# Advertising Competition in Presidential Elections*

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**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 show that eliminating the Electoral College increases campaign reach, but unmasks several factors that still distort the geographic distribution of advertising. Using data from 2000 and 2004, we estimate an equilibrium model of advertising competition between presidential candidates. In a counterfactual with a direct vote, we find that all markets receive advertising, total expenditures rise by 25%, and turnout increases by two million voters. However, systematically higher advertising prices in left-leaning markets lead to 20% fewer exposures per voter compared to right-leaning markets. Equalizing advertising prices eliminates this distortion but reveals a funding asymmetry that tilts advertising the opposite direction: toward the left. Recomputing the equilibrium after equalizing the prices and candidates' financial support yields a nearly uniform distribution of advertising exposures. This suggests that the Electoral College, advertising prices and candidate financial support are the primary sources of geographic variation in advertising, despite extensive local variation in voters' political preferences.

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

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# 1 Introduction

In recent years political advertising has become an important instrument of competition between political candidates. Presidential candidates spent over $1 billion in 2012 on television advertising, the largest component of their media expenditures, and spending is expected to increase (AdAge 2012). The candidates strategically allocate their funds to media markets most likely to shift the election's outcome. Nearly all advertising focuses on tipping markets that reside in so-called battleground states, while candidates pay scant attention to voters in more polarized states where the outcome is foregone. This geographic, and highly concentrated, nature of competition competition arises from the state-level winner-take-all contests in the current Electoral College system.[1] A direct (popular) voting system is an oft-proposed alternative that would eliminate the battleground state distinction and could encourage candidates to expand their campaign efforts to include more voters in the political process.

We assess the effect of the Electoral College on the breadth and intensity of political advertising using a structural equilibrium model of advertising competition between candidates. We estimate the model using observed advertising allocations and vote shares, and then compare outcomes under the Electoral College to a counterfactual with a direct vote. We find that a direct vote expands advertising exposures to include all major media markets, but advertising intensity is lower in left-leaning markets. Using additional model simulations, we find that the disparity in advertising intensity is driven by systematically higher advertising prices in left-leaning markets. Our comparison of electoral mechanisms therefore suggests that while the Electoral College does in fact narrow the breadth of advertising to battleground states, it also overwhelms incentives that might otherwise tilt the intensity of advertising toward left or right leaning states.

Our analysis 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 marginal 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'

[1] 48 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 allocate their votes using a congressional district-based rule. However, in practice, both states have always allocated all their votes to a single candidate.

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 model using data from the 2000 and 2004 general elections for president of the United States. We form moments in a GMM specification around a candidate's local marginal benefits and costs of advertising. Estimation allows us to recover each candidate's financial strength and candidates' uncertainty over voters' preferences. 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.

In a counterfactual experiment with a direct vote in 2000, we find that all states receive positive advertising and that total spending increases by over 25%. 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 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.[2] 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 the stronger candidate, Bush in 2000, 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%

[2] Advertising 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.

more exposures per person than left-leaning markets. Thus the distortions in the Electoral College currently overwhelm the potential for advertising costs and candidates' financial asymmetries to shift candidates' attention toward left- or right-leaning states. In the absence of the Electoral College, advertising prices and candidate financial strength are therefore the primary determinants of variation in the geographic distribution of advertising, despite extensive local heterogeneity in voter preferences.

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.[3]

Our analysis contributes to both the largely theoretical political economy literature on candidate resource allocation and to the structural econometric literature on advertising.[4] Early game-theoretic analyses in political science primarily sought to explain observed allocations (Friedman 1958, Brams and Davis 1974, Colantoni et al. 1975, Owen 1975, Bartels 1985).[5] 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

[3]These 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.

[4]Our 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 candidate's advertising investments. A presidential election aggregates a set of state-level contests to a single outcome.

[5]A 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).

(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. These features play a central role in our finding that the Electoral College masks incentives that could tilt the distribution of advertising toward either left- or right-leaning states.

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., Ackerberg 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 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.

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 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 $j = 1, \ldots, J$ form rational expectations about voter preferences and then simultaneously choose advertising levels $A_{tj} = [A_{t1j}, \ldots, A_{tmj}, \ldots, A_{tMj}]'$ across many markets. Advertising is the same across counties within a market, 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 $\eta_{tmj}$ 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 (forthcoming) 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 $c = 1, \ldots, C$ which belongs to some state, $s = 1, \ldots, S$. Advertising decisions are, however, made at the media market (DMA) level $m = 1, \ldots, M$. 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:

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

where $\delta_{tcj}$ is the mean utility of the candidate. We will often refer to $\delta_{tcj}$ as representing voters' local preferences. $\beta_{tj}$ 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 $\gamma_{mj}$ 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). $\xi_{tcj}$ is an election-county-party demand shock and $\varepsilon_{itcj}$ 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 $\gamma_{mj}$ 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 $\xi_{tcj}$ when casting their votes. However, unlike in standard demand models, candidates do not observe $\xi_{tcj}$ when making their advertising decisions. The shock is also unobserved by the researcher. Candidates' beliefs about the demand shocks $\xi_{tcj}$ induce endogeneity in candidates' advertising strategies.

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

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

where $A_{tm} = [A_{tm1}, \dots, A_{tmJ}]'$. We focus on the model above with homogeneous preferences since

Gordon and Hartmann (forthcoming) do not find significant parameter heterogeneity after estimating the voter model.

The 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.

## 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. Starting with the first-order condition, we motivate two alternative interpretations of the objective function guiding advertising. First, we treat candidates as maximizing their probability of winning subject to a budget constraint where the budget is assumed to efficiently allocate donors' resources to candidates. Second, candidates can also be interpreted as allocating advertising to maximize their payoffs in a contest where the prize is a party-specific value of winning the election. We remain agnostic as to either interpretation, as both yield the same first-order condition.

### 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 $\bar{\xi}_{tcj}$ of each shock's realized value $\xi_{tcj}$. Candidates set advertising levels while forming beliefs according to

$$\boldsymbol{\xi}_{tcj} = \bar{\xi}_{tcj} + \boldsymbol{\eta}_{tmj}, \qquad \boldsymbol{\eta}_{tmj} \sim N(0, \sigma_t) \tag{3}$$

where $\boldsymbol{\eta}_{tmj}$ is a random draw independent across markets, candidates, and elections and $\sigma_t$ represents candidates' ex-ante uncertainty over voting outcomes. Bold facing $\boldsymbol{\xi}_{tcj}$ 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.[6]

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. $\boldsymbol{\eta}_{tmj}$ 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 $\gamma_{mj}$ 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 $\xi_{tcj}$ 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 $A_{tj} = (A_{t1j}, \ldots, A_{tmj}, \ldots, A_{tMj})'$ based on the local marginal costs and benefits of advertising. The marginal cost of advertising is simply a local advertising price, $\omega_{tmj}$. To characterize the marginal benefit of advertising, let $d_{tj}(\cdot)$ indicate whether candidate $j$ wins in election $t$ and let $\mathbb{E}[d_{tj}(\cdot)]$ 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:

$$\frac{\partial \mathbb{E}\left[d_{tj}\left(A, \xi; \theta\right)\right]}{\partial A_{tmj}}.$$

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

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

$$R_{tj}\frac{\partial \mathbb{E}\left[d_{tj}\left(A,\xi;\theta\right)\right]}{\partial A_{tmj}} \leq \omega_{tmj}\ , \ \ \text{for } m=1,\ldots,M, \tag{4}$$

where $R_{tj}$ 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 $R_{tj}$. In particular, we show $R_{tj}$ has a natural interpretation when a candidate's objective function is specified in a form consistent with work on candidate resource allocation (e.g., Strömberg 2008) or contest theory (e.g., Dixit 1987). 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:

$$\underset{A_{tj}}{max} \quad \mathbb{E}\left[d_{tj}\left(A,\xi;\theta\right)\right] \tag{5}$$

$$s.t. \quad \sum_{m=1}^{M}\omega_{tmj}A_{tmj} \leq B_{tj} \tag{6}$$

where $B_{tj}$ is the budget. Note that a candidate's Lagrangian $\mathscr{L}_{tj}(B_t)$ depends on all the budget levels $B_t = [B_{t1},\ldots,B_{tJ}]$ in the election due to strategic interaction between candidates. At a solution, the associated FOC is

$$\frac{\partial \mathscr{L}_{tj}(B_t)}{\partial A_{tmj}} : \quad \frac{\partial \mathbb{E}\left[d_{tj}\left(A,\xi;\theta\right)\right]}{\partial A_{tmj}} = \lambda_{tj}\left(B_t\right)\omega_{tmj} \tag{7}$$

where $\lambda_{tj}\left(B_t\right)$ is the Lagrange multiplier. Inspecting the FOC above makes evident its equivalence with the FOC in equation (4). Our assumed optimal allocation of donor resources implies that in equilibrium,

$$\lambda_{tj}\left(B_t^*\right)=\frac{MU_I}{R_{tj}},\quad \text{for } j=1,\ldots,J.$$

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, $1/R_{tj}$ 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, $\lambda$, is equal to $1/R_{tj}$, yielding the set of optimal budgets $B^*=[B_{t1}^*,\ldots,B_{tJ}^*]$.

Thus $R_{tj}$ 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 $d_{tj}(\cdot)$, the function that determines the winner of the election. Under some $\tilde{d}_{tj}$, the previously optimal budgets $B^*$ may imply that $\lambda_{tj}\left(B^*\right)$ is greater or less than $1/R_{tj}$ because the left-hand side of equation (7) changes (i.e., moving to $\tilde{d}_{tj}$ 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 $1/R_{tj}$. 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.[7]

**Optimization in a Contest** An alternative formulation of a candidate's objective function draws on the theoretical literature on contests (e.g., Tullock 1980, Dixit 1987, Kvasov JET 2007).[8] Such models consider the following unconstrained optimization problem where the candidate balances the

[7]We 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.

[8]In 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 $p(e_1,\ldots,e_J)$, which determines the probability of winning the prize given each participant's effort. In our model, $\mathbb{E}\left[d_j(A,\boldsymbol{\xi};\theta)\right]$ plays the equivalent role.

value of winning against the total cost of advertising:

$$\pi_{tj}\left(A,\boldsymbol{\xi};\theta\right)=R_{tj}\mathbb{E}\left[d_{tj}\left(A,\xi;\theta\right)\right]-\sum_{m=1}^{M}\omega_{tmj}A_{tmj} \tag{8}$$

where $R_{tj}$ is the value associated with candidate $j$ winning election $t$ and $\omega_{tmj}$ 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 $R_{tj}$ converts the probability of winning into monetary terms.[9] 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 $R_{tj}$ as the "prize" of winning the contest. Downs (1957) and Baron (1989) interpret $R_{tj}$ as the candidate's expected stream of benefits associated with winning office and any future election opportunities if he is successful.[10] 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, $R_{tj}$ might be characterized as the collective payoff to all parties who would benefit from candidate $j$'s victory.[11] Yet this interpretation still abstracts away from externalities in donation and fundraising costs.[12]

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

[9] An 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.

[10] These 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.

[11] The 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.

[12] One interesting extension to our model would entail adding an earlier stage in which candidates engage in fundraising to build a warchest 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.

### 2.2.3 Determining a Winner Under the Electoral College

The function $d_{tj}(\cdot)$ 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 $d_{tj}(\cdot)$.

Since a state may contain multiple markets, define $A_{tsj} = \{A_{tmj} : \forall m \in s\}$ as the set of advertising choices for candidate $j$ in state $s$ and let $A_{tm} = [A_{tm1}, \ldots, A_{tmJ}]'$ be the collection of such advertising choices across candidates. Then $d^s_{tj}$ indicates whether a candidate receives the majority of votes in a state,

$$d^s_{tj}(A_s, \xi; \theta^v) = 1 \cdot \left\{ \sum_{m \in s} \sum_{c \in m} N_{tmc} s_{tcj}(A_{tm}, \xi; \theta^v) > \sum_{m \in s} \sum_{c \in m} N_{tmc} s_{tck}(A_{tm}, \xi; \theta^v), \forall k \neq j \right\} \quad (9)$$

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

$$d_{tj}(A, \xi; \theta^v) = 1 \cdot \left\{ \sum_{s=1}^{S} d^s_{tj}(A_{ts}, \xi; \theta^v) \cdot V_{ts} > \bar{V} \right\} \quad (10)$$

where $V_{ts}$ is the state's electoral votes and $\bar{V}$ is the minimum number of votes required for a majority.

## 3 Data

We estimate the model using data from the 2000 and 2004 elections. 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, 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 (forthcoming) 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.[13] 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.[14] Our analysis therefore aggregates exposures across all dayparts into a single advertising variable $A_{tmj}$. We measure $A_{tmj}$ in thousands of GRPs and set $g(A_{tmj}; \alpha) = \alpha \log(1 + A_{tmj})$.

The market-candidate specific *observed* price, $w_{tmj}$, is a weighted average across all the dayparts in which the candidate advertised. If a candidate did not advertise in a market, we set $w_{tmj} = w_{tm}$, where $w_{tm}$ 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 in each election. Ads may 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 $A_{tmj}$ for

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

[14]The 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 by Election for Candidate Advertising

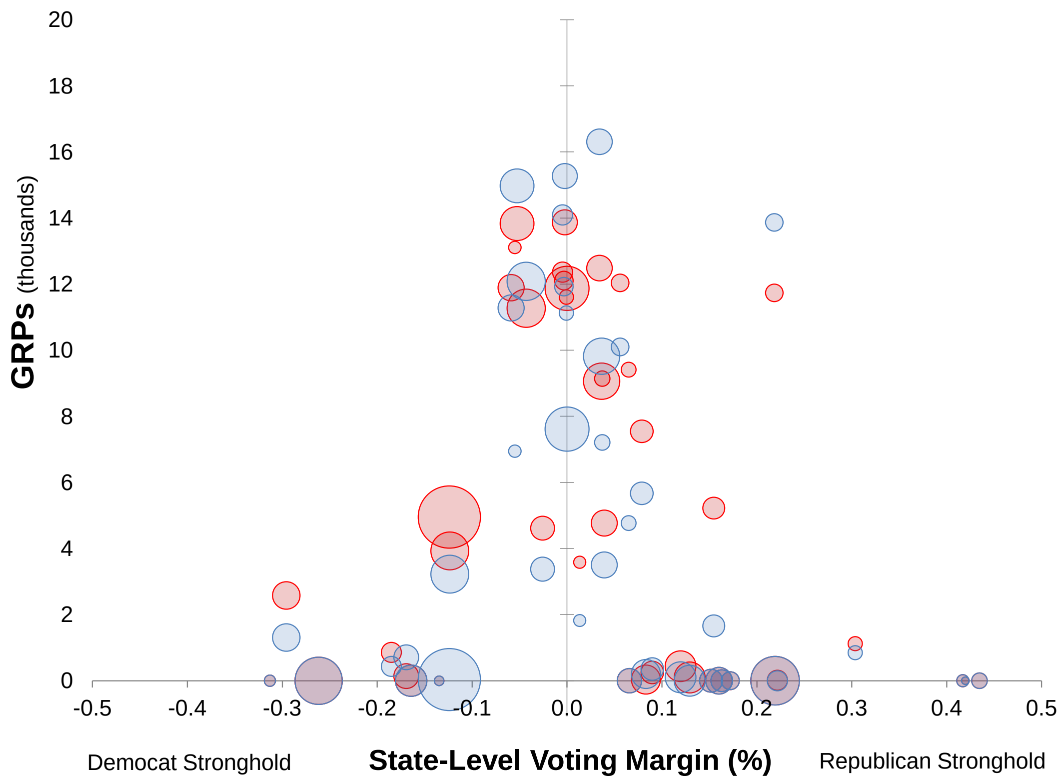
| | Obs | Mean | Std Dev | Min | Max |
|---|---|---|---|---|---|
| **2000 Election** | | | | | |
| GRPs Bush (K) | 75 | 582 | 560 | 0 | 1589 |
| GRPs Gore (K) | 75 | 478 | 568 | 0 | 1794 |
| Expenditures Bush ($ K) | 75 | 879.84 | 1,218.73 | 0 | 6,185.45 |
| Expenditures Gore ($ K) | 75 | 681.53 | 1,072.94 | 0 | 5,941.61 |
| Avg. CPP Bush | 75 | 181 | 198 | 42 | 1155 |
| Avg. CPP Gore | 75 | 180 | 189 | 42 | 1155 |
| **2004 Election** | | | | | |
| GRPs Bush (K) | 75 | 781 | 1044 | 0 | 3598 |
| GRPs Kerry (K) | 75 | 973 | 1281 | 0 | 4622 |
| Expenditures Bush ($ K) | 75 | 1,123.76 | 1,863.43 | 0 | 8,386.41 |
| Expenditures Kerry ($ K) | 75 | 1,349.32 | 2,207.18 | 0 | 9,856.52 |
| Avg. CPP Bush | 75 | 193 | 222 | 46 | 1173 |
| Avg. CPP Gore | 75 | 192 | 220 | 45 | 1173 |

Source: Gordon and Hartmann (forthcoming)

our estimation. Across the 75 media markets, the challenging party (Bush in 2000 and Kerry in 2004) purchased more advertising. Spending for both parties also increased substantially from 2000 to 2004.

Figure 1 plots advertising GRPs for both candidates in the 2000 election 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.

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



### 3.2 Advertising Instruments

Advertising is endogenous because candidates possess knowledge about local demand shocks $\bar{\xi}_{tcj}$. 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 $\bar{\xi}_{tcj}$ 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.[15] 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. Table 2 summarizes the one-year lagged CPMs across media markets for each election and daypart. We use interactions between the dayparts and candidate dummies as instruments because candidates choose different mixes of dayparts across markets.

### 3.3 Votes and Control Variables

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).[16]

It is important to note that we observe advertising at the DMA level and voting outcomes at the county level. We assign the observed advertising in the DMA to each county contained in that market.[17] 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

[15]A possible concern is that the measurement errors in the lagged CPP estimates due to SQAD's methodology could be systematically related to current CPP estimates. We do not expect such a systematic bias to exist because SQAD updates its advertising price predictions each quarter to account for realized prices in the past quarters. If the measurement errors were correlated, then SQAD would be making a systematic mistake in the same direction, which seems unlikely given the nature of the firm's business.

[16]A 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.

[17]In 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.

**Table 2:** Lagged CPM

| Year | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| **1999** | | | | | |
| Early Morning | 75 | 4.40 | 1.13 | 2.18 | 8.60 |
| Day Time | 75 | 5.13 | 1.33 | 2.39 | 9.87 |
| Early Fringe | 75 | 6.34 | 1.69 | 3.38 | 11.62 |
| Early news | 75 | 6.74 | 1.94 | 2.97 | 12.22 |
| Prime Access | 75 | 7.50 | 2.15 | 2.72 | 13.73 |
| Prime Time | 75 | 13.05 | 3.78 | 5.99 | 26.00 |
| Late News | 75 | 8.92 | 2.35 | 5.42 | 15.98 |
| Late Fringe | 75 | 7.59 | 2.07 | 3.22 | 13.31 |
| **2003** | | | | | |
| Early Morning | 75 | 5.61 | 1.70 | 2.95 | 10.72 |
| Day Time | 75 | 5.16 | 1.38 | 3.12 | 10.04 |
| Early Fringe | 75 | 6.99 | 1.67 | 3.80 | 11.62 |
| Early news | 75 | 8.25 | 1.94 | 5.29 | 13.24 |
| Prime Access | 75 | 10.60 | 2.59 | 6.02 | 20.16 |
| Prime Time | 75 | 16.88 | 4.69 | 9.36 | 30.40 |
| Late News | 75 | 12.64 | 2.89 | 7.27 | 20.35 |
| Late Fringe | 75 | 8.63 | 2.29 | 4.99 | 16.03 |

behavior is held fixed in counties representing the remaining 22% of the population.

The DMA-party fixed effects $\gamma_{mj}$ 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 minimize the potential role of these unobservables, 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.[18] 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. We first estimate the voter model, and then take those parameters as given when estimating the candidate model.

## 4.1 Identification

We discuss the intuition behind the identification of our model's parameters. Identification of the voter parameters, $\theta^v = (\beta_{tj}, \alpha, \phi, \gamma_{mj})$, discussed in more detail in Gordon and Hartmann (forthcoming), follows from standard arguments when estimating aggregate market share models.

Identification of the candidate model's parameters, $\theta^c = (R_{tj}, \sigma_t)$, is less standard. At least two parameters are identified within an election because of the different advertising choices across the two major party candidates. The $R_{tj}$ are identified based on a candidate's average advertising level in an election, which can intuitively be seen by examining the FOC in equation (4).

Identification of candidates' uncertainty $\sigma_t$ relies on systematic variation in advertising levels across markets. Candidates form expectations that recognize which markets will have large realized

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

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 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., $\sigma_t = \infty$. At the other extreme, if $\sigma_t$ 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.

We are unable to recover election-county-candidate specific beliefs, so we assume $\bar{\xi}_{tcj} = \xi_{tcj}$. This implies the realized value of $\eta_{mj}$ is always zero, but candidates do not know this.

## 4.2 Estimation

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

$$\omega_{tmj} = w_{tmj} + \upsilon_{tmj} \; , \tag{11}$$

where $w_{tmj}$ is an observed estimate of the marginal cost and $\upsilon_{tmj}$ is a structural error observed by the candidate but unobserved to the econometrician. The error term $\upsilon_{tmj}$ forms the basis of our estimation strategy.[19]

Our discussion focuses on estimating the supply-side parameters in $\theta^c$. Given that advertising is

[19]The 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. We discuss this in more detail in section 4.4.

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 ($A^*_{tmj} = 0$).

We begin by considering observations with positive advertising. In such cases, there is an interior solution to the first-order condition of a candidate's objective function, allowing us to recover the econometric unobservable:

$$R_{tj} \frac{\partial \mathbb{E}\left[d_{tj}(A_{tj}, A_{t-j}; \theta^v, \sigma_t)\right]}{\partial A_{tmj}} - w_{tmj} = v_{tmj} \,.$$

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

$$\mathbb{E}\left[\left(R_{tj} \frac{\partial \mathbb{E}\left[d_{tj}(A_{tj}, A_{t-j}; \theta^v, \sigma_t)\right]}{\partial A_{tmj}} - w_{tmj}\right) |z_{tmj}\right] = 0$$

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 $\mathbb{E}\left[v|z, A > 0\right] \neq 0$. 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 $v_{tmj}$.

Whether this selection problem is an issue for estimation hinges on our beliefs about the potential importance of $v_{tmj}$. In our data the observed marginal costs $w_{tmj}$ are SQAD's forecasts for the election season. The $v_{tmj}$ should represent deviations between these forecasts and candidates' actual advertising costs. For $\mathbb{E}\left[v|z, A > 0\right] \neq 0$, a candidate must receive a sufficiently large $v_{tmj}$ 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 $\xi_{tcj}$ 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 $v_{tmj}$ *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 $w_{tmj}$ and the candidates' beliefs about $\bar{\xi}_{tcj}$. 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:

$$\mathbb{E}\left[\left(R_{tj}\frac{\partial \mathbb{E}\left[d_{tj}(A_{tj}, A_{t-j}; \theta^v, \sigma_t)\right]}{\partial A_{tmj}} - w_{tmj}\right)|z_{tmj}, A_{tmj} > 0\right] = 0\,.$$

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

$$m(\theta) = \frac{1}{TJM^+}\sum_{t=1}^{T}\sum_{j=1}^{J}\sum_{m=1}^{M_j^+}\left[\left(R_{tj}\frac{\partial \mathbb{E}\left[d_{tj}(A_{tj}, A_{t-j}; \theta^v, \sigma_t)\right]}{\partial A_{tmj}} - w_{tmj}\right)\otimes g(z_{tmj})\right]\,,$$

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 $z$.

Rather than estimate the model using the FOCs, an alternative approach would be to define a moment inequality estimator following Pakes, Porter, Ho, and Iishi (2011). Estimation with moment inequalities 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 with continuous control problems.

### 4.3 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 (forthcoming) 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 $s^0_{jm}$ be the vote share of candidate $j \in \{R, D\}$ in market $m$ when all advertising is set to zero. Dropping the election subscripts $t$, we define the political leaning of a market as the Republican share of the two-party vote in the absence of advertising:

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

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.

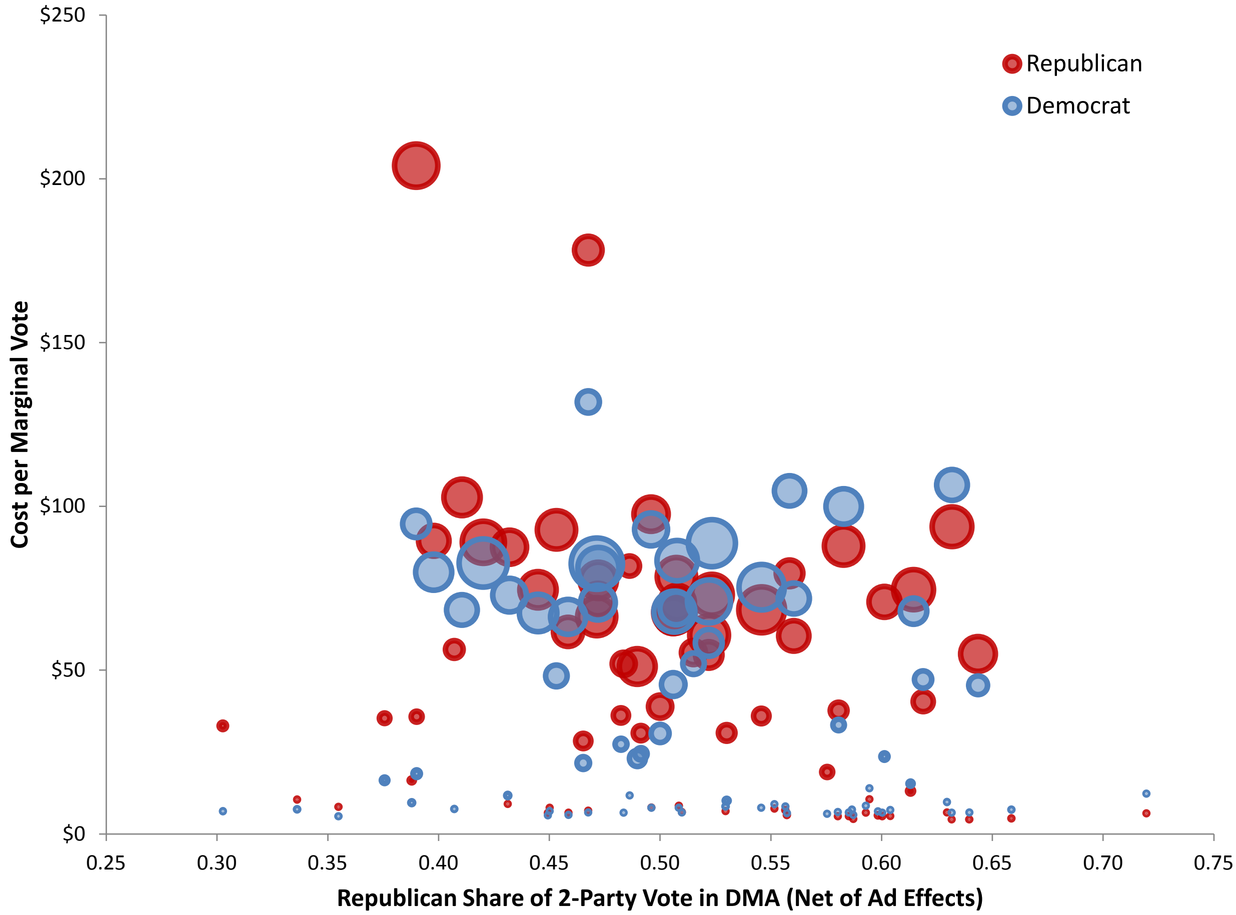
Figure 2 plots the cost per marginal vote in the 2000 election against the political leaning of the media market.[20] Each bubble is proportional to a candidate's GRPs in the market. The majority of markets with substantial advertising tend to have a cost per marginal vote of about \$75. The highest 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 Republican 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.

### 4.4 Candidate Model Estimates

Table 4 presents the parameter estimates from the candidate model. In 2000, Bush outspent Gore by 29% and the estimates for $R_{tj}$ imply that Republicans had a 45% greater return to winning the election. In 2004, Kerry spent 21% more than Bush, and yet the $R_{tj}$ estimates suggest roughly equal values of winning. The uncertainty estimate $\sigma_t$ in 2000 is twice as large compared to 2004, perhaps not surprising given the the narrow margin of victory in the 2000 election. One source of the differences between some of these estimates is Bush's decision to spend heavily in markets contained within left-leaning states (e.g., San Francisco in California). Gore spent zero on advertising in California.

[20]The 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.

**Table 4:** Candidate Model Estimates

| **Parameters** | $\sigma_t$ | $R_{tj}$ (\$M) | Observed Spending (\$M) |
|---|---|---|---|
| 2000 Bush | 0.157 (0.010) | 146.4 (2.743) | 66.0 |
| 2000 Gore | | 100.8 (2.233) | 51.1 |
| 2004 Bush | 0.079 (0.007) | 284.8 (5.999) | 84.2 |
| 2004 Kerry | | 282.1 (5.637) | 101.7 |

Standard errors in parentheses.

In fact, Bush's spending in California in 2000 is difficult to rationalize within the model. For example, the residual $v$ for Bush in Los Angeles implies a negative cost shock of \$998 relative to a CPP of \$1121, thus a strict interpretation as a cost shock seems unreasonable. The unobservables necessary for estimation only enter through advertising prices, but these unobservables absorb all other factors not captured in the model. Given the parsimony of the model—there are only three candidate-side parameters per election—it is not surprising that some residuals from the FOCs are large. There are two general ways to interpret these large residuals.

First, the residual could be due to different beliefs. One such mechanism would be through a deviation in Bush's mean belief about the demand shocks ($\bar{\xi}$) in Los Angeles. However, it seems unlikely that Republican market research could have differed so greatly from that conducted by the Democrats, who spent nothing in Los Angeles. Another way is if the residual indicates a California-specific deviation in Bush's perceived uncertainty over voting outcomes ($\sigma$). This, too, is unlikely because, based on our model, Bush's uncertainty in the California markets would need to be over 13 times higher compared to the national estimate to produce a 50% perceived probability of winning the state.

Second, the residual might represent some extraneous factor or unmodeled component of the objective function that shifts the marginal benefit of advertising. The FOC for advertising in equation 4 could be rewritten as

$$\frac{\partial \pi_j \left(A; \boldsymbol{\xi}, \theta\right)}{\partial A_{mj}} = R_j \frac{\partial \mathbb{E}\left[d_j\left(A, \xi; \theta\right)\right]}{\partial A_{mj}} + \tilde{v}_{mj} - \left(w_{mj} + v_{mj}\right) \text{ for } m = 1, \ldots, M$$

This implies the introduction of an unobserved marginal benefit shock, $\tilde{v}_{mj}$, that is econometrically inseparable from the unobserved marginal cost $v_{mj}$. This explanation is the most plausible for

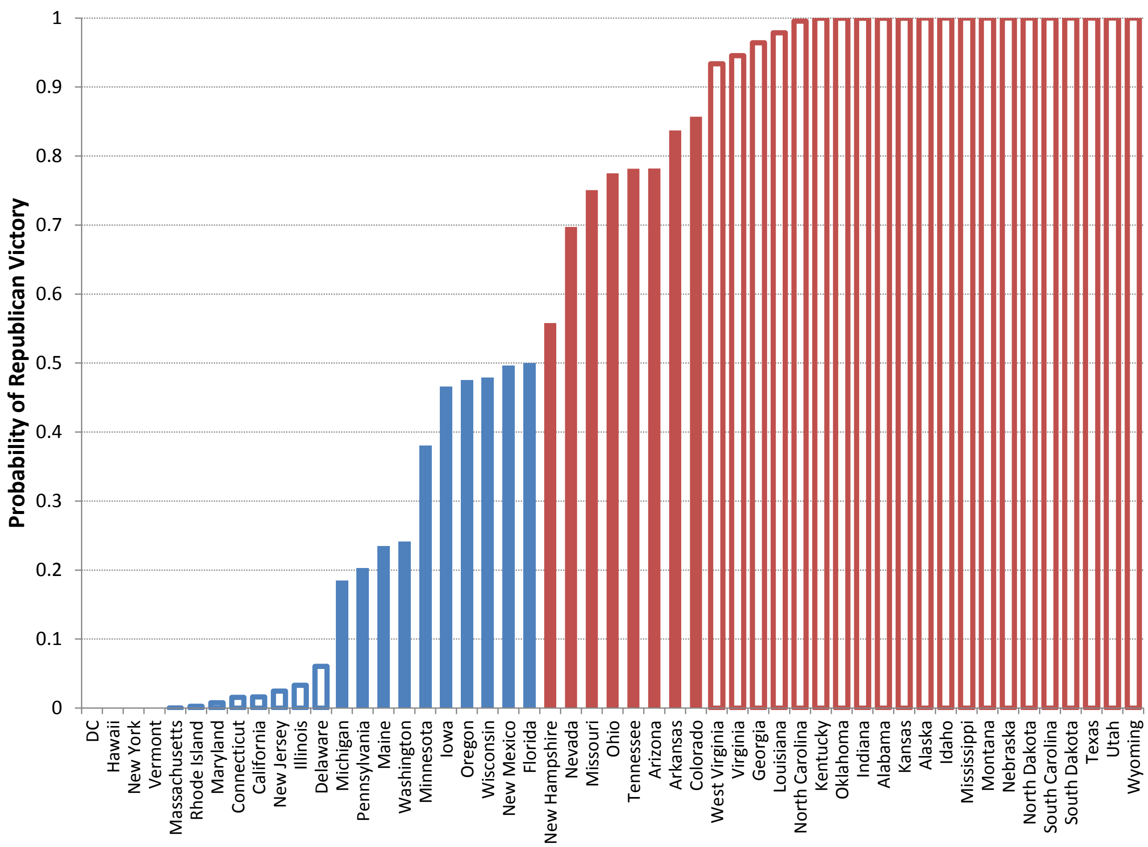
Los Angeles and three other Californian markets which make up four of the six largest negative residuals for Bush in 2000. The source of Bush's "optimization error" in California appears to be an obligation to campaign donors to try to tip California: a top Bush advisor was quoted as saying that "there was a commitment that we made to California early on, and that commitment was time and money," (Marks 2000). The two other large negative Bush residuals are in Lexington and Louisville, Kentucky, where he purchased advertising and Gore did not. Bush won Kentucky with a 15% vote margin and Gore won California with a 12% vote margin. These over-reaching efforts by Bush generate large unobservables, but the model also interprets the basis for such efforts through a stronger financial position ($R_j$) and "wider" beliefs ($\sigma$) about the potential for large market share swings in our model.

To explore our estimates of candidate uncertainty, we consider the implied belief distribution of both state and national outcomes in the 2000 election. Figure 3 depicts candidates' beliefs about the 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 2000 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).

## 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

**Figure 3:** Candidates' Beliefs About the Liklihood of Republican Victory in Each State

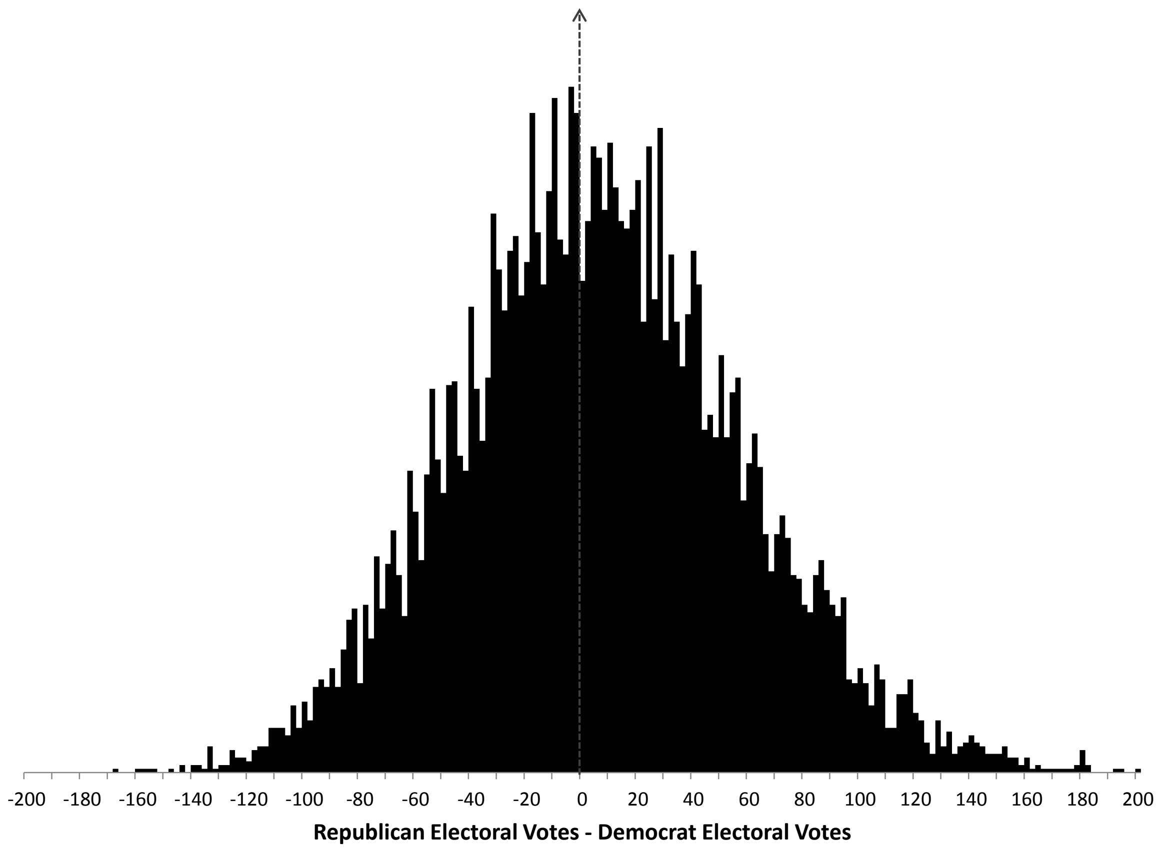



has come the closest to being passed (Congressional Research Service, 2009).[21] Conducting such a counterfactual allows us to understand how candidates reallocate their resources (e.g., advertising dollars) under a new electoral process and how voters subsequently respond. Changing the electoral system 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.

We focus entirely on the 2000 election because it was hotly contested and due to the computational burden of calculating the new equilibrium. To implement the direct popular vote, we modify the

[21]To 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`

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




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

indicator function for winning $d_j(\cdot)$. The total number of popular votes a candidate receives

$$\tilde{V}_j(A, \xi; \hat{\theta}^v) = \sum_{m \in M} \sum_{c \in m} N_c s_{cj} \left( A, \xi; \hat{\theta}^v \right) .$$

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

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

One question that arises when solving counterfactuals is whether the residuals, discussed in the last section, are policy invariant. In the case of the demand side, the residuals $\xi$ represent unobserved voter preferences that are specific to a county, candidate, and election. Such preferences for the candidates should be invariant to the election mechanism. However, this requires the additional assumption that other candidate activities, such as grassroots campaigning and candidate visits, remain fixed. Interpreting the candidate-side cost unobservables as being policy invariant is implausible. As described above, our parsimonious three-parameter model produces some large unobservables. Under the strong incentives of the electoral college, large residuals were required to justify including markets in polarized states such as California. Yet, a stated objective to devote time and money to California can easily be met in a direct vote without large deviations from otherwise optimal allocations. Carrying over the large California unobservables to a direct vote would imply Bush favoring California well beyond any other state in the 2000 election. This could not have even been in the interests of California donors. We therefore set all candidate-side residuals to zero in the counterfactual. While this may eliminate some local variation in candidates' advertising incentives, it provides more plausible predictions and as we show below retains substantial local variation in candidate advertising.

The remainder of the model is unchanged. Solving the counterfactual is non-trivial from a computational perspective but not central to the substantive implications of our results, so we relegate the details to Appendix B.

## 5.1 Direct Vote in 2000

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.[22] 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 increases spending in both large- and medium-sized markets. This difference in strategies explains

[22]Note 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.

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 5.2 we show that this discrepancy in advertising allocations is not simply due to the asymmetry in candidate's $R_j$'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.

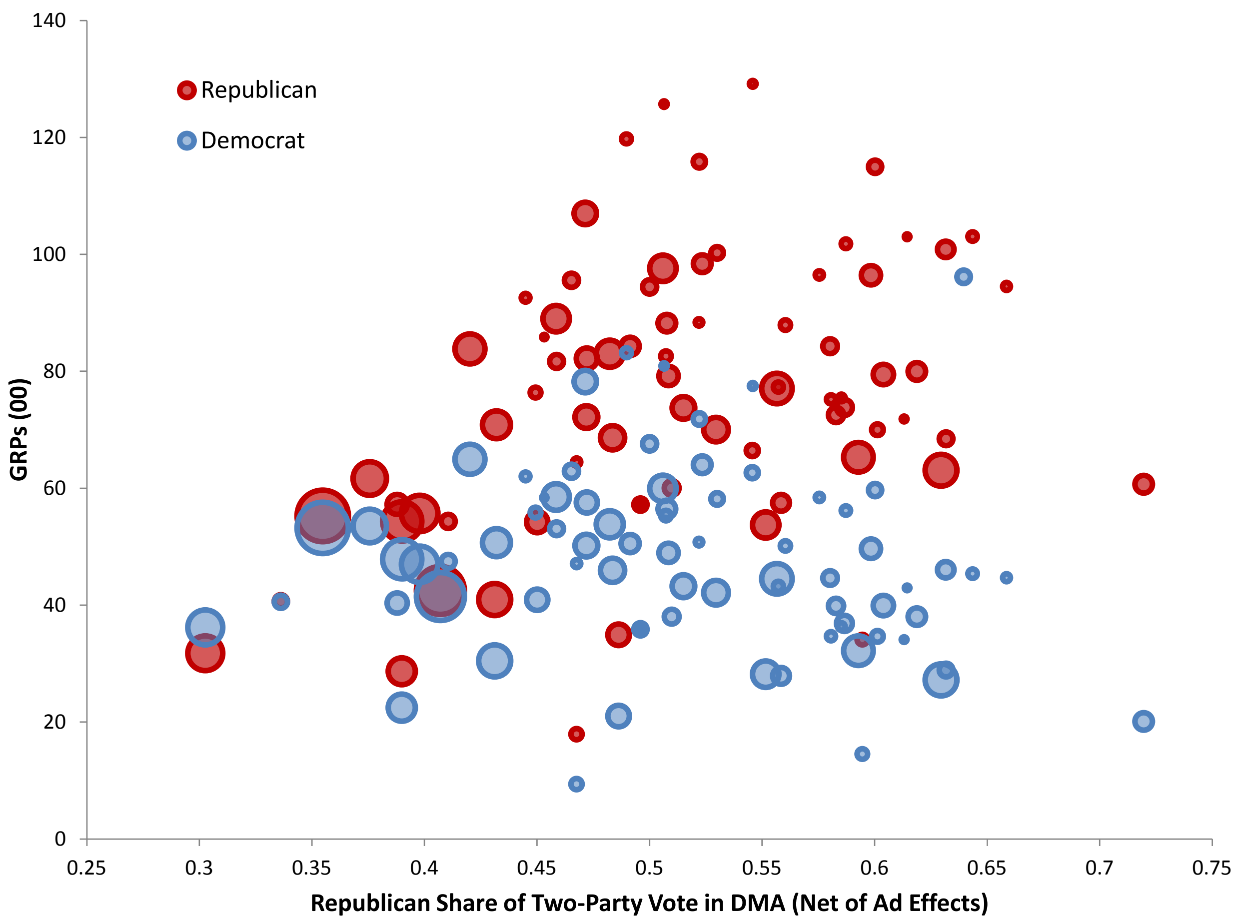
**Table 5:** Comparison of Observed and Counterfactual Results in 2000

| | 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 | |

## 5.2 Prospects for a More Equitable 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 ($\omega_{jm}$), 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.

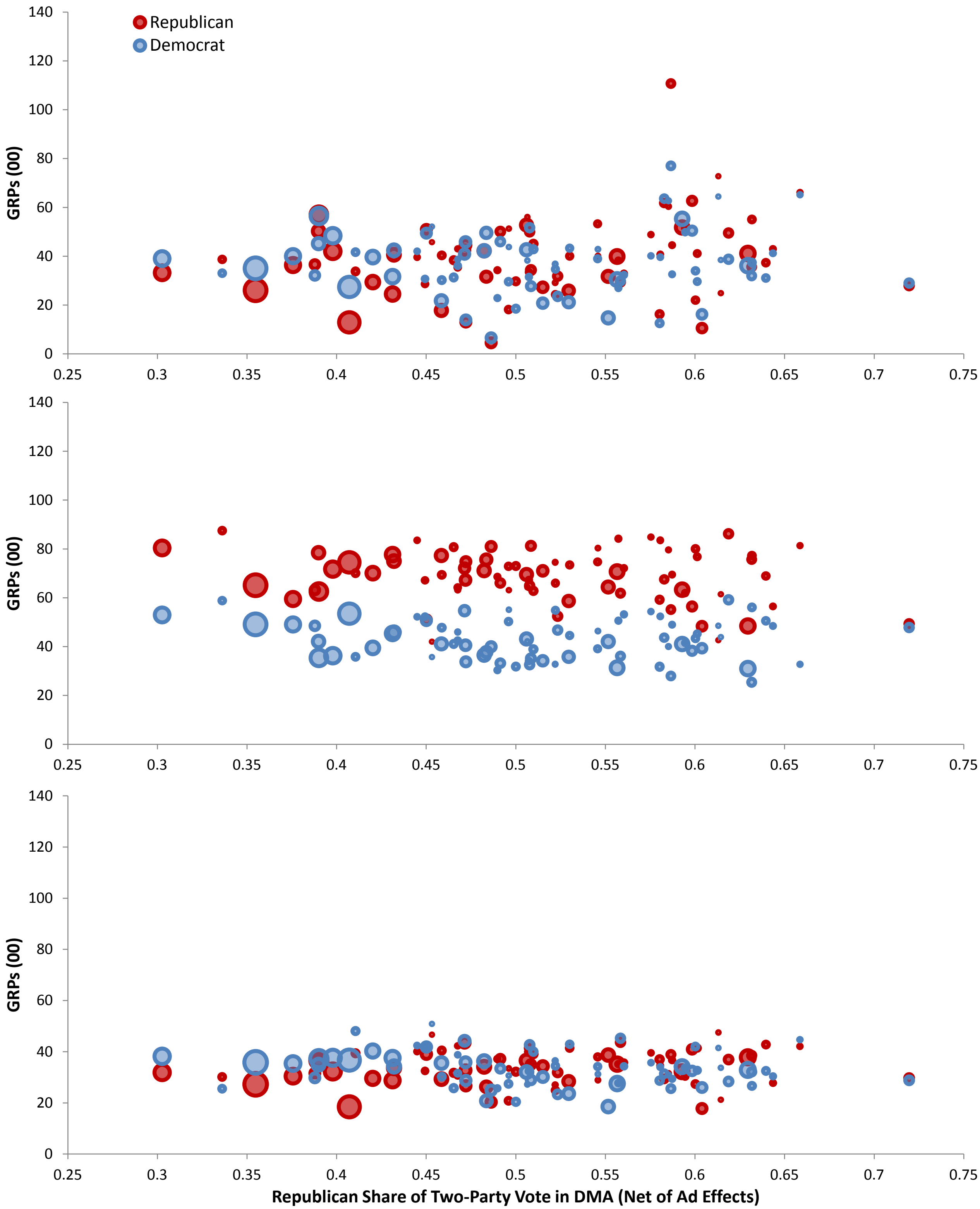
### 5.2.1 Symmetric $R_j$

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 thousand[23] and Gore buying almost 10 thousand. At the opposite extreme both candidates purchase the fewest GRPs in Las Vegas, with Bush buying 1791 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.

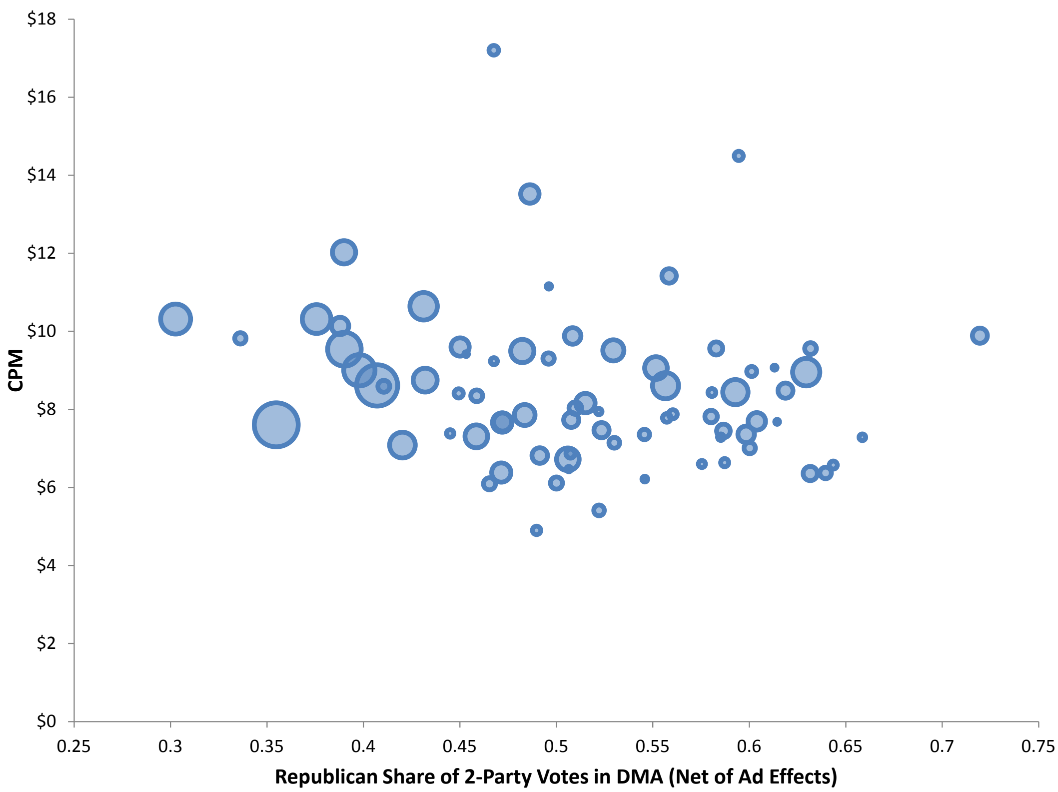
[23]Bush's twenty-thousand predicted GRPs in Oklahoma is outside the plot area in Figure 6. This number is unrealistic because such a large ad purchase would likely increase the ad prices in Oklahoma City thereby reducing the over-emphasis in this market. Our model treats advertising costs (prices) as 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.

#### 5.2.2 Constant CPM

To remove the geographic variation in advertising levels, 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.

#### 5.2.3 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.[24] 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 40 and 27.5. 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.

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

## 5.3 State Representation: Turnout in the Direct Vote

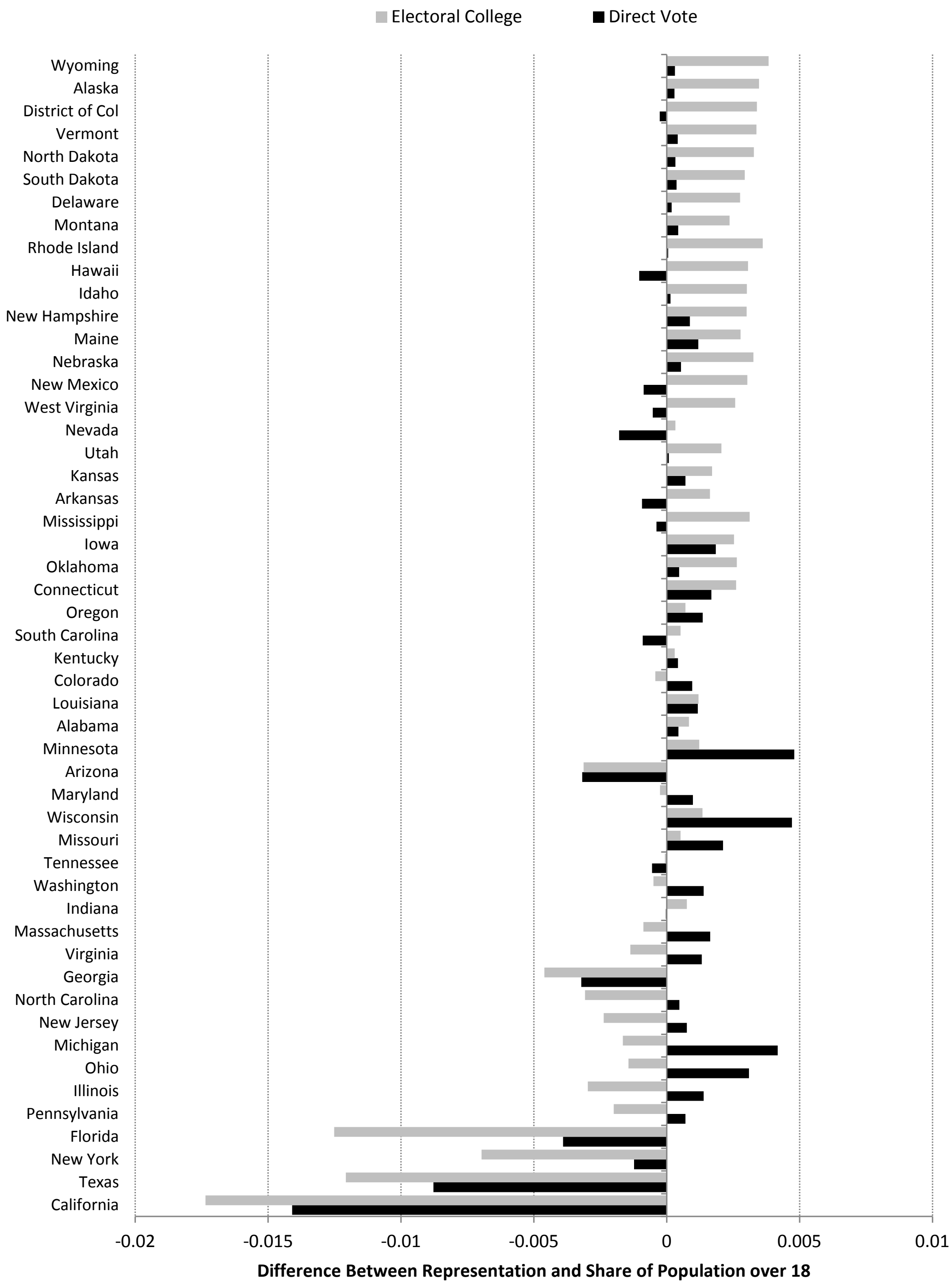
Turnout in the direct vote increases by 1.3%, or about 2 million voters. The popular vote in four states—Iowa, New Mexico, Oregon, and Wisconsin, all with thin margins—flips from Gore to Bush. Gore, however, gains enough votes in the Democratic stronghold of California to win the election even though 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.[25] 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.

[25] The 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. 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.[26]

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

[26] While 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: Equilibrium Computation of the Direct Popular Vote

To simplify notation, we refer use the indices $j$ and $k$ to refer to the two candidates. Recall that candidates are uncertain over a set of random shocks $\eta$ that occur at the candidate-market level that shift voters' decisions. Each shock is drawn from a normal distribution with mean zero and a variance $\sigma_t$ specific to an election.

The mean voter utility under the observed advertising levels is

$$\delta_{cj} = \beta_j + \alpha \log\left(A_{mj}\right) + \phi' X_c + \gamma_{mj} + \xi_{cj}\,.$$

Let the mean utility excluding the observed advertising be $\tilde{\delta}_{cj} = \delta_{cj} - \alpha \log\left(A^*_{mj}\right)$. Given a set of market-level shocks $(\eta_{mj}, \eta_{mk})$, and with a slight abuse of notation, we can rewrite the county-level vote share for a candidate as

$$\tilde{s}_{cj}\left(A_j, A_k, \eta_j, \eta_k; \hat{\theta}^v\right) = \frac{\exp\{\tilde{\delta}_{cj} + \alpha \log\left(A_{mj}\right) + \eta_{mj}\}}{1 + \sum\limits_{\ell \in \{j,k\}} \exp\{\tilde{\delta}_{c\ell} + \alpha \log\left(A_{m\ell}\right) + \eta_{m\ell}\}}\,.$$

The total number of popular votes a candidate receives is

$$V_j(A_j, A_k, \eta_j, \eta_k; \hat{\theta}^v) = \sum_{m \in M}\sum_{c \in m} N_c \tilde{s}_{cj}\left(A_j, A_k, \eta_j, \eta_k; \hat{\theta}^v\right)\,.$$

Candidate $j$ wins the election if his votes exceeds the other candidate's votes,

$$\tilde{d}_j\left(A_j, A_k, \eta_j, \eta_k; \hat{\theta}^v\right) = \mathcal{I}\left(V_j\left(A_j, A_k, \eta_j, \eta_k; \hat{\theta}^v\right) > V_k\left(A_k, A_j, \eta_k, \eta_j; \hat{\theta}^v\right)\right)\,.$$

where $\mathcal{I}(\cdot)$ is an indicator function. Note that candidate $j$'s voting margin $h_j(\cdot)$ is weakly increasing in $A_j$ and weakly decreasing in $A_k$.

The candidate must integrate over the market-level shocks to estimate his probability of winning the election. Thus, each candidate chooses advertising levels to maximize the following objective function

$$\tilde{\pi}_j(A_j, A_k; \hat{\theta}) = \hat{R}_j \mathbb{E}\left[\tilde{d}_j\left(A_j, A_k, \eta_j, \eta_k; \hat{\theta}^v\right)\right] - \sum_{m=1}^{M} \omega_m A_{mj}. \tag{12}$$

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 $\partial\tilde{\pi}_j(\cdot)/\partial A_{jm} > 0$ and $\partial\tilde{\pi}_j(\cdot)/\partial^2 A_{jm} < 0$ and that $\partial\tilde{\pi}_j(\cdot)/\partial A_{km} < 0$ and $\partial\tilde{\pi}_j(\cdot)/\partial^2 A_{km} < 0$. The assumption that advertising enters in logs seems consistent with the notion that voters should receive decreasing marginal utility from increased levels of advertising. However, this assumption also plays an important technical role because, if advertising enters utility linearly, then $\tilde{\pi}_j(\cdot)$ is increasing and convex in own advertising in markets where candidate $j$ has a smaller vote share compared to the competitor.

To compute the equilibrium, we solve for the 150 advertising choices that simultaneously set the FOC of the objective function in equation (12) to zero for each candidate. Before explaining the method, we introduce a slight change in the notation. Define $h_j(\cdot)$ as the vote margin for candidate $j$:

$$h_j\left(A_j, A_k, \eta_j, \eta_k; \hat{\theta}^v\right) = V_j\left(A_j, A_k, \eta_j, \eta_k; \hat{\theta}^v\right) - V_k\left(A_k, A_j, \eta_k, \eta_j; \hat{\theta}^v\right).$$

Thus the candidate's objective function can be written as

$$\tilde{\pi}_j(A_j, A_k; \hat{\theta}) = \hat{R}_j \mathbb{E}\left[\mathcal{I}\left(h_j\left(A_j, A_k, \eta_j, \eta_k; \hat{\theta}^v\right) > 0\right)\right] - \sum_{m=1}^{M} \omega_m A_{mj} \ . \tag{13}$$

The FOC for advertising is

$$\frac{\partial\tilde{\pi}_j(A_j, A_k; \hat{\theta})}{\partial A_{mj}} : \quad \hat{R}_j \frac{\partial \mathbb{E}\left[\mathcal{I}\left(h_j\left(A_j, A_k, \eta_j, \eta_k; \hat{\theta}^v\right) > 0\right)\right]}{\partial A_{mj}} - \omega_{mj} \ .$$

Computing the marginal change in the probability of winning, $\partial\mathbb{E}\left[\mathcal{I}\left(h_j\left(\cdot\right) > 0\right)\right]/\partial A_{mj}$, is difficult because the integrand is non-differentiable and the derivative is non-zero only when $h_j(\cdot) = 0$. We present two methods to compute this quantity and discuss the benefits and costs of each.

**Method 1** The first method relies on a simple change-of-variables. Note that the demand shocks $\eta_{mj}$ enter in additively separable manner into voters' utility. First, we stack all variables across candidates, such that the collection of advertising levels is $A = [A_{1j}, \ldots, A_{Mj}, A_{1k}, \ldots, A_{Mk}]'$ and shocks $\eta = [\eta_{1j}, \ldots, \eta_{Mj}, \eta_{1k}, \ldots, \eta_{Mk}]'$ and index each element by $d = 1, \ldots, 2M$. Define $y_d = \alpha A_d + \eta_d$ and then re-express $h_j(A_d, \eta_d; \hat{\theta}^v)$ as $h_j(\alpha A_1 + \eta_1, \ldots, \alpha A_d + \eta_d, \ldots, \alpha A_1 + \eta_{2M}; \hat{\theta}^v)$, which we can write compactly as $h_j(\alpha \mathbf{A} + \eta; \hat{\theta}^v)$.

$$\begin{aligned}\mathbb{E}\left[\mathcal{I}\left(h_j(\alpha\mathbf{A}+\eta;\hat{\theta}^v)>0\right)\right] &= \frac{1}{(2\pi\sigma^2)^M}\int\ldots\int \mathcal{I}\left(h_j(\alpha\mathbf{A}+\eta;\hat{\theta}^v)>0\right)\exp\left(-\sum_{d=1}^{2M}\frac{\eta_d^2}{2\sigma^2}\right)d\eta_1\ldots d\eta_{2M} \\ &= \frac{1}{(2\pi\sigma^2)^M}\int\ldots\int \mathcal{I}\left(h_j(\mathbf{y};\hat{\theta}^v)>0\right)\exp\left(-\sum_{d=1}^{2M}\frac{(y_d-\alpha A_d)^2}{2\sigma^2}\right)dy_1\ldots dy_{2M}\end{aligned}$$

Taking the derivative:

$$\frac{\partial \mathbb{E}\left[\mathcal{I}\left(h_j(\mathbf{y};\hat{\theta}^v)>0\right)\right]}{\partial A_d} = \frac{\alpha}{\sigma^2(2\pi\sigma^2)^M}\int\ldots\int \mathcal{I}\left(h_j(\mathbf{y};\hat{\theta}^v)>0\right)\exp\left(-\sum_{d=1}^{2M}\frac{(y_d-\alpha A_d)^2}{2\sigma^2}\right)(y_d-\alpha A_d)dy_1\ldots dy_2$$

Once again substituting $y_d = \alpha A_d + \eta_d$ back in, we have

$$\begin{aligned}\frac{\partial \mathbb{E}\left[\mathcal{I}\left(h_j(\alpha\mathbf{A}+\eta;\hat{\theta}^v)>0\right)\right]}{\partial A_d} &= \frac{\alpha}{\sigma^2}\frac{1}{(2\pi\sigma^2)^M}\int\ldots\int \mathcal{I}\left(h_j(\alpha\mathbf{A}+\eta;\hat{\theta}^v)>0\right)\exp\left(-\sum_{d=1}^{2M}\frac{\eta_d^2}{2\sigma^2}\right)(\eta_d)d\eta_1\ldots d\eta_{2M} \\ &= \frac{\alpha}{\sigma^2}E\left[\mathcal{I}\left(h_j(\alpha\mathbf{A}+\eta;\hat{\theta}^v)>0\right)\eta_d\right] \\ &\approx \frac{\alpha}{\sigma^2 R}\sum_{r=1}^{R}\mathcal{I}\left(h_j(\alpha\mathbf{A}+\eta^r;\hat{\theta}^v)>0\right)\eta_d^r\end{aligned}$$

where the last line $\eta_d^r \sim N(0, I\sigma^2)$ is a $2M$-dimensional vector of draws. Note that the indicator function and $\eta_d$ above are correlated.

Thus, we can estimate the above using basic Monte Carlo integration without having to solve for any $\varepsilon^*$ terms that we have been using. The benefit of this approach is it is computationally simple. The downside is that the relative error rates are large, such that we require a large number of Monte Carlo draws to attain a sufficient level of accuracy.

**Method 2** As noted earlier, the derivative of the probability of winning is non-zero only when $h_j(\cdot) = 0$. That is, a candidate has a sufficient margin to ensure victory, then a small change in advertising does little to change the probability of a winning outcome. The derivative of probability of winning is only positive when changing advertising gains the candidate enough votes in a market to place him on the margin of winning the entire election. To see this more clearly, we set $h_j(\cdot) = 0$, such that each candidate receives the same number of votes, and then decompose the terms. Let $M'$ be the set of markets excluding market $m$. Then equating each candidate's voting margin implies:

$$\begin{aligned}
\sum_{m \in M} \sum_{c \in m} N_c s_{cj}(\cdot) &= \sum_{m \in M} \sum_{c \in m} N_c s_{ck}(\cdot) \\
\sum_{m' \in M'} \sum_{c' \in m'} N_{c'} s_{c'j}(\cdot) + \sum_{c \in m} N_c s_{cj}(\cdot) &= \sum_{m' \in M'} \sum_{c' \in m'} N_{c'} s_{c'k}(\cdot) + \sum_{c \in m} N_c s_{ck}(\cdot) \\
\underbrace{\sum_{m' \in M'} \sum_{c' \in m'} N_{c'} \left( s_{c'j}(\cdot) - s_{c'k}(\cdot) \right)}_{\text{External Vote Margin}} &= \underbrace{\sum_{c \in m} N_c \left( s_{ck}(\cdot) - s_{cj}(\cdot) \right)}_{\text{Internal Vote Margin}}
\end{aligned}$$

The expression shows that candidate $j$ must win a sufficient number of votes inside market $m$ (the internal margin) to overcome the margin of votes outside of market $m$ (the external margin). For example, suppose the election contains a total of 1000 voters. Candidate $j$ has 400 votes outside market $m$ and candidate $k$ has 500 votes outside market $m$, so that candidate $j$'s outside margin is -100. The only way candidate $j$ can win the election is if market $m$ has at least 100 votes—otherwise, even winning all of market $m$ will not be sufficient for the candidate to win the election.

Given the form of our voter model and provided that $EVM_j < IVM_j$, there exists a critical value $\eta^*_{mj}$, holding fixed all other shocks, that equates the external and internal voting margins,

$$h_j \left( A_j, A_k, [\eta_{1j}, \ldots, \eta^*_{mj}, \ldots, \eta_{Mj}], \eta_k; \theta \right) =$$

$$V_j \left( A_j, A_k, [\eta_{1j}, \ldots, \eta^*_{mj}, \ldots, \eta_{Mj}], \eta_k; \theta \right) \; - \; V_k \left( A_k, A_j, \eta_k, [\eta_{1j}, \ldots, \eta^*_{mj}, \ldots, \eta_{Mj}]; \theta \right)$$

because $h_j(\cdot)$ is monotonically increasing in $\eta^*_{mj}$.

We can re-express the probability the candidates' votes are equal through the following transformation. For ease of notation, let $y = 0$, and then consider

$$\mathbb{E}_{\eta_{mj}} \left[ \mathcal{I} \left( h_j \left( A_j, A_k, \eta_j, \eta_k; \theta \right) \geq y \right) \right] \;\; = \;\; 1 - F_Y \left( h_j \left( A_j, A_k, \eta_j, \eta_k; \theta \right) < y \right) \qquad (14)$$

where $F_Y$ is the distribution function for the random variable $h_j$. Note that the distribution for$\eta$ is known (by assumption), whereas the distribution $F_Y$ is unknown. A transformation of variables yields

$$F_Y(y) = F_\eta\left(\eta^*_{mj}\right) , \tag{15}$$

where $\eta^*_{mj} = h_j^{-1}\left(A_j, A_k, \eta_j^m(y), \eta_k; \theta\right)$ must be inverted numerically and $\eta_j^m(y) = [\eta_{1j}, \ldots, y, \ldots, \eta_{Mj}]'$ is an $M \times 1$ vector of shocks with the value $y$ in the $m$th position instead of $\eta_{mj}$. This allows us to express the distribution for $F_Y$ in terms of $F_\eta$, evaluated at the critical value for a shock that places the candidate precisely on the margin of winning. Therefore, combining equations (14) and (15),

$$\begin{aligned}
\frac{\partial \mathbb{E}_{\eta_{mj}}[\mathcal{I}\left(h_j\left(A_j, A_k, \eta_j, \eta_k; \theta\right) \geq 0\right)]}{\partial A_{mj}} &= -\frac{\partial F_Y(y)}{\partial A_{mj}} &(16)\\
&= -f_\eta\left(\eta^*_{mj}\right) \frac{\partial h_j^{-1}\left(A_j, A_k, \eta_j^m(0), \eta_k; \theta\right)}{\partial A_{mj}} &(17)\\
&= f_\eta\left(\eta^*_{mj}\right) \alpha &(18)
\end{aligned}$$

where the last step follows after significant algebraic manipulation. Note that the above transformation only holds when a critical value $\eta^*_{mj}$ exists, otherwise the derivative is zero.

This provides an approach to approximate the FOC of the candidate's popular vote objective function using Monte Carlo methods for non-differentiable functions. For each market, we simulate $NS$ draws of the vectors $\left\{\eta^r_{mj}, \eta^r_{mk}\right\}_{r=1}^{NS}$. Within a market we hold fixed the advertising levels of other markets and their random draws. Given these values, we can solve for the $\eta^{r*}_{mj}$ that sets $h_j(\cdot) = 0$, using equation (18) and averaging over draws yields:

$$\frac{\partial \mathbb{E}[\mathcal{I}\left(h_j\left(A_j, A_k, \eta_j, \eta_k; \theta\right) \geq 0\right)]}{\partial A_{mj}} \approx \frac{1}{NS}\sum_{r=1}^{NS} f_\eta\left(\eta^*_{mj}\right) \alpha$$

The equation above forms the basis for computing the FOC. Thus, we compute the equilibrium by solving the system below for the advertising levels $(\tilde{A}^*_j, \tilde{A}^*_k)$:

$$
\begin{aligned}
R_{t\ell}\left[\frac{1}{NS}\sum_{r=1}^{NS} f_\eta\left(\eta_{m\ell}^{r*}\right)\alpha\right] - \omega_{m\ell} &= 0, \quad \text{for } m = 1,\ldots,M \text{ and } \ell = j,k \\
\text{s.t. } \eta_{mj}^{r*} &= h_j^{-1}\left(A_j, A_k, \eta_j^m(y), \eta_k; \theta\right), \quad \text{for } r = 1,\ldots,NS \\
A_{m\ell} &\geq 0 \quad \text{for } m = 1,\ldots,M \text{ and } \ell = j,k
\end{aligned}
$$

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

## Appendix C: Marginal Effect of a Dollar of Advertising

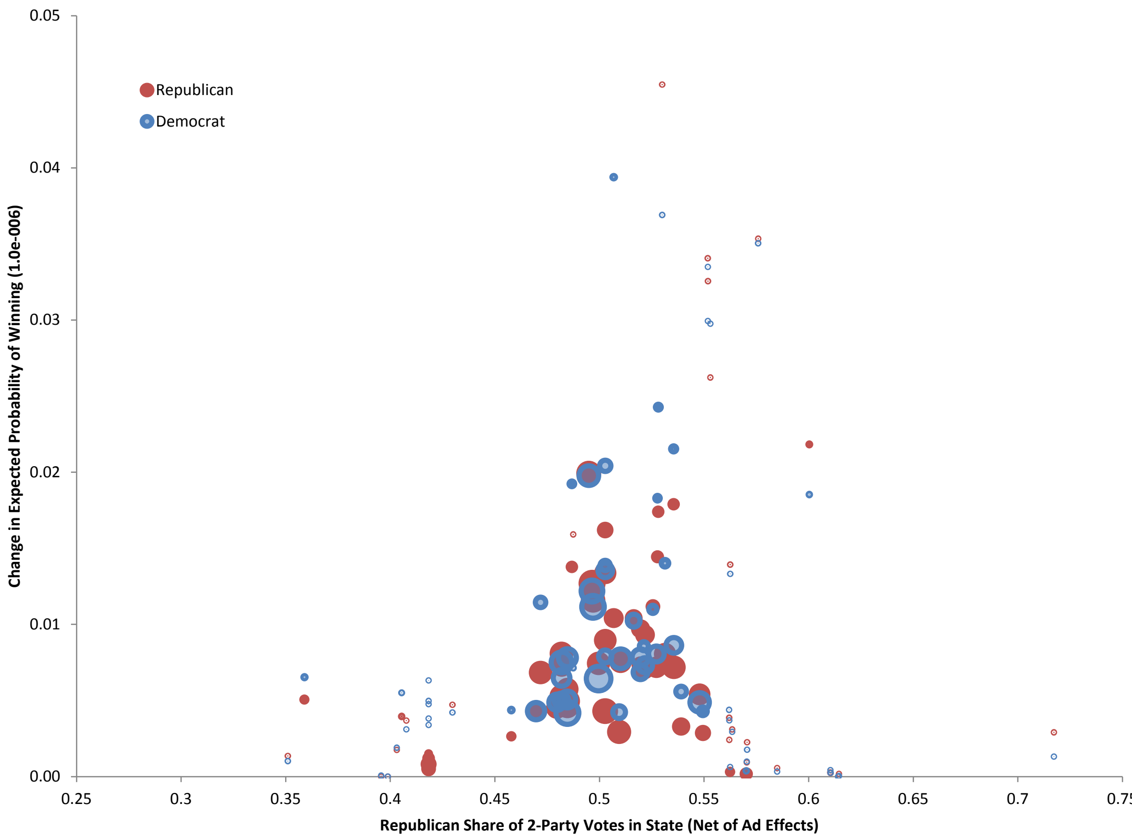
Another critical advertising factor recovered as part of the candidate model estimation is the derivative of the probability of winning with respect to advertising, $\partial\mathbb{E}[d_{tj}]/\partial A_{tmj}$. Setting Equation 4 equal to zero and re-arranging it yields

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

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 unobservable about this market that made it a more challenging place to earn votes. This is likely

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




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 $\sigma$.

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