

# ≡ Political Campaign Advertising Dynamics

JIM GRANATO, NATIONAL SCIENCE FOUNDATION  
M. C. SUNNY WONG, UNIVERSITY OF SOUTHERN MISSISSIPPI

We investigate the effectiveness of political campaign advertisements. From findings in communications, political science, and psychology, we know that the relation between voters and campaign strategists is dynamic and evolves until voters' views on a candidate crystallize. After that point, political campaign advertisements are ineffective. To capture this "dynamic" we develop an adaptive learning model that relates voters' impression formation to expectations about candidate behavior, one form of which (rational expectations), renders political advertising ineffective. We treat rational expectations as a limiting result that supports the concept of crystallization. Our model assumes that voters misspecify their forecasts about a particular candidate's attributes and campaign strategy. Over time voters can reach a rational expectations equilibrium about a candidate's qualities and discount political advertising. We illustrate the learning dynamics using simulations. As one application of this approach we focus on the influence campaign message (strategy) volatility has on crystallization (i.e., reaching the rational expectations equilibrium). Our simulation results show that campaign message volatility has an important effect on crystallization. One implication is that crystallization is a fragile, special case result that can be altered by informational shocks during the campaign.

## I. INTRODUCTION

Estimating the influence of campaigns and campaign advertising (and messages) is one of the enduring issues in the study of politics. Early research suggested that the media in general, political campaign advertising in particular, had a minimal effect on voter behavior (Lazarsfeld, Berelson, and Gaudet 1944). The current scholarly consensus seems to be that political campaigns and political communications do influence individual voting behavior and election outcomes (Ansolabehere and Iyengar 1995; Bartels 1993, 1996; Freedman and Goldstein 1999; Goldstein 1997; Popkin 1991; West 1993; Zaller 1992, 1996).

Despite all the attention that the subject has drawn, there is still a question about exactly how, how much, and under what conditions political advertising matters. There is also a sense that recent research strategies in the study of political phenomena are inappropriate for answering the research questions they are intended to address (Achen 1992, 2002). This methodological problem includes the study of political advertising influence on individual voters and election outcomes. It is often the case these studies use static regression (logit) analysis of a single survey. A significant t-statistic from a single empirical equation means little scientifically since this amounts to a mental report or mental snapshot from one period in time. If the actions and behavior of

voters are a primary concern, then analysis of political box scores is poor scientific practice. Alternative modeling and methodological approaches are required.

Using previous studies in communications, economics, political science, and psychology, we develop a model that identifies political advertising dynamics. To examine voter behavior we use an adaptive learning model to illustrate the effect of political messages (McKelvey and Ordeshook 1985a,b). An adaptive learning model allows us to determine how voters forecast, react, learn, and adjust to a new set of information (Bray 1982; Evans and Honkapohja 2001). In our model this new information, or political communication (Popkin 1991: 38-40), takes the form of campaign advertisements.

Our focus on how voters form expectations and learn about a particular candidate has important substantive implications (Shepsle 1972; Brady 1993). Expectations play an important role since one form of expectation formation, rational expectations, renders political advertising ineffective in changing voter impressions about a candidate's policy positions, competence, and character.<sup>1</sup> Yet, rational expectations is a limiting case, usually not met, but it does ally with the political science concept of crystallization (Brady and Johnston 1987).

A more interesting question is what happens if we relax our restrictions on behavior, and whether these conditions can ever be attained. This issue requires devising a way to examine how impression formation changes and how advertising shapes this learning process. From psychology, we know that impression formation about a candidate is a multifaceted and dynamic process (Bianco 1998; Fiske 1993). Initially, voters categorize candidates by a variety of factors. These first impressions can be updated by more

---

NOTE: An earlier version of this article was presented at the annual meeting of the Midwest Political Science Association, April 2-30, 2000, Chicago. We would like to thank Chris Achen, Mary Bange, George Evans, Brian Humes, Mark Jones, Joan Sieber, and Sandra Sizer Moore for their comments and insights. We also thank Paul Freedman and Kenneth Goldstein for their collaboration on previous versions of this project. The view and finding in this article are those of the authors and do not necessarily reflect those of the National Science Foundation.

---

<sup>1</sup> Less formally, we say voters have rational expectations when an outcome, on average, equals voters' expectations about the outcome (Sargent 1999: 136).

information gathering, which can either confirm or negate these initial impressions (Fiske and Neuberg 1990).

Therefore, we model the transition from a situation without rational expectations in which political advertising is effective to a situation with rational expectations (crystallization) in which political advertising is ineffective. This examination requires that we introduce learning, the dynamic of impression formation. We find that as voters learn more about a particular political message and message strategy, they are more likely to discount future advertising. Our model also identifies these linkages in a transparent way. Unlike a typical empirical investigation, the parameters directly follow the model and also afford the possibility for tests with actual data.

The article is organized as follows. In the next section, we discuss the role and interaction of voters and campaign strategists and the avenues by which political advertising can influence voters. Section 2 includes a discussion on how best to identify campaign advertising effects. Section 3 outlines our model. The model includes the specification and interaction of voting, candidate favorability, and campaign strategy. Section 4 solves for the rational expectations equilibrium, the point in which voter expectations and knowledge harden. Section 5 relaxes the rational expectations assumption. We now assume that voters misspecify their forecasts about a particular candidate's personal and policy attributes and the campaign strategy. However, we leave open the possibility that voters can learn the rational expectations equilibrium about a candidate's qualities and thus discount political advertising. Section 6 describes the model predictions and Section 7 illustrates, via simulation, the model's learning dynamics. As one application of this model and approach we examine the influence of campaign message and strategy volatility on the ability of voters to attain the rational expectations equilibrium (crystallization). Section 8 discusses the implications of these results and provides some concluding comments about the use of this model for more applied settings.

## 2. LEARNING AND EXPECTATIONS IN POLITICAL CAMPAIGNS

### 2.1 *The Role of Voters*

Many studies note that voters have long-lasting partisan commitments (Campbell et al., 1960) and that they tend to attach political parties to specific issues (Petrocik 1987, 1996). These stable commitments contribute to certain political predispositions (Bartels 1988). More generally, Popkin notes that among the principle findings of the Columbia studies (e.g., Lazarsfeld, Berelson, and Gaudet 1944) was that voters "already have some firm beliefs, so are often not moved at all by campaign propaganda" (Popkin 1991: 13).

However, when the focus is on candidates, voters show greater flexibility. This flexibility presents opportunities for campaign strategists to influence voter perceptions and voter support. Not only do voters associate a candidate with a particular party and its policies, but they also assess the

character and competence of a candidate (Markus 1982; Miller and Shanks 1996; Popkin 1991; Popkin et al., 1976).

Voter assessments of candidates are dynamic, but harden over time (Brady and Johnston 1987). The speed with which voters make judgements about candidates varies, given new and old information they receive, but it is clear that over the course of a campaign, voters do learn and update their assessments (Stoker 1993). As voters update their assessments, it is also possible that they can be surprised from time to time and will reassess their projections (Popkin 1991). These (re)assessments include expectations about candidate viability as well as uncertainty about candidate character and policy stances. The sources of these surprises can range from the acquisition of new information to the change in assessment by similarly situated (socially and economically) people (Marsh 1985).

Although political predispositions, expectations, and uncertainty are useful characterizations of voter behavior during the campaign season, these factors do not address the question of accurate articulation. The issue of voter competence has a long history that ranges from pessimistic (Converse 1964) to optimistic (Page and Shapiro 1992). On the more pessimistic side, Zaller (1992) finds that voters are intermittently interested in political and economic matters, are overwhelmed with information, can have conflicting opinions about the same issue, and are generally ambivalent. But, despite these seemingly insurmountable obstacles to coherent articulation, the empirical evidence is more charitable. Voters can make policy distinctions and can be moved to new opinions in reasonable ways (Page and Shapiro 1992).

### 2.2 *The Role of Campaign Strategists*

The role for the campaign strategist centers on maintaining and mobilizing the base as well as trying to persuade voters who are not members of the base. In this latter regard, Zaller (1992) shows that in congressional elections, partisan defections do occur. Zaller finds a positive relation between campaign spending and the expansion of election coalitions. Information levels appear to play a role in this conversion. The voters who are least well-informed are the most difficult to persuade to defect.

Thus, we see that the challenge for campaign strategists is to influence voters to learn about their candidate, particularly if the voter impressions are negative. If we assume that strategists can generate interest, then their other task is to persuade voters to support their candidate.

Research finds that this is indeed possible. Campaign strategists can motivate voters to learn about their candidate by constructing political advertisements that appeal to emotion or raise anxiety (Marcus and MacKuen 1993). Strategists not only motivate the voters, but they also use clever issue-framing to shape candidate favorability or unfavorability for an opponent (Gitlin 1980; Shafer and Claggett 1995).

By no means is an appeal to emotion the only means of persuasion. Campaign advertisements defining a new

position or drawing policy distinctions from the opponent also have the potential to influence voters (Popkin 1991). One added wrinkle to this, however, are source effects. Campaign advertisements drawing policy distinctions appear to be most effective when they are also a reputational strength of the candidate's political party (Iyengar and Valentino 2000).

### 2.3 Identifying Campaign Advertising and Message Effects

The relationship and roles of both voters and campaign strategists create interesting methodological challenges. Even if we leave campaign strategy aside, we still must identify how campaign advertising influences voter expectations and learning. Most studies of advertising have relied on static models. But, a campaign is obviously a dynamic situation in which different degrees of advertising occur at different times.

Consider, for example, the 1996 presidential race in Illinois and Arizona. Campaign advertising money was spent over the summer in Illinois and not in Arizona. As the campaign progressed, Illinois was not targeted in the fall, while Arizona was deluged with campaign advertising in late October. If one modeled this as static with post election results or surveys, the model would assume that both states received the same amount of advertising. Yet, it is likely that the timing and effect of advertising may be different on different voters. Alternatively, what if a citizen was exposed to positive messages throughout the campaign and then a few days before the election was exposed to a barrage of negative advertisements? Would the recent negative advertisements have more of an influence than the long series of positive political advertisements and messages?

Static, single-equation models with many exogenous variables cannot capture this process and interaction because there is almost always a loose relation between these concepts and the tests (Achen 1992, 2002). A significant t-statistic can often mask the confounding influences of many other variables. These concepts and relations demand greater formal and empirical specificity. Static, single-equation empiricism lacks the power to disentangle the real effect from the false one.

Our goal, then, is to take a set of plausible facts or axioms, model them in a rigorous mathematical manner, and identify causal relations that explain empirical regularities. In this way we provide a behavioral interpretation for a probability model that captures the interaction between campaign advertisements and voters. More importantly, the model can then serve as a basis for a variety of extensions in richer environments and scenarios.

Our model has the following features: a termination point at which political advertising is not effective, which we call crystallization (Brady and Johnston 1987; Lazarsfeld, Berelson, and Gaudet 1944; Page and Shapiro 1992); voter expectations (projections) (Bartels 1988); learning dynamics (Stoker 1993); the response to surprise (reassessment) (Popkin 1991); and expectations that voters build on

from the learning and expectations (projections) of other voters (Zaller 1992). Our model can also provide for flexibility in the message that political strategists provide, but we do not pursue that here.

### 3. THE MODEL

The model centers on how a single campaign decides about its campaign advertisements. There are micro foundations of this type of model in previous work (see, e.g., Brady 1993). We do not formalize them here, but instead provide the simple intuition. In addition, while we do specify a relation between campaign strategists and voters, we do not use an explicit game in this model. A game theoretic set up, however, is a possibility since adaptive learning models are related to coordination games (Cooper 1999; Evans and Honkapohja 2001: 53-55).

To begin, we assume voters maximize their subjective expected utility for a multi-dimensional space on a candidate's policy positions, character, and competence. Voters can observe the record for candidates and can thus identify the issue position of candidates. Voters also receive campaign messages in the form of political advertisements and can either use or ignore these advertisements. Finally, voters can and do forecast a candidate's policy positions, character, and competence.

Our model comprises three equations. Each voter ( $i$ ) is subject to an event ( $j$ ) at time ( $t$ ). We aggregate across individuals and events so the notation will only use the subscript  $t$ . The first equation (3.1) specifies what influences citizens vote or vote intention ( $Y_t$ ). We assume that voting habits persist based on certain predispositions (Achen 1992; Bartels 1988; Gerber and Green 1998). The variable,  $Y_{t-1}$ , accounts for this.

We further assume that people vote or intend to vote based on how they currently favor or like the candidate, so-called candidate favorability, ( $F_t$ ). Also, voting can be subject to unanticipated stochastic shocks (uncertainty) ( $v_t$ ) where  $v_t \sim N(0, \sigma_v^2)$ . We assume the relations are positive— $\rho, \zeta \geq 0$ .

Voting Equation:

$$Y_t = \alpha_Y + \rho Y_{t-1} + \zeta F_t + v_t \quad (3.1)$$

Equation (3.2) represents voters' impression of a candidate. We could include other exogenous variables, but they would not be the variables of interest because our purpose is to determine political advertising effectiveness.<sup>2</sup> In any case, favorability is a linear function of the difference between an advertising variable, representing total advertising (e.g., expenditures, timing, content, and geographic location) ( $A_t$ ) and the self-referential (nonrational) expecta-

<sup>2</sup> It is also possible to modify both (3.1) and (3.2) with control variables such as age, education, and race (see Bartels 1993). Achen (1992) critiques this practice, arguing that demographic variables lack proper theoretical interpretation when used as instruments.

tion about advertisements ( $E_{t-1}^*A_t$ ).<sup>3</sup> This difference, ( $A_t - E_{t-1}^*A_t$ ), captures the potential surprises from campaign advertisements and the voter reassessment that results (Popkin 1991).

Self-referential expectations (denoted by the expectations operator  $E_{t-1}^*$ ) are important since they allow for voters to interact and learn from others (Beck et al. 2002; Huckfeldt and Sprague 1995; Marsh 1985; Shafer and Claggett 1995; Zaller 1992). From this assumption, the endogenous variables depend on the expectations of other voters (Durlauf and Young 2001; Evans and Honkapohja 2001). Self-referential systems, although not explicitly rational, can converge to a rational expectations equilibrium and crystallization under a certain stability condition (Brady and Johnston 1987; Bray 1982).

We also use lagged exogenous variable(s) ( $W_{t-1}$ ) that can be taken to represent many things, from personal economic conditions to personal political predisposition (Bartels 1988).  $\eta_t$  is a stochastic shock that represents unanticipated events (uncertainty), where  $\eta_t \sim N(0, \sigma_\eta^2)$ . The parameters ( $\gamma, \lambda$ ) represent either a positive or negative relation between the independent and dependent variables.

Favorability Equation:

$$F_t = \alpha_F + \gamma(A_t - E_{t-1}^*A_t) + \lambda W_{t-1} + \eta_t. \quad (3.2)$$

Equation (3.3) presents the contingency plan or rule that campaign strategists use. We argue that campaign strategists set aside an explicit amount of advertising resources each period and, thereby, maintain a certain level of resource expenditure and coherence (message content and geographic target). This could be done to shore up the base of support, reassert popular party themes (Iyengar and Valentino 2000), or for other reasons pertaining to maintaining and improving their candidate's favorability rating. The lag of the dependent variable, the previous period's advertising effort ( $A_{t-1}$ ), represents this persistence. The previous period's favorability rating, ( $F_{t-1}$ ), also influences campaign strategy since it provides the feedback for future strategy in expenditures, timing, content, and geographic location.

Like voters, campaign strategists also project (and learn) from the reactions from both voters and rival campaigns to the campaign's advertisement efforts. These self-referential expectations of total campaign advertisement efforts ( $E_{t-1}^*A_t$ ) could include a forecast of how well voters and rival campaign strategists cope and learn from, say, the way a campaign strategist frames a particular issue (Gitlin 1980; Shafer and Claggett 1995). Campaign strategy also

responds to stochastic shocks, which can take the form of sudden changes in strategy (uncertainty) ( $\epsilon_t$ ) with  $\epsilon_t \sim N(0, \sigma_\epsilon^2)$ . The parameters ( $\delta, \phi, \beta$ ) can be either positive or negative.

Campaign Strategist Equation:

$$A_t = \alpha_A + \delta A_{t-1} + \phi F_{t-1} + \beta E_{t-1}^*A_t + \epsilon_t. \quad (3.3)$$

#### 4. RATIONAL EXPECTATIONS SOLUTION

##### 4.1 Advertising Effectiveness

We now consider the effectiveness of political advertising when voters possess rational expectations. If voters have rational expectations, then they understand a candidate's personal and policy qualities (as specified in the model) and they can also accurately anticipate the campaign strategy. Political advertising, as represented in (3.3), has no effect on aggregate voting behavior (3.1). Thus, we see that the rational expectations equilibrium is analogous to the crystallization or hardening of voter impressions and knowledge.

If voters have developed rational expectations, then they use all available information in the model (at some point in time) to make a forecast. For our model, voters use all available information up to time  $t-1$  (denoted  $E_{t-1}$ ) about campaign strategy (3.3):

$$E_{t-1}A_t = \alpha_A + \delta A_{t-1} + \phi F_{t-1} + \beta E_{t-1}A_t. \quad (4.1)$$

The rational expectations equilibrium is then:

$$E_{t-1}A_t = (1 - \beta)^{-1} \alpha_A + (1 - \beta)^{-1} \delta A_{t-1} + (1 - \beta)^{-1} \phi F_{t-1}. \quad (4.2)$$

Since (3.3) is a rational expectations solution we can replace  $E_{t-1}^*$  with  $E_{t-1}$  and subtract (4.1) from (3.3). The result is:

$$A_t - E_{t-1}A_t = \epsilon_t. \quad (4.3)$$

If we substitute (4.3) into (3.2), the reduced form for the favorability equation (3.2) becomes:

$$F_t = \alpha_F + \gamma \epsilon_t + \lambda W_{t-1} + \eta_t. \quad (4.4)$$

The result in (4.4) indicates that the voting decision (3.1) is not influenced by any parameter from the campaign strategist's advertising rule (3.3):

$$Y_t = \alpha_Y + \zeta \alpha_F + \rho Y_{t-1} + \zeta \lambda \epsilon_t + \zeta \lambda W_{t-1} + \zeta \eta_t + v_t. \quad (4.5)$$

For both equations, (4.4) and (4.5), the effect of advertising is reduced to a random shock,  $\epsilon_t$ . Only innovations or unanticipated changes in campaign strategy can influence voter forecasts.

<sup>3</sup> There are many ways to measure total campaign advertising. These include and are not limited to: the total dollars spent, the dollars spent relative to a rival candidate(s), the ratio of dollars spent relative to a rival candidate(s), the content, the timing, and the geographic location. For more details on measurement issues consult the Wisconsin Advertising Project (WiscAds) web site: <http://www.polisci.wisc.edu/tvadvertising>.

#### 4.2 Structural Failure

There is another dimension to rational expectations that the concept of crystallization misses. Since campaign strategists try to influence a person's vote (3.1), it is crucial that the parameters of (3.1) remain invariant to changes in campaign strategy. The advertisement strategy then provides a predictable voter response. However, this assured voter reaction does not occur under rational expectations. There is no structural response guaranteed by such campaign strategies.

To illustrate this point we substitute (3.2) and (4.1) into (3.1), then simplify and collect terms:

$$Y_t = \alpha_Y + \zeta\alpha_F + \rho Y_{t-1} + \zeta\gamma A_t - \zeta\gamma\delta(1-\beta)^{-1} A_{t-1} - \zeta\gamma\phi(1-\beta)^{-1} F_{t-1} + \zeta\lambda W_{t-1} + v_t. \quad (4.6)$$

From (4.6), the moving target of voter response is evident, since the parameters ( $\delta$ ,  $\phi$ ,  $\beta$ ) from (3.3) appear. Any change in campaign advertisements or other strategies results in a voter response that is not consistent with (3.1). In fact, the response might be completely opposite to the campaign strategists' intentions.

### 5. LEARNING DYNAMICS

There are at least two schools of thought on determining how voters learn. One approach is to assume that voters use the correctly specified likelihood function and learn the true value of the rational expectations equilibrium parameters through continuous updating via Bayes' rule (Cyert and DeGroot 1974; Townsend 1978, 1983).

Our view is that this approach makes heroic informational demands on voters. Instead, we assume that voters use an incorrect likelihood function but that as they learn, they eventually use the correct rational expectations equilibrium in their updating process (Bray 1982; Evans 1983, 1985). Thus, the issue is to determine the conditions under which voters learn (via least squares) the rational expectations equilibrium.

If we consider that there is a family of forecasting rules (perceived laws of motion) that are formed without rational expectations, we can determine if these nonrational expectations converge to the rational expectations equilibrium. We accomplish this process by inserting the perceived laws of motion into a structural equation that forecasts an actual law of motion. The structural equation can create a mapping between the perceived and actual laws of motion, which is possible if they share the same parameter space even when different values exist for various parameters.

#### 5.1 Specifying a Learning Mechanism

To demonstrate whether voters learn the rational expectations equilibrium for a particular campaign strategy (4.2), we require that three things happen. First, we must specify the rational expectations equilibrium, which we have

already done. Our unique rational expectations solution for (3.3) is:

$$A_t = a_A^{RE} + b_A^{RE} A_{t-1} + c_A^{RE} F_{t-1} + \epsilon_t, \quad (5.1)$$

where  $a_A^{RE} = (1-\beta)^{-1} \alpha_A$ ,  $b_A^{RE} = (1-\beta)^{-1} \delta$  and  $c_A^{RE} = (1-\beta)^{-1} \phi$ .

#### 5.2 The Perceived Law of Motion

Our next step is to specify how voters forecast the variable of interest. We assume voters use a contingency plan or decision rule to decide matters that maximize their discounted subjective expected utility. The ideal case (the rational expectations equilibrium) is when the voters' forecasting equation (the perceived law of motion) correctly predicts candidate behavior (the voter knows the relevant campaign strategy), and the voter can then choose to support or oppose the candidate.

But it is more than likely that voters do not correctly specify their likelihood functions. They use an incorrect forecasting equation of candidate behavior and are slow to determine campaign strategy. Political advertisements can then either speed up or negate the learning process. Although the likelihood functions do not correctly specify the process generating the data that voters receive, in some cases the model that voters use during the learning process includes the rational expectations equilibrium.

This perceived law of motion or forecasting equation can be written in many ways. Following Bray (1982), Bray and Savin (1986), and Marcet and Sargent (1989a, 1989b) we assume that voters update their forecasts, in a way that mimics least squares, up to the period  $t-1$ . Voters update each period thereafter (Bray 1982).

Equation (5.2) expresses the perceived law of motion (forecasting equation):

$$A_t = a_{A,t-1} + b_{A,t-1} A_{t-1} + c_{A,t-1} F_{t-1} + u_t = \theta'_{t-1} Z_{t-1} + u_t, \quad (5.2)$$

$$\text{where } \theta_t = \begin{pmatrix} a_{A,t} \\ b_{A,t} \\ c_{A,t} \end{pmatrix}, Z_t = \begin{pmatrix} 1 \\ A_t \\ F_t \end{pmatrix},$$

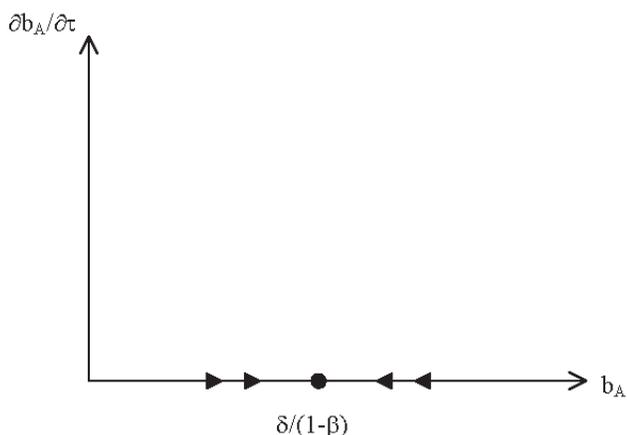
and  $u_t \sim iid(0, \sigma_u^2)$ .

Substituting (5.2) into (3.3) gives the actual law of motion:

$$A_t = (\alpha_A + \beta a_{A,t-1}) + (\delta + \beta b_{A,t-1}) A_{t-1} + (\phi + \beta c_{A,t-1}) F_{t-1} + \epsilon_t = T(\theta_{t-1})' Z_{t-1} + \epsilon_t \quad (5.3)$$

$$\text{where } T(\theta_t) = \begin{pmatrix} \alpha_A + \beta a_{A,t} \\ \delta + \beta b_{A,t} \\ \phi + \beta c_{A,t} \end{pmatrix}, \text{ and } \epsilon_t \sim iid(0, \sigma_\epsilon^2).$$

≡ FIGURE 1



5.3 Conditions for Learning: E-Stability

Having established the perceived and actual laws of motion, our final step is to establish conditions for learning the rational expectations equilibrium. DeCanio (1979) and Evans (1985, 1989) devise a condition under which (5.3) maps into the rational expectations equilibrium (5.1). Evans (1989) defines this condition, known as expectational stability (or E-stability), by the following ordinary differential equation:

$$\frac{d\theta}{d\tau} = T(\theta) - \theta, \tag{5.4}$$

where  $\theta$  is a finite dimension parameter specified in the perceived law of motion (5.2),  $T(\theta)$  is a mapping (so-called  $T$ -mapping) from the perceived to actual laws of motion, and  $\tau$  symbolizes either virtual or artificial time. The rational expectations equilibrium,  $\theta^{RE}$ , corresponds to fixed points of  $T(\theta)$ .

In all cases, we base the test for learning, in the limit, on the stability and almost sure convergence of the perceived and actual law of motion parameters to the rational expectations parameters. From (5.1), our focus is on the parameters dealing with advertising. However, we also include the parameters for favorability.

To determine the E-stability condition, we obtain the associated ordinary differential equation (differentiated with respect to time ( $\tau$ )):

$$\frac{d}{d\tau} \begin{pmatrix} a_A \\ b_A \\ c_A \end{pmatrix} = T \begin{pmatrix} a_A \\ b_A \\ c_A \end{pmatrix} - \begin{pmatrix} a_A \\ b_A \\ c_A \end{pmatrix}. \tag{5.5}$$

According to (5.5), the E-stability condition is satisfied when  $\beta < 1$ . As long as this condition holds voters are able to learn (using least squares) the REE in the long run. We summarize the E-stability condition in the following proposition:

**Proposition 1.** Consider (5.2), (5.3), and (5.5). If the E-stability condition is satisfied,  $\beta < 1$ , then the latter term van-

ishes in the limit: there is local convergence between the perceived (5.2) and actual (5.3) laws of motion to the rational expectations equilibrium (5.1).

An added feature of this result is that it is connected with least squares learning. Least squares learning, in the form of recursive least squares (Hendry 1995), can serve as a direct test for learning (Bray and Savin 1986) and convergence to the steady state (see Appendix).

Note that the associated ordinary differential equation (5.5) represents the dynamic process of the coefficient in the advertising strategy:

$$a'_A = \frac{da_A}{d\tau} = \alpha_A + (\beta - 1)a_A, \tag{5.6}$$

$$b'_A = \frac{db_A}{d\tau} = \delta + (\beta - 1)b_A, \tag{5.7}$$

$$c'_A = \frac{dc_A}{d\tau} = \phi + (\beta - 1)c_A. \tag{5.8}$$

Since we are particularly interested in advertising effects, the result in (5.7) is the most pertinent. Associated with equation (5.1), Figure 1 depicts that the long run or steady state result ( $b'_A = 0$ ) is determinate and locally stable at the value

$$b_A^{RE} = \frac{\delta}{1 - \beta}, \text{ where } \delta \in (-1 + \beta, 1 - \beta).$$

6. MODEL PREDICTION

Since we have established the conditions for expectational stability and convergence, a real or virtual time illustration for learning is straightforward. We examine convergence of the parameters to the rational expectations equilibrium as  $t \rightarrow \infty$ .<sup>4</sup> When an advertisement shock takes place, the focus is on the speed with which voters learn the rational expectations equilibrium. This is the crystallized response (see Appendix).

To formalize the learning dynamics of favorability equation, we substitute the campaign strategist equation (3.3) into the favorability equation (3.2):

$$F_t = \alpha_F + \gamma(\alpha_A + \delta A_{t-1} + \phi F_{t-1} + (\beta - 1)E_{t-1}^* A_t + \epsilon_t) + \lambda W_{t-1} + \eta_t. \tag{6.1}$$

Equation (6.1) is the data generation process (DGP), or true model of the favorability equation. From (6.1) we see that advertising affects favorability. But we are interested in whether voters learn the rational expectations equilibrium of the campaign strategist equation (5.1). If this occurs, then in the long run,  $A_{t-1}$  has no effect on  $F_t$ .

<sup>4</sup> In the spirit of Bray (1982), Bray and Savin (1986), Marcet and Sargent (1989a, 1989b), and Sargent (1993).

From (6.1) we know that as long as voters reach the rational expectations equilibrium, then the two following conditions hold:  $(A_t - E_{t-1}^* A_t) = \epsilon_t$  and  $\alpha_A + \delta A_{t-1} + \phi F_{t-1} + (\beta - 1)E_{t-1}^* A_t = 0$ . Consequently, (6.1) reverts to (4.4). Since this is the limiting result (advertising has no effect) the learning process is exhausted. In other words, voters reach a point in the campaign process where they are no longer systematically influenced by  $A_{t-1}$  and  $F_{t-1}$ , because this information is now accounted for in  $E_{t-1}^* A_t$ . Therefore, voters eventually ignore the information of  $A_{t-1}$  and  $F_{t-1}$  in equation (3.2). When a campaign reaches this stage only unexpected advertising shocks ( $\epsilon_t$ ) can affect voter impressions and opinion.

We summarize the test for learning in the following proposition:

**Proposition 2.** *If voters update equation (6.1) in a manner consistent with recursive least squares, then as long as the E-stability condition ( $\beta < 1$ ) holds in Proposition 1, the parameters of  $A_{t-1}$  and  $F_{t-1}$  will converge to zero—the rational expectations equilibrium.*

Implicit in Proposition 2 is the assumption that voters have the ability to learn over time the campaign strategist equation by using  $a_{A,t-1}$ ,  $b_{A,t-1}$ , and  $c_{A,t-1}$ .

The voter learning process is fully developed in the Appendix, but the essentials follow below. First, we have already assumed voters have a perceived law of motion of the campaign strategists' behavior equivalent to (5.2). If we take the self-referential expectations of (5.2), we have:

$$E_{t-1}^* A_t = a_{A,t-1} + b_{A,t-1} A_{t-1} + c_{A,t-1} F_{t-1}. \quad (6.2)$$

We substitute (6.2) into (6.1) to obtain the dynamic process of the favorability equation:

$$\begin{aligned} F_t = & \alpha_F + \gamma(\alpha_A + \delta A_{t-1} + \phi F_{t-1}) \\ & + \gamma(\beta - 1)(a_{A,t-1} + b_{A,t-1} A_{t-1} + c_{A,t-1} F_{t-1}) + \epsilon_t \\ & + \lambda W_{t-1} + \eta_t, \end{aligned} \quad (6.3)$$

simplifying:

$$\begin{aligned} F_t = & [\alpha_F + \gamma(\alpha_A + (\beta - 1)a_{A,t-1})] \\ & + [\gamma(\delta + (\beta - 1)b_{A,t-1})]A_{t-1} \\ & + [\gamma(\phi + (\beta - 1)c_{A,t-1})]F_{t-1} + \gamma\epsilon_t + \lambda W_{t-1} + \eta_t. \end{aligned} \quad (6.4)$$

In (6.4), the parameters of the favorability equation (an actual law of motion) change over time as voters become aware of the campaign strategy (6.2).

## 7. MODEL ILLUSTRATION: SIMULATION

### 7.1 Results for the Campaign Strategist Equation

For the true model (DGP) of the campaign strategist (3.3), the illustration contains the true parameters:  $\alpha_A = 5$ ,  $\delta = -0.5$ ,  $\phi = -0.5$ , and  $\beta = -0.5$ .  $\epsilon_t$  is an unobservable

normal white noise process with standard deviation one ( $\sigma_\epsilon = 1$ ). The simulation starting values for the perceived law of motion (5.2) are  $a_{A,t-1} = 4$ ,  $b_{A,t-1} = 4$ ,  $c_{A,t-1} = 4$ . We simulate equations (5.2) and (5.3) with these starting parameters.<sup>5</sup>

The simulations have a virtual time period of 10,000. For all figures simply read across each row for each respective parameter. Each column represents a specific time period, ranging from 0 to 200 for column 1, 200 to 1,000 for column 2, and 1,000 to 10,000 in column 3. These break downs are done to highlight the changes and convergence in the parameters.

From (5.1) the rational expectations equilibrium values ( $a_A^{RE}$ ,  $b_A^{RE}$ ,  $c_A^{RE}$ ) are (3.33, -0.33, -0.33). If our model is correct, then the perceived law of motion and the actual law of motion should have values that converge to the rational expectations values. Figure 2 presents the results for the perceived law of motion where  $(a_{A,t-1}, b_{A,t-1}, c_{A,t-1}) \rightarrow (3.28, -0.34, -0.32)$ . Convergence to the rational expectations equilibrium occurs for all parameters. This convergence occurs in roughly 200 time periods for each parameter.

### 7.2 Results for the Favorability Equation

For the simulation of the favorability equation, we simplify equation (6.4) as:

$$\begin{aligned} F_t = & a_{F,t-1} + b_{F,t-1} A_{t-1} + c_{F,t-1} F_{t-1} \\ & + d_{F,t-1} W_{t-1} + e_{F,t} \end{aligned} \quad (7.1)$$

If voters can learn the rational expectations equilibrium in the campaign strategist equation (5.1), then following Proposition 2, the favorability equation converges to the rational expectations equilibrium as well. In this case, the unique rational expectations equilibrium has the following features:

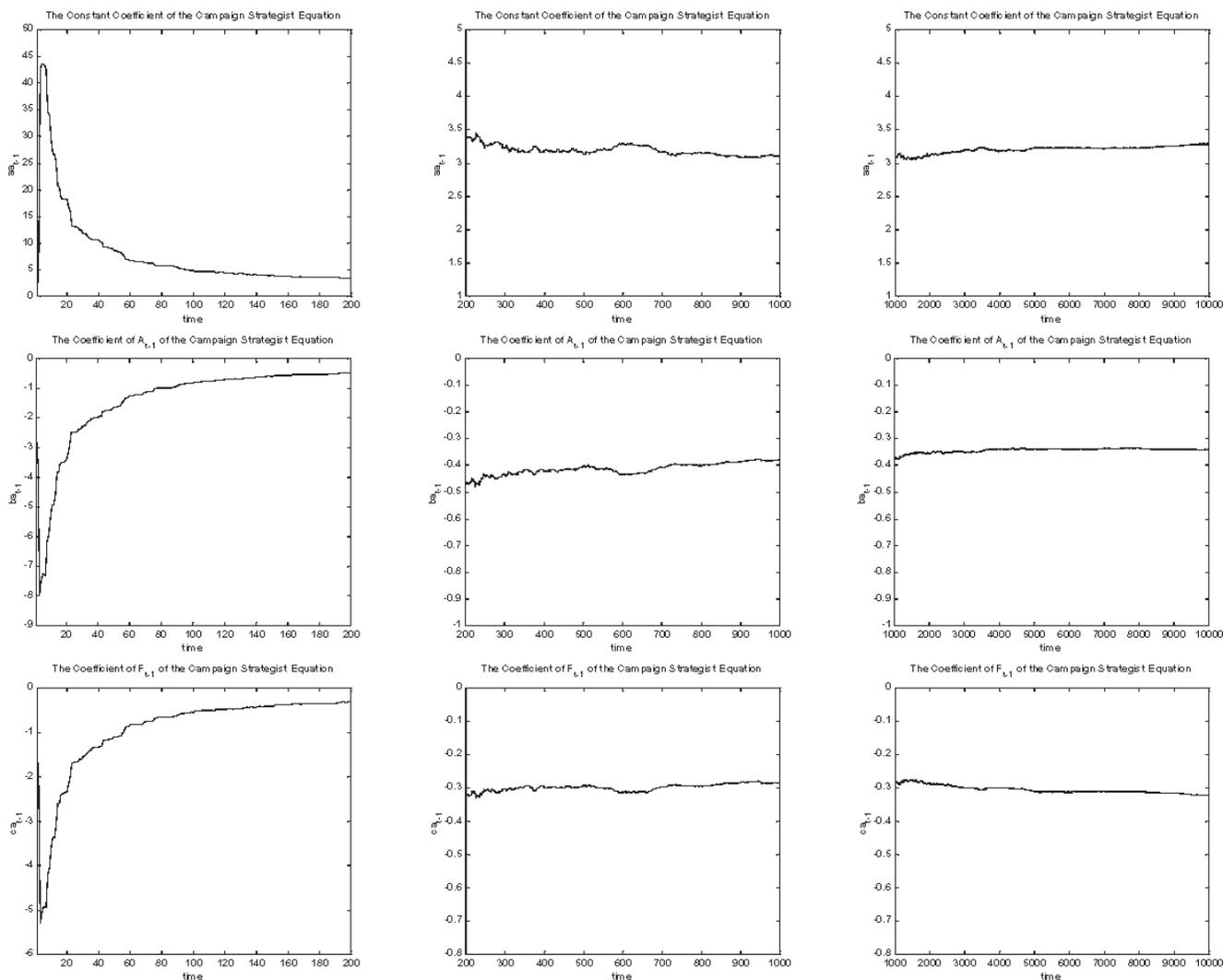
$$\begin{aligned} a_F^{RE} &= \alpha_F + \gamma(\alpha_A + (\beta - 1)a_A^{RE}) = \alpha_F \\ b_F^{RE} &= \gamma(\delta + (\beta - 1)b_A^{RE}) = 0 \\ c_F^{RE} &= \gamma(\phi + (\beta - 1)c_A^{RE}) = 0 \\ d_F^{RE} &= \lambda = -0.5 \\ e_{F,t} &= \gamma\epsilon_t + \eta_t \end{aligned}$$

The simulations have the following starting values and attributes. The variable  $W_{t-1}$  is an observable normal white noise process with standard deviation one and mean zero. The unobservable white noise processes  $\eta_t$  has a standard deviation of one. The simulation starting values for (7.1) are  $a_{F,t-1} = 4$ ,  $b_{F,t-1} = 4$ ,  $c_{F,t-1} = 4$ , and  $d_{F,t-1} = 4$ .

As in the previous simulations, these simulations have a virtual time period of 10,000. From (5.1) and (7.1), the rational expectations equilibrium values ( $a_F^{RE}$ ,  $b_F^{RE}$ ,  $c_F^{RE}$ ,  $d_F^{RE}$ ) are (5, 0, 0, -0.5). Again, if our model is correct, then both the perceived law of motion and the actual law of motion

<sup>5</sup> We also use equation (9.1) from our Appendix in the simulations.

≡ FIGURE 2  
SIMULATION OF THE CAMPAIGN STRATEGIST EQUATION



should have values that converge to the rational expectations values.

The results for the favorability equation show that  $(a_{Et-1}, b_{Et-1}, c_{Et-1}, d_{Et-1}) \rightarrow (5.02, 0.0095, -0.0076, -0.49)$ . Convergence to the rational expectations equilibrium occurs for all parameters (see Figure 3). We note especially that the effect of advertising (working through  $A_{t-1}$  and  $F_{t-1}$ ) has no effect after about 160 periods. Learning does occur. As a general rule, convergence to the rational expectations equilibrium happens for all parameters between 100 and 200 time periods.

7.3 A Model Application:  
*Campaign Message Volatility and Crystallization*

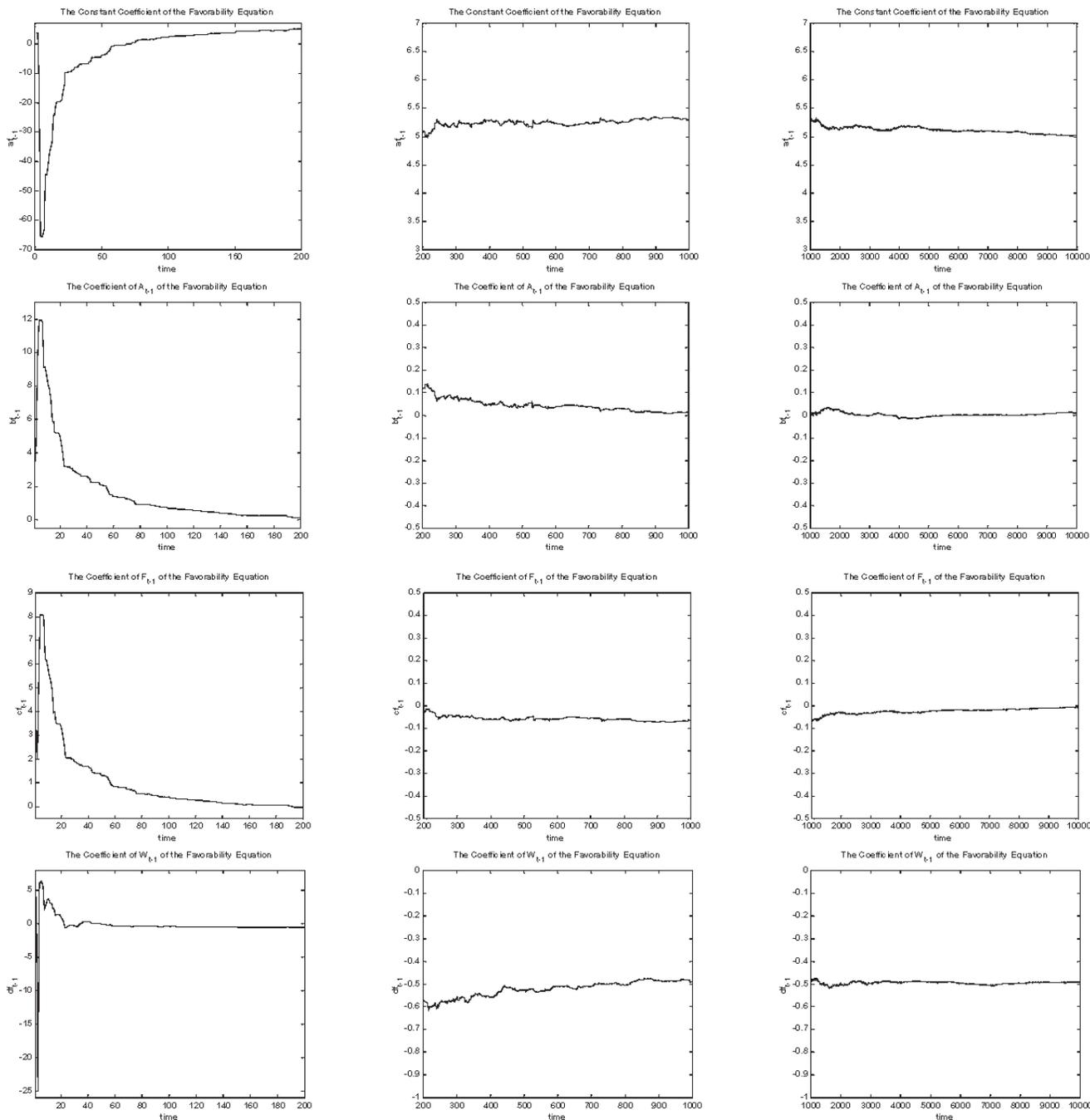
In this particular model application we examine the relation between campaign message volatility and the speed of crystallization. Our model and common sense would tell us that the relation should be negative: greater campaign mes-

sage volatility, due to things such as alternative message sequencing or message content changes, frustrates the learning process and delays crystallization.

While this relation seems obvious, what is not obvious is devising a model with a dynamic predictive framework. The old way of using loosely woven sets of variables, not accounting for confounding factors, and simply stating that these variables move in opposite directions is not helpful when the goal is identifying underlying causal relations and behavior for other scholars to build on.

To examine the effect of campaign message volatility we change the standard deviation of  $\epsilon_t$  (an unobservable normal white noise process) from 1.0 to 20.0. Figure 4 represents the simulations of the campaign strategist equation (3.3) with  $\sigma_\epsilon = 20$ . The convergence becomes slower for this more volatile case. When campaign message volatility is enhanced the parameters take longer to converge to the rational expectations equilibrium.

≡ FIGURE 3  
SIMULATION OF THE FAVORABILITY EQUATION



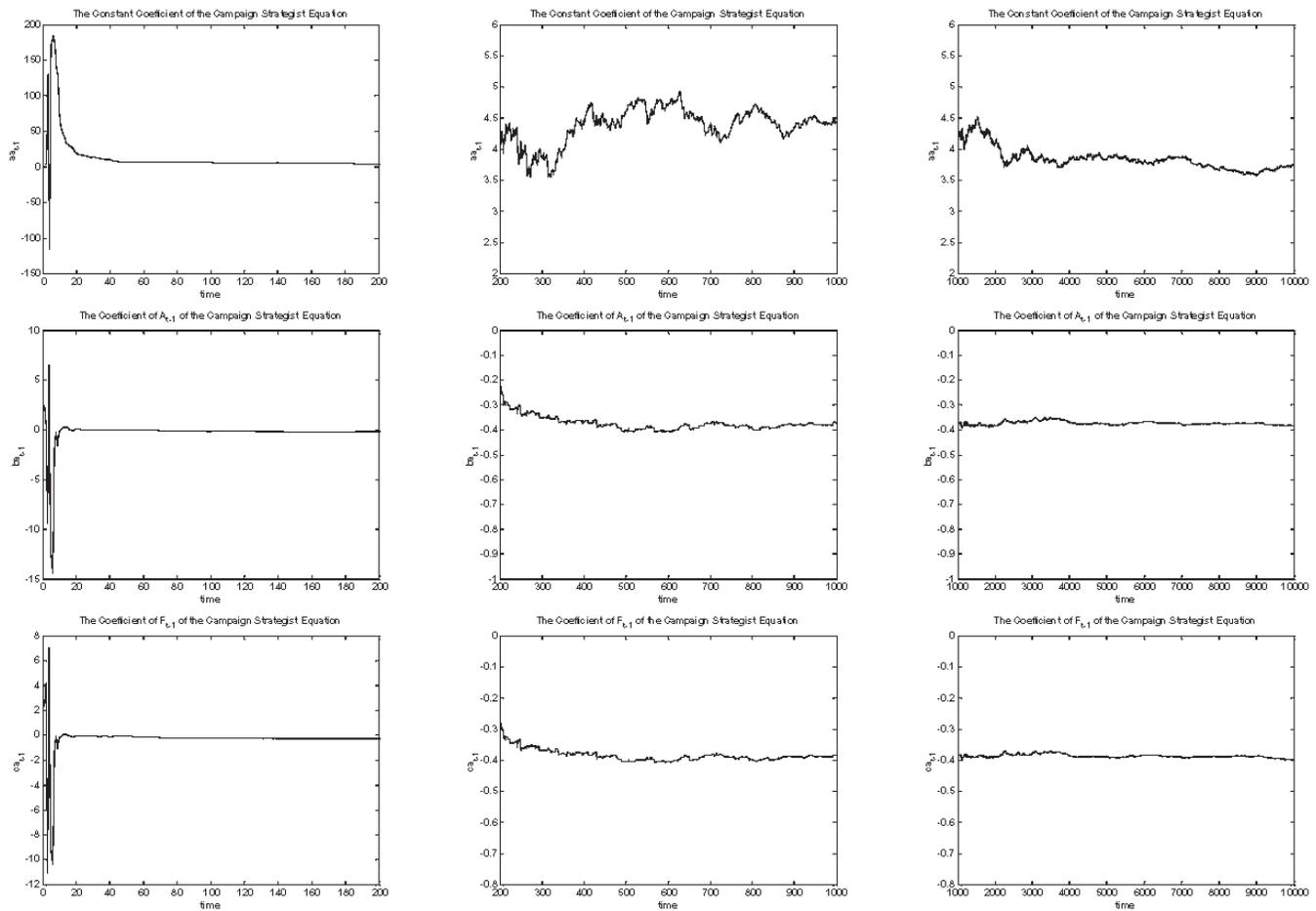
What happens to candidate favorability? The effect is similar. Crystallization is delayed. Figure 5 shows movement towards the rational expectations equilibrium for all parameters, but this crystallization process occurs only after 3,000 time periods have passed.

The intuition behind these results is that crystallization can occur but it is a fragile, possibly a special case of the campaign process. A well-timed and unexpected informational shock may keep voters off balance for extended periods of time.

## 8. SUMMARY AND IMPLICATIONS

In this paper we develop a model of political advertising effectiveness. Effectiveness depends on voter expectations and their ability to discern the true policy views and personal (character) traits of a candidate and the candidate's campaign strategy. This learning process is influenced by the expectations of others. The duration of advertisement effectiveness also depends on the degree to which voters learn to ignore the advertisements, if they ever do.

≡ FIGURE 4  
SIMULATION OF THE CAMPAIGN STRATEGIST EQUATION (ENHANCED VOLATILITY)



We establish testable conditions that derive specifically from the model. This linkage allows for an identifiable behavioral interpretation of the results. Using a simulation, the results indicate that, over time, political advertising has little effect. Following this baseline result, we conduct a model application on the effect campaign message volatility has on crystallization. The effect is as expected: campaign message volatility can provide sufficient information surprises that delay crystallization. Intuitively, this suggests shifting campaign messages by changing content or frequency may have considerable influence.

At this point these results only support the internal validity of the model. On the other hand, this model has the analytical and numerical properties that allow for valid tests of the theory. In fact, there are numerous possibilities for extending the model. One way is to explore deeper behavioral questions that lead to alternative parameter values in order to determine if these alternative values—behavioral and substantive effects—delay or expedite convergence to the rational expectations equilibrium.

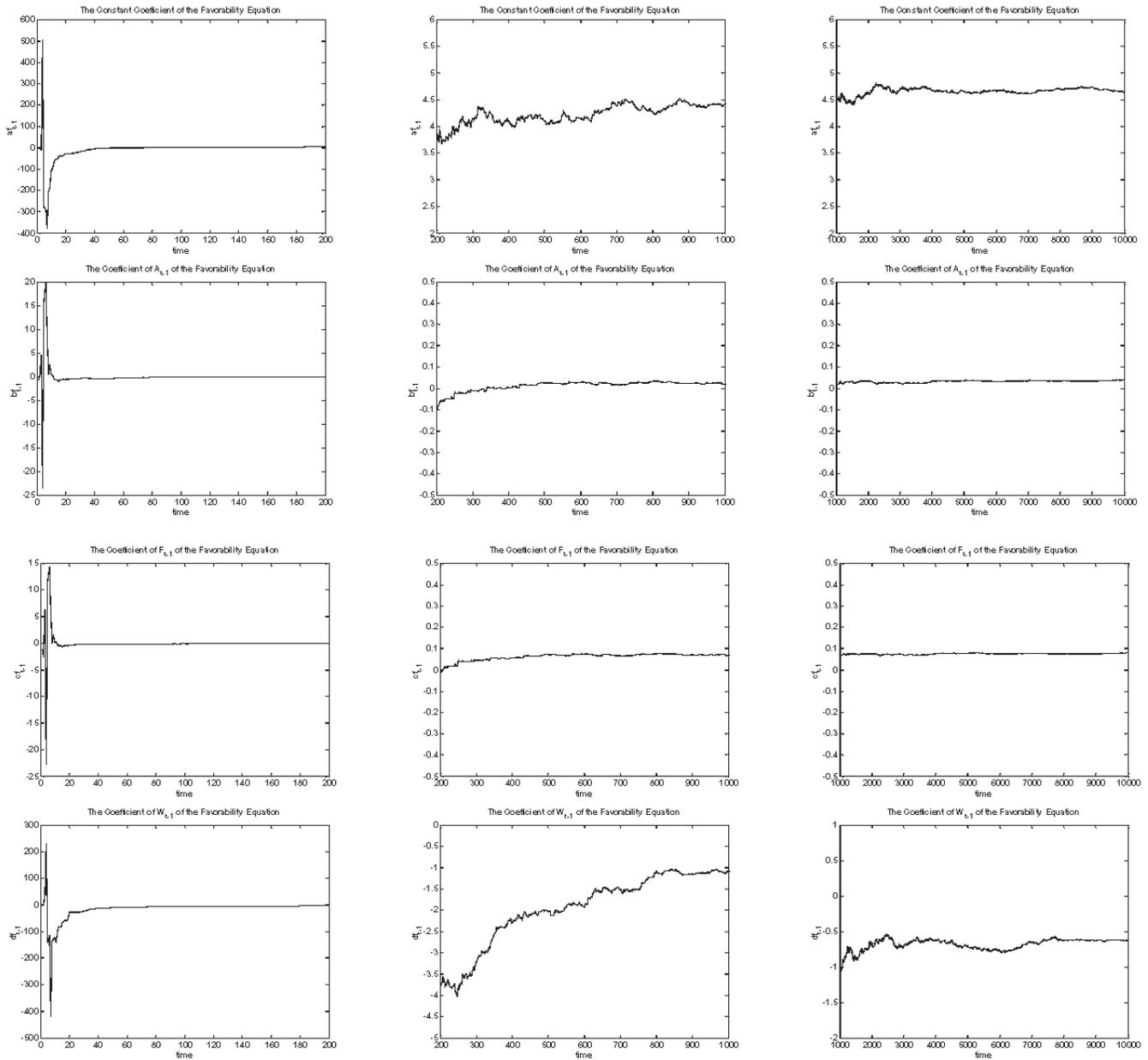
These alternative behavioral and substantive questions have many origins. For example, we could more fully exam-

ine how campaign strategists sequence their campaign advertisements. Campaign strategists are going to adopt a strategy that maximizes the influence of the political advertisement. Another issue is the content of political advertisements, and when it is appropriate to use negative political advertisements (Skaperdas and Grofman 1995; Sigelman and Shiraev 2002). Still another issue is to incorporate a well defined game between competing campaigns and voters.

On the other hand, if we were to augment voter attributes, then the question of information heterogeneity is important. In particular, the transmission of information from issue publics to the general public could introduce new conclusions about the degree of political advertising effectiveness.

Of course, the payoff in this model will be in its application to real situations. The model already has the advantage over standard static approaches in that causal relations are identified. However, this strength is not without cost. The model contains abstractions that will need further specificity. Of first rank is the precise meaning of a “time period.” For this actual data will be required. One way to address this is conduct a series of experiments in the spirit of

≡ FIGURE 5  
SIMULATION OF THE FAVORABILITY EQUATION (ENHANCED VOLATILITY)



McKelvey and Ordeshook (1985a, 1985b). Another avenue is to use actual data, which possesses dynamic attributes and is specific to time and place.

It should be noted that there is disagreement about whether individual-level survey data or aggregate data should be used. While both forms of data yield important information, we believe that understanding the influence of television advertising in political campaigns first demands improved measures of individual voters' exposure to real advertisements in the context of real campaigns. This, of course, means that the present model will need to be disaggregated. Augmenting the model in that way is not only necessary but feasible.

9. APPENDIX

To demonstrate how voters can discern the campaign strategist equation, we start with the data generation process (DGP) or true model (3.3):

$$A_t = \alpha_A + \delta A_{t-1} + \phi F_{t-1} + \beta E_{t-1}^* A_t + \epsilon_t$$

We assume that the perceived law of motion (PLM) for voters in (5.2) is:

$$A_t = a_{A,t-1} + b_{A,t-1} A_{t-1} + c_{A,t-1} F_{t-1} + u_t$$

where  $u_t \sim iid(0, \sigma_u^2)$ . More compactly,

$$A_t = \theta'_{t-1} Z_{t-1} + u_t,$$

where  $\theta'_{t-1} \equiv (a_{A,t-1} \ b_{A,t-1} \ c_{A,t-1})$ .

If we substitute the PLM into the true model, the actual law of motion (ALM) in (5.3) is:

$$A_t = (\alpha_A + \beta a_{A,t-1}) + (\delta + \beta b_{A,t-1}) A_{t-1} + (\phi + \beta c_{A,t-1}) F_{t-1} + \epsilon_t,$$

or in simpler terms:

$$A_t = T(\theta_{t-1})' Z_{t-1} + \epsilon_t.$$

We assume the voters use recursive least squares to update their parameter estimates of the PLM:

$$\theta_t = \theta_{t-1} + \frac{1}{t} R_t^{-1} Z_{t-1} (A_t - \theta'_{t-1} Z_{t-1}) \quad (9.1)$$

$$R_t = R_{t-1} + \frac{1}{t} (Z_{t-1} Z'_{t-1} - R_{t-1}),$$

for some appropriate values of  $\theta_0$  and  $R_0$ .

Our parameter updating mechanism is a stochastic recursive algorithm:

$$\psi_t = \psi_{t-1} + \kappa_t Q(\psi_{t-1}, X_t, t),$$

where  $\psi'_t = (\text{vec}(\theta_t)', \text{vec}(R_{t+1})')$ ,  $X'_t = (Z'_t, Z'_{t-1}, \epsilon_t)$ , and  $\kappa_t = t^{-1}$ .

We establish convergence properties of this algorithm by using the following ordinary differential equation and the E-stability conditions established in (5.4) – (5.8):

$$\frac{d\psi}{d\tau} = f(\psi),$$

and

$$f(\psi) = \lim_{t \rightarrow \infty} EQ(\psi, X_t, t).$$

Now, let  $EZ_t Z'_t = EZ_{t-1} Z'_{t-1} = E \begin{pmatrix} 1 \\ A_t \\ 1 \end{pmatrix} (1 \ A_t \ F_t) =$

$$\begin{pmatrix} 1 & \Omega_{12} & \Omega_{13} \\ \Omega_{21} & \Omega_{22} & \Omega_{23} \\ \Omega_{31} & \Omega_{32} & \Omega_{33} \end{pmatrix} \equiv M \text{ with } \lim_{t \rightarrow \infty} \frac{t}{t+1} = 1$$

and  $EZ_{t-1} \epsilon_t = 0$ . The associated ordinary differential equation in the model becomes:

$$\frac{d\theta}{d\tau} = R^{-1} M (T(\theta) - \theta)$$

$$\frac{dR}{d\tau} = M - R.$$

We have global stability if  $R \rightarrow M$  (and if  $R$  is invertible), and  $R^{-1}M \rightarrow I$  from any starting point. Then, the associated ordinary differential equation is:

$$\frac{d\theta}{d\tau} = T(\theta) - \theta.$$

Therefore, we have:

$$\frac{d}{d\tau} \begin{pmatrix} a_A \\ b_A \\ c_A \end{pmatrix} = T \begin{pmatrix} a_A \\ b_A \\ c_A \end{pmatrix} - \begin{pmatrix} a_A \\ b_A \\ c_A \end{pmatrix} = \begin{pmatrix} \alpha_A + \beta a_A - a_A \\ \delta + \beta b_A - b_A \\ \phi + \beta c_A - c_A \end{pmatrix}.$$

REFERENCES

Achen, Christopher. 1992. "Social Psychology, Demographic Variables, and Linear Regression: Breaking the Iron Triangle in Voting Research." *Political Behavior* 14: 195-211.

\_\_\_\_\_. 2002. "An Agenda for the New Political Methodology: Microfoundations and ART." *Annual Review of Political Science* 5: 423-50.

Ansolabehere, Stephen, and Shanto Iyengar. 1995. *Going Negative: How Political Ads Shrink and Polarize the Electorate*. New York: Free Press.

Bartels, Larry. 1985. "Expectations and Preferences in Presidential Nominating Campaigns." *American Political Science Review* 79: 804-15.

\_\_\_\_\_. 1988. *Presidential Primaries and the Dynamics of Presidential Nominating Campaigns*. Princeton, NJ: Princeton University Press.

\_\_\_\_\_. 1993. "Messages Received: The Political Impact of Media Exposure." *American Political Science Review* 87: 267-81.

\_\_\_\_\_. 1996. "Uninformed Voters: Information Effects and Presidential Elections." *American Journal of Political Science* 40: 194-230.

Beck, Paul, Russell Dalton, Steven Greene, and Robert Huckfeldt. 2002. "The Social Calculus of Voting: Interpersonal, Media, and Organizational Influences on Presidential Choices." *American Political Science Review* 96: 57-73.

Bianco, William. 1998. "Different Paths to the Same Result: Rational Choice, Political Psychology, and Impression Formation in Campaigns." *American Political Science Review* 42: 1061-81.

Brady, Henry. 1993. "Knowledge, Strategy, and Momentum in Presidential Primaries." *Political Analysis* 5: 1-38.

Brady, Henry, and Richard Johnston. 1987. "What's the Primary Message: Horse Race or Issue Journalism?" In G. Orren and N. Polsby, eds, *Media and Momentum*. Chatham, NJ: Chatham House.

Bray, Margaret. 1982. "Learning, Estimation, and the Stability of Rational Expectations." *Journal of Economic Theory* 26: 318-39.

Bray, Margaret, and Nathan Savin. 1986. "Rational Expectations, Equilibria, Learning, and Model Specification." *Econometrica* 54: 1129-60.

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

Converse, Philip. 1964. "The Nature of Belief Systems in Mass Publics." In D. Apter, ed., *Ideology and Discontent*. New York: Free Press.

Cooper, Russell. 1999. *Coordination Games: Complementarities in Macroeconomics*. Cambridge: Cambridge University Press.

- Cyert, Richard, and Morris DeGroot. 1974. "Rational Expectations and Bayesian Analysis." *Journal of Political Economy* 82: 521-36.
- DeCanio, Stephen. 1979. "Rational Expectations and Learning from Experience." *The Quarterly Journal of Economics* 94: 47-57.
- Durlauf, Steven, and H. Peyton Young, eds. 2001. *Social Dynamics*. Cambridge, MA: MIT Press.
- Evans, George. 1983. "The Stability of Rational Expectations in Macroeconomic Models." In Roman Frydman and Edmund Phelps, eds., *Individual Forecasting and Aggregate Outcomes*. Cambridge, MA: Cambridge University Press.
- \_\_\_\_\_. 1985. "Expectational Stability and the Multiple Equilibria Problem in Linear Rational Expectations Models." *Quarterly Journal of Economics* 100: 1217-33.
- \_\_\_\_\_. 1989. "The Fragility of Sunspots and Bubbles." *Journal of Monetary Economics* 23: 297-317.
- Evans, George, and Seppo Honkapohja. 2001. *Learning and Expectations in Macroeconomics*. Princeton, NJ: Princeton University Press.
- Fiske, Susan. 1993. "Social Cognition and Perception." *Annual Review of Psychology* 44: 155-94.
- Fiske, Susan, and Steven Neuberg. 1990. "A Continuum of Impression Formation from Category-Based to Individuating Processes: Influences of Information and Motivation on Attention and Interpretation." In M. P. Zanna, ed., *Advances in Experimental Psychology*. San Diego: Academic Press.
- Freedman, Paul, and Kenneth Goldstein. 1999. "Measuring Media Exposure and the Effect of Negative Ads." *American Journal of Political Science* 43: 1189-1208.
- Gerber, Alan, and Donald Green. 1998. "Rational Learning and Partisan Attitudes." *American Journal of Political Science* 42: 794-818.
- Gitlin, Todd. 1980. *The Whole World is Watching: Mass Media in the Making and Unmaking of the New Left*. Berkeley: University of California Press.
- Goldstein, Kenneth. 1997. Political Advertising and Political Persuasion in the 1996 Election. Paper presented at the Annual Meeting of the American Political Science Association.
- Hendry, David. 1995. *Dynamic Econometrics*. New York: Oxford University Press.
- Huckfeldt, Robert, and John Sprague. 1995. *Citizens, Politics, and Social Communication*. Cambridge, MA: Cambridge University Press.
- Iyengar, Shanto, and Nicholas Valentino. 2000. "Who Says What? Source Credibility as a Mediator of Campaign Advertising." In Arthur Lupia, Mathew McCubbins, and Samuel Popkin, eds., *Elements of Reason: Cognition, Choice, and the Bounds of Rationality*. Cambridge, MA: Cambridge University Press.
- Lazarsfeld, Paul, Bernard Berelson, and Hazel Gaudet. 1944. *The People's Choice*. New York: Duell, Sloane, and Pearce.
- Marcet, Albert, and Thomas Sargent. 1989a. "Convergence of Least-Squares Learning in Environments with Hidden State Variables and Private Information." *Journal of Political Economy* 97: 1306-22.
- \_\_\_\_\_. 1989b. "Convergence of Least-Squares Learning Mechanisms in Self-Referential Linear Stochastic Models." *Journal of Economic Theory* 48: 337-68.
- Markus, Gregory. 1982. "Political Attitudes During an Election Year: A Report on the 1980 National Election Studies Panel Study." *American Political Science Review* 76: 538-60.
- Marcus, Gregor, and Michael MacKuen. 1993. "Anxiety, Enthusiasm, and the Vote: The Emotional Underpinnings of Learning and Involvement During Presidential Campaigns." *American Political Science Review* 87: 672-85.
- Marsh, Catherine. 1985. "Back on the Bandwagon: The Effect of Public Opinion Polls on Public Opinion." *British Journal of Political Science* 15: 51-74.
- McKelvey, Richard, and Peter Ordeshook. 1985a. "Elections with Limited Information: A Fulfilled Expectations Model using Contemporaneous Poll and Endorsement Information as Information Sources." *Journal of Economic Theory* 36: 55-58.
- \_\_\_\_\_. 1985b. "Sequential Elections with Limited Information." *American Journal of Political Science* 29: 480-512.
- Miller, Warren, and J. Merrill Shanks. 1996. *The New American Voter*. Cambridge: Harvard University Press.
- Page, Benjamin, and Robert Shapiro. 1992. *The Rational Public: Fifty Years of Trends in American Policy Preferences*. Chicago: University of Chicago Press.
- Petrocik, John. 1987. "Realignment: New Party Coalitions and the Nationalization of the South." *Journal of Politics* 49: 347-75.
- \_\_\_\_\_. 1996. "Issue Ownership in Presidential Elections, with a 1980 Case Study." *American Journal of Political Science* 40: 825-50.
- Popkin, Samuel. 1991. *The Reasoning Voter*. Chicago: University of Chicago Press.
- Popkin, Samuel, John Gorman, Charles Phillips, and Jeffrey Smith. 1976. "What Have You Done for Me Lately? Toward an Investment Theory of Voting." *American Political Science Review* 70: 779-805.
- Sargent, Thomas. 1993. *Bounded Rationality in Macroeconomics*. Oxford: Oxford University Press.
- \_\_\_\_\_. 1999. *The Conquest of American Inflation*. Princeton, NJ: Princeton University Press.
- Shafer, Byron, and William Claggett. 1995. *The Two Majorities: The Issue Context of Modern American Politics*. Baltimore: Johns Hopkins University Press.
- Shepsle, Kenneth. 1972. "The Strategy of Ambiguity: Uncertainty and Electoral Competition." *American Political Science Review* 66: 555-68.
- Sigelman, Lee, and Eric Shiraev. 2002. "The Rational Attacker in Russia? Negative Campaigning in Russian Presidential Elections." *Journal of Politics* 64: 45-62.
- Skaperdas, Stergios, and Bernard Grofman. 1995. "Modeling Negative Campaigning." *American Political Science Review* 89: 49-61.
- Stoker, Laura. 1993. "Judging Presidential Character: The Demise of Gary Hart." *Political Behavior* 15: 193-223.
- Townsend, Robert. 1978. "Market Anticipations, Rational Expectations, and Bayesian Analysis." *International Economic Review* 19: 481-94.
- \_\_\_\_\_. 1983. "Forecasting the Forecasts of Others." *Journal of Political Economy* 91: 546-88.
- West, Darrell. 1993. *Air Wars*. Washington, DC: Congressional Quarterly Press.
- Zaller, John. 1992. *The Nature and Origins of Mass Opinion*. Cambridge: Cambridge University Press.
- \_\_\_\_\_. 1996. "The Myth of Massive Media Impact Revisited." In Diana Mutz, Paul Sniderman, and David Brody, eds., *Political Persuasion and Attitude Change*. Ann Arbor: University of Michigan Press.

Received: November 12, 2003

Accepted for Publication: January 13, 2004

jgranato@nsf.gov

wong@cba.usm.edu