A Heteroscedastic Spatial Model of the Vote:
A Model with Application to the United States

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Abstract: How do candidate policy positions affect the citizen's vote choice? From the Downsian tradition, a common response to this question is that voters identify where contending candidates are located on policy space and then select the candidate closest to them. A well-known finding in current models of political psychology, however, is that voters have biased perceptions of the ideological location of competing candidates in elections. In this chapter we offer a general approach to incorporate information effects into current spatial models of voting. The proposed *heteroscedastic proximity model* (HPM) of voting incorporates information effects in equilibrium models of voting to provide a solution to common attenuation biases observed in most equilibrium models of vote choice. We test the *heteroscedastic proximity model* of voting on three U.S. presidential elections in 1980, 1996, and 2008.

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I. Introduction

How do candidate policy positions affect the citizen's vote choice? For over 50 years scholars in political science have built on the standard spatial model inherited from Black (1958) and Downs (1957), where voters assess the relative distance between their own preferred policies and the expected policies to be implemented by competing candidates. The greater the difference between the preferences of the voter and policies of the candidates, the lower the utility the voter derives from selecting them at the polls.

The building blocks of all spatial models of voting are similar: firstly, voters *know* their preferred polices. It may be the case that such preferences are misguided and lead to suboptimal outcomes. But voters know what they want and can compare said policy preferences to those of each of the candidates. Secondly, voters *know* the revealed policy preferences of the candidates. They may use informational shortcuts to assess candidate preferences; they may have imperfect information about likely policy choices; and they may even have very biased views of the policies that different candidates will eventually implement. But voters nonetheless make rational decisions by comparing their perceived distance to the candidates using the available information. And thirdly, preferences are assumed to be transitive and single-peaked, allowing our models to produce sensible theoretical social choice results. While not made explicit in most research, single-peaked preferences are drawn with the assumption that the metric of distances in the policy space are identical for all actors involved. That is, if two parties in the same policy location move, say, to the left a given distance, voters use the same metric to measure this change for both parties.

But what if voters have different perceptions of the movement of parties in the policy space? What if when two parties move, say, to the left in the policy space voters perceive a more dramatic change in one compared to the other? In other words, what if voters have different metrics when assessing their relative distance to different parties? In this chapter we will relax this fundamental assumption of standard spatial models of voting and allow voters to *stretch* or *compress* the policy space measuring the distance from their preferred policy location to that of different parties and candidates. To this end, we propose here a *heteroscedastic spatial model of voting*, where the perceived distance from voters to parties is systematically altered by information effects.

Our emphasis on informational biases is directed at observed inadequacies in the existing research on spatial models of the vote. Previous research has shown that "voters may misestimate the policy platforms of candidates or parties either out of ignorance or in a fashion which reflects systematic bias" (Merrill *et al.* 2001, 200). In particular, respondents tend to overstate the reported proximity to parties which they intend to vote for as well as the distance between themselves and parties which they will not vote for (Granberg and Brent 1980; Granberg and Jenks 1977; Haddock 2003). These biases are not trivial and in many cases contribute adversely to the predictive accuracy of spatial models. Empirical tests of proximity voting often find smaller than expected statistical effects and yield attenuated parameter magnitudes, even if most analysis validate the general tenants of the theory. Furthermore, equilibrium positions for parties are often attenuated, resulting in models that overestimate centrist positions of parties and candidates. Attenuation biases give rise to theoretical problems when trying to ascertain the "correct" location of candidates in policy space and, hence, when testing spatial models of voting under *misreported* proximity. Attenuated proximity estimates and centripetal biases are but one of many puzzles confronting scholars in recent years, as more extensive empirical testing falsifies the theoretical validity of spatial models of voting (e.g., Adams and Merrill 1999; Iversen 1994; Rabinowitz and Macdonald 1989).

Attempts have been made to address the problem. Adams, Merrill, and Grofman (2005), for example, propose a "discount" model in which a weight is assigned to recalibrate the effect of proximity. Others have augmented existing spatial model to include behavioral factors (Erikson and Romero 1990) and information in regards to the candidates' non-policy appeals (Sanders *et al.* 2011). Scholars also have looked to the effect of political institutions, suggesting that centripetal biases are moderated through the consideration of the distribution of power across party actors

(Kedar 2009). Electoral rules have also been shown to alter the incentives facing political parties (Calvo and Hellwig 2011) and the voter's perception of party locations (Dahlberg 2012). More fundamentally, others posit alternative non-proximity models for how party and candidate policy positions enter the vote calculus (Macdonald *et al.* 2001). Many argue that these solutions improve on traditional proximity models. Yet others have used experimental designs to show that proximity voting rules are, in fact, more commonly employed than discounting or directional models (Tomz and van Houweling 2008; see also Lacy and Paolino 2010).

In this chapter our goal is to confront the observed systematic biases in the reported locations of parties and candidates. Working within the standard spatial model of Black and Downs, our emphasis is how information biases contort voter perceptions. The solution we propose allows the analyst to model *how information biases alter the shape of the policy space used by voters to assess their proximity to candidates.* Our model *allows us to alter the perceived distance between the voter and the candidate, allowing the policy space to contract or expand as a function of a variety of covariates.*

The chapter proceeds as follows. The next section elaborates on information biases and how they are reflected in how voters place candidates in policy space. We use data from the 1992, 1996, and 2008 American presidential elections to illustrate the magnitude of these information biases. As a motivating example, we draw from the field of optics and conceive of these biases in terms of ideological lensing, or *magnification*. We provide a naïve estimate of the degree of magnification in the voters' perceived ideological distance from themselves to the candidate. Finally, we propose a heteroscedastic proximity model of voting where magnification is estimated as a function of behavioral and candidate specific covariates. Section 4 reports results of estimating the effect of ideological proximity on vote choice—with and without correcting for magnification—using data from three U.S. presidential elections. Section 5 concludes.

II. Voting with Biased Perceptions of Candidate Positions

Despite decades of research, the literature on how voters decide remains divided by a conceptual gulf. On the one hand, researchers have developed a rich set of models to explain how rational voters make decisions by measuring their relative *proximity* to the policies proposed by candidates and parties. On the other hand, a large body of research shows that voters are ignorant —rationally or not— about politics and, more to the point, the preferences of political candidates running for office.

Contending models of voting differ in important ways. Spatial proximity models assume that voters select among candidates by minimizing the distance from their ideal policy outcome to that proposed by each candidate (Downs 1957; Enelow and Hinich 1984). A competing school argues that voters are motivated by conviction and prefer candidates that take on more extreme positions (Rabinowitz and Macdonald 1989). Finally, a third group of scholars argue that voters also make decisions based on valence-issues, with candidates or parties building a reputation for performance rather than positions (Stokes 1963). Each of these approaches assumes that voters know something about the characteristics of competing candidates for office—be it in terms of policy positions, policy extremity, competence/reputation, or some combination thereof.

The research on political knowledge and voter choice naturally calls into question the validity of said proximity based models of vote choice. Indeed, there is a vast American and comparative literature documenting information deficits and political naïveté among voters. Describing voters' abilities to assimilate candidate positions in summary terms, Converse (1964) succinctly argued that Americans are "ideologically innocent." He showed that very few people could meet the criteria of voting on the basis of a liberal-conservative (or left-right) scale. In his seminar work on public opinion formation, Zaller (1992) largely echoed Converse's view. While the typical voter may know something about politics, such knowledge tends to be shallow and ephemeral. As Zaller (1992, 16) puts it, "a majority pays enough attention to public affairs to learn something about it. But even so, it is easy to underestimate how little typical Americans know about even the most prominent political events – and also how quickly they forget what for a time they do understand." This view certainly calls into question the average American's ability to cast a vote based on candidate positions on one or a set of issues.[1]

There is much evidence in existing survey data to support this more pessimistic view of voters' ability to discern and correctly use information about parties and candidates when making their decisions. Survey respondents differ in predictable ways when reporting the location of parties in the ideological space. Respondents with very different political leanings consistently overestimate their distance to parties with which they do not identify as well as the ideological distance to parties they do not expect to vote for (Adams *et al.* 2005; Bartels 1988; Page 1976).

As an example of this phenomenon, consider voter choice in the 1980, 1996, and 2008 US presidential elections. In Figure 1 we plot respondent placements of the two major party candidates in each of these elections. The graphs illustrate how respondents' self-placements affect their view of where the candidate is located in policy space. Take as example the task of placing the Democratic Party's candidate in 2008, Barack Obama. When asked in to place Obama on the 1-7 liberal-conservative scale, a self-identified "extremely conservative" respondent (scored 7 on the scale) places Obama around 6 (5.8) on the scale if she intends to vote for Obama. A similarly conservative respondent places Obama at less than 2 (1.7) if she instead planned to support another candidate. This can be taken as strong evidence of projection effects: party supporters systemati-

[1] The authors of *The American Voter* (Campbell *et al.* 1960) laid out such criteria for voting according to issue position. These include the ability to cognicize the issue in some form (generally interpreted as have an opinion on the issue), to perceive where the candidates stand on it, and to see a difference between them. To this list, Abramson *et al.* (2009) add that voters must see the positions of the relevant parties or candidates (approximately) correctly if they are to make reasonable decisions.

cally locate the party closer to their own ideal point, while non-supporters place the party further away.[2]

<<Figure 1 about here>>

We might surmise that such biases due to assimilation and contrast effects shape how voters make use of candidates' placements when making their decision (Adams *et al*. 2005; Granberg and Brent 1980; Granberg and Jenks 1977; Merrill *et al*. 2001). As we show in the next section, this picture implies that individual, candidate, and contextual factors may *stretch* or *compress* the policy space, altering the perceived distance between the voter and the candidates. Our contribution in this chapter is to provide a means to model and assess the factors that contribute to what we term *magnification*: the curving of the policy space in response to information. In the next section we propose a novel way to incorporate assimilation and contrasting biases into a spatial model of candidate choice.

III. A Motivating Example to describe *Magnification* (assimilation and contrast) in Policy Distances

Let us begin with a motivating example for our heteroscedastic spatial model of voting. The intuition comes from the field of physics, which has developed an extensive literature on *gravitational lensing*: i.e., the effect that matter exerts on a beam of light from a background source as it travels across the space towards an observer. The curving of a beam of light passing through a lens alters the perceived location of the background source while revealing information about the distribution of matter in space. Such altered perceptions apply to politics as well. When it comes to elite-mass

[2] These biases are not strictly an American phenomenon. For example, British election studies data from 2005 show that when asked to place the Conservative Party on the left-right scale, a voter located on the far-right of the left-right scale identify the Party as very conservative, at approximately 9 (8.9) 0-10 point scale if she voted for one of its candidates. A similarly conservative voter will perceive the Tories as very liberal—at 2.2—if she voted against the party (see Calvo *et al.* 2012). See also Adams *et al.'s* (2005, chapter 10) analysis of survey data from France, Norway, and Britain.

communications, the perceived policy position of a political representative is shaped by the location of the observer—the observer here being the voter. Drawing from an extensive literature on information bias, we describe similar lensing effects in the perceived location of parties in the ideological space.

Let us assume that all voters see the location of a party through a *convex* lens that projects an "image" of the location of the party that differs from its actual location. While we expect all voters to observe the party in a single "true" location in the ideological space, spherical aberration[3] shifts the view of observers so that the image of the party appears closer or further away from its true location. When voting **for** a party, the *focal point* of the object (party or candidate) falls *behind* the object, which appears closer than it should. When voting **against** the party, the *focal* point appears ahead of the object, which is projected further away than it should. We might think of the first of these cases as one where the voter is farsighted (unable to focus at a distance); in the second case the voter is nearsighted.

Just as individuals correct their eyesight with lenses, we can speculate that there is a graduation of this lens which explains the degree of optical aberration in ideological distances. The curvature of this lens can be approximated by a large number of different functions, but for the sake of our example we can use a simple parabola (e.g. a quadratic approximation) estimating the convexity of lenses or the projection of a ray of light on a parabolic mirror.

As an illustrating example, let us use the case of the Republican Party in the U.S. In the model L_{iR} describes the reported location of the Republican Party by respondent *i*. The self-reported ideological position of the same respondent is given by x_i. The quadratic approximation is thus

$$L_{iR} = a + bx_i + cx_i^2. \qquad (1)$$

[3] A convex lens suffers from spherical aberration when light transmitted through the lens fails to converge to a single point. This is known in optics as hyperopia or, more commonly, as farsightedness.

We can center the convex lens of the Republican Party at its projected axis; that is, where there exists an individual x_i^* that observes the "true" location of the Republican Party, designated L_{iR}^*, from a position perpendicular to the principal ideological axis on which the *N* respondents—each with a different image of *R*'s position—are arrayed. This allows us to set $L_{iR}^* = x_i^*$. With this equality, we can use equation (1) to solve for x_i^*. The solution is

$$L_{iR}^* = x_i^* = -\frac{1}{2}\frac{-1+b+\sqrt{1-2b+b^2-4ca}}{c}. \tag{2}$$

When voting for the party, all respondents $x_i \neq x_i^*$ observe images that are either closer to or further away from $L_{iR} \neq L_{iD}^*$ for every $x_i \neq x_i^*$, e.g. magnification.

We can describe this *magnification* (*M*) of the mirror that *i* attaches to *R* as:

$$M_{iR} = \frac{(x_i - L_{iR})^2}{(x_i - L_{iR}^*)^2} \tag{3}$$

Note that magnification is defined as the ratio of two quadratic (Euclidian) distances: the distance from the voter's position and her perception of the candidate's position, and the distance from the voter's position to the "true" location of the party. We can think of the first of these as "reported distance" and the second as "true distance." Thus, when $M < 1$ we have a lens that *stretches* ideological, distance and when $M > 1$ the effect of the lens is to *compress* ideological distance. Moreover, if we had information to explain the degree of magnification in reported data, we could also estimate the "true" rather than the reported distance from the voters to the candidates.

$$(x_i - L_{iR}^*)^2 = \frac{(x_i - L_{iR})^2}{M_{iR}}. \tag{4}$$

While there are many different functional forms that can be used to estimate biases in the perceived location of parties, the previous example serves two purposes. First, it provides the intuition for how we might link lessons from physics to models of voter choice. And second, it provides a point of departure to estimate assimilation and contrast in proximity models of voting.

IV. A Heteroscedastic Proximity Voting Model

The existing literature on assimilation and contrast has shown that reported proximity to parties is different for respondents that expect to vote for or against a party. We can go one step further and argue that a number of covariates will explain assimilation and contrast, compressing and stretching ideological distances as described in equation 4. Indeed, let us assume that magnification is the result of information processes that can be explicitly modeled with covariates.

As it is commonly done when estimating heteroscedastic discrete models (e.g., models in which the variance component is explained by covariates such as heteroscedastic probit models, negative binomial, etc.), we can assume that the level of magnification in ideological proximity can also be itself a function of other covariates. We can therefore use a placeholder parameter θ_{iR} in lieu of our magnification term, which will be used to assess the effect of variables that induce magnification:

$$\mathrm{U}(\mathrm{V_R}) = -\alpha \frac{(x_i - L_{iR})^2}{\exp(\theta_{iR})} + \boldsymbol{BZ} \,. \qquad (5)$$

In equation 5 we have substituted the angular magnification estimate with the exponentiated parameter θ_{iR}, so that $\log(\theta_{iR}) \sim N(\mu_\theta, \sigma_\theta^2)$. Notice that if all covariates for the magnification equation have no effect, the $exp(0) = 1$, and equation 5 will be reduced to the standard proximity model.

As in the case of a heteroscedastic choice model (Alvarez and Brehm 1995), the expression in (5) has the desirable feature of allowing us to model the variance as a linear function of a set of covariates. Yet different from a heteroscedastic model, the variance is only rescaling the ideological proximity measure. The second component of the model, $\boldsymbol{BZ}$, is a vector of individual-specific controls which are unaffected by the covariates for the magnification. Since the variance applies only to distance, we label this a *heteroscedastic proximity model*.

By explicitly modeling the magnification in the ideological scale, equation 5 provides a means for testing arguments about which factors, both individual and systemic, shape the voter's capacity to "see clearly." In particular, this representation provides a novel way to bring in different candidate and voter attributes into the spatial model of the vote and, hence, gives us a strategy for incorporating those factors discussed in the introduction: non-proximal (directional) spatial components, candidates' valence characteristics, and voter attributions. Let's consider each of these in turn.

First, take directional effects. Directional models provide an alternative conception of how voters incorporate information on party positions. First proposed by Rabinowitz and Macdonald (1989), the directional model has long been the chief rival to the proximity model from *within* the spatial modeling tradition. Like the Downsian proximity model, the directional model posits that voters obtain utility from candidates' positions on the issues. This utility is not gained by minimizing proximity but is a positive function of the candidate's distance from the voter. Specifically, when candidates are on opposite sides of the neutral point, N, directional voters prefer the candidate who advocates their side. In the context of American politics, voters select the larger from $(x_i - N)(L_{iR} - N)$ and $(x_i - N)(L_{iD} - N)$.

The explanatory power of directional models relative to the Downsian proximity model has been much contested, and with mixed results.[4] Tests of the two models, however, have compared them directly, with each component affecting voter utility directly and in additive fashion. Conclusions in favor of one or the other often hinge on how analysts measure voter utility or on which modeling assumptions are relaxed (see Lewis and King 1999). Mixed findings aside, directional and proximity effects are typically pitted against one another within the context of a mean model. Tests between rival models are thus on the order of a horse race between variables as analysts discern whether proximity of directional components carry greater weight. Our approach is different. It uses information on the extremity of where respondents place candidates as shaping the degree of angular magnification, rather than on affecting directly the choice model.

[4] Recent research, however, has used experimental designs to get around previous measurement problems and finds stronger support for the proximity view (Tomz and van Houweling 2008; Lacy and Paolino 2010). We take this as instructive evidence for using direction extremity to modify ideological lensing arising from proximity models, rather than the other way around.

Next, consider valence. Our model of ideological lensing provides a new strategy for incorporating candidates' non-policy appeals. A great deal of recent scholarship has emphasized the importance of parties' non-positional related reputations with respect to competence, integrity, charisma, and the like (Adams *et al.* 2005; Clarke *et al.* 2009; Schofield and Sened 2006). These studies demonstrate that the inclusion of non-proximity components into the random utility model yields more complete models for understanding election outcomes and how party strategies respond to voter preferences. We build on this insight. However, rather than incorporating party valence advantages additively, we explore whether valence evaluations bias voters' perceptions of where the party is positioned in ideological space. We know from previous work that valence advantages allow parties to attain larger shares of the vote than they would as predicted solely by spatial considerations.[5] But voters' assessment of a party's location in policy space, on the one hand, and its valence (dis)advantage, on the other hand, are typically assumed to be unrelated to one another.[6] Further, the spatial modeling literature generally assumes that parties' valence advantages are identical across voters.

We relax these assumptions. We model the degree of bias in voter assessments of party positions as a function of the voter's perception of the party's valence appeals. We maintain that if a voter i views the image of a party R as proximally closer to her than R's actual location, then the degree of magnification, M, should decrease. With reference to equation 4, this makes it likely that $(x_i - L_{iR}^*)^2 > (x_i - L_{iR})^2$. To the extent that reputational considerations are built on familiarity, this claim finds support in work on voter choice out of the behavioral tradition which shows that voters dislike uncertainty and resist supporting parties they know little about (even if they share the par-

[5] See especially Adams *et al.*'s (2005) unified model; also see Wittman (1983), Groseclose (2001), Calvo and Hellwig (2011).
[6] Something of an exception is Sanders *et al.* (2011) who model valence as a function of voter-party issue proximity, thus positing that spatial effects shape utility indirectly, through valence characteristics.

ty's policy preferences).[7] Parties who voters view as being more competent, trustworthy, charismatic, and the like, should receive a biased evaluation by the voter in positional terms (that is, the distance between x_i and L_{iR} is small). Lastly, the heteroscedastic proximity model provides a way to model how the effect of voter perceptions of candidate location on the vote is altered by the individual's acquisition of information about politics. As noted above, there exists a large and generally uncontested literature highlighting the dearth of Americans' objective knowledge about political institutions and affairs (Converse 1964; Delli Carpini and Keeter 1996). More contested among scholars is whether such information discrepancies matter for voter choice and, by extension, election outcomes. Perhaps not surprisingly, researchers have sought out different pathways through which information effects are present (Gomez and Wilson 2001; Zaller 2004). Using our heteroscedastic proximity model, we examine whether exposure to information about politics matters for voter choice by sharpening, or "clarifying," the influence of ideological distance.

With this information, the heteroscedastic proximity model is as shown in equation (5) with desirable feature of allowing us to model the variance, θ_{iR}, specified as a linear function of policy extremism, valence, and political information, expressed as

$$\theta_{iR} = \gamma_1 D_{iR} + \gamma_2 T_{iR} + \gamma_3 I_i. \qquad (6)$$

In equation 6, D_{iR} represents voter *i*'s perception of the extremity of *R*'s policy preferences, T_{iR} is *i*'s assessment of *R*'s non-positional qualities, or valence characteristics, I_i represents *i*'s exposure to political information, and the γs are parameters to be estimated. The directional effect, D_{iR}, is scored 1 if the voter places the candidate as more extreme but on the same side of the neutral point as herself, and 0 otherwise. Valence, T_{iR}, is coded +1 if the respondent likes anything about the

[7] See, among others, Alvarez (1997) and Bartels (1996). Enelow and Hinich's (1981) formal model yields consistent predictions.

presidential candidate's party, -1 if she dislikes anything about the party, and 0 otherwise.[8] The political information variable, I_i, is a subjective measure of how much attention the respondent pays to news about government and politics.[9] Finally, note that we control for the respondent's partisan dispositions using the standard ANES seven-point scale for party identification. This is entered into the specification in equation 5 as part of $\boldsymbol{BZ}$, the vector of controls.

We estimate a set of heteroscedastic proximity models—one each for U.S. presidential elections in 1980, 1996, and 2008—using the Markov Chain Monte Carlo (MCMC) engine in WinBUGS (Spiegelthaler *et al.* 2003). We estimate two equations – one for the choice model and the other for the variance component. The choice model is further split between the vector of exogenous controls (party identification), $\boldsymbol{BZ}$, and the ideological distance component, $(x_i - L_{iR})^2$.

Table 1 presents the model results: the choice model includes the estimated effect of ideological distance on the likelihood the respondent selects the candidate. The choice-specific coefficients for partisanship are positively signed and precisely estimated in each case. Our interest, however, lies with the results for ideological distance. Here, we observe differences in the effect of positional proximity in models that do model the variance as a function of ideological extremity, valence, and information (Models 2, 4, 6) and those that do not (Models 1, 3, 5). When the variance model is left unspecified, parameter estimates on *Ideological Distance*, while negatively signed, are imprecisely estimated. However, when we do specify the variance, these estimates in the choice model attain statistical significance. This finding holds across the 1980, 1996, and 2008 elections. The remaining covariates pertaining to directional, valence, and information effects are specified to

[8] Specifically, the American National Election Studies surveys ask respondents to identify whether there is anything they like about the Democratic and Republican Parties. This is followed by an item asking whether there is anything they dislike about the two main parties. With responses to these two binary choice items, we construct a three-point scale scored -1 dislike only, 0 for neither like nor dislike, or both like and dislike, and +1 for like only.

[9] The measure is coded 1 = "don't pay much attention," 2 = "pay some attention," 3 = "pay a great deal of attention."

account for *variations* about the voter's decision with respect to ideological proximity. We consider each in turn.

<<Table 1 about here>>

Explaining the Effect of Candidate Extremity on Proximity Voting

First consider the influence of directional effects. The heteroscedastic specification implies that the ideological space is stretched so that candidates' distance to voters differs as they move to the extreme or to the center of the ideological space. A positively signed coefficient on the directional term would indicate ideological distance matters less when that when the candidate is more extreme than the voter, and on the same side of *N*, than otherwise. A negative sign, on the other hand, means that the penalty attached to the non-proximal candidates is greater. That is, while the proximity model attaches a penalty to candidate R when L_{iR} is far from x_i, the magnitude of that penalty is greater if $\gamma_1 < 0$. Table 1 shows that this is in fact the case for the 1980 and 1996 elections. In these cases, voters who viewed the candidate as more extreme than themselves put greater (negative) weight on ideological distance than voters who did not. In terms of ideological lensing, the directional effect *stretches* the distance between the voter and the candidates. This story does not apply, however, to the 2008 election. In this case, γ_1 is indistinguishable from zero, meaning that extremely placed candidates receive no penalty on policy terms.

These results suggest that in 1980, a typical voter *i* was less and less likely to support Ronald Reagan or Jimmy Carter for president as a function of how extreme he viewed the particular candidate's ideology to be. In 1980 the large and precisely estimated coefficient on *Directional Effect* indicates that she assigns a relatively heavy penalty on extreme position-taking candidates. The same story applies to 1996. The negatively signed coefficient on the directional term in the variance equation implies that proximity voters punished the candidates, Bob Dole and Bill Clinton, for taking what they perceived as extreme positions. However, the "extremity penalty" confronting

Dole and Clinton in 1996 was less than that facing Reagan and Carter in 1980, as evinced by the relative sizes of the coefficients. And by 2008, this penalty had altogether disappeared: taking extreme positions (on the preferred side of the neutral point) had no adverse effect on proximity voting. We can infer from this result that the candidates in 2008, John McCain and Barack Obama, did not suffer from coming across as either too conservative or too liberal or conservative the way their predecessors did.

Explaining the Effect of Valence on Proximity Voting

Next consider valence effects. Unlike the directional effect, coefficients estimated for the valence parameters are consistent across elections: in 1980, 1996, and 2008, the estimate on *Party Valence* is positively signed and statistically significant. In terms of the heteroscedastic model, this means that as valence increases, the voter's perceived ideological distance,$(x_i - L_{iR})^2$, shrinks. Put differently, as the distance between the voter's preferred policy location and that of the party increases, higher valence makes the distance smaller and the disutility smaller. As a party's valence advantage goes up, the effect of ideological distance on the vote becomes smaller. In the extreme, if valence is sufficiently high, a voter will perceive that the candidate is "right next to her," irrespective of the policy proposed, and the utility of spatial proximity voting will remain constant. In effect, *as a candidate's valence advantage approaches its maximum, he becomes spatially closer to each and every voter in the population*.

Figure 2 illustrates this effect for a moderately liberal voter (located at 3 on 1-7 scale) using parameter estimates from Model 6 in Table 1 for the 2008 election. If the candidate is also located at 3, then *i* prefers the candidate with equally high probability (~0.63) regardless of its valence level.[10] But as the candidate moves away from *i*'s preferred location, it loses less utility if it is deemed to have high valence (solid line) than if it has low valence (dashed line). Notice that this interpreta-

[10] In this illustration, the other candidate in the two-candidate race is placed at 5 on the 1-7 scale.

tion shows that the effect of high valence is to "drown out" spatial proximity as a determinant of voting. By contrast, as valence declines, the effect of spatial proximity becomes more pronounced.

<<Figure 2 about here>>

The intuition is straightforward and surprising: voters will perceive low valence parties as ideological and high valence parties as pragmatic, irrespective of their actual policy location. In other words, voters who attach high valence marks to their party will see them close to themselves and pragmatic, while parties with low valence will appear further removed and much more ideological. Again, this trait remains constant in all model results.

Attention to News and Ideological Distance

Finally, consider information effects, captured in our models as attention to political news. Many researchers have sought to ascertain the influence of political information on an individual's voting behavior. We examine what effect, if any, information acquisition has on ideological lensing. The same logic applies as above: a positive coefficient on the information variable in the variance component implies that ideological distance is *compressed*, or that ideology matters for voter utility among informed individuals. A negative coefficient, on the other hand, implies that the politically informed are more likely to use ideological proximity to inform their vote—in this case, information *stretches* distance. Results show that that our information measure, *Attention to News*, does not exert the same general effect across the three elections. In the 1980 and 1996 polls, attention to news had no biasing effect on *Ideological Distance*. In 2008, however, the coefficient on *Attention to News* is precisely estimated and negatively signed. This means that *among those located proximally close* to a candidate (say Barack Obama), the utility of voting for Obama was greater as information levels increased. This utility, however declines rapidly among the informed as the candidate moves away from the voter, i.e., as $(x_i - L_{iR})^2$ increases. Among the less informed ideology matters less: the gains from proximally located candidates are lower but so are the losses incurred by moving further away on the ideological continuum. Figure 3 illustrates this dynamic, again using parameter estimates from the 2008 election. We again set $x_i = 3$.

<<Figure 3 here>>

Taken together, the results of these heteroscedastic proximity models provide insights into American presidential politics. Voters in the United States do select candidates to the office of president based policy (ideological) considerations. The voter's view of the candidates' policy positions, however, is highly biased, particularly but not exclusively among those at self-identify at the extreme positions on the liberal-conservative scale (see Figure 1). And once we model the "shape" of this lensing effect, ideological distance becomes a stronger predictor of voter utility (Table 1). Yet perhaps of greatest interest to students of American politics come from when we model the lensing effects via the heteroscedastic proximity model of voter utility. Comparing the voter's calculus in the 1980, 1996, and 2008 elections, we uncover a mix of continuity and change. Not surprisingly, partisanship and ideology matter, and do so consistently. Candidates' non-positional valence appeals, with respect to competence, integrity, and the like, also matter across elections—yet we provide a novel means for showing how valence blunts the proximity effect.

V. Concluding Remarks

The assumptions undergirding spatial models of voting are by now familiar: 1) voters *know* their preferred polices; 2) voters *know* the revealed policy preferences of candidates; and 3) voter preferences are transitive and single-peaked. Employing a novel *heteroscedastic proximity model*, we are able to relax these assumptions. In particular, we allow voters to use different metrics when measuring their relative proximity to parties. Furthermore, we show that information effects *stretch* and *compress* the policy space in systematic ways. While we have not been the first to acknowledge this perceptual bias in the voters' perceptions, our work offers a more cogent and theoretically informed way (a) to measure ideological lensing and (b) to correct for it.

By allowing spatial distances to vary in response to changes in information, our *heteroscedastic proximity* approach is able to explain attenuation biases in current proximity models of voting. Drawing on insights from physics, this research sheds new light on the problems of—and offer solutions to—ideological lensing in elections. Borrowing from lens models in optics, we assume that individuals observe the image of a party located in the ideological space rather than the actual location of a party.

In this chapter, we applied the heteroscedastic proximity model to three presidential elections in the United States. As a means to correct for—or make adjustments to—ideological aberration, we model the level of angular magnification in proximity voting via a trio of non-proximity covariates. Our model of magnification includes a directional component, a valence component, and an information component. Using this *heteroscedastic* proximity model, we show that the directional component and the information component both vary across electoral contests. Regarding direction, our three-period analysis shows that the penalty of candidates' taking extreme positions as declined over time. Indeed, the size of the coefficient on the directional effect, D_{iR}, is half as great in 1996 as in 1980, and by 2008 is essentially zero. This trend suggests that while presidential candidates used to be penalized by taking extreme positions on the issues, such penalties have declined with time. This tendency comports with a general sentiment that American politics has become polarized and that such polarization is electorally sustainable (McCarty *et al.* 2005). As for political information, our results imply that in earlier periods, access to information had no effect in terms of enhancing (stretching) or blunting (compressing) the effects of voter and candidate policy positions. However, in the recent 2008 election, proximity voting was stronger among the more politically informed. Both of these changes comport with common characterizations of the changing, increasingly volatile nature of presidential politics in the United States.

Future work on elections in the U.S. and elsewhere should might extend and improve upon the framework we have provided. For example, extrapolating from current trends, it might be the case that the heteroscedastic proximity model applied to the 2012 U.S. election would yield a positive coefficient on the directional parameter, indicating that proximity voting is *greater* among those perceiving candidates as more extreme. Future work might also distinguish among different sources of political information. Are viewers of more politically charged news outlets like Fox News or MSNBC more likely to vote on the basis of ideological proximity than those receiving information from other sources? In short, our contribution has provided a tool for systematically comparing these effects across elections and, in turn, a means for deepening our understanding about how voters decide.

References

Abramson, Paul R., John Aldrich, and David W. Rohde. 2009. *Change and Continuity in the 2008 Elections*. Washington D.C.: CQ press.

Adams, James, and Samuel Merrill III. 1999. "Modeling Party Strategies and Policy Representation in Multiparty Elections: Why are Strategies so Extreme?" *American Journal of Political Science* 43: 765-91.

Adams, James, Samuel Merrill III, and Bernard Grofman. 2005. *A Unified Theory of Party Competition*. New York: Cambridge University Press.

Alvarez, R. Michael. 1997. *Information and Elections*. Ann Arbor: University of Michigan Press.

Alvarez, R. Michael, and John Brehm. 1995. "American Ambivalence Toward Abortion Policy: Development of a Heteroskedastic Probit Model of Competing Values." *American Journal of Political Science*.

Bartels, Larry. 1988. *Presidential Primaries and the Dynamics of Public Choice*. Princeton, NY: Princeton University Press.

Bartels, Larry. 1996. "Uninformed Votes: Information Effects in Presidential Elections." *American Journal of Political Science* 40: 194-220.

Black, Duncan. 1958. *The Theory of Committees and Elections*. New York: Cambridge University Press.

Calvo, Ernesto, and Timothy Hellwig. 2011. "Centripetal and Centrifugal Incentives under Different Electoral Systems." *American Journal of Political Science*. 55(1): 27-41.

Calvo, Ernesto, Timothy Hellwig, and Kiyoung Chang. 2012. "The Eye of the Beholder: Ideological Lensing, Information Effects, and the Vote." Paper presented Paper prepared for the conference "Contemporary Applications of the Spatial Model," Instituto Juan March, 27 April 2012.

Campbell, Angus, Philip Converse, Warren Miller, and Donald Stokes. 1960. *The American Voter*. New York: Wiley.

Clarke, Harold D., David Sanders, Marianne C. Stewart, and Paul F. Whiteley. 2009. *Performance Politics and the British Voter*. Cambridge: Cambridge University Press.

Converse, Philip. 1964. “The Nature of Belief Systems in Mass Publics.” In *Ideology and Discontent*, ed. David Apter. New York: Free Press. pp. 206-261.

Dahlberg, Stefan. 2012. “Does Context Matter? The Impact of Electoral Systems, Political Parties and Individual Characteristics on Voters’ Perceptions of Party Positions.” Unpublished manuscript, University of Gothenburg.

Delli Carpini, Michael, and Scott Keeter. 1996. *What Americans Know about Politics and Why It Matters*. New Haven, CT: Yale University Press.

Downs, Anthony. 1957. *An Economic Theory of Democracy*. New York: Harper and Row.

Enelow, James M, and Melvin J. Hinich. 1981. “A New Approach to Voter Uncertainty in the Downsian Spatial Model.” *American Journal of Political Science* 25(3): 483-93.

Enelow, James M, and Melvin J. Hinich. 1984. *The Spatial Theory of Voting: An Introduction*. New York: Cambridge University Press.

Erikson, Robert, and David Romero. 1990. “Candidate Equilibrium and the Behavioral Model of the Vote.” *American Political Science Review* 84: 1103-26.

Granberg, Donald, and Edward Brent. 1980. "Perceptions of Issue Positions of Presidential Candidates: Candidates are often perceived by their supporters as holding positions on the issues that are closer to the supporters' views than they really are." *American Scientist* no. 68 (6):617-625.

Granberg, Donald, and Richard Jenks. 1977. "Assimilation and Contrast Effects in the 1972 Election." *Human Relations* no. 30 (7):623-640.

Gomez, Brad T., and J. Matthew Wilson. 2001. "Political Sophistication and Economic Voting in the American Electorate: A Theory of Heterogeneous Attribution." *American Journal of Political Science* 45 (October): 899-914.

Groseclose, Tim. 2001. "A Model of Candidate Location When One Candidate Has a Valence Advantage" *American Journal of Political Science*. 45 (October): 862-86.

Haddock, Geoffrey. 2003. "Making a Party Leader Less of a Party Member: The Impact of Ambivalence on Assimilation and Contrast Effects in Political Party Attitudes." *Political Psychology* no. 24 (4):769-780.

Iversen, Torben. 1994. "Political Leadership and Representation in Western European Democracies: A Test of Three Models of Voting." *American Journal of Political Science* 38: 45-74.

Kedar, Orit. 2009. *Voting for Policy, Not Parties*. New York: Cambridge University Press.

Lacy, Dean, and Philip Paolino. 2010. "Testing Proximity versus Directional Voting using Experiments." *Electoral Studies* 29(3): 460-71.

Lewis, Jeffrey B., and Gary King. 1999. "No Evidence on Directional vs. Proximity Voting." *Political Analysis* 8(1): 21-33.

Macdonald, Stuart Elaine, George Rabinowitz, and Ola Listhaug. 2001. "Sophistry versus Science: On Further Efforts to Rehabilitate the Proximity Model." *Journal of Politics* 63(2): 482-500.

McCarty, Nolan, Keith Poole, and Howard Rosenthal. 2005. *Polarized America: The Dance of Ideology and Unequal Riches*. Cambridge, MA: MIT Press.

Merrill, Samuel III, Bernard Grofman, and James Adams. 2001. "Assimilation and Contrast Effects in Voter Projections of Party Locations: Evidence from Norway, France and the USA." *European Journal of Political Research* 40(2): 199-221.

Page, Benjamin I. 1976. "The Theory of Political Ambiguity." *American Political Science Review* 70(3): 742-52.

Rabinowitz, George, and Stuart Elaine McDonald. 1989. "A Directional Theory of Issue Voting." *American Political Science Review* 83: 93-121.

Sanders, David, Harold D. Clarke, Marianne C. Stewart, and Paul Whiteley. 2011. "Downs, Stokes, and the Dynamics of Electoral Choice." *British Journal of Political Science* 41(3): 287-314.

Schofield, Norman, and Itai Sened. 2006. *Multiparty Democracy: Elections and Legislative Politics*. New York: Cambridge University Press.

Spiegelhalter, David, Andrew Thomas, Nicky Best, Dave Lunn. 2003. WinBUGS user Manual 1.4, Cambridge UK. {http://www.mrc-bsu.cam.ac.uk/bugs}.Stokes, Donald. 1963. "Spatial Models of Party Competition." *American Political Science Review* 57: 368-77.

Tomz, Michael, and Robert P. van Houweling. 2008. "Candidate Positioning and Voter Choice." *American Political Science Review* 102(3): 303-318.

Wittman, Donald. 1983. "Candidate Motivation: A Synthesis." *American Political Science Review* 142-57.

Zaller, John R. 1992. *The Nature and Origins of Mass Opinion*. New York: Cambridge University Press.

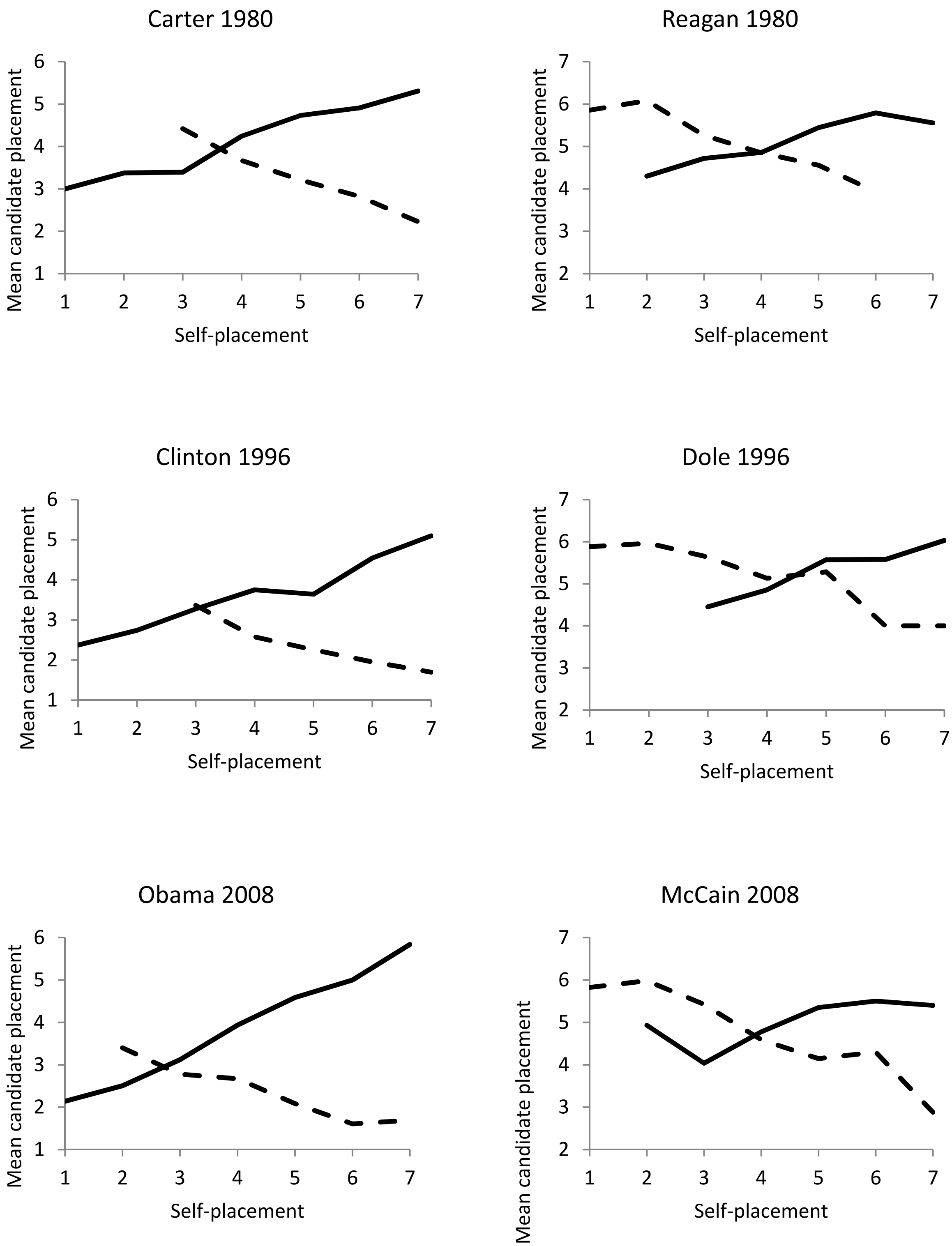
Zaller, John R. 2004. "Floating Voters in U.S. Presidential Elections, 1948-2000." In W.E. Saris and P.M. Sniderman, eds., *Studies in Public Opinion: Attitudes, Nonattitudes, Measurement Error, and Change*. Princeton, NJ: Princeton University Press.

Table 1. Heteroscedastic Proximity models

	1	2	3	4	5	6
	1980	1980	1996	1996	2008	2008
Choice Model						
Ideological Distance	-0.068	-0.067	-0.065	-0.190	-0.056	-0.039
	(0.746)	(0.018)***	(0.302)	(0.033)***	(0.060)	(0.010)***
Party Identification	0.029	0.040	0.071	0.094	0.096	0.099
	(0.009)**	(0.009)***	(0.008)***	(0.009)***	(0.008)***	(0.011)***
Constant	-0.290		-0.750		-0.594	
	(10.973)		(4.656)		(1.080)	
Ideological Variance Model						
Directional Effect		-0.811		-0.398		-0.028
		(0.171)***		(0.118)**		(0.198)
Party Valence		0.747		0.698		1.252
		(0.092)***		(0.101)***		(0.132)***
Attention to News		-0.088		0.078		-0.210
		(0.099)		(0.046)+		(0.067)**
LogLik	-1102.1	-998.7	-1389.2	-1075.8	-1717.4	-753.1
N	1838	1736	2570	2076	3064	1418

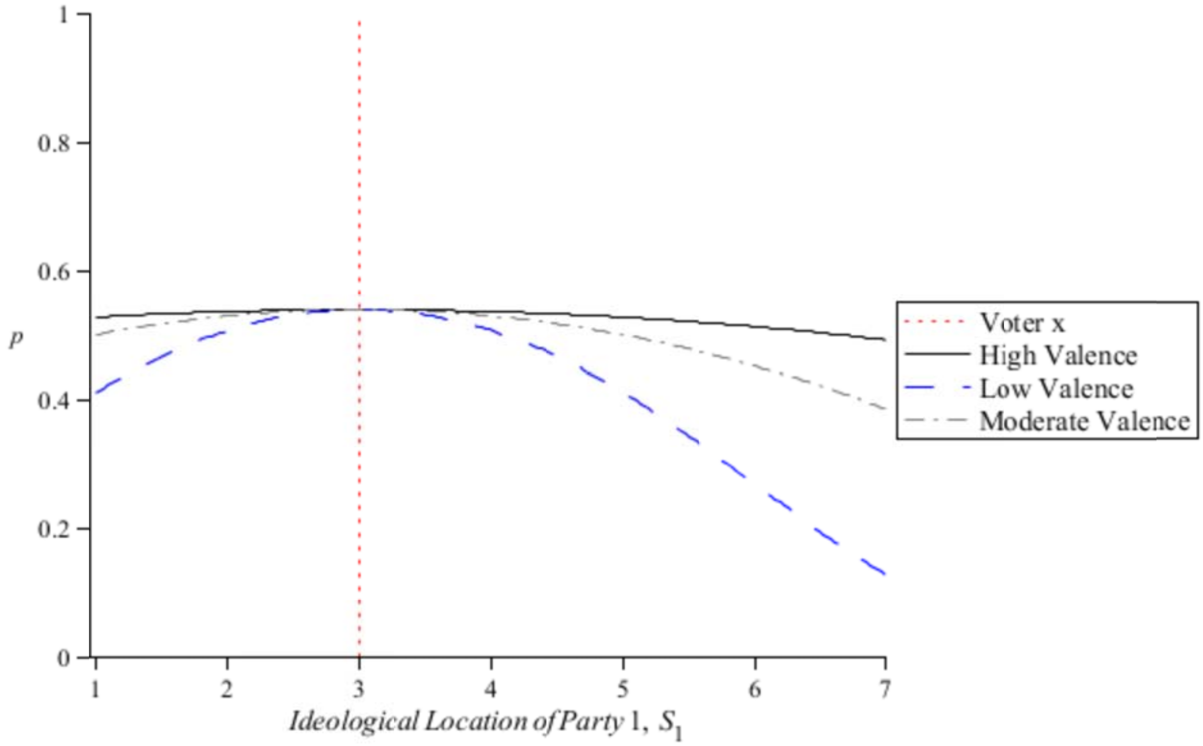
Notes: Cells report coefficients and standard errors from estimating heteroscedastic proximity model described in the text. ****p*<0.001, ***p*<0.01, **p*<0.05, +*p*<0.1, two-tailed tests.
Source: American National Election Studies.

Figure 1. Mean Candidate Placements versus Self-Placements, US 1980, 1996, 2008



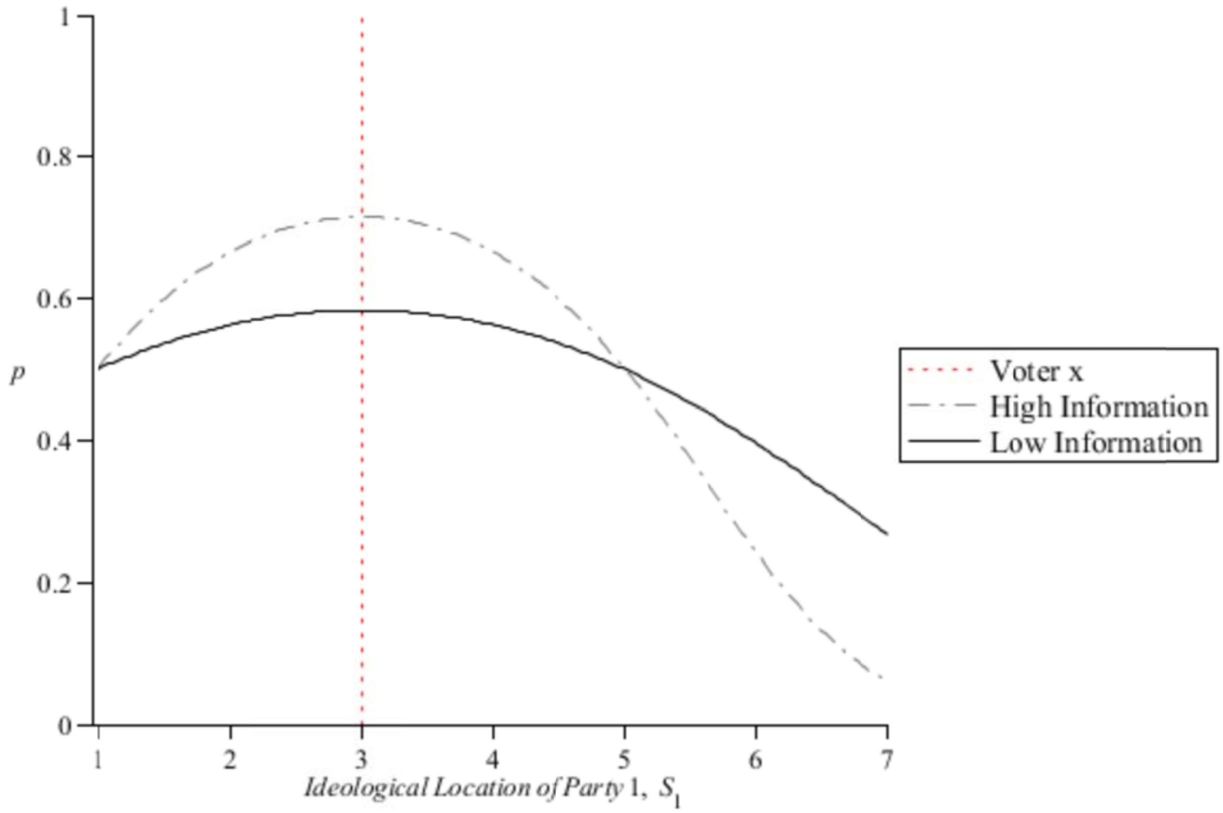
Notes: solid lines report mean candidate placements among candidate supporters, dashed lines report mean candidate placements among non-supporters. Means with 10 or fewer respondents not reported. Source: American National Election Studies.

Figure 2. The Effect of Party Valence in the Heteroscedastic Proximity Model



Notes: Figure displays the probability voter *i* intends to vote for a candidate as the candidate moves in policy space. Voter *i* is located at 3 on the 1-7 ideology scale. The other candidate (not shown) is located at position 5. The figure indicates how the candidate's position as perceived by *i* (horizontal axis) and *i*'s perceived valence of the candidate's party (solid and dashed lines) affect the probability *i* supports the candidate. Simulated probabilities are based on parameter estimates from Table 1 Model 6 for the 2008 U.S. presidential election.

Figure 3. The Effect of Information (Attention to News) in the Heteroscedastic Proximity Model



Notes: Figure displays the probability voter *i* intends to vote for a candidate as the candidate moves in policy space. Voter *i* is located at 3 on the 1-7 ideology scale. The other candidate (not shown) is located at position 5. The figure indicates how the candidate's position as perceived by *i* (horizontal axis) and *i*'s level of attention to news (solid and dashed lines) affect the probability *i* supports the candidate. Simulated probabilities are based on parameter estimates from Table 1 Model 6 for the 2008 U.S. presidential election.