

Advertising Competition in Presidential Elections*

Brett R. Gordon

Columbia University

Wesley R. Hartmann

Stanford University

April 29, 2013

Abstract

Presidential candidates in the U.S. compete by strategically placing their advertisements across markets based on each state's potential to tip the election. The winner-take-all nature of the Electoral College concentrates most advertising in battleground states, thereby ignoring the majority of voters. We evaluate the alternative of a direct vote which removes state-level contests and counts each vote equally in determining the president. Using data from 2000, we estimate an equilibrium model of advertising competition between presidential candidates. We solve for the equilibrium distribution of advertising under the direct vote to better evaluate the distortions of the Electoral College. We find that while states' political preferences drive competition in the Electoral College, competition in a direct vote focuses on finding the cheapest advertising targets. Nevertheless, the inclusion of less contentious states in the direct vote increases total expenditures by 25% and turnout by two million voters.

Keywords: Political advertising, presidential election, electoral college, direct vote, resource allocation, voter choice, contests.

*We thank Ron Goettler, Mitch Lovett, Sridhar Moorthy, Michael Peress, Ron Shachar, Ali Yurukoglu, and seminar participants at Columbia, Erasmus, Helsinki (HECER), Kellogg, Leuven, MIT Sloan, NYU Stern, Stanford GSB, Toronto, University of Pennsylvania, USC, Yale, Zürich, NBER IO, QME, and SICS for providing valuable feedback. All remaining errors are our own. Email: brgordon@columbia.edu, hartmann_wes@gsb.stanford.edu.

1 Introduction

Advertising is a critical instrument of competition between political candidates. In 2012, three billion dollars was spent on television advertising, representing the largest component of candidates' media expenditures (TVB 2013). Candidates in the presidential general election strategically allocate their funds to media markets most likely to tip the election's outcome. The majority of advertising focuses on a minority of voters who reside in so-called battleground states where significant uncertainty exists over the eventual winner of the state-level contest. Candidates pay scant attention to the majority of the electorate residing in more polarized states where the outcome is foregone. This geographic and concentrated nature of competition arises from the state-level winner-take-all contests in the current Electoral College system.¹ Proposals to eliminate the Electoral College and its distortions typically consider the alternative of a direct popular vote, which would eliminate the battleground state distinction by giving equal weight to each vote in determining the president.

Public interest in eliminating the Electoral College has swelled when the respective winners under the electoral vote and the popular vote are in conflict.. Such dialogue arose following the 2000 election when Al Gore won the popular vote but lost the Electoral College to George W. Bush (New York Times, 2000). A post-election poll found that Democrats were 50 percent more likely to support eliminating the Electoral College than Republicans (CNN/Time Poll 2000). The situation was reversed just prior to the 2012 election. When polling data suggested Romney might win the popular vote but lose the election, a Republican strategist noted that their base would "be screaming that Romney should be president," (Washington Post 2012). Implicit in both reactions is the reliance on the popular vote to evaluate the outcome in the absence of the Electoral College. However, altering the election mechanism would change candidates' strategies and hence voters' choices.

To provide a better understanding of the forces that shape candidates' strategies, we build and estimate an equilibrium model of advertising competition between candidates. We use the model

¹48 states allocate all of their electoral votes to the presidential candidate who receives the majority of the votes cast within the state. The two exceptions are Maine and Nebraska, which have used a congressional district method since 1972 and 1996, respectively. However, in practice, both states have always allocated all of their votes to a single candidate.

to compare competition and outcomes in the Electoral College and a counterfactual with a direct vote. Although states where voters' preferences are equally divided between the candidates draw the most attention under the Electoral College, in a direct vote we find that voters' preferences are secondary relative to local advertising prices in shaping candidates' geographic targeting strategies. Despite the price of advertising leading candidates to seek out "cheap votes," the results indicate that removing the Electoral College would increase both spending and turnout as voters across all states are brought into the political process.

Our model seeks to equate candidates' local (e.g., market-specific) marginal benefits of advertising to local advertising prices. A candidate's local marginal benefit of advertising is the product of (1) the change in the probability of winning and (2) the dollar value of such a change. The first term results from the election mechanism, voters' preferences, and candidates' uncertainty over voters' preferences. The second term is a candidate-election specific parameter that translates marginal probabilities into dollar terms and serves as our measure of a candidate's financial strength. Although the model abstracts away from a more formal fundraising and budget process, our specification is able to parsimoniously endogenize candidates' spending levels across an array of election mechanisms and counterfactuals.

We estimate the candidate model using data from the 2000 general election for president of the United States. We form moments in a GMM specification around the first-order conditions for candidates' advertising decisions, which balances the local marginal benefits and costs of advertising. Estimation allows us to recover each candidate's financial strength and the uncertainty over the election's eventual outcome. We identify a candidate's financial strength as the amount needed to rationalize observed expenditures and we identify their uncertainty by their willingness to spend money in ex-post uncontested states. The voter model is estimated using a slight modification of Gordon and Hartmann (2013)'s analysis of advertising effects with data from 2000 and 2004.²

In a counterfactual experiment with a direct vote in 2000, we find that all states receive positive advertising. Advertising is more equitably distributed: the mean and standard deviation of exposures per person are 91 and 110 under the Electoral College, compared to 115 and 41 under the direct

²Despite our focus on 2000 for the candidate model and direct vote counterfactual, the voter estimates are still recovered using 2000 and 2004 data so that we can include market fixed effects to resolve biases in estimating the advertising effects.

vote, respectively. However, advertising exposures are “tilted” such that markets with left-leaning voter preferences receive 20% fewer exposures per person. This discrepancy is due to systematically higher advertising costs per voter in left-leaning markets.

To understand this variation in exposures, we consider a set of simulations that make the model more symmetric and recompute the equilibrium. First, we equalize both the price of advertising (per voter) across all markets and make candidates symmetric in their financial strength.³ We find this yields a nearly uniform distribution of advertising exposures, despite the underlying geographic variation in voters’ political preferences. Second, we restore the asymmetry in candidates’ financial strengths while still holding ad prices constant across markets. We find that Bush, the stronger candidate, advertises 30 percent more on the left than the right. The fact that the actual direct vote outcome has less advertising on the left suggests this incentive is overwhelmed by the role of advertising prices. Third, this point is made clear after restoring the variation in advertising prices and making candidates symmetric. In this scenario the right leaning markets receive 31% more exposures per person than left-leaning markets. Thus, local voter preferences, which are the source of advertising distortions in the Electoral College, take a secondary role to advertising prices when candidates compete in a direct vote.

Finally, under a direct vote, a state’s influence in the election outcome is proportional to its turnout. We find that a direct vote removes the Electoral College’s bias that tends to favor small states relative to their percentage of the national population. However, several states receive less proportional influence than their populations might warrant. California, Texas, Florida, Georgia and Arizona receive the least representation relative to their population, while Minnesota, Wisconsin, Michigan and Ohio receive the greatest representation relative to their population.⁴

Our analysis contributes to both the largely theoretical political economy literature on candidate resource allocation and to the structural econometric literature on advertising.⁵ Early game-theoretic

³Advertising costs vary based on demographics, population density, and other factors such that, for example, reaching 1000 people in Las Vegas costs about five times more than in Oklahoma city.

⁴These under and over-represented states in the direct vote are determined based on their predicted turnout rates. It is useful to note that a current battleground state is included in each group suggesting that this is not arising from any inability of our model to properly account for turnout effects of battleground-ness. In addition, while many of the under-represented states list above have large immigrant shares, New York with the second largest non-citizen share is absent from this group.

⁵Our model could also be viewed in relation to the literature on contests (Tullock 1980). An election is a contest where the payoff function combines the winner-take-all feature of winning the election with the sunk costs of a

analyses in political science primarily sought to explain observed allocations (Friedman 1958, Brams and Davis 1974, Colantoni et al. 1975, Owen 1975, Bartels 1985).⁶ Snyder (1989) extends this work to study two-party competition under more realistic modeling assumptions. More recent research is either descriptive (e.g., Nagler and Leighley 1992, Shaw 2006, 2009) or focuses on decomposing the factors behind resource allocations in the Electoral College (e.g., Grofman and Feld 2005, Strömberg 2008).

Our paper is most closely related to Strömberg (2008), which also considers how presidential resource allocations would change under a direct vote. However, the models and estimation strategies differ substantially. First, we use an aggregate discrete-choice model of voters in the style of Berry (1994) to address the endogeneity of advertising. Strömberg (2008), building on Lindbeck and Weibull (1987), uses a probabilistic-voting model and does not recover the marginal effect of a candidate’s visit on voting outcomes. Second, we impose the model’s equilibrium on the data to estimate candidates’ parameters, whereas Strömberg (2008) does not use candidates’ choices to recover the parameters of the candidates’ game. Third, our analysis focuses on how asymmetries in candidates’ financial strength and variation in market-level advertising costs simultaneously affect outcomes.

In contrast to the political economy literature, we pursue a structural econometric approach to study advertising allocations in the Electoral College and a direct vote. In doing so we extend the structural econometric literature on advertising both substantively and methodologically. The relevant empirical literature on advertising considers a variety of topics: the informational effects of advertising (e.g., Akerberg 2003 and Goeree 2008), measuring dynamic effects (e.g., Sahni 2012), and how firms make intertemporal advertising decisions (e.g., Dubé, Hitsch, and Manchanda 2005 and Doganoglu and Klapper 2006). Although these factors are likely relevant in presidential campaigns, the primary strategic dimension for candidates is, however, geographic. Therefore we develop and estimate a model where advertising decisions are interdependent across markets. Our model also recovers an advertiser’s uncertainty about demand by comparing ex-ante allocations and

candidate’s advertising investments. A presidential election aggregates a set of state-level contests to a single outcome.

⁶A related literature focuses on measuring various biases in the Electoral College by quantifying the notion of pivotal voting power in a game (Banzhaf 1968, Blair 1979, Katz, Gelman, and King 2002, Gelman, Katz, and Bafumi 2004).

ex-post realizations of demand. Together these features extend the econometrics of advertising to the context of presidential elections where the stakes of advertising are arguably more important than in many applications with firms.

Finally, this paper extends the literature on contests (e.g., Tullock 1980, Dixit 1987, Kvasov 2007). General presidential elections in the United States represent contests where competition occurs across multiple dimensions (e.g., advertising in multiple media markets). The Electoral College is a nested contest where the final contest outcome depends on the sum of binary outcomes in state-level contests. In analyzing such a contest econometrically, we define a computational approach for calculating marginal effects that applies generally to both contests and to single-agent effort allocation problems with outcomes based on a threshold. In the literature’s terminology, a central component of the model is a contest success function that satisfies common theoretical axioms (see Skaperdas, 1996) but is estimated from data on voters’ choices..

The rest of the paper is organized as follows. Section 2 presents the voter and candidate models. Section 3 discusses the data set. Section 4 explains our estimation strategy, which focuses on recovering the candidate model’s parameters. Section 5 presents our counterfactual results under the direct vote. Section 6 concludes.

2 Model

We develop a model of strategic interaction between presidential candidates in the general election. The game has two stages. First, candidates campaign in election t through advertising to influence voters’ preferences. This campaign activity occurs in a single period as candidates $j = 1, \dots, J$ form rational expectations about voter preferences and then simultaneously choose advertising levels $A_{tj} = [A_{t1j}, \dots, A_{tmj}, \dots, A_{tMj}]'$ across M markets. Advertising is the same across counties within market m , such that $A_{tmj} = A_{tcj}, \forall c \in m$. Candidates allocate advertising before votes are cast and are uncertain about future market-specific demand shocks η_{tmj} that could influence voters’ decisions.

Second, at the conclusion of campaigning is Election Day, on which voters perfectly observe the demand shocks and candidates’ advertising choices. A voter chooses the candidate who yields

the highest utility for the voter or opts not to vote. At the conclusion of the second stage, voting outcomes across all counties are realized and one candidate is deemed the winner. In our application, we set $J = 2$ and ignore minor party candidates for simplicity. Gordon and Hartmann (2013) estimate a version of this voter model extended to include third-party candidates.

The model differs in an important way from standard equilibrium models of differentiated products in the industrial organization literature (e.g., Berry et al. 1995). Typically both consumers and firms perfectly observe demand shocks, which affect firms' pricing decisions. In contrast, uncertainty over voter preferences is an important determinant of candidates' advertising decisions. Candidates in our model form beliefs over market-level demand shocks at the time of their advertising decisions, which must be made prior to Election Day.

2.1 Voters

Each voter resides in some county $c = 1, \dots, C$ which belongs to some state, $s = 1, \dots, S$. Advertising decisions are, however, made at the media market (DMA) level $m = 1, \dots, M$. Let $c \in s$ denote the set of counties in state s and similarly for $c \in m$. A voter's utility for candidate j in election t is:

$$\begin{aligned} u_{itcj} &= \beta_{tj} + g(A_{tmj}; \alpha) + \phi' X_{tc} + \gamma_{mj} + \xi_{tcj} + \varepsilon_{itcj} \\ &= \delta_{tcj} + \varepsilon_{itcj} \end{aligned} \tag{1}$$

where δ_{tcj} is the mean utility of the candidate. We will often refer to δ_{tcj} as representing voters' local preferences. β_{tj} is the average preference common across all locations for a candidate in election t . $g(A; \alpha)$ permits advertising to have a diminishing marginal effect. X_{tc} is a vector of observables, which might be at the county or market level, that shift voters' decisions to turnout for the election or their decision to vote for a particular candidate. The γ_{mj} are DMA-party fixed effects that represent the mean time-invariant preference for a party in a given market (e.g., to capture the fact that Democrats consistently do well in Boston and that Republicans consistently do well in Dallas). ξ_{tcj} is an election-county-party demand shock and ε_{itcj} captures idiosyncratic variation in utility, which is i.i.d. across voters, candidates, and periods. If a voter does not turnout for the election, she selects the outside good and receives a utility of $u_{itc0} = \varepsilon_{itc0}$.

The fixed effects γ_{mj} help address the endogeneity of advertising because they capture any

unobserved characteristics that vary across markets and parties. Thus, any correlation between advertising and market-specific party preferences is controlled for without the need for an instrument. We use instrumental variables, explained in the Data section, to control for the remaining unexplained time-specific deviations from the unobserved component.

On Election Day, voters observe perfectly ξ_{tcj} when casting their votes. However, unlike standard demand models, candidates do not observe ξ_{tcj} when making their advertising decisions. The shock is also unobserved by the researcher. Candidates' beliefs about the demand shocks ξ_{tcj} induce endogeneity in candidates' advertising strategies.

Assuming that $\{\varepsilon_{itcj}\}_j$ are i.i.d. extreme-valued shocks, integrating over them implies county-level vote shares of the form:

$$s_{tcj}(A_{tm}, \xi; \theta^v) = \frac{\exp\{\beta_{tj} + g(A_{tmj}; \alpha) + \phi' X_{tc} + \gamma_{mj} + \xi_{tcj}\}}{1 + \sum_{k \in \{1, \dots, J\}} \exp\{\beta_{tk} + g(A_{tmk}; \alpha) + \phi' X_{tc} + \gamma_{mk} + \xi_{tck}\}} \quad (2)$$

where $A_{tm} = [A_{tm1}, \dots, A_{tmJ}]'$. We focus on the model above with homogeneous preferences since Gordon and Hartmann (2013) do not find significant parameter heterogeneity after estimating the voter model.⁷

2.2 Candidates

The candidates' activities occur during the first stage of the model, prior to Election Day. Candidates set advertising levels based on their expectations about voting outcomes. We assume advertising is efficiently allocated across markets based on the local marginal benefits and costs of advertising.

2.2.1 Candidate Belief Formation

Prior to making their advertising decisions, candidates gather information through campaign research and other sources about the nature of potential demand shocks in each county. This information provides the candidate with an expectation $\bar{\xi}_{cj}$ of each shock's realized value ξ_{cj} . From here forward,

⁷The voter model above necessarily makes two assumptions. First, we assume voters sincerely choose the candidate for whom they receive the highest utility, which is consistent with evidence presented in Degan and Merlo (2011) using individual-level data spanning multiple elections. Second, voters are not strategic; voters make their decisions independently of the expected margin of victory in their states. Evidence in support of this assumption is mixed: although Feddersen and Pesendorfer (1999) show that such pivotal voter effects vanish in large elections, results in Shachar and Nalebuff (1999) for presidential elections indicate that voter turnout is responsive to changes in the state-level voting margin.

we suppress the t subscript. Candidates set advertising levels while forming beliefs according to

$$\boldsymbol{\xi}_{cj} = \bar{\xi}_{cj} + \boldsymbol{\eta}_{mj}, \quad \boldsymbol{\eta}_{mj} \sim N(0, \sigma) \quad (3)$$

where $\boldsymbol{\eta}_{mj}$ is a random draw independent across markets, candidates, and elections and σ represents candidates' ex-ante uncertainty over voting outcomes. Bold facing $\boldsymbol{\xi}_{cj}$ indicates that the variable is random from the perspective of the candidates. We define the uncertainty in candidates' beliefs as a DMA level shock common to all counties within because candidates choose advertising at the DMA level.⁸

Uncertainty over voting outcomes is an inherent feature of political contests: unexpected gaffes, surprising news stories, and the weather all contribute to candidate uncertainty over voters' preferences on Election Day. $\boldsymbol{\eta}_{mj}$ absorbs all the factors that are unknown at the time candidates set advertising and which will be known to voters when they vote on Election Day. Consider, for example, that weather affects voter turnout on Election Day and that Gomez, Hansford, and Krause (2007) provide evidence that rain differentially suppresses the turnout of one party. The DMA-party fixed effects in γ_{mj} account for the fact that, on average, some DMAs receive more rain than others and that voters' responses may vary by candidate. The realized value of the demand shock ξ_{cj} captures whether it actually rained on Election Day in the counties within the DMA.

2.2.2 Candidates' Optimal Advertising Allocation

Candidates choose a set of advertising levels $A_j = (A_{1j}, \dots, A_{mj}, \dots, A_{Mj})'$ based on the local marginal costs and benefits of advertising. The marginal cost of advertising is simply a local advertising price, ω_{tmj} . To characterize the marginal benefit of advertising, let $d_{tj}(\cdot)$ indicate whether candidate j wins the election and let $\mathbb{E}[d_j(\cdot)]$ be the probability candidate j wins the election. The expectation is taken over the demand shocks $\boldsymbol{\eta}_{mj}$ that generate candidates' uncertainty. The marginal benefit of advertising in market m depends on the derivative of the probability of winning the election with respect to advertising:

$$\frac{\partial \mathbb{E}[d_j(A, \xi; \theta)]}{\partial A_{mj}}$$

⁸The specification of the shocks could be extended to allow for correlation across markets. This would, however, increase the computational burden of estimation.

Since the term above is in probability units, a candidate's first-order conditions (FOCs) for advertising must satisfy

$$R_j \frac{\partial \mathbb{E}[d_j(A, \xi; \theta)]}{\partial A_{mj}} \leq \omega_{mj}, \text{ for } m = 1, \dots, M, \quad (4)$$

where R_{ij} is an unknown structural parameter that translates the probability of winning into dollar terms, placing both sides of the condition in equivalent units. Thus the FOC balances the value of an increase in the candidate's probability of winning the election relative to the marginal cost of a unit of advertising.

Below we discuss in detail the interpretation of R_j . In particular, we show R_j has a natural interpretation when a candidate's objective function is specified in a form consistent with work on candidate resource allocation or contest theory. Either approach yields advertising FOCs consistent with (4).

Optimization with a Budget Constraint Suppose each candidate sets advertising levels to maximize his probability of winning subject to a budget constraint. As with Strömberg (2008) and Shachar (2009), we do not specify an explicit model of budget formation. Unlike these papers, however, we do not assume the budget is exogenous. Instead the observed budgets in our model arise from the optimal allocation of resources among a pool of potential donors. Specifically, a candidate's problem is:

$$\max_{A_j} \mathbb{E}[d_j(A, \xi; \theta)] \quad (5)$$

$$\text{s.t.} \quad \sum_{m=1}^M \omega_{mj} A_{mj} \leq B_j \quad (6)$$

where B_j is the budget. A candidate's Lagrangian $\mathcal{L}_j(B)$ for this constrained optimization problem, as with the Lagrange multiplier $\lambda_j(B)$, depends on all the budget levels $B = [B_1, \dots, B_J]$ in the election due to strategic interaction between candidates. At a solution, the associated FOC is

$$\frac{\partial \mathcal{L}_j(B)}{\partial A_{mj}} : \frac{\partial \mathbb{E}[d_j(A, \xi; \theta)]}{\partial A_{mj}} = \lambda_j(B) \omega_{mj}. \quad (7)$$

Inspecting this FOC makes evident its equivalence with the FOC in equation (4). Our assumed optimal allocation of donor resources implies that in equilibrium,

$$\lambda_j(B^*) = \frac{MU_I}{R_j}, \text{ for } j = 1, \dots, J.$$

Suppose there exists a pool of representative donors each faced with a decision of whether to allocate funds to the candidate's campaign or to some outside opportunity. Normalizing the marginal utility of income MU_I to one, $1/R_j$ represents donors' opportunity costs of investing in the campaign relative to the utility they expect from the candidate winning. In equilibrium, donors contribute funds until the shadow price of an additional dollar, λ , is equal to $1/R_j$, yielding the set of optimal budgets $B^* = [B_1^*, \dots, B_J^*]$.

Thus R_j is a policy-invariant parameter that is independent of campaign fundraising. Note this formulation does not consider donors' individual expected utilities from election outcomes, nor does it make explicit the public goods problem in funding a shared election outcome. However, the specification provides a simple way to conceptualize the endogenous formation of the budget. For example, consider a policy change that alters $d_j(\cdot)$ to some $\tilde{d}_j(\cdot)$. The previously optimal budgets B^* may imply that $\lambda_j(B^*)$ is greater or less than $1/R_j$ because the left-hand side of equation (7) changes (i.e., moving to \tilde{d}_j changes candidates' marginal benefits of advertising). This imbalance could result in a new set of efficient budgets \tilde{B}^* that would equate each Lagrange multiplier to $1/R_j$. We assume that political campaign contributions are a small enough share of the larger fundraising market such that the return to donors' outside opportunities is invariant to the election mechanism and outcome.⁹

Optimization in a Contest An alternative formulation providing the first-order condition in Equation (4) draws on the theoretical literature on contests (e.g., Tullock 1980, Dixit 1987, Kvasov

⁹We assume that $1/R_{tj}$ is invariant to the actual amount of money donated. This implies two features of donor behavior. First, the marginal utility of donors' income must be invariant to the amount they donate to the campaign. This seems reasonable unless policy changes significantly alter the proportion of a donor's lifetime income that is offered to the campaign. Second, the expected utility from the candidate winning cannot be contingent on the amount donated. This may be a stronger assumption as it is often speculated that large donations earn political favors. Nevertheless, such issues are beyond the scope of the paper and we merely hope that this assumption is reasonable for small local changes in donation amounts.

2007).¹⁰ Such models consider the following unconstrained optimization problem where the candidate balances the value of winning against the total cost of advertising:

$$\pi_j(A, \xi; \theta) = R_j \mathbb{E}[d_j(A, \xi; \theta)] - \sum_{m=1}^M \omega_{mj} A_{mj} \quad (8)$$

where R_j is the value associated with candidate j winning and ω_{mj} is candidate j 's marginal cost of one unit of advertising in market m . Since the second term above is candidate j 's total spending, scaling the first term by R_j converts the probability of winning into monetary terms.¹¹ The key distinction relative to the first objective function is the lack of a budget constraint imposed on the candidate.

The literature on contests commonly refers to R_j as the “prize” of winning the contest. Downs (1957) and Baron (1989) interpret R_j as the candidate’s expected stream of benefits associated with winning office and any future election opportunities if he is successful.¹² Such an interpretation might be appropriate if a candidate were personally funding his entire election campaign, but otherwise it ignores the fact that most of a candidate’s financing comes from donors. To this end, R_j might be characterized as the collective payoff to all parties who would benefit from candidate j 's victory.¹³ Yet this interpretation still abstracts away from externalities in donation and fundraising costs.¹⁴

The precise interpretation of R_j is not critical for this paper. In this setting, R_j , together with $\partial \mathbb{E}[d_j(\cdot)] / \partial A_{mj}$, provides a simple characterization of the marginal benefit of advertising. Since the FOC of the above is identical to equation (4), R_j could also be viewed as the inverse of the Lagrange multiplier at an equilibrium of the game involving budget constraints. By estimating R_j we avoid

¹⁰In a contest, participants must expend resources no matter if they win or lose, such as elections, lobbying activities, and R&D races. An important input to these models is the contest success function $p(e_1, \dots, e_J)$, which determines the probability of winning the prize given each participant’s effort. In our model, $\mathbb{E}[d_j(A, \xi; \theta)]$ plays the equivalent role.

¹¹An alternative candidate objective function posits that candidates maximize the expected number of electoral college votes (Brams and Davis 1974, Shachar 2009). Snyder (1989) provides a theoretical comparison of these alternative candidate objectives in the context of two-party competition for legislative seats.

¹²These benefits could include the perceived monetary value of winning the election, the ability to implement policies consistent with the candidate’s preferences, or simply the candidate’s “hunger” for the office.

¹³The candidate can either be interpreted to not engage in agency problems when allocating advertising on behalf of this group or one could view the party as the agent internalizing all parties’ interests. These distinctions clearly resurface the challenges in building a candidates objective function, but we feel this specification is simple and complete enough to capture the necessary features of the process.

¹⁴One interesting extension to our model would entail adding an earlier stage in which candidates engage in fundraising to build a war chest with which to compete in the election. A related point is that some component of fundraising activity might be advertising itself; one benefit of advertising is that a candidate might generate additional funds for his overall election campaign.

the specification of a budget formation process, while still allowing an endogenously determined total spending level. This facilitates our ability to model candidates' allocation of advertising under various election mechanisms, as manifested in the particular form of $d_j(\cdot)$.

2.2.3 Determining a Winner Under the Electoral College

The function $d_j(\cdot)$ encapsulates the precise rules of the election system that determines how votes are tallied to determine the winner. We estimate the preceding model using data under the U.S. electoral college system which aggregates votes at the state level and then to the national level, so we employ the following definition of $d_j(\cdot)$.

Since a state may contain multiple markets, define $A_{sj} = \{A_{mj} : \forall m \in s\}$ as the set of advertising choices for candidate j in state s and let $A_m = [A_{m1}, \dots, A_{mJ}]'$ be the collection of such advertising choices across candidates. Then d_j^s indicates whether a candidate receives the majority of votes in a state,

$$d_j^s(A_s, \xi; \theta^v) = 1 \cdot \left\{ \sum_{m \in s} \sum_{c \in m} N_{mc} s_{cj}(A_m, \xi; \theta^v) > \sum_{m \in s} \sum_{c \in m} N_{mc} s_{ck}(A_m, \xi; \theta^v), \forall k \neq j \right\} \quad (9)$$

where N_{tmc} is the number of voters in a county. Under a winner-take-all rule, a candidate wins all of a state's Electoral College votes if he obtains a majority of the popular vote. Then the indicator function for whether a candidate wins the general election by obtaining a majority of the Electoral College votes is

$$d_j(A, \xi; \theta^v) = 1 \cdot \left\{ \sum_{s=1}^S d_j^s(A_s, \xi; \theta^v) \cdot E_s > \bar{E} \right\} \quad (10)$$

where E_s is the state's electoral votes and \bar{E} is the minimum number required for a majority.

3 Data

Four sources of data are combined for the analysis. First, we use advertising spending by candidate within each of the top 75 designated media markets (DMAs). These markets account for 78% of the national population. Second, to instrument for advertising levels in the voter model, we obtain data on the price of advertising across markets. Third, voting outcomes are measured at the county level. Fourth, we include a collection of control variables, drawn from a variety of sources, based on local

demographics, economic conditions, and weather conditions on election day.

Gordon and Hartmann (2013) describes this data set in more detail. We revisit some important aspects of the data here and focus on some minor differences, and refer the reader to the other paper for further details.

3.1 Advertising

We measure advertising as the average number of exposures a voter observes. The advertising industry commonly refers to this measure of advertising as Gross Rating Points (GRPs), which is equal to the percent of the population exposed (reached) multiplied by the number of times each person was exposed (frequency). For example, 1,000 GRPs indicates that, on average, each member of the relevant population was exposed 10 times.

Our advertising data come from the Campaign Media Analysis Group (CMAG) and contains detailed information about each advertisement in the election.¹⁵ Although the data do not directly contain GRPs, we can derive them based on the total expenditure for an advertisement divided by its cost-per-point (CPP) for the appropriate daypart (i.e., one of eight timeslots during the day) of the ad in a particular market.¹⁶ Our analysis therefore aggregates exposures across all dayparts into a single advertising variable A_{mj} . We measure A_{mj} in thousands of GRPs and set $g(A_{mj}; \alpha) = \alpha \log(1 + A_{mj})$.

The market-candidate specific *observed* price, w_{mj} , is a weighted average across all the dayparts in which the candidate advertised. If a candidate did not advertise in a market, we set $w_{mj} = w_m$, where w_m is calculated by weighing each daypart CPP in a market by the exposures both candidates purchased in that daypart across all markets. Appendix A provides detailed derivations of the advertising levels and prices.

Table 1 reports the GRPs, expenditures, and average CPPs for the each candidate. Ads may

¹⁵Freedman and Goldstein (1999) describe the creation of the CMAG data set in more detail.

¹⁶The price of political advertising in the 60-days prior to the general election is subject to laws which require the station to offer the sponsor the lowest unit rate (LUR). However, advertising slots purchased with the LUR may be preempted by the TV station and replaced with a higher paying advertiser. The TV station is only required to deliver the contracted amount of GRPs within a specific time frame and allows them to substitute less desirable slots for the original slot. According to the former president of CMAG, well-financed candidates in competitive races rarely pay the LUR because they want to avoid the possibility that their ads will be preempted by another advertiser (such as another candidate).

Table 1: Descriptive Statistics for Candidate Advertising

	Obs	Mean	Std Dev	Min	Max
2000 Election					
GRPs Bush (K)	75	582	560	0	1589
GRPs Gore (K)	75	478	568	0	1794
Expenditures Bush (\$ K)	75	879.84	1,218.73	0	6,185.45
Expenditures Gore (\$ K)	75	681.53	1,072.94	0	5,941.61
Avg. CPP Bush	75	181	198	42	1155
Avg. CPP Gore	75	180	189	42	1155

Source: Gordon and Hartmann (2013)

be sponsored by a candidate, a national party, a hybrid candidate-party group, or an independent interest group. We aggregate advertising across sponsors when forming A_{mj} for our estimation.

Figure 1 plots advertising GRPs for both candidates against a state’s voting margin. The figure highlights two important features of our data. First, the figure illustrates how the winner-take-all rule in the Electoral College creates sharp incentives for candidates to concentrate their advertising in battleground states. These states receive over 81% of advertising spending and comprise only 41% of the voting population. This leads candidates to not advertise at all in some markets. This pattern of greater spending in battleground states is consistent across both candidate and interest group spending, suggesting that advertising can safely be aggregated across these sources. Second, the breadth of advertising across vote margins in Figure 1 reveals the degree of candidates’ uncertainty about eventual outcomes. Advertising observed in states with substantial vote margins suggests a candidate might have been better off moving those funds to a state at the (ex-post) margin to potentially alter the election outcome. Ex-ante uncertainty about outcomes allows our model to rationalize candidate spending in states with large realized vote margins.

3.2 Data Used in Voter Model

Data on voting outcomes at the county level comes from www.polidata.org and www.electiondataservices.com. The 75 DMAs in our data set contain 1,607 counties. In each county, we observe the total number of votes cast for all candidates and the voting-age population (VAP). The VAP serves as our market size for the county, which we use to calculate voter turnout (i.e., the percentage of voters who choose the inside option to vote for any candidate). Table

Figure 1: GRPs by State-level Voting Margin in 2000 Election

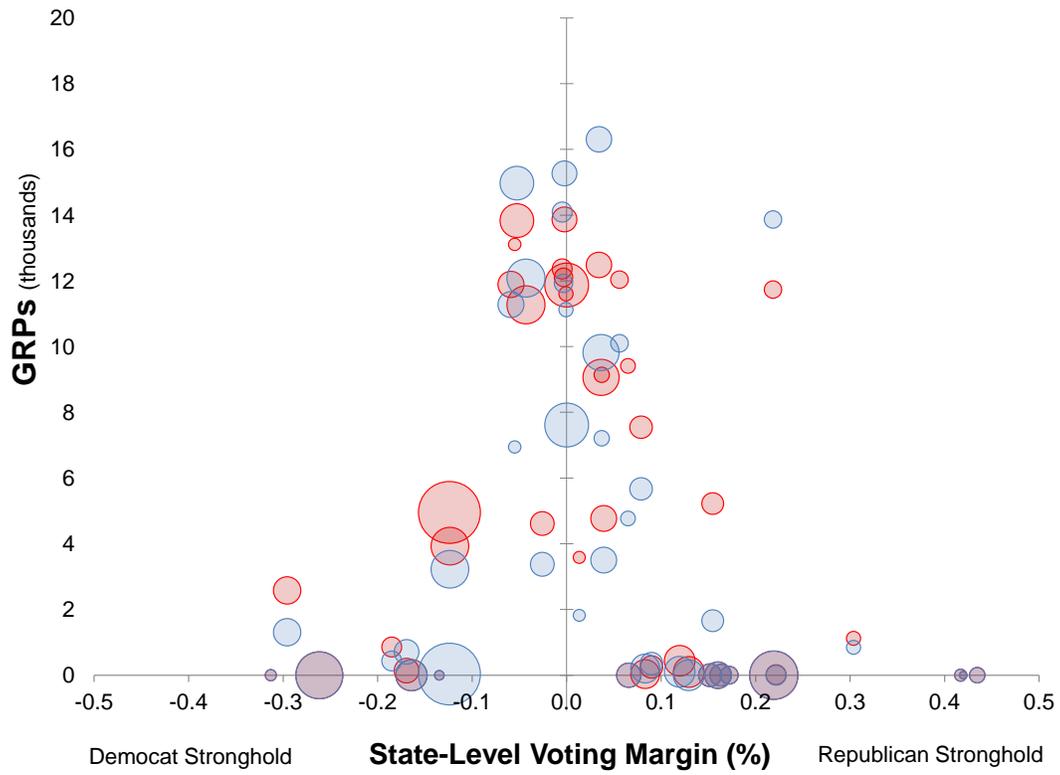


Table 2: Descriptive Statistics for Variables in Voter Model

	Mean 2000	Std Dev 2000	Mean 2004	Std Dev 2004
Republicans				
Votes	23,721	51,787	29,349	63,178
GRPs	4,863	5,406	6,411	9,448
Democrats				
Votes	25,639	77,929	29,785	89,030
GRPs	4,141	5,465	8,136	11,625
County and Market Variables				
LagCPM in Early Morning	4.18	0.95	5.47	1.55
LagCPM in Day Time	4.85	1.11	4.89	1.08
LagCPM in Early Fringe	5.88	1.45	6.67	1.34
LagCPM in Early news	6.26	1.63	7.93	1.73
LagCPM in Prime Access	7.06	1.91	10.41	2.54
LagCPM in Prime Time	12.37	3.47	16.17	4.66
LagCPM in Late News	8.50	2.10	12.26	2.56
LagCPM in Late Fringe	7.18	1.81	8.30	1.94
Rain (in.)	0.20	0.27	0.28	0.51
Snow (in.)	0.08	0.40	0.02	0.12
Distance*100 (miles)	9.49	4.11	9.49	4.11
Percent Aged 25 to 44	0.38	0.05	0.34	0.05
Percent Aged 45 to 64	0.32	0.03	0.33	0.03
Percent Aged 65 and up	0.19	0.05	0.19	0.05
Unemployment	4.09	1.56	5.61	1.66
Average Salary	24.99	6.63	27.92	6.93
Percent Identifying Republican	0.29	0.06	0.33	0.06
Percent Identifying Democrat	0.30	0.05	0.31	0.06

There are 1,607 county-level observations for each party and year.

2 summarizes the mean and standard deviation of the votes and advertising levels spread across the 1,607 counties as well as county and market-specific variables such as ad prices, weather and demographics.¹⁷

We assign the observed advertising in the DMA to each county contained in that market.¹⁸ We conduct our analysis using all counties for which we observe the DMA-level advertising. When estimating the candidate model and analyzing counterfactual policies, voting behavior is held fixed in counties representing the remaining 22% of the population.

¹⁷A more accurate measure of turnout is the voting-eligible population (VEP) because it removes non-citizens and criminals. However, data on the VEP is only available at the state level.

¹⁸In the rare cases that a county belongs to multiple DMAs, we use zip code-level population data to weigh the advertising proportionally according to the share of the population in a given state.

Advertising is endogenous because candidates possess knowledge about local demand shocks $\bar{\xi}_{cj}$. A variable naturally excluded from the demand side that enters candidates' decision problem is the price paid for advertising. However, particular realizations of the unobservable $\bar{\xi}_{cj}$ could induce a candidate to purchase enough advertising to alter its market clearing price, violating the independence assumption required for a valid instrument. Stories in the popular press confirm this suspicion (e.g., Associated Press 2010). To avoid this concern, we use the prior year's advertising price (i.e., 1999 for 2000 and 2003 for 2004) because there are no presidential, gubernatorial, or congressional elections in odd-numbered years. We define these prices in terms of cost-per-thousand impressions (CPM) as opposed to CPP because candidates care about the absolute number of voters they can reach per dollar of advertising. The ad prices, obtained from the media research firm SQAD, are reported separately by daypart, which we interact with candidate dummies because candidates choose different mixes of dayparts across markets.

The DMA-party fixed effects absorb time-invariant geographic variation in the mean preferences for a given political party. The advertising instruments are therefore necessary to address time-varying unobservables. To avoid other unobservables that could be correlated with the instruments and votes, we include three categories of variables to address this remaining within-market variation: (1) variables that measure local political preferences, (2) variables that affect voter turnout but not candidate choice, and (3) demographic and economic variables.

First, we use data from the National Annenberg Election Surveys (NAES) to measure the percentage of voters in a market who identify as Democrat, Republican, or Independent. These data capture variation in preferences across parties, and hence candidates, within a market. We include interactions between the Democrat and Republican choice intercepts and the three party identification variables to allow for asymmetric effects across parties. We also include an indicator for whether the incumbent governor's party is the same as the presidential candidate.

Second, we include two types of variables that should solely affect voters' decisions to turnout. One is a dummy if a Senate election occurs in the same market and year, since strongly contested Senate races could spur additional turnout for the presidential election. Because Gomez, Hansford, and Krause (2007) show that weather can affect turnout in presidential elections, we include

county-level estimates of rain and snowfall on Election Day.

Third, we add a set of demographic and economic variables to control for unobserved changes in these conditions which could be correlated with within-market changes in voter preferences and the advertising instruments. We use the county-level percentage of the population in three age-range bins (e.g., 25 to 44) from the Census, the county-level unemployment from the Bureau of Labor Statistics, and the county-level average salary from the County Business Patterns.¹⁹ Interactions between each candidate’s choice intercepts and the demographic and economic variables capture differences across parties in voters’ responses to these conditions.

4 Empirical Application

This section discusses the identification of our model’s parameters, details our estimation strategy, and then discusses our model’s parameter estimates. First we estimate the voter model, taking those parameters as given when estimating the candidate model. Identification of the voter parameters, $\theta^v = (\beta, \alpha, \phi, \gamma)$ follows from standard arguments when estimating aggregate market share models. Since Gordon and Hartmann (2013) focus on the voter model, the rest of this section centers on the estimation of the candidate model.

4.1 Identification

We discuss the intuition for the identification of the candidate model’s parameters $\theta^c = (R, \sigma)$. Inspection of the FOCs in equation (4) reveals that the R_j parameters are identified based on a candidate’s average advertising level in an election.

Identification of candidates’ uncertainty σ relies on systematic variation in advertising levels across markets. Candidates form expectations that recognize which markets will have large realized voting margins. In markets that lean heavily to the left or right, such that one candidate is strongly favored over the other, the incentive to advertise should be close to zero for both candidates. The returns to advertising should be higher in contested markets where each candidate expects to receive a similar number of votes because advertising by either candidate could attract a sufficient number

¹⁹To calculate the average salary, we use the total annual wages paid by firms divided by the total number of employees in a county.

of votes to clinch the state’s election outcome. If observed advertising levels were invariant to such cross-market differences, it would suggest that candidates felt outcomes were purely random, i.e., $\sigma = \infty$. At the other extreme, if σ is close to zero it would be hard to rationalize observed spending levels in a great number of states where the realized voting margin was significant. Thus the degree to which candidates advertise in ex-post uncontested markets reveals their uncertainty over the voting outcomes. Without such ex-ante uncertainty, candidates should have shifted advertising from some less-contested states to those on the margin.

Our identification approach for uncertainty contrasts with Strömberg (2008), which infers uncertainty solely through cross-state variation in voting outcomes. While this variation may be related to candidate uncertainty, such variation would exist even if candidates had perfect certainty over outcomes.

4.2 Estimation

To make the candidate model estimable, we add a stochastic component. Decompose the true marginal cost of advertising into

$$\omega_{mj} = w_{mj} + v_{mj}, \tag{11}$$

where w_{mj} is an observed estimate of the marginal cost and v_{mj} is a structural error observed by the candidate but unobserved to the econometrician. The error term v_{mj} forms the basis of our estimation strategy.²⁰

Given that advertising is a continuous choice variable, we form moments based on the first-order conditions of the candidate’s decision problem. Our approach assumes the collection of advertising choices we observe constitute a (pure-strategy) equilibrium of the advertising competition game. Note that our model under the Electoral College may possess multiple equilibria but our estimation strategy does not require us to solve the equilibrium. The primary complication is that we observe some advertising choices on the boundary ($A_{mj}^* = 0$).

We begin by considering observations with positive advertising. In such cases, there is an interior

²⁰The unobserved cost shock therefore absorbs any other differences between the observed choices and the model, such as local differences in the level of uncertainty about outcomes. While it might be appealing to include the unobservable in the marginal benefit of advertising, the non-linearities in d prevent inversion of an additively linear error term.

solution to the first-order condition of a candidate’s objective function, allowing us to recover the econometric unobservable:

$$R_j \frac{\partial \mathbb{E} [d_j(A_j, A_{-j}; \theta^v, \sigma)]}{\partial A_{mj}} - w_{mj} = v_{mj}.$$

A moment-based estimator only requires the existence of a sufficient number of exogenous variables z to identify the parameters. Given instruments that satisfy $\mathbb{E} [v|z] = 0$, we could form an estimator around the moment:

$$\mathbb{E} \left[\left(R_j \frac{\partial \mathbb{E} [d_j(A_j, A_{-j}; \theta^v, \sigma)]}{\partial A_{mj}} - w_{mj} \right) | z_{mj} \right] = 0$$

However, the moment above does not hold when advertising is zero. One solution is to drop the observations with zero advertising. Although this action would reduce the efficiency of the estimator, the more serious concern is that it might invalidate the moment condition because possibly $\mathbb{E} [v|z, A > 0] \neq 0$. We argue that the specific nature of our problem should minimize the concern that focusing on positive advertising markets results in a selection problem on v_{mj} .

Whether this selection problem is an issue for estimation hinges on our beliefs about the potential importance of v_{mj} . In our data the observed marginal costs w_{mj} are SQAD’s forecasts for the election season. The v_{mj} should represent deviations between these forecasts and candidates’ actual advertising costs. For $\mathbb{E} [v|z, A > 0] \neq 0$, a candidate must receive a sufficiently large v_{mj} that would lead him not to advertise in a particular market. This seems unlikely because the zero advertising outcomes are primarily due to demand-side shocks which, through the structure of the electoral college, reduce the incentives of candidates to advertise in non-battleground states. Since we can consistently recover the demand-side shocks ξ_{cj} using revealed preferences in the voter model, this reduces the concern of selection on unobservable supply-side shocks. The more likely situation is that a candidate only observes realizations of v_{mj} *after* the candidate commits to some positive amount of advertising in a market. We therefore assume that $\mathbb{E} [v|z, A > 0] = 0$ because candidates select markets in which to advertise based on w_{mj} and the candidates’ beliefs about $\bar{\xi}_{cj}$. We observe the former in our cost data and recover the latter from the demand-side estimation. Note that this is not exactly a “selection on observables” argument because the demand-side unobservables are the primary force behind selection.

Under these assumptions, estimation of the supply side relies on the following moment condition:

$$\mathbb{E} \left[\left(R_j \frac{\partial \mathbb{E} [d_j(A_j, A_{-j}; \theta^v, \sigma)]}{\partial A_{mj}} - w_{mj} \right) | z_{mj}, A_{mj} > 0 \right] = 0.$$

Let M_j^+ denote the set of markets in which candidate j has $A_{mj} > 0$ and $M^+ = \sum_j M_j^+$. The relevant sample moment is

$$m(\theta) = \frac{1}{JM^+} \sum_{j=1}^J \sum_{m=1}^{M_j^+} \left[\left(R_j \frac{\partial \mathbb{E} [d_j(A_j, A_{-j}; \theta^v, \sigma)]}{\partial A_{mj}} - w_{mj} \right) \otimes g(z_{mj}) \right],$$

where $g(\cdot)$ is any function and \otimes is the Kronecker product. For instruments, we use DMA voting margins differenced across two prior elections (e.g., for 2000, we difference the voting margin for 1996 and 1992). Differencing removes any location-specific unobservable and retains information that should relate to a candidate’s uncertainty about voting outcomes in that market. We interact these variables with party-year dummies to form z .²¹

4.3 The Marginal Effect of Advertising

Calculating the marginal effect of advertising, $\frac{\partial \mathbb{E} [d_j(A_j, A_{-j}; \theta^v, \sigma)]}{\partial A_{mj}}$, is challenging because $d_j(\cdot)$ is non-differentiable in A_{mj} and the expectation involves a high-dimensional integral. The expression integrates over the cost shocks $\{\eta_{mj}\}_{m,j}$, which enter the candidate’s indicator function $d_j(\cdot)$ for winning the election. Calculating the derivative by simulating $\mathbb{E} [d_j(\cdot)]$ in conjunction with finite differences is imprecise because small deviations from a given A_{mj} are unlikely to shift the election outcome in $\mathbb{E} [d_j(\cdot)]$.

We therefore compute the derivative using a hybrid approach that simulates all but one of the unobservables. The approach is general to any problem where an agent or agents exert observed effort to pass a threshold. We begin with the simple case of a single agent in a single market choosing effort to exceed a threshold. In this case, the derivative can be solved analytically. Our

²¹An alternative estimation approach is using moment inequalities following Pakes, Porter, Ho, and Iishi (2011). Their approach requires somewhat weaker assumptions (e.g., the method is agnostic about whether the game is complete or incomplete information) and would allow us to use multiple deviations per observed advertising level to potentially enhance the efficiency of the estimator. However, computing the counterfactual—which is the key point of estimating the supply-side model—would still require us to assume complete information, and the difficulty of selection on unobservables due to choices on the boundary would still remain. Moreover, using moment inequalities is more natural in discrete-choice settings, whereas estimation based on the FOCs fits well with continuous control problems.

application involves extensions to competing agents and multiple markets/dimensions. These additional components involve simulation, whereas the marginal benefit for a focal agent in a focal market remains analytically computed.

The general objective function under a goal may be written as above:

$$\Pi(A) = R \cdot \mathbb{E}[d(A, \eta; \theta)] - \omega' A$$

where R is the prize for success, ω is the cost of effort, $d(\cdot)$ is the success function and $\mathbb{E}[d(A, \eta; \theta)]$ is the probability of success that integrates over unobservables, η .

The simplest application involves a single agent choosing a single effort allocation, A , that creates a score V that yields the prize when the success function is $d(A, \eta) = 1 \cdot \{V(A, \eta) > \bar{V}\}$. The probability of success can therefore be expressed in terms of the cumulative distribution function for the score:

$$\mathbb{E}[d(A, \eta; \theta)] = 1 - F_V(V(A, \eta) < \bar{V}).$$

We assume the distribution of η is known, so we use a change of variables to re-express the cumulative distribution, F_V in terms of η .

$$F_V(V(A, \eta) < \bar{V}) = F_\eta(\eta < \eta^*(A, \bar{V})) \tag{12}$$

where η^* is the critical value that equates the score with the threshold, $V(A, \eta^*) = \bar{V}$. With some abuse of notation, the inverse function from V to η is $\eta(A, V) = V^{-1}(A, V)$, such that $\eta^* = \eta(A, \bar{V})$. This allows us to express the marginal effect of A on the probability of success as:

$$\begin{aligned} \frac{\partial \mathbb{E}[d(A, \eta)]}{\partial A} &= \frac{\partial [1 - F_\eta(\eta < \eta^*(A, \bar{V}))]}{\partial A} \\ &= f_\eta(\eta^*) \left(\frac{-\partial \eta(A, \bar{V})}{\partial A} \right) \end{aligned}$$

Therefore, knowledge of f_η and the existence of a unique inverse function $\eta(\cdot)$ provides an analytic expression of the derivative. If scores are bounded (e.g., $V \in [0, K]$), there may not exist an η^* that equates the score and threshold. In such cases, $\frac{\partial \mathbb{E}[d(A, \eta)]}{\partial A} = 0$.

Our application involves an extension to multiple dimensions (markets) and a competing agent.

The success function is representative of a contest with effort and scoring across multiple dimensions:

$$\begin{aligned} d(A, \eta) &= 1 \cdot \left\{ V_{mj}(A_m, \eta_m) - V_{mk}(A_m, \eta_m) > \sum_{n \neq m} V_{nk}(A_n, \eta_n) - V_{nj}(A_n, \eta_n) \right\} \\ &= 1 \cdot \{IM_{mj}(A_m, \eta_m) > -EM_{mj}(A_{-m}, \eta_{-m})\} \end{aligned}$$

In words, a contestant's score relative to his opponent's in any given market m must be greater than his deficit across all other markets. We refer to this in terms of an internal margin (IM_{mj}) and external margin (EM_{mj}) for the purposes of computing the marginal benefit of agent j exerting effort in market m . The probability of success can now be expressed:

$$\mathbb{E}[d(A, \eta)] = 1 - F_{IM}(IM_{mj}(A_m, \eta_m) < -EM_{mj}(A_{-m}, \eta_{-m})).$$

The inverse to obtain η and change variables is now in terms of the internal margin instead of the the agent's local score, i.e. $\eta_{mj} = \eta(A_m, IM_{mj})$. Next, we draw NS sets of simulated unobservables (indexed by r) across all other markets, $-m$, to calculate the external margin and thus obtain the following derivative of the probability of success with respect to j 's effort in market m :

$$\frac{\partial \mathbb{E}[d(A, \eta)]}{\partial A_{mj}} = \frac{1}{NS} \sum_r f_{\eta_m}(\eta_{mj}^*(A_m, -EM_{mj}(A_{-m}, \eta_{-m}^r))) \left(\frac{-\partial \eta(A_m, -EM_{mj}(A_{-m}, \eta_{-m}^r))}{\partial A_{mj}} \right).$$

Finally, our application actually involves two unobservables (one for each candidate/contestant) in the focal market, so we also simulate the competitor's unobservable in the focal market, η_{mk}^r . The inverse is now also a function of η_{mk}^r and we obtain the following derivative:

$$\frac{\partial \mathbb{E}[d(A, \eta)]}{\partial A_{mj}} = \frac{1}{NS} \sum_r f_{\eta_{mj}}(\eta_{mj}^*(A_m, -EM_{mj}(A_{-m}, \eta_{-m}^r), \eta_{mk}^r)) \left(\frac{-\partial \eta(A_m, -EM_{mj}(A_{-m}, \eta_{-m}^r), \eta_{mk}^r)}{\partial A_{mj}} \right).$$

In the Electoral College, these contests occur within each state. The internal margin would be calculated for one media market in the state, while the external margin is calculated across all other media markets in the state. Electoral votes in other states determine whether the focal state is "in play" and therefore whether the above derivative is zero for a particular set of draws. Adding the electoral college to the above, we obtain:

$$\frac{\partial \mathbb{E}[d(A, \eta)]}{\partial A_m} = \frac{1}{NS} \sum_r f_{\eta_{jm}}(\eta_{jm}^{r*}) \left(\frac{-\partial \eta(A_m, -EM_{mj}^r, \eta_{mk}^r)}{\partial A_{mj}} \right) 1 \cdot \left\{ E_m > \sum_{s \notin \mathcal{S}(m)} E_j(\eta_s^r) - E_k(\eta_s^r) \right\}.$$

where $\tilde{s}(m)$ gives the set of states overlapping with media market m .

Note that the above characterizes the marginal effect of effort in a contest with a general contest success function. One primary focus of the theoretical contest literature has been on the derivation of analytically tractable success functions (Skaperdas, 1996). In practice, contests such as elections have their own specific success functions implying CDFs for the probability of success that may inherently not be analytically tractable. We show that the above approach is beneficial by compressing a large multidimensional integration problem into unidimensional external and internal margins.

4.4 Voter Model Estimates

Table 3 presents parameter estimates from the voter model. The advertising coefficient is positive and highly significant. To help interpret the demand estimates, consider that the average own advertising elasticity is about 0.03. This estimate is smaller than the median advertising elasticity of 0.05 reported in the meta-analysis of consumer goods in Sethuraman, Tellis, and Briesch (2011). We refer the reader to Gordon and Hartmann (2013) for more discussion of the estimation results from the voter model.

We use the estimates from the voter model to calculate two quantities. First, we calculate the political leaning of media markets and states by removing advertising's effects while holding all other factors fixed. Let s_{jm}^0 be the vote share of candidate $j \in \{R, D\}$ in market m when all advertising is set to zero. We define the political leaning of a market as the Republican share of the two-party vote in the absence of advertising:

$$L_m = \frac{s_{Rm}^0}{s_{Rm}^0 + s_{Dm}^0}.$$

This provides a summary measure of voters' party preferences without the potential contaminating effects of advertising.

Table 3: Voter Model Estimates

	Coefficient	Std. Err.
Candidate's Advertising	0.0693***	0.0159
Senate Election	0.0134	0.0098
Gov. Incumbent Same Party	0.0090	0.0106
Rain (in.)	0.0300	0.0293
Rain \times 2004	-0.0201	0.0285
Snow (in.)	-0.0108	0.0072
Snow \times 2004	-0.2210***	0.0606
Distance*100 (miles)	0.0036	0.0025
% 25 \leq Age < 44	-0.7317***	0.2186
% 25 \leq Age < 44 \times 2004	-1.2942***	0.1987
% 25 \leq Age < 44 \times Republican	0.9047**	0.3535
% 45 \leq Age < 64	3.7490***	0.3345
% 45 \leq Age < 64 \times 2004	0.3468	0.2247
% 45 \leq Age < 64 \times Republican	1.6595***	0.5279
% 65 \leq Age	0.1538	0.3771
% 65 \leq Age \times 2004	-1.6048***	0.1700
% 65 \leq Age \times Republican	1.6091***	0.5254
% Unemployment	0.0019	0.0108
% Unemployment \times 2004	0.0101**	0.0050
% Unemployment \times Republican	-0.1229***	0.0123
Average Salary	0.0161***	0.0020
Average Salary \times 2004	0.0038***	0.0007
Average Salary \times Republican	-0.0195***	0.0024
Fixed Effects		
Party	Y	
Year-Party	Y	
DMA-Party	Y	

Notes: Obs = 6,428. Robust standard errors clustered by DMA-Party in parentheses. F-stat of excluded instruments is 88.2. '*' significance at $\alpha = 0.1$ '**' significance at $\alpha = 0.05$ and '***' significance at $\alpha = 0.01$. Some coefficients omitted due to space.

Second, we calculate the cost per marginal vote at the observed advertising levels in each media market:

$$CPV_{mj} = \frac{CPP_m}{\left(\frac{\partial s_{mj}(A_m; \theta^v)}{\partial A_{tmj}}\right) N_m}.$$

This represents the cost the candidate would face if he attempts to acquire one additional vote in the media market. The CPP_m in the equation above differs slightly from the w_{mj} used to estimate the candidate model. To facilitate comparison, we calculate CPP_m as the common cost across

candidates, weighting each daypart-specific CPP by the fraction of total exposures purchased in the entire election in that daypart.

Figure 2 plots the cost per marginal vote in the 2000 election against the political leaning of the media market.²² Each bubble is proportional to a candidate’s GRPs in the market. The majority of markets with substantial advertising tend to have a cost per marginal vote of about \$75. The highest cost, \$204 per vote for Republicans in the Miami-Ft. Lauderdale market, is over twice that faced by the Democrats in the same market. This disparity in costs must arise solely through asymmetries in the marginal effect of advertising, $\partial s_{mj}/\partial A_{mj}$, because the equation’s other components are constant across candidates. The Republican’s marginal effect of advertising is lower in Miami-Ft. Lauderdale for two reasons. First, in the absence of advertising, this market leans substantially to the left. The two-party vote shares excluding advertising are 41% Republican to 59% Democrat, such that it is generally more difficult for Republicans to generate votes in the market. Second, the Republicans purchased 64% more GRPs in Miami-Ft. Lauderdale than the Democrats, leading to greater diminishing marginal effects of advertising for the Republicans. Figure 2 also depicts many markets with low costs per marginal vote, yet the marginal benefit of these votes is generally small because they are in polarized states that are unlikely to tip.

4.5 Candidate Model Estimates

Table 4 presents the parameter estimates from the candidate model. Bush outspent Gore by 29% and the estimates for R_j imply that Republicans had a 45% greater return to winning the election. The uncertainty estimate σ is 0.157

Table 4: Candidate Model Estimates

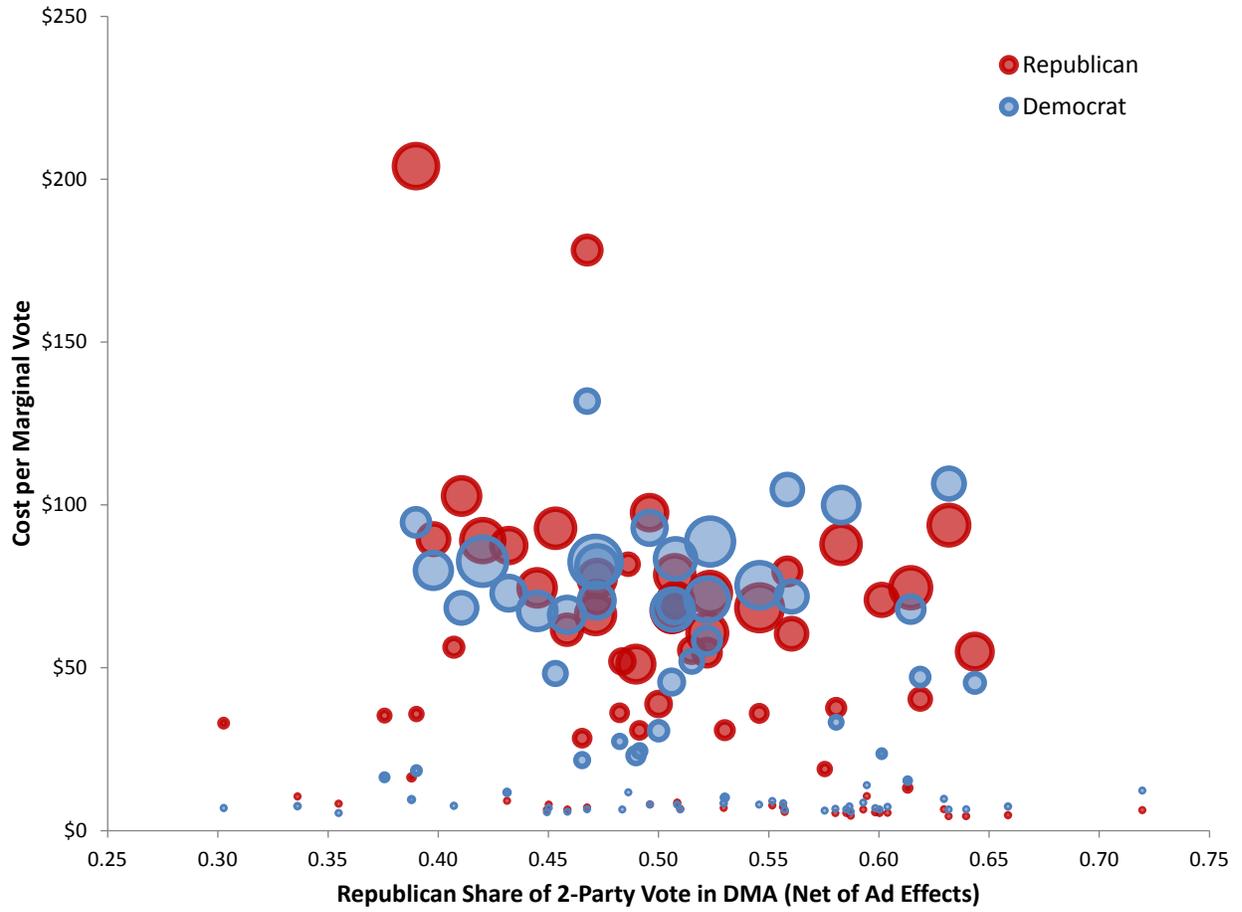
Parameters	σ	R_j (\$M)	Observed Spending (\$M)
Bush	0.157 (0.010)	146.4 (2.743)	66.0
Gore		100.8 (2.233)	51.1

Standard errors in parentheses.

To explore the degree of candidate uncertainty, we consider the implied belief distribution of both state and national outcomes in the election. Figure 3 depicts candidates’ beliefs about the

²²The cost per marginal vote is not the same as the average cost per vote, which is the total spent in a market divided by the number of votes obtained in the market.

Figure 2: Cost Per Marginal Vote in the 2000 Election



Notes: Bubbles are proportional to a candidate's GRPs in the market.

likelihood of a Republican victory in each state. The shaded bars represent those states in which each candidate has at least a ten percent chance of winning. Among these, we see well-known battleground states such as Florida, New Mexico, and Pennsylvania. A non-traditional battleground state included is Arizona with a 22% Democrat chance of victory. Neither candidate advertised here, however, suggesting that either it was a missed opportunity (optimization error), or there are market specific factors we are not able to capture in our model. This variation in state outcomes translates into a distribution of electoral vote margins depicted in Figure 4. While the distribution is centered around zero because of the tightness of this election, a reasonable mass exists at electoral vote margins of 40 or more due to the number of electoral votes in battleground states such as Florida (27) and Pennsylvania (21).

Figure 3: Candidates’ Beliefs About the Likelihood of Republican Victory in Each State

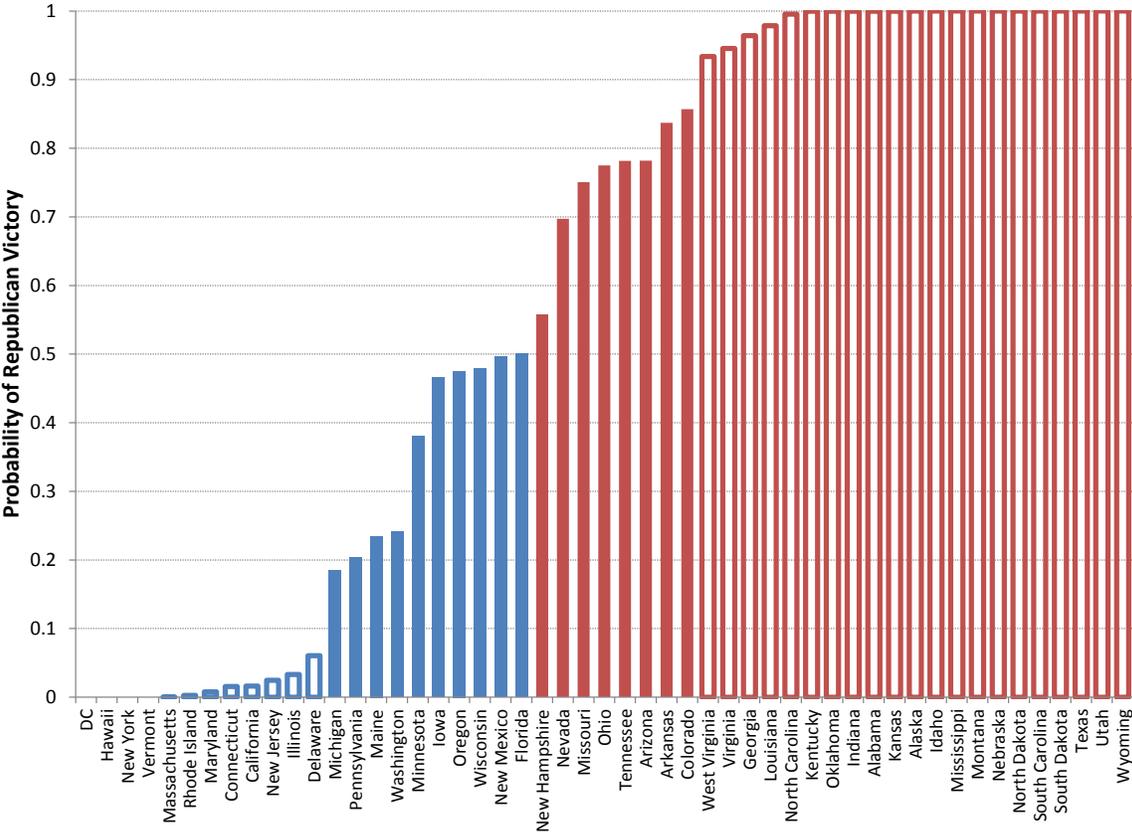
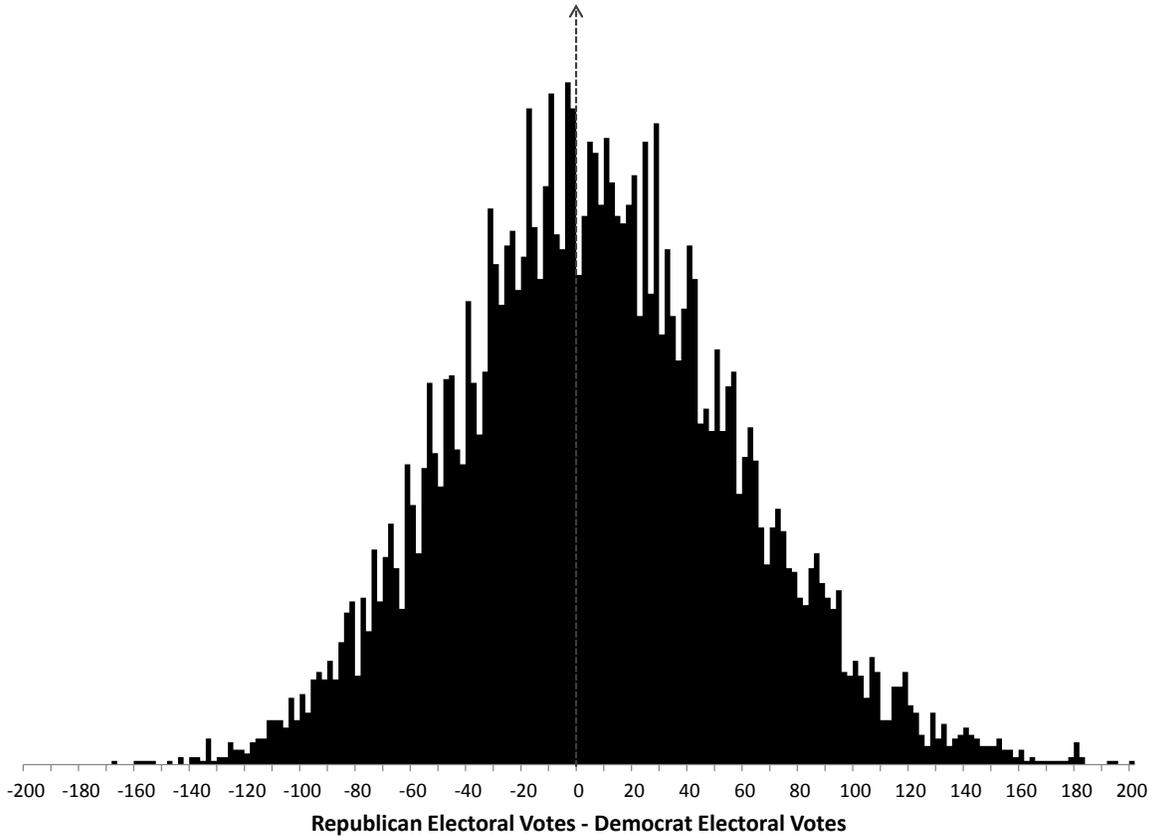


Figure 4: Candidates' Beliefs about the Distribution of Electoral Vote Margins



Notes: Simulated distribution of electoral vote margins in 2000 given candidates' estimated beliefs.

5 Counterfactuals

We consider a counterfactual election system with a direct (popular) vote, in which the candidate with the most popular votes is deemed the winner. Although other Electoral College reforms have been considered, such as the proportional allocation of Electoral College votes, a direct popular vote has come the closest to being passed (Congressional Research Service, 2009).²³ Conducting such a counterfactual allows us to understand how candidates reallocate their resources (e.g., advertising

²³To circumvent the need to pass a Constitutional amendment, eight states and Washington DC have passed the National Popular Vote bill since 2006. According to the bill's website: "Under the National Popular Vote bill, all of the state's electoral votes would be awarded to the presidential candidate who receives the most popular votes in all 50 states and the District of Columbia. The bill would take effect only when enacted, in identical form, by states possessing a majority of the electoral votes—that is, enough electoral votes to elect a President (270 of 538)." <http://www.nationalpopularvote.com/pages/explanation.php>

dollars) under a new electoral process and how voters subsequently respond. Changing the electoral system has a direct effect on candidates' marginal incentives to advertise across markets, thus necessitating the use of a structural model to deliver the new equilibrium strategies and outcomes.

The next subsection briefly discusses how we compute the counterfactual equilibrium. Subsection 5.2 presents the outcomes under the new equilibrium and subsection 5.3 decomposes the results using a series of simulations. The last subsection discusses how states' representation in the election changes from the Electoral College to the Direct Vote.

5.1 Model Solution

To implement the direct popular vote, we modify the indicator function for winning $d_j(\cdot)$. The total number of popular votes a candidate receives is

$$\tilde{V}_j(A, \xi; \hat{\theta}^v) = \sum_{m \in M} \sum_{c \in m} N_{c^s c^j} (A, \xi; \hat{\theta}^v) .$$

Candidate j wins the election if his vote count exceeds the opposing candidate's votes,

$$\tilde{d}_j (A, \xi; \hat{\theta}^v) = 1 \cdot \left\{ \tilde{V}_j (A, \xi; \hat{\theta}^v) > \tilde{V}_k (A, \xi; \hat{\theta}^v) \right\} .$$

Next we rewrite the objective function in terms of the estimated parameters, $\hat{\theta}$, and the success function for the direct vote, \tilde{d} :

$$\tilde{\pi}_j(A; \hat{\theta}) = \hat{R}_j \mathbb{E} \left[\tilde{d}_j (A, \eta; \hat{\theta}^v) \right] - \sum_{m=1}^M \omega_m A_{mj} . \quad (13)$$

Existence of a Nash equilibrium follows from basic results assuming an interior solution. With an arbitrarily large upper bound on advertising, the action space is continuous over a compact set. The return function $\tilde{\pi}_j$ is strictly increasing and concave in own advertising levels and decreasing and concave in the competitor's advertising due to the fact that advertising enters in logged form, i.e., that $\partial \tilde{\pi}_j(\cdot) / \partial A_{mj} > 0$ and $\partial \tilde{\pi}_j(\cdot) / \partial^2 A_{mj} < 0$ and that $\partial \tilde{\pi}_j(\cdot) / \partial A_{mk} < 0$ and $\partial \tilde{\pi}_j(\cdot) / \partial^2 A_{mk} < 0$. The assumption that advertising enters in logs is consistent with the notion that voters should receive decreasing marginal utility from increased levels of advertising.

To compute the equilibrium, we solve for the 150 advertising choices that simultaneously set the FOC of the objective function in equation (13) to zero for each candidate. The FOC is:

$$\hat{R}_j \frac{\partial \mathbb{E} [\tilde{d}_j (A, \eta; \hat{\theta}^v)]}{\partial A_{mj}} \leq \omega_{mj}, \text{ for } m = 1, \dots, M, \quad (14)$$

where the marginal effect of advertising on the probability of winning is

$$\begin{aligned} \frac{\partial \mathbb{E} [d(A, \eta)]}{\partial A_{mj}} &= \frac{1}{NS} \sum_r f_{\eta_{jm}} (\eta_{mj}^* (A_m, -EM_m (A_{-m}, \eta_{-m}^r), \eta_{mk}^r)) \left(\frac{-\partial \eta (A_m, -EM_m (A_{-m}, \eta_{-m}^r), \eta_{mk}^r)}{\partial A_{mj}} \right) \\ &= \frac{1}{NS} \sum_r f_{\eta_{jm}} (\eta_{mj}^* (A_m, -EM_m (A_{-m}, \eta_{-m}^r), \eta_{mk}^r)) \frac{\hat{\alpha}}{1 + A_{mj}} \end{aligned}$$

The derivative of $\eta(\cdot)$ with respect to A_{mj} in our application is $\frac{-\alpha}{1+A_{mj}}$ because A_{mj} and η_{mj} are perfectly substitutable within the utility function as follows: $\delta_{cj} = \tilde{\delta}_{cj} + \alpha \log(1 + A_{mj}) + \eta_{mj}$.

Thus, we compute the equilibrium by solving the system below for the advertising levels $(\tilde{A}_j^*, \tilde{A}_k^*)$:

$$\begin{aligned} \hat{R}_\ell \left[\frac{1}{NS} \sum_{r=1}^{NS} f_\eta (\eta_{m\ell}^{r*}) \frac{\hat{\alpha}}{1 + A_{m\ell}} \right] - \omega_{\ell m} &\leq 0, \text{ for } m = 1, \dots, M \text{ and } \ell = j, k \\ \text{s.t. } \eta_{m\ell}^{r*} &= \eta (A_m, -EM_m (A_{-m}, \eta_{-m}^r), \eta_{mk}^r), \text{ for } r = 1, \dots, NS \\ A_{m\ell} &\geq 0 \text{ for } m = 1, \dots, M \text{ and } \ell = j, k \end{aligned}$$

subject to a set of complementarity conditions between the FOCs and the advertising choice variables to allow for zero advertising outcomes.

5.2 Outcomes under a Direct Vote

Table 5 summarizes the counterfactual equilibrium and compares various outcomes to those observed with the Electoral College. All markets in the direct vote equilibrium receive positive advertising.²⁴ Total spending increases by 25.2% to \$146.7 million. Part of this increase is due to a shift in spending towards larger and more expensive markets that previously received little advertising: spending in the ten largest markets increases by 76% and their share of total spending rises from 26% to 37%. Both candidates allocate similar amounts of advertising dollars to the largest markets. Bush, however, spends 70% more dollars in the 25 mid-sized markets relative to the Electoral College while Gore's total spending in these markets is roughly the same. Thus, Gore primarily shifts spending in former battleground states to the newly relevant large and polarized markets, whereas Bush

²⁴Note that positive advertising in all markets is not an inevitable result of the model. A sufficient increase in the marginal cost of advertising in a market does generate corner solutions.

increases spending in both large- and medium-sized markets. This difference in strategies explains most of the increase in Bush's overall spending gap over Gore.

Figure 5, which plots the new advertising levels against each market's political leaning, makes clear each candidate's new advertising strategies. Each circle in the figure is proportional in size to the market's population. The figure makes clear that Bush advertises more than Gore in nearly all markets, due to his higher value for R_j . In general, the distribution of advertising is flatter compared to outcomes in the Electoral College (recall Figure 1), although significant variation remains. The variation in the total GRPs of both candidates across markets declines from a standard deviation of 110 to 41. Part of this decline in the variation in GRPs in the direct vote is due to the disappearance of battleground markets.

Table 6 summarizes the population-weighted total GRPs separately for the left-, center- and right-leaning markets, where center markets are defined as having between 45% to 55% of the Republican vote share. Recall that in Figure 1, the Electoral College effectively excluded the left and right markets relative to the center. In the baseline counterfactual, voters in left-leaning states receive 21% fewer GRPs compared to voters in centrist states. This result is in contrast to the belief in Grofman and Feld (2005) that moving to a direct vote would lead candidates to focus entirely on the largest media markets. In section 5.3 we show that this discrepancy in advertising allocations is not simply due to the asymmetry in candidates' R_j 's but depends on a combination of factors, most notably variation in advertising prices across markets.

Table 6: GRPs By Political Leaning

	Political Leaning of State (Net of Advertising)				
	Left		Center	Right	
	GRPs	% from Center	GRPs	% from Center	GRPs
Electoral College	26.34	-85%	177.12	-98%	3.42
Direct Vote					
Baseline	97.34	-21%	122.59	0%	122.74
Symmetric Candidates	61.45	-20%	77.25	5%	80.79
Constant CPMs	119.94	7%	111.80	-15%	101.80
Symmetric Candidates & Constant CPMs	62.07	-9%	68.33	-3%	66.55

GRPs in units of 100 with population-weighted averages across DMAs. DMAs in the center are those defined to have between a political leaning of between 45% and 55%, as measured using the Republican share of the two-party vote excluding advertising. Left-leaning markets are those with less than a 45% political leaning and right-leaning markets have greater than a 55% political leaning.

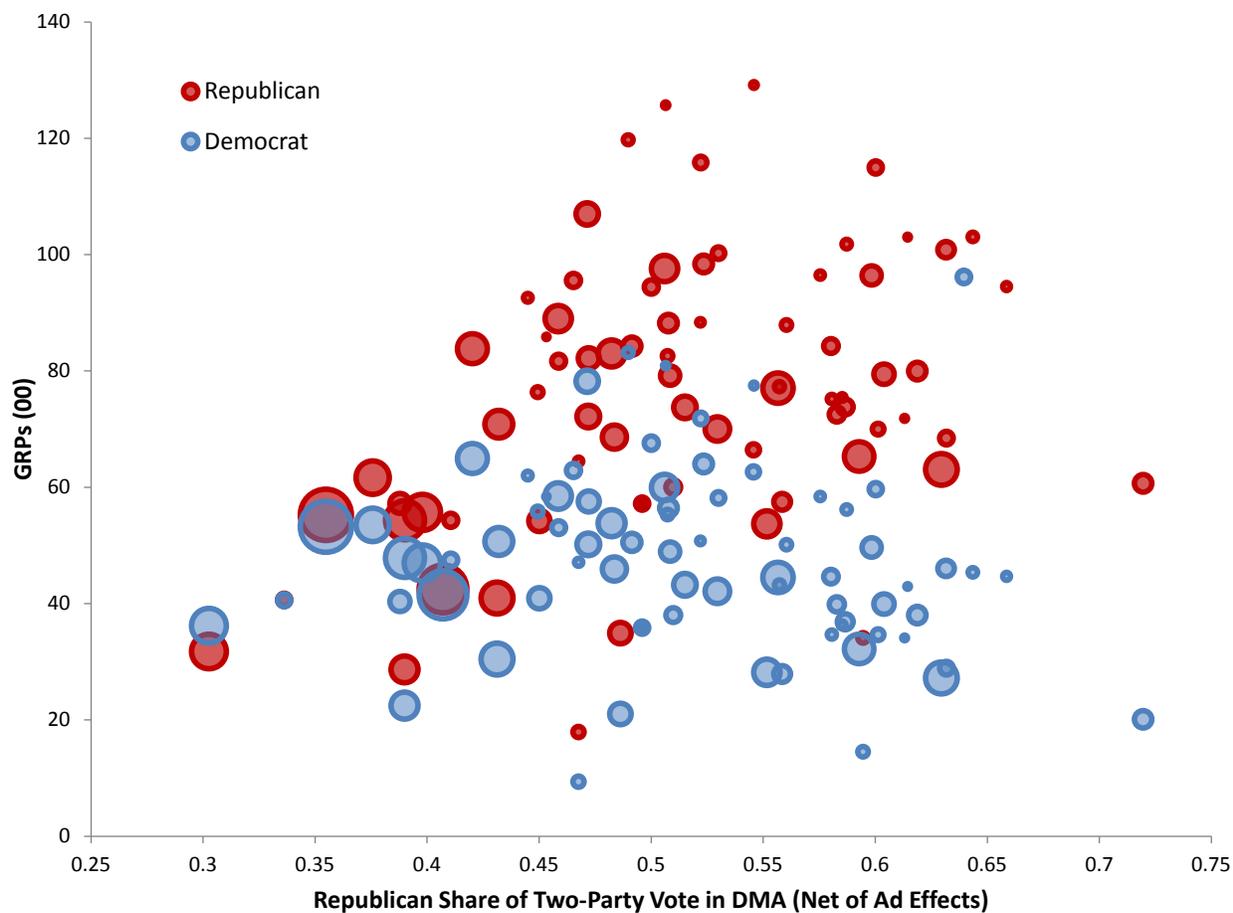
Table 5: Comparison of Observed and Counterfactual Results in 2000

	Observed		Direct Vote	
	Bush	Gore	Bush	Gore
Advertising				
Total Spending (\$ M)	117.1		146.7	
Spending (\$ M)	66.0	51.1	87.1	59.6
Avg. Exposures	90.68		114.66	
Std. Dev. of Exposures	109.78		40.81	
Avg. Exposures (K)	50.53	40.15	68.23	46.43
Voting				
Votes (M)	50.46	51.00	51.52	52.02
Popular Vote Margin (M)	-0.54		-0.49	
% Voter Turnout	61.89		63.17	

5.3 Decomposing the Geographic Distribution of Advertising

The results in Figure 5 reveal significant variation in advertising levels despite the switch to the direct popular vote. As discussed in the introduction, the variation in advertising levels arises through

Figure 5: Advertising under the Direct Vote



Notes: Baseline result from the counterfactual under a direct vote. The horizontal axis is the political leaning of the market, as defined by the Republican share of the two-party vote with advertising set to zero. Each bubble's size is proportional to the population in the market.

several sources: asymmetries in the candidates (R_j), geographic variation in advertising costs (ω_{jm}), and geographic variation in voters' political preferences ($\tilde{\delta}_{cj}$). To gain a better understanding of the relative importance of each force in determining the equilibrium vote and advertising outcomes, we consider a sequence of simulations that remove the first two asymmetries above. These simulations let us examine how each factor influences the variation in the distribution of advertising.

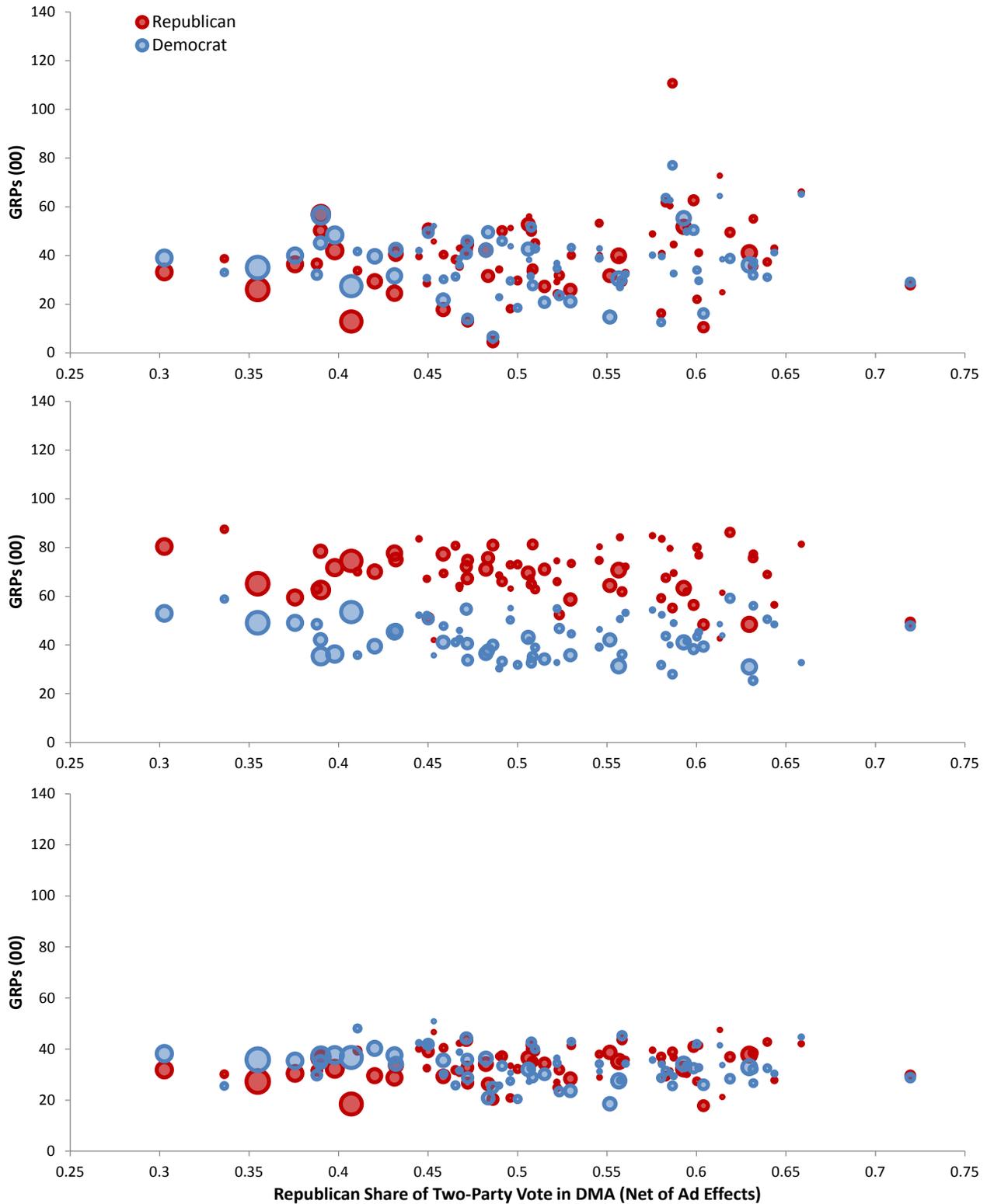
5.3.1 Symmetric R_j

The impact of Bush's higher R_j is evident in Figure 5 with his higher advertising levels, even in Democrat-leaning markets. The upper panel of Figure 6 presents the equilibrium advertising levels after setting each candidate's R_j equal to the average of their estimated values. Advertising levels are now more symmetric across candidate and less dispersed, with the majority of DMAs receiving six thousand GRPs or fewer. Note that both the Republican and the Democratic advertising levels declined. However, there still exist greater levels of advertising in markets near the center and to the right. In fact, Table 6 documents that this case of symmetric candidate financial positions actually leads the right to have 5% more GRPs than the center and 31% more than the left.

To understand the variation in advertising levels in this symmetric model, it is important to consider the role of geographic variation in advertising costs. First, consider the two markets with the lowest and highest CPM: a thousand impressions in Oklahoma City costs \$3.46, whereas it costs about \$16.80 to reach the same number in Las Vegas. Each candidate purchases the most GRPs in Oklahoma City, with Bush buying nearly 20 thousand²⁵ and Gore buying almost 10 thousand. At the opposite extreme both candidates purchase the fewest GRPs in Las Vegas, with Bush buying 1,791 and Gore buying 938. Second, Figure 7 plots the 2000 CPM against each market's political leaning. The cheapest media markets are those in the center, which likely explains the greater ad levels in the center in the upper panel of Figure 6. The next cheapest CPM markets are to the right while more of the expensive markets are to the left.

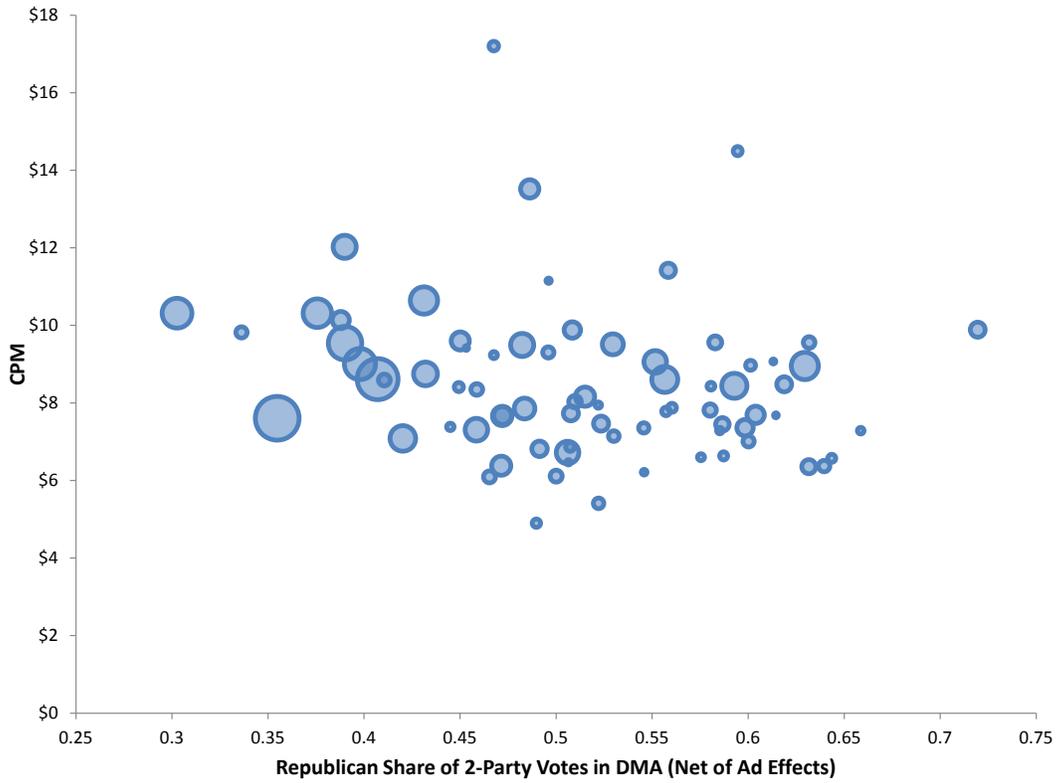
²⁵Bush's twenty-thousand predicted GRPs in Oklahoma is outside the plot area in Figure 6. This number is unrealistic because such a large ad purchase would likely increase the ad prices in Oklahoma City thereby reducing the over-emphasis in this market. Our model treats advertising costs (prices) as fixed. In reality candidates' demand for advertising can shift the market-clearing price of advertising. This effect is more likely to be an issue in smaller markets where the influx of presidential advertising is greatest relative to the local advertising market's size. However, we ignore this issue in our counterfactual as we consider it beyond the scope of this paper to model how political advertising affects market advertising prices.

Figure 6: Equilibrium Advertising in a Direct Popular Vote



Notes: Upper panel sets makes each candidates' R_{tj} symmetric by setting the values equal to the average of the estimates. Middle panel equalizes the advertising price per exposure across markets. Bottom panel makes symmetric the R_{tj} values and equalizes advertising prices.

Figure 7: CPM by Political Leaning of the DMA in 2000



Notes: Vertical axis is the cost-per-thousand impressions (CPM). Each bubble's size is proportional to the population of the market.

5.3.2 Constant CPM

To remove the geographic variation in advertising prices, we solve the equilibrium after setting the marginal cost of reaching voters constant across DMAs. We do so by equalizing the CPM (e.g., the cost to reach 1000 people) across markets to its population-weighted average. The middle panel of Figure 6 presents the advertising levels under constant CPMs across markets and with the (asymmetric) estimated R_j values. Two features stand out in this panel. First, the Republican advertising is greater than the Democrats in all but one market. Second, the advertising tilts to the left in that left leaning markets receive 7% more GRPs than the center and 17% more than the right. Furthermore, the dominantly funded candidate, Bush, advertises 30% more on the left than the right. This is reflective of the left vs. right disparity of Bush's advertising in Figure 1, but in the absence of the electoral college and advertising price variation, it is now the left (as opposed to the center) that receives the most exposures per person.

5.3.3 Symmetric R_j and Constant CPM

The results in the bottom panel of Figure 6 present the equilibrium advertising under both symmetric R_j and constant CPMs.²⁶ The figure shows that advertising exposures are nearly symmetric across markets. This model with symmetric R_j and equal ad costs across markets therefore approaches the theoretical ideal of nearly uniform political inclusion across the country. The standard deviation of exposures here has been reduced to 10 exposures per person, whereas the top and middle panels involved standard deviations of 27.5 and 14.4. The center still receives slightly more exposures, but the left now has less than 10% fewer exposures than the center. This remaining variation likely derives from differences in advertising elasticities across political leanings. The Democrats have a tendency to advertise more in left leaning markets, while the Republicans advertise slightly more on the right. This is consistent with an advertising turnout strategy in which a candidate targets his stronghold markets because encouraging turnout in strongholds will garner the most votes for him.

²⁶Note that making the $\tilde{\delta}_{c,j}$ constant across markets would effectively make the entire country one large undifferentiated market, such that advertising would be constant across all markets.

5.4 State Representation: Turnout in the Direct Vote

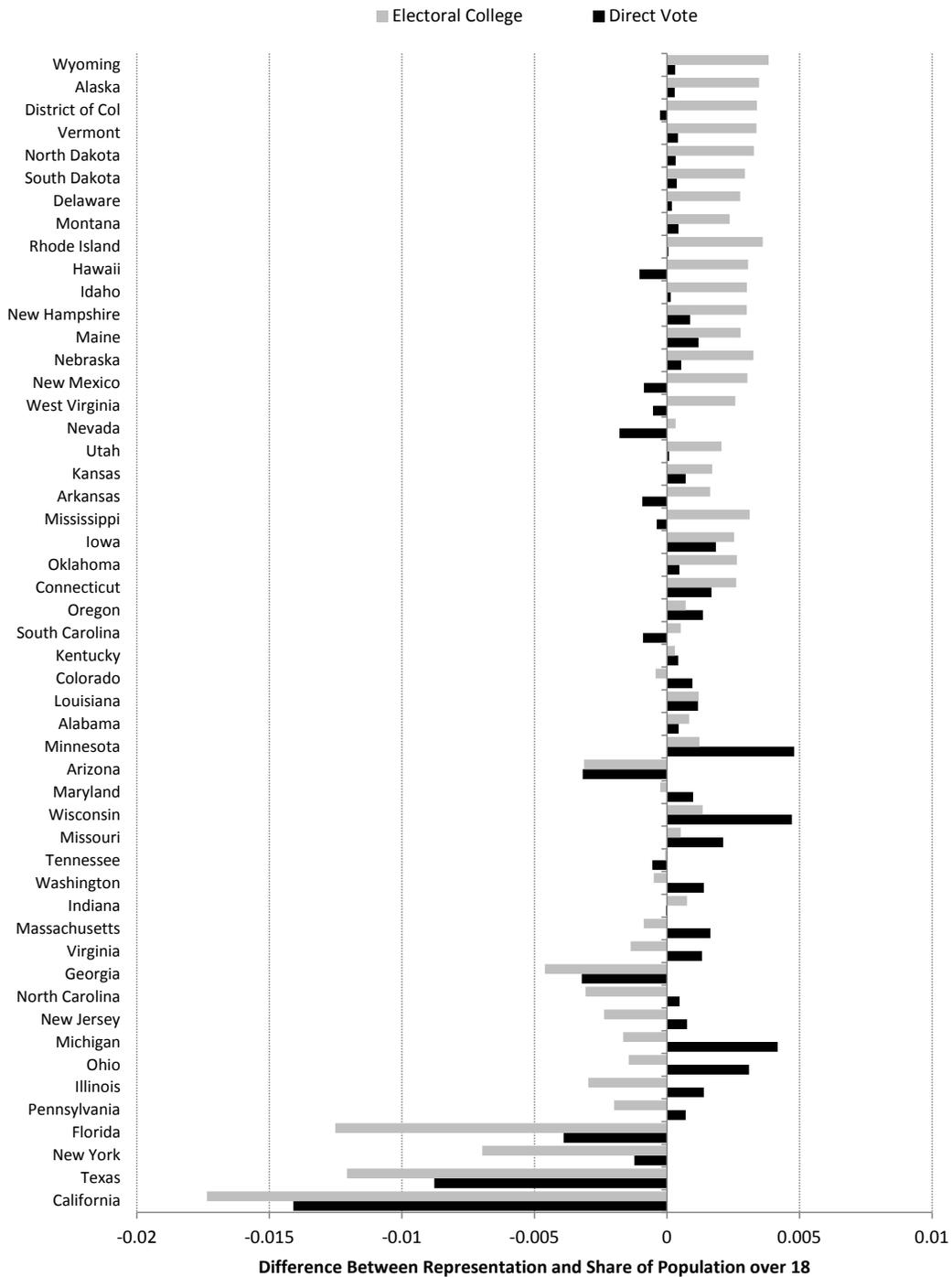
Turnout in the direct vote increases by 1.3%, or about 2 million voters. The popular vote in four states—Iowa, New Mexico, Oregon, and Wisconsin, all with thin margins—flips from Gore to Bush. Gore, however, gains enough votes in the Democratic stronghold of California to win the election even though his national vote margin shrinks from about 543,000 to 494,000.

An important distinction between the Electoral College and a direct vote is a state's relative influence in the election outcome. Under the Electoral College, a state's influence is fixed and proportional to its fraction of the total electoral votes.²⁷ The Electoral College essentially protects states from political losses if a state implements policies that make it more difficult or disqualifies certain voters from casting their votes. Furthermore, the winner-take-all rule gives partisan members of a state's government strong motivation to influence voter turnout to favor their own political party (as witnessed recently in the form of voter identification and anti-voter fraud laws proposed in many states).

In contrast, in a direct vote, a state's relative influence in the election outcome is endogenous—it is proportional to the percent of its population that turns out to vote relative to national voter turnout. Figure 8 depicts the difference in representation of a state between each electoral mechanism and the representation that their population constitutes as percentage of the US population over age 18. States are ordered on the left axis by increasing size of their voting age population. On the top, the series of positive bars reflect the electoral college's protection of small states. On the bottom, large states such as California, Texas and Florida are under-represented in both the electoral college and a direct vote. Under-representation in the direct vote arises from a smaller fraction of the state's voting age population actually voting. Other states such as Georgia, Arizona and Nevada also are under-represented in a direct vote. Minnesota, Wisconsin, Michigan and Ohio are however over-represented in a direct vote. A direct vote therefore eliminates both the electoral college's protection of small states and the tie in to state population size, as a state is now represented only by its voters turning out for the election.

²⁷The Constitution specifies the number of a state's electoral votes as equal to its number of Senators (two) plus its number of Representatives (proportional to its Census population). This allocation implies that each elector in a small state represents fewer voters compared to larger states: as of 2008, each of Wyoming's three electoral votes represented about 177,000 voters, compared to 715,000 for each of the 32 electors in Texas.

Figure 8: States' Election Influence under the Electoral College and Direct Vote



Notes: The horizontal axis reports the difference between a state's relative influence in the election outcome under a particular electoral system relative to the state's voting-age population. Under the Electoral College, a state's influence is its number of electoral votes divided by the total number of electoral votes in the country. Under a direct vote, a state's influence is its voter turnout divided by the total voter turnout in the country. Bars to the left of zero indicate that a state has less influence under that system relative to its share of the total voting-age population. States are sorted from top to bottom in order of ascending population.

6 Conclusion

This paper develops an empirically tractable equilibrium model of advertising competition between presidential candidates. The model allows for the recovery of voter preferences and candidate-side primitives that can guide advertising allocations under alternative electoral mechanisms. With only three primitives of candidate behavior in a two-party contest, the model is general enough to consider any change affecting the determination of a winner. Importantly, the model's ability to endogenize the total spending accommodates changes that might alter spending levels in a counterfactual.

We apply the model to evaluate sources of geographic variation in presidential candidates advertising allocations. States' winner-take-all rules for electoral votes generate the well-known focus on contestable states. This creates concerns about the political exclusion of roughly two-thirds of the population in more polarized states, but also has the benefit of masking other factors that can lead to disproportionate emphases between the left and right. We find that while a direct vote is more inclusive in that all major markets receive advertising, the left leaning markets receive only 80 percent of the center and right's advertising exposures. This is primarily due to systematically higher advertising prices in the left-leaning media markets.

We focus on candidates' geographic targeting because of the emphasis placed on the role of states' in US politics generally and in the Constitution's defined electoral mechanism. Nevertheless, many other disparities in candidates' targeting policies likely exist. Just as candidates in our analysis place more effort in markets with cheap advertising prices, they may also target voters that are more accessible in other ways. For example, the retired population's availability to be more engaged in politics likely explains some of their disproportionate influence in politics. Internet advertising's ability to target based on behavioral characteristics may also generate disparities in the attention candidates pay to various psychographic groups where variation in costs of reach exist.

Appendix A: Advertising and Advertising Price Derivations

We construct a market-candidate observed aggregate advertising level and advertising price (A_{mj} and w_{mj}) based on two observed variables. $\text{Expenditure}_{mjad}$ is CMAG's estimate of the dollars spent by candidate j in market m on an advertisement a in daypart d . CPP_{md} is SQAD's reported advertising price for the 18 and over demographic in market m during daypart d . We use the CPP from the 3rd quarter of the election year.²⁸

Let the daypart level of advertising by candidate j in market m be:

$$GRP_{mjd} = \frac{\sum_{a \in \mathbb{A}_{mjd}} \text{Expenditure}_{mjad}}{CPP_{md}}$$

where \mathbb{A}_{tmjd} is the set of advertisements for a candidate in a market and daypart. Then total advertising by candidate j in market m is:

$$A_{mj} = \sum_{d=1}^8 GRP_{mjd}.$$

The market-specific advertising price for candidate j is defined as follows:

$$w_{mj} = \begin{cases} CPP_{md} \frac{GRP_{mjd}}{A_{mj}} & \text{if } A_{mj} > 0 \\ CPP_m & \text{if } A_{mj} = 0 \end{cases}$$

where

$$CPP_m = \sum_{d=1}^8 \left[CPP_{md} \frac{\sum_{j=1}^J \sum_{m=1}^M GRP_{mjd}}{\sum_{j=1}^J \sum_{m=1}^M \sum_{d=1}^8 GRP_{mjd}} \right].$$

In other words, we use a weighted average across the dayparts in which candidate j advertised in market m if the candidate did in fact advertise there, or a weighted average based on both candidates advertising in all markets within each daypart if the candidate did not advertise in the market.

The advertising price in our candidate-side estimation is $\omega_{mj} = w_{mj} + v_{mj}$ where v_{mj} is the candidate's market-specific unobservable component of advertising. (Recall that the SQAD prices

²⁸While the advertising primarily spans both September (3rd quarter) and October (4th quarter), it is problematic using a separate cost for each quarter because a discontinuity in costs would be artificially be generated on October 1. Furthermore, 4th quarter ad costs are likely not a good estimate of the true cost of the ad because they include the holiday season.

are forecasts) When we analyze the cost per marginal vote, we use CPP_m in all markets to highlight the role of diminishing marginal effectiveness and political leaning in the costs of acquiring an additional vote. Finally, when we solve the direct vote counterfactual, we use w_{mj} as the price of advertising. This avoids odd implications from large local residuals that likely do not relate to costs, but retains a source of local variation in advertising. We remove both the candidate and local market ad price variation in the final simulation by setting an equal price per thousand people (CPM) such that $\tilde{w}_{mj} = \left(\left(\frac{1}{2M} \sum_{j=1}^2 \sum_{m=1}^M CPM_{mj} \right) \times Pop \right) / 100$.

Appendix B: Marginal Effect of a Dollar of Advertising

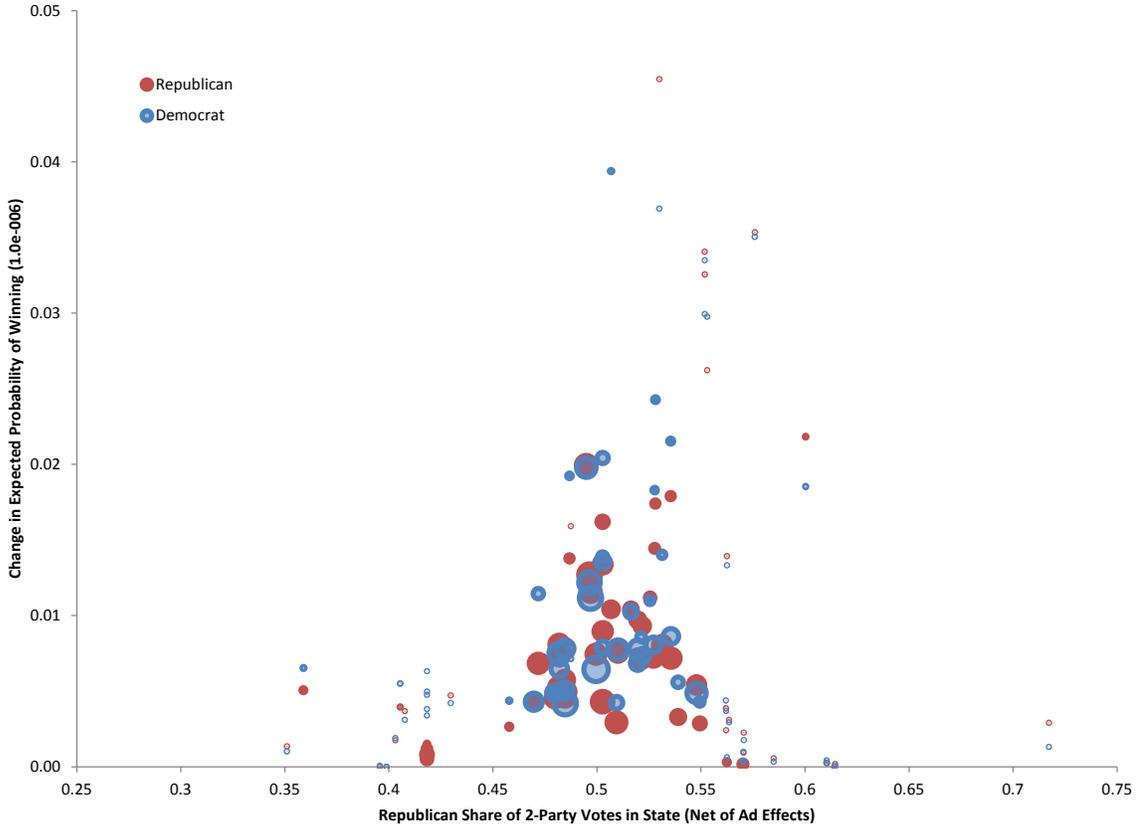
Another critical advertising factor recovered as part of the candidate model estimation is the derivative of the probability of winning with respect to advertising, $\partial \mathbb{E}[d_{tj}] / \partial A_{tmj}$. Setting Equation 4 equal to zero and re-arranging it yields

$$\frac{1}{\omega_{mj}} \frac{\partial \mathbb{E}[d_j(A, \xi; \theta)]}{\partial A_{mj}} = \frac{1}{R_j}.$$

The change in the probability of winning per dollar of advertising should equal $1/R_j$ for all markets where the candidate advertised. We plot in Figure 9 the expression $\frac{\partial \mathbb{E}[d_{tj}(\cdot)] / \partial A_{mj}}{CPP_m}$ against the political leaning of the state. The size of the bubbles in the figure represent the number of GRPs actually purchased by the candidates. As expected, the greatest ad purchases were in centrist states. The change per dollar on the vertical axis is quite small as expected, but it can be better interpreted by considering that an extra million dollars spent under the assumption of no diminishing marginal effects would translate into the numbers depicted next to the axis. For example, a million dollars more in each state would typically generate somewhere between a 0.005 and 0.01 increase in the probability of winning.

The plot certainly does not follow a horizontal line. But its deviations, help us understand some of the additional asymmetries across markets. For example, the Jacksonville-Brunswick media market has a much greater Democrat marginal effect per dollar. One interpretation is that this might have been an opportunity for Gore. On the other hand, there could have been something

Figure 9: Change in Expected Probability of Winning per Additional Dollar Spent



unobservable about this market that made it a more challenging place to earn votes. This is likely the case for Phoenix, which is depicted to be the most promising market to invest an extra dollar, despite neither candidate advertising there. Any market without advertising should exhibit a change in winning per dollar less than all markets where advertising occurred. As mentioned previously, there are likely unique factors about Arizona that make it a more challenging place to earn votes than would otherwise be predicted, e.g. it might have a very small σ .

References

- [1] AdAge (2012), "Has Political Ad Spending Hit a Ceiling? Sorry, But No," November 7. Accessed at <http://adage.com/article/campaign-trail/political-ad-spending-hit-a-ceiling/238185/>.
- [2] Associated Press (2010), "Sick of Campaign Ad Avalanche? TV Stations Aren't," October 30. Accessed at <http://finance.yahoo.com/news/Sick-of-campaign-ad-avalanche-apf-3274707232.html>.
- [3] Baron, D. P. (1989), "Service-Induced Campaign Contributions and the Electoral Equilibrium," *The Quarterly Journal of Economics*, 104(1), 45-72.
- [4] Berry, S., J. Levinsohn, and A. Pakes (1995), "Automobile Prices in Market Equilibrium," *Econometrica*, 63(4), 841-890.
- [5] Blair, D. H. (1979), "Electoral College Reform and the Distribution of Voting Power," *Public Choice*, 34(2), 201-215.
- [6] Brams, S. J. and M. D. Davis (1974), "The 3/2's Rule in Presidential Campaigning," *American Political Science Review*, 68(1), 113-134.
- [7] Coate, S., M. Conlin, A. Moro (2008), "The Performance of Pivotal-Voter Models in Small-Scale Elections: Evidence from Texas Liquor Referenda," *Journal of Public Economics*, 92(3-4), 582-596.
- [8] Colantoni, C. S., Levesque, T. J., and Ordeshook, P. C. (1975), "Campaign Resource Allocation Under the Electoral College," *American Political Science Review*, 69(1), 141-154.
- [9] Congressional Research Service (2009), "Electoral College Reform: 111th Congress Proposals and Other Current Developments," by T. H. Neale, 7-5700, R40895, www.crs.gov.
- [10] Degan, A. and A. Merlo (2011), "A Structural Model of Turnout and Voting in Multiple Elections," *Journal of the European Economic Association*, 9(2), 209-245.
- [11] Downs, A. (1957), *An Economic Theory of Democracy*, New York: Harper and Row.
- [12] Dixit, A. (1987), "Strategic Behavior in Contests," *American Economic Review*, 77(5), 891-898.
- [13] FairVote.org (2012), "How the Electoral College Became Winner-Take-All," by D. McCarthy, accessed at <http://www.fairvote.org/how-the-electoral-college-became-winner-take-all> on October 30, 2012.
- [14] Feddersen, T. and W. Pesendorfer (1999), "Abstention in Elections with Asymmetric Information and Diverse Preferences," *American Political Science Review*, 93(3), 381-398.
- [15] Freedman, P. and K. Goldstein (1999), "Measuring Media Exposure and the Effects of Negative Campaign Ads," *American Journal of Political Science*, 43(4), 1189-1208.
- [16] Friedman, L. (1958), "Game-Theory Models in the Allocation of Advertising Expenditures," *Operations Research*, 6, 699-709.
- [17] Garrett, R. S. and L. P. Whitaker (2007), "Coordinated Party Expenditures in Federal Elections: An Overview," *Congressional Research Service*, The Library of Congress, Order Code RS22644.
- [18] Gelman, A., G. King, and W. J. Boscardin (1998), "Estimating the Probability of Events that have Never Occurred: when is your vote decisive?," *Journal of the American Statistical Association*, 93, 1-9.
- [19] Gomez, B. T., T. G. Hansford, and G. A. Krause (2007), "The Republicans Should Pray for Rain: Weather, Turnout, and Voting in U.S. Presidential Elections," *Journal of Politics*, 69(3), 649-663.

- [20] Gordon, B. R. and W. R. Hartmann (2013), "Advertising Effects in Presidential Elections," *Marketing Science*, 32(1), 19-35.
- [21] Green, D. P., and J. S. Krasno (1988), "Salvation for the Spendthrift Incumbent: Reestimating the Effects of Campaign Spending in House Elections," *American Journal of Political Science*, 32(4), 884-907.
- [22] Grofman, B. and S. L. Feld (2005), "Thinking About the Political Impacts of the Electoral College," *Public Choice*, 123, 1-18.
- [23] Hillygus, D. S. (2005), "The Dynamics of Turnout Intention in Election 2000," *Journal of Politics*, 67(1), 50-68.
- [24] Hopkins, D. and D. Goux (2008), "Repealing the Unit Rule: Electoral College Allocation and Candidate Strategy," Working paper, University of California, Berkeley.
- [25] Kaplan, T. R. and A. Sela (2008), "Effective Political Contests," Working paper, Department of Economics, Ben-Gurion University of the Negev.
- [26] Marks, P. (2000), "The 2000 Campaign: The Spending on Ads; Bush has Advertised More in California than in Swing States," *The New York Times*, <http://www.nytimes.com/2000/10/31/us/2000-campaign-spending-ads-bush-has-advertised-more-california-than-swing-states.html>.
- [27] Mitchell, D. W. (1987), "Candidate Behavior under Mixed Motives," *Social Choice and Welfare*, 4, 153-160.
- [28] Pakes, A., J. Porter, K. Ho, and J. Ishii (2011), "Moment Inequalities and Their Application," mimeo, Harvard University.
- [29] Sahni, N. S. (2012), "Effect of Temporal Spacing between Advertising Exposures: Evidence from an Online Field Experiment," working paper, Stanford GSB.
- [30] Sethuraman, R., G. J. Tellis, R. Briesch (2011), "How well does advertising work? Generalizations from a meta-analysis of brand advertising elasticity," *Journal of Marketing Research*, 48(3), 457-471.
- [31] Shachar, R. (2009), "The Political Participation Puzzle and Marketing," *Journal of Marketing Research*, 46(6), 798-815.
- [32] Shachar, R. and Nalebuff, B. (1999), "Follow the Leader: Theory and Evidence on Political Participation," *American Economic Review*, 89(3), 525-547.
- [33] Siegel, R. (2009), "All-Pay Contests," *Econometrica*, 77(1), 71-92.
- [34] Snyder, J. (1989), "Election Goals and the Allocation of Campaign Resources," *Econometrica*, 57(3), 637-660.
- [35] Skaperdas, S. (1996), "Contest Success Functions," *Economic Theory*, 7(2), 283-290.
- [36] Solomon, J., A. MacGillis, and S. Cohen (2007), "How Rove directed federal assets for GOP gains," *Washington Post*, August 19, p. A1.
- [37] Strömberg, D. (2008), "How the Electoral College Influences Campaigns and Policy: The Probability of Being Florida," *American Economic Review*, 98(3), 769-807.
- [38] Tullock, G. (1980), "Efficient Rent Seeking." In J. M. Buchanan, R. D. Tollison, G. Tullock, (Eds.), *Toward a Theory of the Rent-Seeking Society*. College Station, TX: Texas A&M University Press, 97-112.