A Possible Solution to the Paradox of Voter Turnout

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The paradox of voter turnout is a major empirical puzzle that has been unresolved in rational choice theory. Why do rational actors contribute to the public good of electoral outcomes, especially since the likelihood that their vote will be decisive is nearly zero? I propose a possible solution to this paradox based on the stochastic learning model rather than the subjective expected utility maximization model. In the stochastic learning model, actors are conceived to be backward-looking adaptive learners, rather than forward-looking utility maximizers, and use the past correlations between their choices and collective action outcomes as a guide for their decision whether or not to vote. The stochastic learning model of calculus of voting can solve the paradox because now $p \cong .500$ instead of $p \cong 0$. The analyses of the 1972-74-76 panels of the American National Election Study largely support the hypotheses derived from the stochastic learning model.

The paradox of voter turnout (sometimes known as the paradox of not voting) has been one of the most persistent and recalcitrant empirical puzzles for the rational choice theory of politics. The probability that one would cast a decisive vote is not significantly different from zero in large national elections, and the electoral outcomes are public goods that are equally enjoyed (or suffered) by voters and nonvoters alike. Why then would rational actors invest their personal time and energy into driving to the polls and casting their ballots? Rational choice theory predicts that actors free ride and do not voluntarily contribute to the production of public goods (unless the "psychic benefits" of contribution outweigh its total costs), yet millions of citizens vote at every election. This paradox of voter turnout is perceived to be so devastating that Fiorina calls it "the paradox that ate rational choice theory" (1990, 334). In the most comprehensive and incisive critique to date, Green and Shapiro (1994) choose this paradox as

one of the four areas where rational choice theory has not performed well empirically.

While rational choice theorists wonder why *anyone* should vote, other social scientists (Chen 1992; Teixeira 1992; Wolfinger and Rosenstone 1980) ask why *so few* Americans vote. In the late 1980s, for instance, two books by the identical title appeared: *Why Americans Don't Vote* (Piven and Cloward 1988; Teixeira 1987). In their search for the answer to this question, political scientists have asked whether electoral closeness affects turnout (Berch 1993; Matsusaka 1993), whether bad weather (which lowers turnout) helps Democrats or Republicans (Knack 1994; Merrifield 1993; Radcliff 1994), and have investigated the relationship between race and turnout (Brace et al. 1995; Radcliff and Saiz 1995). In sharp contrast to rational choice theory, however, the dominant perspective in this literature assumes that most citizens are motivated to vote and *would* vote, if it weren't for the institutional constraints that they face in the form of laws regarding registration and absentee voting (Fenster 1994; Heckelman 1995; Jackman 1987; Jackman and Miller 1995; Oliver 1996; Piven and Cloward 1988).

In their attempts to solve the paradox of voter turnout, Palfrey and Rosenthal (1983, 1985) and Ledyard (1984) construct game-theoretic models of electoral behavior. While Palfrey and Rosenthal (1983) demonstrate that substantial turnout could occur if every voter has complete information about the preferences and costs of every other voter, Ledyard (1984) and Palfrey and Rosenthal (1985) nevertheless conclude that turnout at equilibrium is zero in large electorates where strategic uncertainty among voters is high. Thus, the current conclusion in the literature is that "we have come full circle and are once again beset by the paradox of not voting" (Palfrey and Rosenthal 1985, 64) and that "notwithstanding its greatly refined insight into the decision to participate, the application of game theory has not yet solved the original problem" (Grafstein 1991, 990).

Aldrich (1993, 261) maintains that "turnout is not a particularly good example of the problem of collective action" because it is "for many people most of the time, a low-cost, low-benefit action." However, the essence of the collective action problem is not the absolute or relative levels of benefit or cost but instead its dilemma nature; individually rational action leads to a collectively disastrous outcome. The cost of turnout (while it may be low) is still positive and borne by individuals; the benefit (while it may be low) is still public (nonexcludable with jointness of supply). These two characteristics combine to make defection a dominant strategy, and create a dilemma. Turnout therefore *is* a particularly good example of the problem of collective action.[1]

[1] That Aldrich (1993) seems to misconstrue the essence of the collective action problem, however, should have no implication whatsoever for the validity of the "strategic politicians" theory of voter turnout (derived from Cox and Munger 1989), which he presents in the same article. I believe it is a promising micro-macro theory of voter turnout that potentially solves another persistent empirical puzzle in the literature: why the closeness of electoral outcome has a positive effect at the margin on the turnout at the aggregate level, when individuals do not seem to weigh p in their decision whether or not to vote.

In this paper I propose a model of voter turnout that can potentially contribute to the discussion of the paradox. The model depends neither on the size of the electorate nor the level of information that voters possess about other potential voters. I rely heavily on the recent work of Macy (1989, 1990, 1991a, 1991b, 1993, 1995) on the stochastic learning model, and argue that actors are backward-looking and adaptive, rather than forward-looking and utility maximizing. In essence, I simultaneously propose a new definition of the "p" term and endogenize the "D" term in Riker and Ordeshook's (1968, 1973) calculus of voting model. I derive hypotheses about the voting behavior of citizens on a series of elections, and test them with the 1972-74-76 Michigan Election Panel data.

The Calculus of Voting Model[2]

Probably the most influential theory of voting behavior is the calculus of voting, originally proposed by Downs (1957), and later developed by Riker and Ordeshook (1968, 1973). It predicts that a citizen will turn out to vote if:

$$pB + D > C \qquad (1)$$

where B represents all the *B*enefits that the voter will personally receive only if the voter's candidate of choice wins the election; D, which Downs (1957) originally called value in *D*emocracy, but Riker and Ordeshook (1968, 1973) later called the "citizen *D*uty" term, captures all the intrinsic satisfaction that the voter receives from the act of voting itself, *regardless* of who wins the election; in other words, B represents the *instrumental* value of voting whereas D represents its *immanent* value (Hechter 1992); C (*C*osts) is the sum of all the personal costs of voting, both direct costs, in terms of the time and energy it takes to make the trip to the polls on the day of the election as well as the time and energy one invests beforehand in learning about the issues and the candidates, and the opportunity costs, in terms of forgone wages, etc.; finally, p represents the *p*robability that one's vote will be decisive, in the sense that it either makes or breaks a tie in one's candidate's favor.[3] The calculus of voting model predicts that a citizen will abstain if pB + D < C, and will be indifferent if pB + D = C.

However, in any large electorate, with millions of potential voters, p is essentially zero, because even the closest contests are decided by a margin of tens of thousands of votes and the probability that one's vote proves to be decisive is in-

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[2] I make no effort to provide a comprehensive review of the vast theoretical and empirical literature on the calculus of voting model, let alone of the even vaster one on the paradox of voter turnout. I refer the interested readers to excellent recent reviews by Aldrich (1993) and Green and Shapiro (1994, chap. 4).

[3] Theories of voting universally assume that, in the case of a tie, a coin toss will determine the winner (Aldrich 1993, 248); thus, a tie-making vote changes a certain loss for one's candidate, by one vote, to an even chance for a victory.

finitesimal. If p is essentially zero, then the first term in the above inequality, pB, is 0, however large the personal material benefits that one receives from the election of one candidate as opposed to the other(s). Thus the inequality reduces to D > C, and the model predicts that a citizen will turn out to vote if one's satisfaction from fulfilling the "citizen duty," performing one's share to uphold democracy and all the other intangible psychic benefits from the act of voting itself, outweighs all the tangible personal costs.

In the face of this observation, the defense of the calculus of voting model has taken three separate lines. First, some have played up the size of D and maintained that the duty to vote is indeed significant for most citizens. Riker and Ordeshook (1968, 28; 1973, 63) enumerate five psychic benefits that citizens might derive from the act of voting. These are satisfaction derived from: complying with the ethic of voting; affirming allegiance to the political system; affirming a partisan preference; deciding, for those who enjoy the act of informing themselves for the decision; and affirming one's efficacy in the political system. However, this and other similar lists of potential psychic benefits that citizens derive from the act of voting tend to be extremely ad hoc, not derived from any coherent set of behavioral assumptions. They also tend to be contradicted by empirical evidence (Green and Shapiro 1994, 50–56). In the calculus of voting literature, D remains completely exogenous to the model, and thus its interindividual variations remain unexplained.

The second line of defense is to play down C and argue that the cost of voting is not really high.[4] However, while they may have shown that the cost of voting is "insignificant and imperceptible for most people" (Olson 1965, 164n) and "has been tremendously exaggerated" (Niemi 1976, 115), it still remains true that the cost is real and positive while the electoral outcome is a public good. Besides, in the absence of a clearly defined set of all factors that go into both the D and C terms, and reasonably precise measures of them, it will be impossible to demonstrate D > C.

The third line of defense is to shift the focus from the absolute level of voter turnout to its marginal changes. Riker and Ordeshook (1968), Barzel and Silberberg (1973), Silberman and Durden (1975), and Settle and Abrams (1976) all found that the closeness of electoral outcomes has a positive effect on the turnout rate at the aggregate level. These findings presumably support the calculus of voting model because the closer the contest, the more likely it is that any given voter casts a decisive vote. However, as Green and Shapiro (1994, 59–65) note, demonstrating that voter turnout responds to electoral closeness (a measure of p) *at the margin* is different from explaining why *anybody* should vote in large

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[4] Hinich (1981) also argues that the cost of voting is small, but does so completely outside of the calculus of voting model. In fact, while he still holds the subjective expected utility maximizing conception of the actor, his argument that voters derive utility from voting for the winner and disutility from voting for the loser strongly foreshadows the stochastic learning model of voting that I present below.

national elections in the first place. Since even the closest of such national contests are decided by tens of thousands of votes, to argue that the probability of casting a decisive vote increases with the closeness of electoral outcomes is, to use Schwartz's memorable words, "like saying that tall men are more likely than short men to bump their heads on the moon" (1987, 118).

The paradox of voter turnout therefore remains largely unsolved. Throughout the entire debate, in all the articles, comments, and rejoinders, one assumption that has been unquestioned by both the supporters and the critics of the calculus of voting model is that p is infinitesimally small ($\cong 0$). While some have argued that voters' subjective estimates of p could be unreasonably large (Riker and Ordeshook 1968, 38–39), nobody has questioned the assumption that it is *in fact* not significantly different from 0. This assumption of $p \cong 0$ leads to $pB \cong 0$, and then to the necessity of explaining rational actors' decision to vote by demonstrating $D > C$.

But what if p were indeed not infinitesimal? What if p were large? As large as, say, .500? If $p \cong .500$, then any modest preference for one candidate over another (B) will lead to a sufficiently large pB, which can easily outweigh C, thus $pB > C$, obviating the need to explain the decision to vote in terms of the "noninstrumental" D term (Aldrich 1993, 257–58; Barry 1970, 13–19). The paradox of voter turnout would be solved if $p \cong .500$, would it not?

Another problem with Riker and Ordeshook's calculus of voting model, as well as some of its defense in the literature, is that the D term is completely exogenous. While it seems reasonable enough to assume that citizens in democratic societies feel certain obligations to vote as a matter of norm compliance, where does this sense of obligation come from? More importantly, why do some citizens comply with this norm more strictly than others? Where does the individual variation in the size of the D term come from?[5]

A Stochastic Learning Model of Voter Turnout

The calculus of voting is a decision-theoretic model that uses the conception of rational actors as subjective expected utility maximizers. Actors in the sub-

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[5] Uhlaner (1989) and Morton (1991) use selective incentives provided by leaders of groups to which individuals belong, in order to explain positive turnout. The selective incentives in their models are similar to the D term (and dissimilar to the B term) in that their provisions do not depend on who wins the election. However, they are different from the D term in two important respects. First, the selective incentives provided by the group leaders are mostly *material,* whereas D represents psychic benefits (although it may be possible to modify Uhlaner's and Morton's models to incorporate psychic benefits). Second, and more important, the provision of the selective incentives is contingent, not on voting per se (as D is), but on voting *for a certain candidate.* I therefore believe that Uhlaner (1989) and Morton (1991) add another term to the calculus of voting with their selective incentives, which is neither B nor D. (In fact, in Morton's [1991] model, D or the "consumption benefit" is expressed as U(BB) and is explicitly set at 0.)

jective expected utility maximization theory *look forward,* evaluate all options available to them within the informational and structural constraints, and assess their consequences. They evaluate each consequence of a given contemplated course of action in terms of its utility or disutility; weigh it by the subjective probability of that particular consequence happening; sum across all potential consequences; and derive subjective expected utility for each contemplated course of action. Then rational actors choose the course of action that carries the highest subjective expected utility.

In a series of articles, Michael W. Macy (1989, 1990, 1991a, 1991b, 1993, 1995) has challenged the subjective expected utility maximization theory as a model of human behavior. He criticizes the theory on two grounds. First, the cognitive demands that it places on actors are beyond the capabilities of most humans, especially since it requires them to estimate the probabilities of different future states of the world (Petersen 1994). Second, while the theory predicts that rational actors will make a contribution toward collective action only when the expected returns from their contributions (i.e., the "difference" they make) exceed their personal costs of contribution, the actors can never observe the marginal impact of their contribution because such observations require knowledge of counterfactuals. Would the collective action have failed had they not contributed toward it (when in fact they did and it succeeded)? Would it have succeeded had they contributed toward it (when in fact they didn't and it failed)? Macy points out that the only things that actors can accurately observe without posing counterfactuals are their own behavior (cooperation or defection) and the outcome of the collective action (success or failure).

Macy proposes an alternative model of human behavior: the stochastic learning model. The model derives from the earlier work of Bush and Mosteller (1955) on individual behavior; Macy applies their learning model to large-N collective action problems. In this model, actors are backward-looking adaptive learners, rather than forward-looking utility maximizers.[6] They do not perceive the *causal* link between their contribution and the collective action outcome, but merely the *correlational* one. They take the success and the failure of the collective action as reinforcers and punishers from the environment, and associate

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[6] Even leading game theorists (e.g., David M. Kreps) now emphasize the importance of backward-looking behavior (Kreps 1990, chap. 6, "Bounded Rationality and Retrospection"; see also Winter 1986). It is interesting to note, however, that, while Macy considers forward-looking utility maximization to be cognitively too taxing for ordinary actors and backward-looking adaptive learning to be easier, Kreps thinks the exact opposite: "Learning from the past is a fantastically complex problem, often well beyond the cognitive powers of individuals to accomplish 'optimally'" (152). Lave and March (1975, 248–49) distinguish between *calculated* rationality and *adaptive* rationality. They explain the process of adaptive learning thus: "An action is taken; the world responds to the action; and the individual infers something about the world and then adapts his behavior so as to secure desirable responses." The subjective expected utility maximization model assumes that actors are calculatedly rational; the stochastic learning model posits that actors are adaptively rational.

them with their own behavior. If they contribute, and the collective action succeeds, then their contribution is reinforced, and (following the operant conditioning paradigm) they become somewhat more likely than before to contribute in the future. If they contribute, and the collective action fails, then their contribution is punished, and they become somewhat less likely than before to contribute in the future. The same operant logic applies when the actors do not contribute. If the collective action succeeds, then their defection is reinforced and they become even less likely to contribute. If the collective action fails, then their defection is punished, and they become somewhat more likely to contribute.

Formally, the stochastic learning model defines the individual's propensity toward cooperation as:

$$p_{i+1, j} = p_{ij} + [O_{ij}(1 - p_{ij})C_{ij}] - [O_{ij}(p_{ij})(1 - C_{ij})] \qquad \text{if } O_{ij} > 0$$

$$= p_{ij} + [O_{ij}(p_{ij})C_{ij}] - [O_{ij}(1 - p_{ij})(1 - C_{ij})] \qquad \text{if } O_{ij} < 0 \qquad (2)$$

where p_{ij} is the probability that actor j will contribute toward the collective action on the ith round, O_{ij} is a positive constant if the collective action succeeds on the ith round (and therefore reinforces j's choice) and a negative constant if it fails (and therefore punishes j's choice), and $C_{ij} = 1$ if j contributes on the ith round and $C_{ij} = 0$ if j defects on the ith round.[7] $|O_{ij}|$ captures the magnitude of reinforcement or punishment in the learning process.

In a recent Axelrod-style tournament, Nowak and Sigmund (1993) show that a game strategy based on the same principle of stochastic learning named PAVLOV[8] typically outperforms one of the most successful of all game strategies: Tit-for-Tat. PAVLOV's strategy is usefully summarized as "Win-Stay, Lose-Shift." If the actor makes a choice and the joint outcome of the game results in a "win" from the actor's individual perspective (by getting either T or R payoff), then the actor stays with the same choice on the next round. If the actor "loses" (by getting either P or S payoff), then the actor shifts to the other option (from C to D, or from D to C). Macy's (1995) recent laboratory experiment with human subjects strongly supports the hypothesis that humans behave as backward-looking adaptive learners and engage in the Win-Stay, Lose-Shift pattern.

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[7] Macy (1990, 816; 1991a, 816; 1991b, 739; 1993, 826) adds the exponent $\frac{1}{|O_{ij}|}$ to P_{ij} in the second and the third terms in Equation (1), in order to define diminishing effects of reinforcers and punishers with propensity (such that the same reinforcers and punishers have smaller effects when p is already high). However, I have decided to simplify the equation and assume that reinforcers and punishers have linear effects (as in Bush and Mosteller 1955).

[8] As Macy (1995, 74) points out, however, "PAVLOV" is a gross misnomer, because Ivan Pavlov's work was on respondent conditioning involving reflexes, not on operant conditioning of voluntary behavior. Nowak and Sigmund should have named the strategy "THORNDIKE" (for his Law of Effect) or "SKINNER."

One of the strengths of Macy's stochastic learning model is that it can explain not only instrumental behavior but also normative, habitual behavior as well. In fact, "although learning theory can be used to model consciously instrumental (but backward-looking) behavior, it is typically applied to behavior that is unthinking or habitual" (Macy 1990, 811; 1991a, 812). The same operant conditioning takes place when actors engage in behavior in order to comply with norms, and the resultant reinforcement or punishment strengthens or weakens their attachment to norms and the extent to which they will comply with them in the future. "The attachment to prosocial norms increases when those who comply are repeatedly rewarded and when those who disregard social obligations and disdain collective welfare are penalized. Conversely, the attachment declines when compliance is penalized and deviance is rewarded" (Macy 1990, 811). As in instrumental behavior, normative behavior is reinforced when the collective action to which the actors contribute (through their norm compliance) succeeds, and it is punished when the collective action fails.

However, Macy notes an important distinction between instrumental and normative behavior in his stochastic learning model. While instrumental learning can take place rather quickly, possibly in response to a single reinforcer (successful collective action) or punisher (failed collective action), as in the case of a pure Win-Stay, Lose-Shift strategy like PAVLOV, normative learning can take longer because norm compliance tends to be habitual and unthinking. "While pragmatists may change tack after every wind shift, habits are slow to change" (Macy 1991a, 813). Normative learning thus lags behind instrumental learning, and it takes a larger number of reinforcers and punishers to change normative behavior than it does to change instrumental behavior.

What implication do the stochastic learning model and Win-Stay, Lose-Shift have for the paradox of voter turnout? Voting in a large national election is a quintessential example of collective action. There is clearly winning (or success) and losing (or failure) involved; individuals (voters and nonvoters) win if their candidate of choice wins the election, and they lose if their candidate loses the election. Thus, learning can take place over a series of elections. And Macy's model, applied to Riker and Ordeshook's calculus of voting, can endogenize, and explain individual variations in, both the p and D terms.

p

As Macy points out, it is virtually impossible to assess one's marginal contribution to the outcome of large-N collective action. All that individuals can accurately assess in voting in a large electorate, for instance, are their individual action (voting or not voting) and the collective outcome (win or loss for their candidate of choice). When prospective voters look backward, the p in the calculus of voting no longer measures the probability that their vote will be decisive

in the future; this will not be a variable in their calculus because there is no way to compute it before the fact. *For the backward-looking adaptive learners, p represents the probability that one's vote was associated with a win in the past.*[9]

I propose to substitute the p term in the original calculus of voting model with Macy's $p_{i+1,j}$. In terms of Equation (2) above, p_{ij} is the probability that individual j has voted for a winning candidate prior to the ith election, $O_{ij} > 0$ if j's preferred candidate wins the ith election and $O_{ij} < 0$ if the candidate loses, and $C_{ij} = 1$ if j votes on the ith election and $C_{ij} = 0$ if j abstains. Since, in a typical presidential election, about half of the voters vote for the winning candidate, and about half of the nonvoters support the winning candidate, in the stochastic learning model of voter turnout, on average over a series of elections, $p \cong .500$. While Macy's model of behavior is stochastic and his p_{ij} is the probability of cooperation, my reformulation of the calculus of voting model is still deterministic *overall* (as in the original formulation); an individual would vote if $pB + D > C$ and abstains otherwise. The only stochastic components in my reformulation are the new definitions of the p and D terms.

D

For the first time in the calculus of voting literature, the stochastic learning model of voter turnout can endogenize the citizen duty term (D), and parsimoniously explain why some citizens have larger D's than others (without resorting to an ad hoc list of psychic benefits as in Riker and Ordeshook [1968, 28; 1973, 63]). The D term fluctuates as a result of stochastic learning of normative behavior. Citizens' attachment to the norm of civic duty will strengthen if their voting results in a successful election of their candidate, and it will similarly decline if their voting results in a defeat of their candidate. Conversely, their sense of citizen duty will decline if their candidate wins when they didn't vote, and strengthen if their nonvoting is associated with the defeat of their candidate. In the stochastic learning model of voter turnout, therefore, the p term (redefined as the past correlational link between individual behavior and collective action) and the D term (attachment to the prosocial norm of civic duty) have the same source of variation.

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[9] Grafstein's (1991) evidential decision theory of voter turnout also assumes that voters engage in magical thinking in that they believe other supporters of their candidate of choice will be more likely to vote if they voted (thereby leading to their candidate's victory) and the fellow supporters will be less likely to vote if they didn't vote (thereby leading to their candidate's loss). Grafstein's voters therefore perceive an illusory correlation between their present behavior (voting vs. abstention in the current election) and the simultaneous behavior of other voters (*their* voting or abstention). My voters perceive an illusory correlation between their *past* behavior (voting vs. abstention in the last election) and the past electoral outcomes. In this sense, Grafstein's voters are still looking forward (albeit diagnostically rather than causally), while my voters are looking backward. Further, my model is a modification of the original calculus of voting model, while Grafstein works completely outside of it.

The rates at which p and D respond to collective action outcomes are different, however, because the instrumental learning (changes in p) occurs faster than normative learning (changes in D). If a citizen votes for a candidate who wins the election, then both her instrumental and normative behavior are reinforced and she becomes somewhat more likely to vote again in the next election because her p and D are both larger now than before. If a citizen votes for a candidate who loses the election, then both her instrumental and normative behavior are punished. However, the former is quicker to respond to the punishment than the latter, and while the pragmatist in her immediately becomes somewhat less likely to vote again in the next election, the normativist in her might still choose to vote out of habit or attachment to the norm of civic duty. It would take a longer series of punishers for the normativist to stop voting. After one failed collective action, she becomes somewhat less likely to vote than had her collective action succeeded, but not as much as if voting was purely instrumental, with no normative components.

The converse is true of nonvoters. If a citizen doesn't vote, and her candidate of choice wins the election, then both her instrumental and normative behavior are reinforced and she becomes somewhat less likely to vote in the next election because her p and D are now smaller than before. If a citizen doesn't vote, and her candidate of choice loses the election, then both her instrumental and normative behavior are punished. However, the former is quicker to respond to the punishment than the latter, and while the pragmatist in her immediately becomes somewhat more likely to vote in the next election, the normativist in her lags behind and still might not want to vote because her attachment to the prosocial norm of civic duty has been considerably weakened by a long history of past reinforcement contingency. It would take a longer series of punishers for the normativist to (re)build a strong attachment to the prosocial norm. After one failed collective action, she becomes somewhat more likely to vote than had her collective action succeeded without her voting, but not as much as if voting was purely instrumental.

Formally, I redefine the D term as:

$$D_{i+1,j} = D_{ij} + k\{[O_{ij}(D_{ij})C_{ij}] - [O_{ij}(D_{ij})(1 - C_{ij})]\} \qquad (3)$$

where D_{ij} is individual j's magnitude of normative attachment to voting prior to the ith election, O_{ij} and C_{ij} are as defined in Equation (2), and k varies between 0 and 1 and sets the rate of learning, which is always slower for normative behavior than for instrumental behavior (and hence $k < 1$).

The logic of the stochastic learning model of voter turnout thus leads to the following complementary hypotheses:

H_1 (vote $\times$ win $\rightarrow$ + +): *Individuals who vote for the winning candidate at time t_0 will be significantly more likely to vote at time t_1.*

H_2 (vote $\times$ lose $\rightarrow$ +): *Individuals who vote for the losing candidate at time t_0 will be less likely to vote at time t_1 than those who vote for the winning candidate, but still more likely to vote than those who do not vote at time t_0.*

H_3 (nonvote $\times$ lose $\rightarrow$ −): *Individuals who do not vote but support a losing candidate at time t_0 will be more likely to vote at time t_1 than those who do not vote but support a winning candidate, but still less likely to vote than those who vote at time t_0.*

H_4 (nonvote $\times$ win $\rightarrow$ − −): *Individuals who do not vote but support a winning candidate at time t_0 will be significantly less likely to vote at time t_1.*

I do not argue that stochastic learning is the *sole* determinant of voter turnout. Factors unrelated to stochastic learning, such as the perceived closeness of contest (Berch 1993; Matsusaka 1993), weather (Knack 1994; Merrifield 1993; Radcliff 1994), and campaign expenditure (Aldrich 1993) all contribute to the aggregate levels of turnout. My stochastic learning theory is therefore unable to predict the aggregate levels of voter turnout by itself; it is a partial theory that only predicts and explains the *marginal* effects of past reinforcement and punishment on the *individual* tendency to vote in the next election. It also provides a possible solution to the paradox of voter turnout by showing why it is rational for a large number of people to vote.

Empirical Results

Data

I use the 1972-74-76 panels of the American National Election Study, conducted by the Center for Political Studies (CPS) at the University of Michigan. A nationally representative sample of respondents ($N = 1,320$) was interviewed five times: before and after the 1972 presidential election, after the 1974 midterm election, and before and after the 1976 presidential election. Respondents were asked, among a large number of other questions, whether or not they voted in each of the three elections. Their binary responses to these questions serve as the measures of their *self-reported* voting. Further, to the best of its abilities, the CPS also validated their verbal report of voting behavior, by checking the official voting record in each respondent's precinct. These official records serve as the measures of the respondent's *validated* voting. I estimate two logistic regression equations using both self-reported and validated voting, for each of the three elections.

It is extremely unfortunate that I must use data from the early 1970s, given how unusual and atypical the period was in the history of American politics, with Watergate and Vietnam. In particular, the interviews for the 1974 panel took place shortly after the sitting President of the United States resigned under the threat of impeachment for the first time in American history. This monumental

event may have influenced the respondents' voting behavior in unknown ways. However, I must nonetheless use these data because *they are the only available panel data on three consecutive national elections with vote validation.* The earlier panels of the American National Election Study (1956-58-60) did not include vote validation. There have not been panel data collected on consecutive national elections since the early 1970s.[10]

1976 Presidential Election

Table 1 presents the results of logistic regression equations predicting the respondents' voting in the 1976 presidential election. All respondents are classified into one of four categories: (1) those who voted for the winner (Nixon) in the 1972 presidential election; (2) those who voted for a loser (McGovern, Schmitz, or other minor candidates) in the 1972 presidential election; (3) those who did not vote in the 1972 presidential election but supported the winner; and (4) those who did not vote in the 1972 presidential election but supported a loser.[11] (At the 1972 preelection interview, conducted a few days before the election, all respondents were asked which presidential candidate they supported. I use the response to this question to measure which candidate the nonvoters supported.)

The four stochastic learning predictors show the effect of being in one of these categories on the likelihood of voting. These are deviation coefficients, and the categories are *not* dummy variables. Each deviation coefficient shows the effect of being in a given category *relative to the mean of all four categories.*[12] I include variables to control for prior voting behavior (before 1972), party

[10] I must note two other potential weaknesses of the data. First, some of my analyses rely on retrospective data, where respondents recall in 1972 who they voted for in 1968. Such retrospective data may be unreliable, especially given some evidence of the "bandwagon effect" where nonvoters claim to have voted for the winning candidate (Traugott and Katosh 1979, 366). Second, all of my conclusions derive from the analysis of validated data, rather than self-reported data. While the validated data obviously correct for misreporting, the process of validation may introduce a bias of its own to the extent that it is not perfect.

[11] I use the 1972 presidential election as time t_0, instead of the 1974 midterm election, to predict voting in 1976 (at time t_1) because, theoretically, it is difficult to decide what constitutes winning and losing in midterm elections. If one's gubernatorial candidate wins but senatorial candidate loses, does that count as winning or losing? While many citizens still vote for governors, senators, representatives, and other offices and propositions in presidential elections, there is a clear focus on the presidential contest and thus it justifiably counts as a win (a reinforcer) if one's presidential candidate wins, no matter what the outcomes of lesser contests. There is some evidence that the presidential race dominates other races in presidential election years (Merrifield 1993, 665n.).

[12] This is the default method of computing the effects of categorical variables for logistic regression in SPSS. The coefficient for each category of respondents tells how much more or less likely they are to vote compared to the average of all respondents, which is set to 0. Therefore, the set of coefficients has a unique feature that each coefficient is the negative of the sum of the other three, and the sum of all four is 0. When the coefficients are statistically significant, that means that the given category of respondents are significantly different from the average of all respondents.

TABLE 1

1976 Presidential Election

	Self-Reported Voting	Validated Voting
Stochastic learning predictors		
1972 voters		
for winner	1.128****	.587**
	(.162)	(.195)
for loser	.714****	.298
	(.173)	(.201)
1972 nonvoters		
support winner	−1.079****	−.534*
	(.173)	(.259)
support loser	−.762****	−.351
	(.184)	(.247)
Prior voting behavior		
Past frequency of voting	.524****	.358**
	(.099)	(.125)
Vote in 1968	.353	.036
	(.284)	(.395)
Party ID		
Democrat	.612**	−.236
	(.218)	(.266)
Republican	.154	−.302
	(.264)	(.319)
Demographic controls		
Age	.012	.017*
	(.006)	(.008)
Race	−.660*	−.112
	(.324)	(.344)
Sex	−.072	.025
	(.188)	(.222)
Education	.112**	.014
	(.035)	(.041)
Income	.084****	.113****
	(.020)	(.023)
Constant	−2.646	−1.183
	(.744)	(.902)
−2 log likelihood	789.778	600.806
χ^2 (df = 12)	372.584****	87.866****
Percent correctly classified	85.24	87.71
Number of cases	1,145	903

*$p < .05$; **$p < .01$; ***$p < .001$; ****$p < .0001$

identification, and standard demographic characteristics. (See the appendix for the definitions of control variables.)

If one looks at the respondents' *self-reported* voting behavior, it appears that there are two permanent categories of voters and nonvoters. Those who voted in 1972 are highly significantly (p < .0001) more likely to vote in 1976, regardless of which candidate they voted for in 1972. In contrast, those who did not vote in 1972 are equally significantly less likely to vote, once again regardless of which candidate they supported for the election. Thus, using self-reported voting gives the impression that voters and nonvoters are impervious to the past collective action outcomes.

Inspection of the *validated* voting, however, reveals that this is not the case. Contrary to what the respondents verbally told the interviewers, among the voters, only those who voted for the winner in 1972 are significantly (p < .01) more likely to vote in 1976, and those who voted for the losers are not. However, the coefficient for the latter is still positive, indicating that those who voted for the 1972 losers are still more likely to vote in 1976 than the average citizen. Conversely, among those who did not vote in 1972, only those who supported the winner are significantly (p < .05) less likely to vote, while those who supported the losers are not. However, the coefficient for the latter is still negative, indicating that nonvoters who supported the losers are still less likely to vote than the average citizen.

The analysis of validated voting for the 1976 presidential election thus perfectly supports all the stochastic learning predictions. Those who contributed and won (whose collective action succeeded) are more likely to stay with the same strategy (voting) again.[13] Those who contributed and lost (whose collective action failed) are more likely to shift to the other strategy (nonvoting) than contributors to a successful collective action, but due to normative inertia, they are still more likely to contribute in the future than noncontributors (regardless of which candidate they supported). Those who defected and won are more likely to stay with the same strategy (nonvoting). Those who defected and lost are more likely to shift to the other strategy (voting) than noncontributors who successfully freerode, but, due to normative inertia, they are still less likely to contribute in the future than contributors (regardless of which candidate they supported).

How much difference does stochastic learning alone make for individuals' propensity to vote? Using only statistically significant variables from the validated voting equation in Table 1, a hypothetical 35-year-old person with a family income between $17,000 and $20,000 (the modal category) who has voted in "some" of the presidential elections in the past would have a 94.1% baseline probability of voting in the 1976 presidential election. (This figure is unusually

[13] One of the reasons why those who vote for the winner are more likely to vote again might be that they feel more efficacious (Acock and Clarke 1990; Mirowsky, Ross, and van Willigen 1996). A sense of political efficacy might underlie the process of stochastic learning in the calculus of voting.

high because only positive coefficients are statistically significant in this equation.) This same hypothetical person, however, would have a 96.6% probability of voting if she had voted for Nixon in 1972. Her probability of voting in 1976 would go down to 90.3% if she had supported Nixon but abstained in 1972.

1974 Midterm Election

Table 2 presents the results for the 1974 midterm congressional election. Once again, the use of self-reported voting produces the illusion that there are two permanent categories of voters and nonvoters, and that they are not responsive to the correlation between their individual behavior and the collective action outcomes in the past.

The examination of validated voting once again reveals a different picture, even though the stochastic learning predictions are only partially supported. The 1972 voters seem to be equally likely to vote again in 1974, regardless of which candidate they voted for in 1972. Among the 1972 nonvoters, however, the stochastic learning pattern is apparent. Only those who supported the winner in 1972 are significantly (p < .05) less likely to vote in 1974, while those who supported the loser are not, and thus are more likely to "shift" to the other strategy. The results for the 1974 midterm congressional election thus support H_3 and H_4 only.[14]

Once again, using only statistically significant variables in the validated voting equation, a hypothetical 35-year-old white person with a family income between $17,000 and $20,000 would have a 51.9% baseline probability of voting in 1974. Her probability goes up to 65.7% if she had voted for Nixon in 1972, but goes down to 36.6% if she had supported Nixon but had abstained.

1972 Presidential Election

In their 1972 preelection interview, the respondents were asked if they voted in the 1968 presidential election, and if so, for which candidate. From this information, I was able to compute the stochastic learning status of the respondents after the 1968 presidential election. Unfortunately, the survey did not ask 1968 nonvoters whom they supported or would have voted for, thus I must delete the 1968 nonvoters from my analysis of the 1972 voting. Table 3 presents the logistic regression model of voting in 1972 among the 1968 voters only.

Once again, the use of the self-reported voting as the response variable gives the impression that the 1968 voters are not responsive to the collective action outcome when they decide whether or not to vote in 1972. Whether they voted for the winner (Nixon) or a loser (Humphrey, Wallace, or any of the minor

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[14] My analyses presented in Tables 1 and 2 replicate the recent findings by Presser and Traugott (1992). Education has a significantly positive effect on self-reported voting, but not on validated voting. In other words, the more educated are not more likely to vote, only more likely to lie about it.

TABLE 2

1974 Midterm Election

	Self-Reported Voting	Validated Voting
Stochastic learning predictors		
1972 voters		
for winner	1.045****	.574**
	(.131)	(.189)
for loser	.876****	.538**
	(.141)	(.199)
1972 nonvoters		
support winner	−1.030****	−.624*
	(.203)	(.305)
support loser	−.893****	−.488
	(.179)	(.332)
Prior voting behavior		
Past frequency of voting	.350****	.169
	(.086)	(.119)
Vote in 1968	.801**	.597
	(.273)	(.392)
Party ID		
Democrat	.505**	.167
	(.178)	(.227)
Republican	.313	.235
	(.205)	(.259)
Demographic controls		
Age	.031****	.028***
	(.005)	(.007)
Race	.200	.935**
	(.252)	(.304)
Sex	−.009	−.110
	(.150)	(.191)
Education	.093**	−.022
	(.029)	(.037)
Income	.051**	.040*
	(.016)	(.019)
Constant	−4.936	−2.480
	(.639)	(.833)
−2 log likelihood	1,159.467	738.723
χ^2 (df = 12)	412.513****	75.904****
Percent correctly classified	77.62	77.98
Number of cases	1,211	754

*p < .05; **p < .01; ***p < .001; ****p < .0001

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TABLE 3

1972 Presidential Election

	Self-Reported Voting	Validated Voting
Stochastic learning predictors		
1968 voters		
for winner	−.060	.401*
	(.139)	(.184)
Prior voting behavior		
Past frequency of voting	.914****	.734**
	(.162)	(.242)
Party ID		
Democrat	.330	−.244
	(.288)	(.383)
Republican	.826*	3.115**
	(.374)	(1.044)
Demographic controls		
Age	.019*	−.005
	(.010)	(.014)
Race	−.614	−.366
	(.436)	(.557)
Sex	−.217	−.333
	(.252)	(.354)
Education	.022	−.033
	(.045)	(.063)
Income	.077**	.032
	(.027)	(.036)
Constant	−1.547	1.516
	(1.020)	(1.454)
−2 log likelihood	483.478	260.814
χ^2 (df = 9)	58.277****	37.848****
Percent correctly classified	90.74	92.53
Number of cases	862	562

*$p < .05$; **$p < .01$; ***$p < .001$; ****$p < .0001$

candidates) does not have any significant effect on the 1972 self-reported voting. However, the use of validated voting paints a different picture. Among those who voted in 1968, only those who voted for the winner are significantly ($p < .05$) more likely to vote again in 1972, and those who voted for the losers are not and thus are more likely to shift to the other strategy. The results for the 1972 presidential election thus support H_1 and H_2. A hypothetical Republican who has voted for "some" of the presidential elections in the past would have a 97.9% baseline probability of voting in 1976. Her probability would go up to 98.6% if

she had voted for Nixon in 1968. (Once again, these figures are unusually high due to the large positive effect of being a Republican in this equation.)

Conclusion

My analyses of the 1972-74-76 panel data from the American National Election Study indicate that citizens make decisions whether or not to turn out to vote in a manner consistent with Macy's stochastic learning model of human behavior. Actors seem to be looking backward, not forward, and to make decisions on the basis of whether their prior choice was reinforced or punished. Further, consistent with Riker and Ordeshook's (1968, 1973) calculus of voting model, voting behavior seems to have both instrumental and normative components, and consistent with Macy's theory, the two components seem to respond to reinforcement and punishment differentially. While instrumental behavior responds quickly to each reinforcer and punisher, normative learning takes longer and lags behind. The behavior patterns confirmed in a laboratory experiment (Macy 1995) also manifest themselves in natural settings of voting in large national elections. It is important to note, however, that my empirical analysis in this paper has only established the possible importance of the stochastic learning process for voter turnout. Since I did not simultaneously test other theories of voter turnout along with the stochastic learning model, my empirical analysis has nothing to discount or discriminate among them.

The stochastic learning model provides a potential solution to the paradox of voter turnout. In rational choice theory, actors are conceived to be purposive, and they make choices in order to achieve certain goals. The overriding goal in the collective action of national elections is to elect one's candidate of choice (with the secondary goal of compliance with the norm of civic duty). In the subjective expected utility maximization theory, which forms the basis of Riker and Ordeshook's (1968, 1973) original formulation of the calculus of voting, "success" (the attainment of goals) is to be *causally* decisive in the election of one's candidate in the future (and thus $p \cong 0$). In the stochastic learning model, which underlies my reformulation of the calculus of voting, "success" is to have been *correlationally* associated with the election of one's candidate in the past (and thus $p \cong .500$). With this new definition of p, the calculus of voting model can solve the paradox by showing $pB > C$. The Michigan Election Panel data, which are the only reliable panel data on voting among a nationally representative sample of respondents, indicate that individuals (voters and nonvoters) make their decisions to turn out to vote in a manner consistent with the stochastic learning model (which includes both instrumental and normative components) and a "Win-Stay, Lose-Shift" decision rule. Further and better testing of this theory in natural settings (the theory has already been confirmed in a laboratory experiment) will probably require a more extensive panel study that monitors citizens' turnout choices over a long series of national elections.

It is important to note, however, that the subjective expected utility maximiza-tion theory and stochastic learning model may not necessarily be mutually incompatible. Heckathorn (1996) argues that whether actors are forward-look-ing, backward-looking, or sideways-looking (a third model that he proposes in his article) depends on the nature of available information. If accurate and reli-able information about the future is available, actors will be forward-looking. If the best available information about the future is the past, actors will be back-ward-looking. If the best way to understand the future is to learn how others are doing now, actors will be sideways-looking and learn from successful others in the local population. The same actors can be all three, depending upon what in-formation is available. My claim in this article is therefore *not* that people are always backward-looking and make all of their decisions in ways consistent with Macy's stochastic learning model. My claim instead is that citizens seem to be backward-looking when they decide whether or not to vote in large national elec-tions, and if they are, then the paradox of voter turnout may be solved.

Further, it might be possible to incorporate backward-looking decision mak-ing into the traditional rational choice theory of politics. For instance, the logic underlying my theory of voter *turnout* is similar to that underlying Fiorina's (1981) retrospective theory of voter *choice*. Fiorina argues that voters largely dis-regard the promises that candidates make for the *future,* and instead base their choice between candidates and parties on their *past* performance. There's a sec-ond sense in which voters in Fiorina's theory are similar to those in mine. Fiorina's voters make an *association* between their immediate economic and so-cial situations and the incumbent party, and either reward or punish the party depending upon their personal circumstances. To the extent that even the Presi-dent cannot directly cause every worker to be fired or every crime to be committed, and to the extent that other factors (beyond the President's control) also influence these events, voters' perception of association in retrospective vot-ing is largely illusory, just like their perception of association between voting for their candidate and the electoral outcome in my theory of voter turnout. One of the next theoretical challenges, therefore, is to integrate a theory of voter turnout with that of voter choice.

Appendix

Control Variables

Prior Voting Behavior

PAST FREQUENCY OF VOTING. How often respondents have voted in presidential elections since they have been old enough to vote, before 1972 (3 = all, 2 = most, 1 = some, 0 = none)

VOTE IN 1968. Whether they voted in the 1968 presidential election (1 = yes)

Party ID

DEMOCRAT. 1 = if respondent identifies self as a Democrat; 0 = otherwise

REPUBLICAN. 1 = if respondent identifies self as a Republican; 0 = otherwise

Demographic Controls

AGE. Chronological age

RACE. 1 = if white; 0 = otherwise

SEX. 1 = female; 0 = male

EDUCATION. Years of formal education, from 1 = first grade to 17 = more than four years of college

INCOME. Family income, in 20 ordinal categories, from 0 = less than $2,000 to 20 = $35,000 and over

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