relatively costless effort. Because distance and impedance can act independently to influence accessibility, they can be considered as separate measures. Taken together, distance and impedance provide a complete concept of travel cost to and from a destination. And as these costs increase, turnout is hypothesized to diminish.

The literature on accessibility is extensive and offers a variety of different measures (Pirie, 1979; Song, 1996). Typical of these is the standard gravity model, defined as:

$$P_i = \sum_j S_j / d_{ij}^2$$

Where P_i is the accessibility measure for origin location i, S_j is the "weight" measure for the destination j representing its attractiveness and d_{ij}^2 is the distance between i and j raised to the second power (Kwan, 1998; Haynes & Fotheringham, 1984; Fotheringham & O'Kelly, 1989). The distance between i and j is often squared, or raised to some positive power, in order to take into account realistic impedances associated with distance. This adjustment to the accessibility formula suggests that accessibility drops precipitously with initial units of distance, then diminishes at a decreasing rate with greater distances, eventually reaching 0. Impedance considered as an independent factor, such as variable traffic flows, variably dense settlement patterns, or the presence of difficult terrain situated between the origin and destination points, are usually not considered in most accessibility studies deploying gravity-type models.

Most of the applications for accessibility indices, however, have different applications in mind than we do here. They are typically examining population densities in metropolitan areas by studying the accessibility of jobs from residential locations. Such models may include a calculation of the number of job opportunities available at several (destination) locations weighted by the travel costs of getting to that location from various origins. Locations with more jobs are given more weight, or are assumed to be more attractive. The idea is that the wider the range of job opportunities at a given destination, the higher the probability of finding a satisfying one.

These attractions are then subtracted from the costs associated with taking advantage of them, mainly costs in travel time and transport expenses—such as operating a car, or buying subway tokens—to explain residential location choices, for example (Shen, 2000).

Other approaches might have in mind travel between a specific origin and a set of destinations, or the converse; multiple origins but a single destination (Haynes & Fotheringham, 1984, 42). We are interested in a more general notion of accessibility than those typically found in the literature. Since precinct places are not plural and cannot be chosen by most voters unless they want to cast an absentee ballot, and given that jobs return tangible economic benefits that the act of voting does not, the customary applications of the gravity model are not neatly analogous to studying the level of voting participation. Indeed, with only a single destination and a single origin, the task of measuring accessibility is greatly simplified. Between a single origin (the centroid of a precinct) and a single destination (a given precinct polling place) distance can still be conceived of as simply the inverse of the distance between *i* and *j*, or:

$$Ai = 1/d_{ij}$$

Taking into account the likelihood of impedance, or distance decay, the distance between *i* and *j* is commonly squared, as this adjustment has often proven to be more realistic in other travel-related applications, giving us the familiar:

$$A_i = 1/d_{ij}^2$$

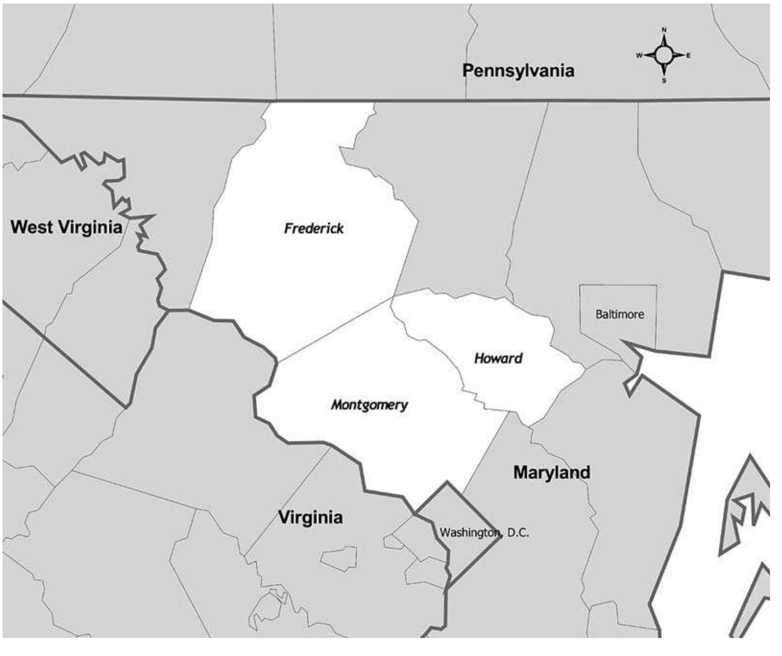
In our hypothesis tests, we will consider both a straightforward linear distance decay function, as well as the more traditional squared distance function specified above. But departing from other studies of access, we will also consider residential density as a separate general indicator of impedance, on the basis that greater residential density is likely to entail slower travel speeds, heavier traffic and more complex traffic networks. It is clearly possible to obtain data on specific traffic flows in certain streets and highways at specific locations, but we were unable to find a suitable measure of traffic flow that would capture the conditions prevailing generally (throughout a precinct, as opposed to at specific locations), and for many lightly populated precincts, traffic counts are not measured. Moreover, our goal was not to identify impedance for a specific route to and from a polling place, but to characterize the conditions in the most general way possible.

Using density as a separate measure of impedance is helpful for another reason. Previous research has noted that in rural areas of the United States turnout is usually quite high, even though farmers and other rural dwellers presumably have to drive considerable distances to shop, vote, or even visit their neighbors. One explanation for the high turnout in rural locations is that the routes traveled are rather unimpeded. They are direct, and can be traveled at relatively high speed.

GIS methods and measures

Given that the costs of getting to and from a polling place may matter to some people, how should we measure these costs? While the contingent valuation literature often draws upon survey data to estimate costs, we do not have the luxury of having conducted a survey here. Instead we draw upon ecological data to make inferences about the impact of accessibility on turnout, controlling for alternative and complimentary explanatory variables. Taking over 300 precinct locations from three suburban Maryland counties (see Map 1), we calculated distance measures between the polling sites and voter district centroids of each. We have used a Geographic Information System (GIS) to construct a simple measure of accessibility based on the mileage between the centroid of a voter district (or precinct) and the actual location of that district's polling site. To ensure that the centroid of the voter district closely approximated the true center of population, we adjusted all precinct boundaries for the presence of uninhabited parks, wetlands, and bodies of water. This method ensured that the precinct centroid was not calculated on the basis of uninhabited tracts of land or water. Since these voter districts are rather small units of geographic granularity, and since the precincts are suburban and relatively evenly populated, we are not concerned that the method we used to calculate the precinct centroids is far from the true population centroid.

Another way of thinking about our method of measuring accessibility is to imagine



Map 1. Location of Frederick, Mongomery and Howard counties relative to Washington, D.C. and surrounding states.

a random voter positioned squarely in the middle of the precinct area, then, determining the distance between each of these random voters' homes and the site where they must cast their ballot. The GIS was then used to measure the distance between the centroids and the polling places using the Manhattan Block method. Manhattan block distance is defined as:

$$d_i = |x_i - x_j| + |y_i - y_j|,$$

where x, y are the longitude and latitude coordinates for the origin i and destination j. This measure of distance is especially useful when it is unreasonable to assume that travelers can move along the hypotenuse of a triangle formed of point a, point b, and a third point, but must instead travel a more angular path from a to b. By taking the inverse of Manhattan block distance, and then taking the inverse of the square of this distance, we calculate our two measures of access, expecting turnout to rise as accessibility increases.

Measures of motivation, information and resources

Distance to precinct polling locations is far from the only factor relevant to explaining an electorate's level of participation. A number of control variables should be taken into account as we model the turnout in voter precincts. It is difficult to argue credibly that the voluminous literature on political participation has been wrong about social-psychological factors being the main source of variation in the decision to vote. Interest in the campaign, political efficacy, and strength of partisan identification, are among the most important variables predicting turnout in survey-based studies of participation (Campbell, Converse, Miller & Stokes, 1960; Rosenstone & Hansen, 1993). And while we do not aim to prove this work to be wrong, in assessing the impact of accessibility, we clearly need to control for ecological variables capturing the underlying knowledge and political interest of the precinct populations. Education is not a perfect proxy for political interest, especially in survey data (Luskin, 1987), but the two variables have been found to be correlated in much of the literature (Leighley, 1990; Miller & Shanks, 1995; Rosenstone & Hansen, 1993; Wolfinger & Rosenstone, 1980; Zaller, 1992). In aggregate data analysis of participation rates, most variables related to turnout have been closely related to education (Rosenstone & Wolfinger, 1978). In the words of Rosenstone and Hansen, "Education...imparts the knowledge and the skills most essential to the citizen's task." (Rosenstone & Hansen, 1993, 136). Furthermore, how complex a model of turnout needs to be depends upon both the generality and the level of analysis (Cassel & Luskin, 1988). For a study of turnout at the precinct level, detailed data on efficacy and political knowledge may not be as critical as they would be in survey research.

Since we are working with ecological data, our indicators for motivation will include percent of the precinct population with a four year college degree (or more).[1]

[1] In the course of conducting many hypothesis tests we investigated other education measures, as well as indicators for income and poverty. Percent with a four year college degree provided more variation than most of the others and seemed the most reasonable alternative among numerous candidates.

Related constructs to be evaluated for their relevance to predicting turnout include the percentage residing outside the county or state in the previous five years. Domestic migrants are less inclined to vote than long term natives, suggesting that a variable capturing the percentage of those new to the area may be associated with lower turnout (Gimpel, 1999; Highton, 1997; Squire, Wolfinger, & Glass, 1987). We also control for the percentage of female headed households with children, on the basis that such households are not only lacking resources by which to afford flexible modes of transportation, but are also less informed about politics, and under more space-time constraints from the combination of work and childcare than two-parent households of otherwise similar size (Kwan, 1999). The greater the proportion of female headed households in a community, we anticipate the lower political participation is likely to be.

Finally, we control for the relative youth of the precinct population. A number of studies have shown that younger citizens between the ages of 18 and 29 are far less likely to vote than older voters who have settled down, acquired a stake in their communities, and then establish habits of regular participation (Rosenstone & Hansen, 1993; Plutzer, 2002). Previous research leads us to expect that precincts with larger proportions of younger voters will exhibit lower turnout levels than those in which the age distribution is skewed to the left (more older voters).

The dependent variable is the number of voters casting ballots in the 2000 presidential election, divided by the total number of voters registered to vote in each precinct, expressed as a percentage. Note that this measure captures participation only among those already registered to vote, for whom distance to a precinct site on election day may present a burdensome obstacle. We recognize that registration requirements are themselves obstacles to participation. But we do not understand the accessibility of precinct sites to be a hurdle for those who are ineligible to vote because of their unregistered status. Because most already know they cannot vote, these citizens are not likely to consider convenience factors as election-day approaches.

Spatial regression analysis of turnout: taking geography seriously

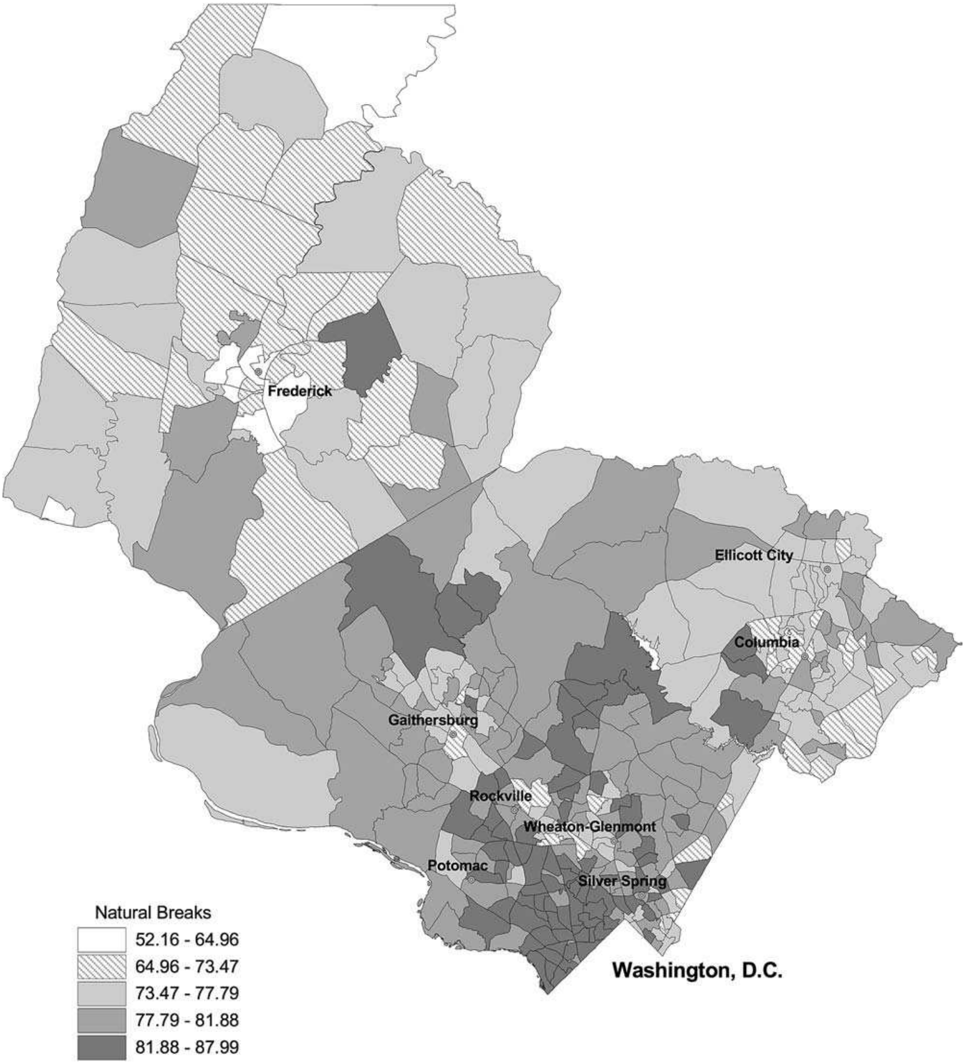
The precincts within counties we will be examining are adjacent units of analysis—they border one another. Given that precinct boundaries are merely conventions, and given that residents (including voters) freely cross precinct boundaries not even knowing they are there, it is likely that turnout in one jurisdiction will be positively related to turnout in neighboring jurisdictions. Candidate and campaign mobilization efforts in one precinct are likely to spill over into neighboring precincts. Theories of contextual influence would predict the existence of spatial dependency in the units of analysis (Huckfeldt, 1979; Huckfeldt & Sprague, 1995).

Beyond the substantive reasons for taking into account the spatial relationships among units, there are important econometric reasons. Standard regression models assume no spatial dependency. Indeed, such models routinely assume that observations on the dependent variable are independent of one another (the condition called *i.i.d.* in statistical parlance). But clearly in the case of geographically situated data such as ours, this assumption is false. When we tested for the presence of spatial dependency in our dependent variable for turnout in the 2000 presidential election, we found that the global Moran's I coefficient was 0.44 ($p \leq 0.0001$). Treating these units as independent when they are in fact related would violate classic regression assumptions, and introduce bias into the coefficients in the same manner as if an important explanatory variable had been excluded. To adjust our estimates for spatial dependency, we compute a spatially lagged version of each of our dependent variables, and then include this variable on the right hand side of our regression models.

Briefly, the spatially lagged dependent variable is a weighted sum of the observations adjacent to a given observation of the dependent variable. Taking each county separately, we calculate the arc distance between precinct centroids for all observations using the statistical software *Spacestat*. This produces an $N \times N$ matrix specifying the spatial relationship between each observation (precinct) in each county. We then convert the distance matrix to a binary contiguity matrix (1,0) based on the minimum distance necessary to link each observation to at least one other observation. In adopting this method of defining the values of the spatial weights matrix, then, we assume that no precinct in a county is totally isolated from, or independent of, all other precincts in that county. The conversion of the distance matrix to a binary contiguity matrix results in a $N \times N$ matrix, w_{ij}, of 1s and 0s, with 1s indicating linkages to the most proximate observation(s), 0s indicating no such linkage. The spatial weights matrix, once constructed, is then standardized such that the row elements sum to one. This facilitates later interpretation of the coefficients in spatial regression analysis (Anselin, 1988, 23).

Results

To illustrate what we are attempting to explain, the reader can examine the data on turnout grouped by natural breaks in Map 2 for Montgomery, Howard and Frederick Counties, immediately north of the US capital. The map shows that it is the darkly shaded precincts closer to the center of the metro area that exhibit very high turnout—these are precincts that tend to be smaller in land area, lending some *prima facie* support to the notion that geographic accessibility matters. In fact, what distinguishes the three counties from one another is, above all else, the land area and population density of precincts, with the most rural county (Frederick) exhibiting considerable distance between home and polling place. Still, some of the larger, more rural areas of Frederick County also exhibit high turnout (dark shades in Map 2), suggesting that distance may be related to political participation in a non-linear, specifically u-shaped, pattern. Turnout is highest when distances to the polling place are very short, and when they are excessively long, but lower in the middling ranges of distance. If this is the case, we might expect turnout to increase as a linear function of accessibility ($1/d_{ij}$), but to drop with the square of distance in the denominator ($1/d_{ij}^2$). Of course the geographic variation shown in Map 2 could be explained as the result of any of a number of variables we have mentioned above, not simply distance. So what does multivariate analysis show?



Map 2. Turnout as a percent of registered voters in Frederick, Montgomery and Howard counties in the 2000 presidential election.

We present both the OLS models and the models with the spatial autoregressive adjustment in Table 1. The first two (columns 1 and 2) include only the accessibility and residential density measures as explanatory variables. The second pair (columns 3 and 4) show the effect of adding the demographic variables. The coefficients in our spatial autoregressive models are interpreted in the same way that OLS coefficients are interpreted, except that the *b* provides a measure of the effect of a one unit increase of X on Y controlling for the spatial relationships among precincts.

From a substantive standpoint, our analysis of turnout for the 363 precincts show

Table 1
Estimates of the impact of accessibility on precinct turnout in the 2000 US presidential election, controlling for related variables

	Model 1		Model 2	
Variable	Column 1 OLS	Column 2 spatial autoregressive	Column 3 OLS	Column 4 spatial autoregressive
Constant	76.402	14.341	76.966	28.098
	(0.432)	(4.539)	(0.964)	(4.725)
Spatial lag of turnout	–	0.811***	–	0.674***
		(0.058)		(0.062)
Accessibility (inverse of miles)	1.015***	0.453***	0.641***	0.348***
	(0.216)	(0.169)	(0.169)	(0.137)
Accessibility (inverse of miles squared)	−0.041***	−0.022***	−0.022***	−0.014**
	(0.010)	(0.008)	(0.008)	(0.006)
Residential density (1000s)	−0.022	−0.185***	0.017*	0.037
	(0.108)	(0.084)	(0.009)	(0.072)
% Age 18–29	–	–	−0.348***	−0.318***
			(0.051)	(0.041)
% Female headed households	–	–	−0.287***	−0.309***
			(0.081)	(0.074)
% Migrants (last five years)	–	–	0.036	0.054*
			(0.371)	(0.033)
Percent with 4 years college +	–	–	0.097***	0.032***
			(0.114)	(0.012)
R^2	0.062	0.341	0.465	0.612
N	363	363	363	363
Moran's I for residuals	0.047	−0.042	0.057	−0.023
Significance level for Moran's I	$p \leq 0.002$	$p \leq 0.01$	$p \leq 0.0001$	$p \leq 0.18$

Maximum likelihood estimation of spatial lag model.Unstandardized regression coefficients (standard errors).Significance test of Moran's I is based on normal approximation.$^{*}p \leq 0.10$; $^{**}p \leq 0.05$; $^{***}p \leq 0.01$

that accessibility expressed with a linear distance function is positively related to turnout in both the OLS and spatial lag specifications. We see an unquestionably strong effect for distance in our coefficients. In the second column for model 1, for instance, the *b* indicates that for each one mile increase in proximity to the polling site, turnout jumps by 0.453%, or nearly half a point. A five mile increase would produce a 2.3% increase in turnout. However, all of our models reveal the presence of a non-linearity in the relationship between distance and participation. With accessibility included in the model with the squared distance function, turnout drops. This indicates that voter districts where the travel times to the polling place are excessively long (6, 7 or more miles) have slightly higher turnout rates than those in the middling ranges of driving distance (3–5 miles). Residential density also acts as a barrier to turnout according to model 1—a ten point increase in housing units per square mile of precinct area contributing to notable 1.85 drop in the level of turnout.

The addition of the spatial lag in the second column adds substantial explanatory power to our first OLS model, suggesting that turnout is subject to neighborhood influence extending across precincts. The coefficient for the spatial lag in column 2 shows that a one unit increase in the turnout of spatially adjacent precincts yields a 0.81 increase in turnout in a given precinct of interest. Not only were we able to substantially reduce the prediction error by including the spatial lag of turnout, spatial autocorrelation in the residuals was reduced to statistical insignificance over the simple OLS specification. Still, spatial autocorrelation, while small and in a *negative* direction in column 2 of Table 1, remains statistically significant. Some important explanatory variables may still be missing.

When we add the control variables capturing the socioeconomic and demographic characteristics of precinct populations, the accessibility indices maintain their statistical significance and direction of influence, although their magnitude is reduced by nearly half. Still, a five mile increase in accessibility increases turnout by an average of 1.74% (from column 4). Aggregating this figure over precincts throughout an entire metropolitan area or state, yields an effect of great magnitude, influencing the turnout of thousands of voters.

As we expected, precincts with high proportions of young citizens exhibit lower turnout, as do those with more female heads of households. Those precincts with better educated populations exhibit higher levels of participation than the less well educated. The effect for the variable capturing short-term migration into the state is actually contrary to expectations—increasing turnout by about half a point for every ten percent increase in recent migrants in the fourth column of Table 1. A control for income (not shown) did undermine the statistical significance of this effect, however, suggesting that the precinct populations with large migratory populations are also wealthy, perhaps an indication that they may overcome the barriers associated with mobility more quickly than we expected (at least for presidential elections). We must bear in mind that these are ecological findings we are reporting, and may not capture the true individual level relationships.

Because we included the spatially lagged dependent variable in column 4, we were able to substantially purge the estimation of the troublesome econometric problem of spatial dependency. Tests performed on the residuals for the model in column 4 indicate that the Moran's I coefficient dropped to insignificance using either a normal approximation or a randomization method to test significance levels.[2] Using both substantive and econometric criteria, then, this final model would appear to be the best of the alternative specifications we have presented.

Conclusions

Ask someone to give up their quarter acre lot in order to be closer to their precinct site and they are not likely to make the trade. Preferences for low density, single family housing are likely to remain quite strong. This means that improving the accessibility of precinct sites will mean bringing the sites closer to voters—multiplying the number of sites and precincts. This is not always an easy thing to do given the siting requirements of state and federal election law. For example, Maryland state election law requires that sites are accessible to the handicapped in compliance with the Americans with Disabilities Act (ADA); have adequate space for the polling booths, voters, and election officials; and that they have proper electrical power to operate optical scanning devices used to tally votes. Local officials are also authorized to make additional evaluations of accessibility, making changes according to local traffic and road conditions.

Compliance with the ADA requirements is surprisingly difficult and the stipulation that polling places must be handicapped-accessible rules many potential sites off limits. In this sense, the cost of requiring that sites be accessible for the handicapped is that they have become less geographically accessible for hundreds of non-handicapped voters of marginal motivation and political interest. One might reasonably ask the controversial question about whether the votes of physically handicapped people highly interested in voting are worth more than the votes of non-handicapped people of marginal interest and political motivation. If votes are considered to be of equal value, the cost of ADA compliance on turnout may be substantial, particularly to those that do not have the private transportation to overcome the burdens of distance and impedance.

Assuming for the moment that our ecological results approximate an individual reality, we believe that our findings point in the direction of several policy changes that could have a practical effect on increasing turnout. There are major policy-related steps that involve the important matters of population motivation and voter education, but these have been addressed by many other investigators so we will not focus much attention on them here, preferring instead to focus on the issue of geographic access.

First, we begin with the controversial suggestion that state and local governments relax the ADA standards for handicapped accessibility, while continuing to fund

[2] The normal approximation and the conditional randomization approach of evaluating significance did produce slightly different significance levels at three places to the right of the decimal point, but the difference was sufficiently small to indicate the equivalence of conclusions reached from using either method.

efforts to provide more ramped public and private facilities that could serve as polling sites. In the absence of ramped facilities, other accommodations could be made to ease the voting of the handicapped, such as bringing the ballot box to them by allowing them to vote by mail.

Second, space requirements are not as critical if more sites are created for fewer eligible voters per site. Presumably Texas has sacrificed a space requirement in selecting early voting sites, and California's tradition of placing sites in private households is also a step in this direction. Fourth, subject to the above changes in site requirements, policymakers may want to investigate the placement of polling sites along public transit lines, making the precinct places available to those who do not have flexible transportation modes. It is also important that local elections boards advertise changes in precinct site locations so that voters know that these venues have moved. Nothing is more frustrating on a rushed workday than showing up at a site expecting to be able to vote and learning that the site has moved two miles down the road.

Making election day a national holiday would make sense as it would eliminate the time pressures that busy voters typically confront on a typical Tuesday in early November. For long-distance commuters, in particular, there are two narrow windows before and after work to reach the polling place. If the time a voter allots to casting a ballot amounts to 20 minutes before work or 20 minutes afterward, even a short but congested drive to the polling place, on top of a 45 minutes commute to work, can be a deciding factor on whether a ballot is cast.

Finally, the state of Oregon has taken the distance issues out of the equation by mandating vote-by-mail for all voters. This step has led to an increase in participation of about 10% in the initial elections in which is has been used (Southwell & Burchett, 2000, 76). Other research has shown that all-mail elections have boosted participation but not among those whose non-voting is the result of factors other than convenience, such as motivation or education. And, after all, only registered voters receive ballots in the mail, so such a method does not reach the large mass of unregistered voters (Berinsky, Burns, & Traugott, 2001).

We do not deny that many people fail to vote for reasons other than the accessibility of precinct sites. Nevertheless, all of the steps we have recommended seem like reasonable methods state and local government can take to improve turnout by treating the accessibility illnesses that continue to plague the system at many locations.

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