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### A Psychologically-Based Model of Voter Turnout

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#### Abstract

We analyze a psychologically-based model of voter turnout. Potential voters experience regret if they fail to vote, which is the motivation for participation in voting. Regret from abstention is inversely related to the margin of victory. Voters on the winner's side experience less regret than those on the loser's side. We show that the unique equilibrium involves positive voter turnout. We show that the losing side has higher turnout. In addition, voter turnout is positively related to importance of the election and the competitiveness of the election. We also consider scenarios in which voters are uncertain about the composition of the electorate's political preferences and show similar phenomena emerge.

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# 1 Introduction

CBS News and the New York Times conducted a poll of 1720 Americans during November 10-12, 2007 and found that 55% of those who did not vote regretted not voting in the 2000 US presidential election.<sup>1</sup> In France, following the surprising elimination of the socialist candidate Lionel Jospin at the hands of the far-right anti-immigration candidate Jean-Marie Le Pen in the first round of the 2002 French presidential election, many French voters regretted their decision not to vote.<sup>2</sup> Clearly, in these elections, each individual voter's decision would not have affected the outcome of the election, yet voters who did not vote experienced regret afterwards. In this paper, we maintain that psychological payoffs are an important force in determining voting behavior. We posit that voters who do not vote in elections suffer regret and this ultimately provides an incentive to vote in elections.

The question of why people vote in large elections is one that has occupied the minds of political scientists and economists alike. The initial idea of the “rational voter paradox” is contained in the celebrated work of Downs (1957). If voting is costly and the only motivation for people to vote is to affect the outcome of the election, then they should never vote. The reason is that, in large elections, the probability that any single voter can affect the outcome of the election is infinitesimal. However, observed turnout rates are quite high. Since Downs, there have been many attempts to explain this paradox. In our opinion, a satisfactory theoretical model has to be able to achieve three goals. First, it must explain significantly positive turnouts as equilibrium behavior in large elections. Second, it must account for other frequently observed empirical facts; for example, the positive correlation between turnout and the perceived competitiveness of elections. Lastly, it must be parsimonious so that the model can be enriched to study other interesting issues in large elections, for example, candidates' political positioning.

In this paper, we explain voter turnout by introducing voter regret. We study an election with two candidates, each with a group of supporting voters. Voters who fail to vote in an election experience regret. The magnitude of a voter's regret depends on whether or not his preferred candidate wins the election and on the margin of victory. The smaller the margin of victory, the higher is the regret suffered by any voter who does not vote. Moreover, for any fixed margin of victory, a voter who supports the losing candidate has higher regret than one who supports the winning one. We call this assumption “winner regrets less.” A potential voter votes if and only if his cost of voting is less than the expected regret he would suffer after the election if he did not vote.

Our model is a departure from the strictly “rational” model, in which the only incentive for voting is to affect the outcome. With a continuum of voters in our model, the probability of any voter being pivotal is zero. Another common approach to explaining voter turnout is to assume that voters derive utility from participation in elections, either because of self-

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<sup>1</sup> *CBS News*, November 13, 2000. Since it was a national poll, many of these voters reside in states where the election result was not in dispute.

<sup>2</sup> *Financial Times*, London, May 4, 2002, pg. 09.

expression or a sense of civic duty. We neither dispute the plausibility of such concerns nor rule them out from our model. However, we enhance them with a psychological factor with intuitive appeal.

Here, we provide a short justification for our assumptions about voter regret, and we provide in Section 6 a detailed discussion of the concept of regret in our model. In our model, voters feel regret if they do not vote because failure to vote is viewed negatively in a democratic society. It is conceivable that such negative (self-)perception is especially strong when the election is close or when a voter's favored candidate loses the election. One possible interpretation is that ethical voters are empathetic towards those that belong to the same political group. Thus, an ethical voter thinks that if he does not vote he will disappoint his peers or his favored candidate.<sup>3</sup> Such regret becomes more poignant when the election result is close because the psychological effect of the letdown is stronger. This is also consistent with the anecdotal observation that voter apathy is contagious.

Assuming a decreasing density function for the distribution of the cost of voting, we show that there exists a unique equilibrium with a positive level of turnout. We account for consistently observed empirical facts, namely, that turnout is higher for the minority side, that it is positively correlated with the perceived closeness of the election, and that it is positively correlated with the importance of the election.<sup>4</sup> We also allow voters to be uncertain about the composition of the electorate's political preferences, and derive similar results.

In our model, a voter participates in an election because he anticipates that he will experience regret if he does not. The voting equilibrium in our model is a margin of victory and turnout levels for the two groups that are consistent with each other. First, an *anticipated* margin of victory determines a cost threshold for each group, such that voters with voting cost below those thresholds vote in the election, and thereby determine the turnout for each group. Conversely, each pair of turnout levels determines a *resulting* margin of victory. Consistency requires the anticipated margin of victory and the resulting margin of victory to be the same. The first condition requires that turnouts decrease as the margin of victory increases, since regret is inversely related to the margin of victory. On the other hand, the second condition causes margin of victory to increase as turnouts increase, given our "winner regret less" assumption and the decreasing density function of the cost distribution. Therefore, there is a unique voting equilibrium.

There is a natural intuition behind the comparative statics results. First, lower turnout for the winning side is simply implied by the fact that winning voters regret less about not voting. Second, as the election is perceived to be closer, fixing turnout levels, the anticipated winning margin is going to be smaller. By our "winner regrets less" assumption and the decreasing density function of the cost distribution, an increase in turnout would cause the winning margin to increase. Thus, the equilibrium turnout must increase to

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<sup>3</sup>An ethical voter may also feel regret about not voting because this contributes to making himself an apathetic person. This is reminiscent of arguments made by Frank (1988) (Ch. 11, "Human Decency.").

<sup>4</sup>See, for example, Blais (2000) and Coate and Conlin (2004).

restore consistency. Finally, as the election becomes more important, given the same winning margin, both turnouts will increase, causing the equilibrium turnout to increase.

The rest of the paper is organized as follows. Section 2 discusses the related literature. Section 3 introduces the model of voting with regrets. Section 4 characterizes the equilibrium and analyzes how voter turnout varies with various factors. Section 5 introduces an example in which there is uncertainty about the voter population. Section 6 discusses the concept of regret in our model and its relation to the existing literature. Section 7 concludes and discusses possible extensions.

## 2 Related Literature

In this section, we discuss the relationship of our paper to the literature on voter turnout. In Section 6, we discuss the concept of regret that we use in our model.

Since the work of Downs, there has been a large literature seeking to explain voter turnout in large elections. Starting with Tullock (1968), much of the early work uses decision theoretic models. An important and controversial paper in this literature is by Ferejohn and Fiorina (1974). They assume voters make participation decisions not according to expected utility, but via minimax regret. They show that under some condition on the cost parameter, a voter’s decision to vote for his most preferred candidate corresponds to minimizing the maximum regret. Their approach has been criticized in relation to the validity of minimax regret as a choice criterion.<sup>5</sup>

Riker and Ordeshook (1968), in a classic paper, analyze a decision theoretical model of voter participation in which voters receive a civic duty payoff  $D > 0$  from voting for their preferred candidate. Our model is close in spirit to theirs. One can reinterpret regret in our model as a (negative) payoff that the agents receive for not voting for their preferred candidate. A key difference is that the civic duty payoff in their model is (fittingly) not dependent on the election outcome, while voter regret in our model is. This causes our models to have different comparative statics. For example, in Riker and Ordeshook’s model, turnout level is independent of the relative size of the minority. By contrast, our model predicts that turnout is higher for the minority than for the majority and yet the majority’s preferred candidate wins. Moreover, turnout progressively diminishes as the size of the minority goes down.

Also closely related to our work are papers by Feddersen and Sandroni. Feddersen and Sandroni (2006c) introduce the basic two-candidate model of election while Feddersen and Sandroni (2006a) and (2006b) further develop it. In their model, there are both ethical and nonethical voters. The former are called “rule-utilitarians” in the spirit of Harsanyi (1980), who derive a positive payoff from taking the ethical action, namely the one that is called for by the minimization of the social cost of voting. This has two implications. First, which action is ethical for a voter depends on the equilibrium aggregate behavior of other

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<sup>5</sup>For a sample of such criticisms, see Beck (1975), Mayer and Good (1975), and Tullock (1975).

voters. Second, abstention, rather than voting, may give a voter an ethical payoff. These two features are in stark contrast to Riker and Ordeshook's and our models, where voters' ethical concerns are "private" in that voting is always the ethical action to take, regardless of other voters' choices. Feddersen and Sandroni (2006c) impose a consistency condition on the behavior of the agents and look for consistent behavior profiles. The fractions of voters (both in the majority and in the minority group) who take the ethical action are random variables. In contrast, the voters in our model are all ethical and our equilibrium construction works regardless of whether voters are certain about the composition of voter preferences for candidates. Moreover, in their model ethical voters care about aggregate voting costs (rather than voting costs of their own group), and their comparative statics results depend on this assumption. By contrast, in our model each voter cares only about his own cost. In short, our model has similar comparative statics to theirs but is more parsimonious with different theoretical justification.

Thus, our paper can be put in the broad category of research that uses "ethical-voter" models. The survey on political economy by Merlo (2006) contains a concise discussion of various voter turnout models.<sup>6</sup>

The first game-theoretical papers on voter turnout use the so-called pivotal-voter model. Examples include work by Ledyard (1982), Palfrey and Rosenthal (1983) (1985), and Myerson (1998). The main conclusion of this literature is that in large elections turnout must be extremely low.

According to the classification proposed by Merlo (2006),<sup>7</sup> in addition to the pivotal-voter and ethical-voter models, there is a third category: the uncertain-voter model, in which turnout is related to voters uncertainty about who is the best candidate. In all such models (e.g., those of Feddersen and Pesendorfer (1996), Matsusaka (1995), Degan (2006), and Degan and Merlo (2007)), the possibility of voting for the wrong candidate engenders a cost and therefore uncertain voters may prefer to abstain. In the models of Degan (2006) and Degan and Merlo (2007), there is a continuum of voters. Thus the cost is not instrumental but psychological, similar in spirit to our model.

Recently, there has been some interesting work that empirically or experimentally tests voting models, including papers by Coate and Conlin (2004), Coate, Conlin, and Moro (2008), Degan and Merlo (2007), and Levine and Palfrey (2007).

### 3 The Model

Two candidates,  $A$  and  $B$ , compete for one position in an election. Correspondingly, there are two types of voters:  $A$ -voters and  $B$ -voters. Each voter favors the candidate that bears

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<sup>6</sup>See also Aldrich (1993), Feddersen (2004), and Dhillon and Peralta (2002).

<sup>7</sup>Another branch of literature explains voter turnout as the result of mobilization by group leaders. See Uhlaner (1989), Morton (1991), and Shachar and Nalebuff (1999). They do not explicitly model why, however, leaders are able to influence voters' decisions. We believe that they, at least partly, achieve it by intensifying voters' psychological response.

the same label as his own. Voters are uniformly distributed on the interval  $[0, 1]$ , with  $A$ -voters occupying  $[0, \alpha]$  and  $B$ -voters occupying  $(\alpha, 1]$ . We assume

$$\alpha > \frac{1}{2}.$$

Let  $\eta > 0$  be the difference in utility for a voter between when his favored candidate gets elected and when the opposing candidate gets elected. So,  $\eta$  can be interpreted as the importance of the election.

Let  $c$  be the cost of voting, a random variable that is distributed on  $[0, +\infty)$  according to the same distribution function  $F$  and corresponding density function  $f$  for both  $A$ - and  $B$ -voters. The parameters  $\alpha$ ,  $\eta$ , and  $F$  are common knowledge among voters.

A voter incurs regret when he fails to vote or votes for the opposing candidate. We assume the voter's *absolute regret function*,  $R : [-1, 1] \times \mathbb{R}_+ \rightarrow \mathbb{R}_+$ , takes the form

$$R(m, \eta) = \eta r(m),$$

where  $m \in [-1, 1]$  is the margin of victory for the voter's favored candidate ( $m < 0$  means that the candidate loses), and  $r$  is the *relative regret function*, or simply the *regret function*. Note that absolute regret is simply relative regret scaled up by  $\eta$ , the importance of the election.

We make the following assumptions about the regret function,  $r$ .

**Assumption 1.** The regret function  $r$  is nonnegative, continuously differentiable except possibly at  $m = 0$ , strictly increasing for  $m < 0$ , and strictly decreasing for  $m > 0$ .

For clarity of exposition, we separate the regret function into two parts:  $r_- : [-1, 0] \rightarrow \mathbb{R}_+$  and  $r_+ : [0, 1] \rightarrow \mathbb{R}_+$ . These are defined by

$$\begin{aligned} r_-(m) &= r(m) \text{ for } m < 0; \\ r_+(m) &= r(m) \text{ for } m > 0; \\ r_-(0) &= \lim_{m \rightarrow 0^-} r(m); \\ r_+(0) &= \lim_{m \rightarrow 0^+} r(m). \end{aligned}$$

The following assumption is crucial to the results of our paper.

**Assumption 2.** (*Winner regrets less.*) The regret function  $r$  satisfies:

- a.  $r_-(0) \geq r_+(0)$ ;
- b.  $\frac{r'_-(-m)}{-r'_+(m)} < 1$  for all  $m > 0$ .

The first part of the assumption says that when an abstaining voter’s favored candidate loses by an arbitrarily small margin, his regret is higher than that if his favored candidate wins by an arbitrarily small margin. The second part can be interpreted as: “when the margin of victory increases by a small amount, the decrease in regret for an abstaining voter on the winner’s side is more than that if he were on the loser’s side”. In other words, “a winner gets complacent more easily”. These two parts imply

$$r_+(m) < r_-(-m)$$

for all  $m > 0$ , hence the phrase “winner regrets less.”

*Remark.* The assumption that an abstaining voter experiences regret even if his favored candidate wins may appear controversial. We offer the following justification. First, in our model, ethical concerns affect voters’ voting decisions through a psychological mechanism. We believe that in democratic societies the dominant ethical concerns induce, rather than discourage, voter participation. Abstention is inherently an act to be regretted. Accordingly, in our model, voter regret is experienced by, and only by, voters who abstain, even if their favored candidate wins the election. Second, although for parsimony we focus on *negative* payoffs associated with *not voting*, we may also allow *positive* payoffs associated with *voting*. In addition to Riker and Ordeshook’s civic-duty payoff, which is independent of the election outcome, we believe it is plausible that there exists “elation” from voting and winning the election. Further, such elation is stronger for elections that are closer.<sup>8</sup> Elation from participation and regret from abstention are technically equivalent if these are both decreasing in the winning margin. Finally, in Example 2 of Section 5, we show that when voters are uncertain about the political composition of the electorate, it is possible that our equilibrium construction still works, even if abstaining voters on the winning side do not feel regret.

## 4 Equilibrium

We look for equilibria of the model defined as follows.

**Definition 1.** A *voting equilibrium* is a profile of strategy and beliefs that satisfies:

- a. each voter forms Bayesian beliefs about the result of the election;
- b. based on these beliefs, each voter chooses to vote or not based on the expected utility of these two alternatives;

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<sup>8</sup>Tideman (1985) argues that an abstaining voter should feel strong remorse and a participating voter strong elation, *when his vote is pivotal*. In order for such psychological payoffs to impact voting behavior, they would have to be of comparable magnitude to the actual difference between candidates. Schuessler (2000) advocates a theory of expressive choice by voters. He argues that expressive utility from voting for a particular candidate should be endogenously determined by how many voters vote for the same candidate. He also briefly discusses political campaigns’ tactic in exaggerating the potential regret from abstention.

c. the candidate with a majority of the votes wins.

Now we consider voters' decisions. Note that for an  $I$ -voter,  $I \in \{A, B\}$ , voting for  $I$  dominates voting for  $I$ 's opponent as he would suffer regret for doing so. By voting for his favored candidate, he receives a payoff of

$$-c.$$

The reason is that the probability of any agent's vote affecting the outcome is zero as we have a continuum of voters.

A voter's expected payoff from not voting is

$$-\eta E(r(m)).$$

Therefore, a voter chooses to vote if and only if

$$-c \leq -\eta E(r(m)) \quad \text{or} \quad \eta E(r(m)) \geq c. \quad (1)$$

This implies that if an  $I$ -voter ( $I = A, B$ ) of cost  $c$  finds it optimal to vote, then another  $I$ -voter of cost  $c' < c$  must also find it optimal to vote. Therefore, the equilibrium can be characterized by two cutoff cost values for each group of voters,  $c_A$  and  $c_B$ . Note that candidate  $I$ 's *margin of victory* is equal to the difference between the number of voters voting for candidate  $I$  and the number of those voting for his opponent,  $-I$ . Let  $\tau_A$  and  $\tau_B$  be the turnouts for each type of voters. Thus, candidate  $A$ 's margin of victory is

$$m_A = \alpha \tau_A - (1 - \alpha) \tau_B.$$

Thus, the equilibrium is characterized by the following equations:

$$\tau_A = F(c_A), \quad (2)$$

$$\tau_B = F(c_B), \quad (3)$$

$$c_A = \eta r(\alpha \tau_A - (1 - \alpha) \tau_B), \quad (4)$$

$$c_B = \eta r((1 - \alpha) \tau_B - \alpha \tau_A). \quad (5)$$

The following lemma states that the candidate with a higher proportion of supporters,  $A$ , wins the election.

**Lemma 1.** *In equilibrium, voters on the winner's side must have a lower turnout. Hence,  $A$  must win the election in equilibrium.*

*Proof.* The first statement is a direct consequence of Assumption 2. A voter on the winner's side has lower regret. Therefore, the cutoff cost value for the winner's side must be lower, which implies lower turnout since both types have the same cost distribution,  $F$ .

The second statement is implied by the first. Since  $\alpha > \frac{1}{2}$ , in order for  $B$  to win,  $B$ -voters must have a higher turnout than  $A$ -voters, which contradicts the first statement.  $\square$



Note that the above discussion is conditional on the existence of an equilibrium, to which we turn now. As we know  $A$  wins the election in equilibrium, let  $m$  be the winning margin by  $A$ . From equations (4) and (5), we have

$$\tau_A = F(\eta r(m)), \quad (6)$$

$$\tau_B = F(\eta r(-m)), \quad (7)$$

$$m = \alpha \tau_A - (1 - \alpha) \tau_B. \quad (8)$$

A triple  $(\tau_A, \tau_B, m)$  constitutes a voting equilibrium outcome if and only if it is a solution to (6), (7), and (8). Together, they imply

$$m = \alpha F(\eta r(m)) - (1 - \alpha) F(\eta r(-m)). \quad (9)$$

An  $m$  that satisfies the above equation uniquely determines a voting equilibrium outcome.

Denote by  $\mu(\cdot)$  to denote the function defined by the right hand side of (9).<sup>9</sup>

The right hand side of (9) can be interpreted as the *resulting* winning margin by candidate  $A$  given that  $A$ -voters with voting costs lower than or equal to  $\eta r(m)$  vote in the election and  $B$ -voters with voting costs lower than or equal to  $\eta r(-m)$  vote in the election. Thus, an equilibrium winning margin  $m$  is a fixed point of the function  $\mu(\cdot)$ .

We make the following assumption to guarantee the existence of an equilibrium.

**Assumption 3.**  $\alpha F(\eta r_+(0)) - (1 - \alpha) F(\eta r_-(0)) > 0$ .

Intuitively, the assumption requires that when the winning margin is arbitrarily close to zero, the voters on the majority side who prefer voting to abstention will outnumber such voters on the minority side. That is, the majority voters will not be so complacent as to make the election outcome go the other way. Mathematically, taking  $\alpha$  and  $F$  as fixed, this assumption requires that the discontinuity of  $r$  at 0 cannot be too severe.<sup>10</sup> In particular, if  $r$  is continuous at 0, then this assumption is satisfied as  $\alpha > \frac{1}{2}$ .

**Theorem 1.** *Given Assumptions 1, 2, and 3, there exists at least one voting equilibrium.*

*Proof.* We show this by applying the intermediate value theorem to (9).

First, by Assumption 1, both sides of (9) are continuous functions of  $m$ .

Second, when  $m = 0$ , the right hand side of (9),  $\mu(m)$ , is positive by Assumption 3. Therefore,  $m < \mu(m)$  at  $m = 0$ .

Third, let  $m = \alpha$ . Then,

$$\mu(m) \leq (2\alpha - 1)F(\eta r(m)) \leq 2\alpha - 1 < \alpha,$$

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<sup>9</sup>Note that  $\mu$  is a function of  $\alpha$ ,  $\eta$ ,  $F(\cdot)$ , and  $m$ . However, whenever without confusion, we treat it as only a function of  $m$ . In this sense, an  $m$  satisfying (9) is a fixed point of  $\mu$ .

<sup>10</sup>We make this assumption here to guarantee the existence of an equilibrium, as we have an essentially deterministic model. We show in Section 5, however, we do not need this assumption when there is uncertainty about  $\alpha$ .

where the first inequality is implied by Assumption 2 and the third inequality by  $\alpha > \frac{1}{2}$ . Therefore,  $m > \mu(m)$  at  $m = \alpha$ .

Using the intermediate value theorem, we conclude there exists  $m \in (0, \alpha)$  such that  $\mu(m) = m$ .  $\square$

The uniqueness of equilibrium is not guaranteed with the given set of assumptions. The following is a sufficient condition.

**Assumption 4.** The density function of the cost distribution,  $f$ , is non-increasing.

A rough interpretation of Assumption 3 is that voters with low costs are more populous than those with high costs.

**Theorem 2.** *Given Assumptions 1 through 4, equilibrium is unique.*

*Proof.* Consider (9). To show uniqueness of equilibrium, it suffices to show its right hand side,  $\mu(m)$ , is non-increasing in  $m$ .

To see this, observe that

$$\mu'(m) = \alpha f(\eta r(m)) \eta r'_+(m) + (1 - \alpha) f(\eta r(-m)) \eta r'_-(-m), \quad (10)$$

which we conclude to be negative by Assumptions 2 and 4 and  $\alpha > \frac{1}{2}$ .  $\square$

To understand the argument for uniqueness, note that in equilibrium candidate  $A$  wins the election and that the winning margin  $m$  uniquely determines the equilibrium. Let us consider an alternative equilibrium with a lower winning margin for  $A$ . Thus, the turnouts of  $A$ -voters and  $B$ -voters should both increase. However, since the corresponding cutoff cost level for  $B$ -voters is higher than that for  $A$ -voters (Assumption 2) and the density of high-cost voters is lower (Assumption 4), since the cutoff level for  $B$ -voters increases at a slower rate than that for  $A$ -voters (Assumption 2), and since  $B$ -voters are less populous, this will cause  $A$ 's winning margin to rise, contradicting our stipulation that the winning margin falls. We can derive a similar contradiction if we try to find an equilibrium with a higher winning margin. Thus, there is only winning margin that ensures the resulting turnouts produce exactly the same winning margin, or the turnouts and winning margin are “mutually consistent.”

Figure 1 demonstrates the determination of the equilibrium winning margin when Assumptions 2, 3, and 4 are satisfied.

The following lemma makes explicit the relationship between turnout and margin of victory in equilibrium as an implication of properties of the regret function.

**Lemma 2.** *Fix the importance of the election,  $\eta$ , the regret function,  $r$ , and the cost distribution,  $F$ . In equilibrium, turnouts for  $A$ - and  $B$ -voters,  $\tau_A$  and  $\tau_B$ , are inversely related to the winning margin,  $m$ .*

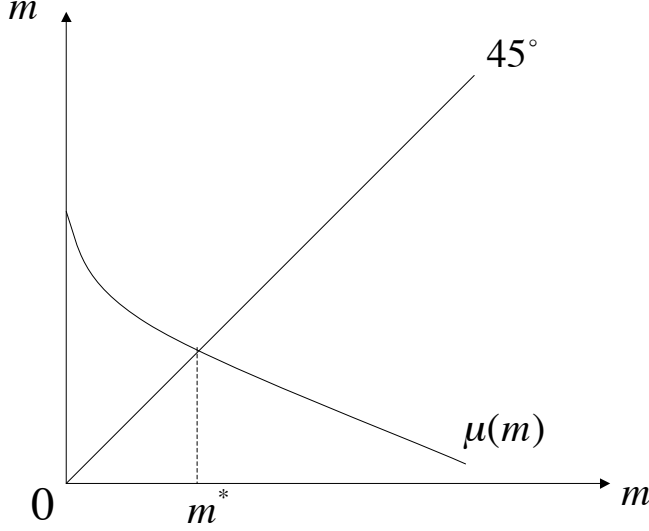


Figure 1: The determination of the equilibrium winning margin by  $A$ . The function  $\mu$  maps from an anticipated margin to a resulting margin.

*Proof.* This is simply a consequence of the equilibrium equations, and the properties of the regret function,  $r$ .  $\square$

Note that the turnouts in the above lemma is the within-group turnout, not the total turnout of all voters. The lemma states that if a change in parameter values causes the turnout in  $A$ -voters (or  $B$ -voters) to rise, it must also cause the winning margin to drop.

We now turn to comparative statics of turnouts with respect to various aspects of the election. First, turnouts are inversely related to the dominance of the majority, or positively related to the competitiveness of the election.<sup>11</sup>

**Theorem 3.** *Turnouts for  $A$ - and  $B$ -voters,  $\tau_A$  and  $\tau_B$ , are decreasing in  $\alpha$ . Furthermore, the total turnout,  $\tau = \alpha\tau_A + (1 - \alpha)\tau_B$ , is also decreasing in  $\alpha$ .*

*Proof.* We show that the equilibrium turnout,  $m$ , increases as  $\alpha$  increases. Then, by Lemma 2, both  $\tau_A$  and  $\tau_B$  are decreasing in  $\alpha$ .

As we have seen in the proof of Theorem 2, the right hand side of (9),  $\mu(\cdot)$ , is strictly decreasing in  $m$ . Note also the left hand side of (9) does not depend on  $\alpha$ . In addition,

$$\frac{\partial \mu}{\partial \alpha} = \tau_A + \tau_B > 0.$$

<sup>11</sup>One need use caution in interpreting this result. As Lemma 2 states, the *equilibrium* turnout is inversely related to the *equilibrium* winning margin, or the *realized* lopsidedness of the election. However, it is not immediately clear that the *ex ante* lopsidedness of the election will translate into *realized* lopsidedness. Theorem 3 shows that such translation does occur. Thus, it is appropriate to interpret the theorem as saying turnouts decrease with the *perceived* lopsidedness of the election. See also Corollary 6.3 in Section 5.

A direct application of the implicit function theorem gives us the desired conclusion. In fact,

$$\frac{dm}{d\alpha} = -\frac{\tau_A + \tau_B}{\mu'(m) - 1},$$

which we conclude to be positive, as the denominator is negative and the numerator positive.

We now turn to how the total turnout,  $\tau = \alpha\tau_A + (1 - \alpha)\tau_B$ , varies with  $\alpha$ . We have

$$\frac{d\tau}{d\alpha} = \tau_A - \tau_B + \alpha \frac{d\tau_A}{d\alpha} + (1 - \alpha) \frac{d\tau_B}{d\alpha}.$$

First, observe  $\tau_A < \tau_B$  in equilibrium by Lemma 1. Second, both  $d\tau_A/d\alpha$  and  $d\tau_B/d\alpha$  are negative. Thus, we may conclude

$$\frac{d\tau}{d\alpha} < 0. \quad \square$$

Theorem 3 states that within-group turnouts must decrease as the winning side becomes more dominant, or the level of disagreement among all voters becomes lower. As the dominance of majority increases, the resulting winning margin at a given level of turnout for  $A$ -voters is higher. Thus, the equilibrium turnout has to decrease to restore the consistency between turnout and winning margin. In the meantime, the total turnout also decreases, as the turnouts for both groups are lower and more weight is put on the low-turnout group, the  $A$ -voters.

Our next result concerns the relationship between turnouts and the importance of the election.

**Theorem 4.** *Turnouts for  $A$ - and  $B$ -voters,  $\tau_A$  and  $\tau_B$ , are increasing in the importance of the election,  $\eta$ . In addition, the total turnout,  $\tau$ , is also increasing in  $\eta$ .*

*Proof.* We discuss  $\tau_A$  only, as the argument for  $\tau_B$  is similar. From (6), we have

$$\frac{d\tau_A}{d\eta} = f(\eta r(m)) \left( r(m) + \eta r'_+(m) \frac{dm}{d\eta} \right).$$

Consider again (9). Its left hand side does not depend on  $\eta$ . But derivative of the right hand side with respect to  $\eta$  can be written

$$\frac{\partial \mu}{\partial \eta} = \alpha f(\eta r(m)) r(m) - (1 - \alpha) f(\eta r(-m)) r(-m).$$

Applying the implicit function theorem to (9), we have

$$\frac{dm}{d\eta} = -\frac{\partial \mu / \partial \eta}{\mu'(m) - 1}.$$

Using (10), we have

$$\frac{d\tau_A}{d\eta} = \frac{\eta(1-\alpha)f(\eta r(-m))[r(m)r'_-(-m) + r(-m)r'_+(m)] - r(m)}{\mu'(m) - 1}.$$

Assumption 2 implies the first term in the numerator is negative. Since  $\mu'(m) < 0$  as we have shown in the proof of Theorem 2, we conclude  $d\tau_A/d\eta > 0$ . Similarly,  $d\tau_B/d\eta > 0$ . Combining these, we have  $\tau = \alpha\tau_A + (1-\alpha)\tau_B$  also increases in  $\eta$ .  $\square$

Note that the relationship between the equilibrium winning margin and the importance of the election is ambiguous. If a higher  $\eta$  always caused  $\mu(\cdot)$ , the “resulting winning margin,” to rise, then the equilibrium winning margin would go up, and it would go down if a higher  $\eta$  had the opposite effect. Fixing a winning margin, an increase in the importance of election causes turnouts of both groups to increase. The effect on  $A$ -voters, the winning group, is weaker than on  $B$ -voters by the assumption of “winner regrets less.” However, since the pdf of the cost distribution is non-increasing, and since there are more  $A$ -voters than  $B$ -voters, the marginal effect of an increase in the importance of the election on the resulting margin is ambiguous.

Despite such ambiguity in the relationship between the equilibrium margin and the importance of the election, the previous theorem states that turnouts always increase with the importance of the election. The reason is that even if an increase in the importance of the election causes the equilibrium winning margin to go up, thereby having the *indirect* effect of causing turnouts to fall, such effect is offset by the *direct* turnout-increasing effect of an increase in the importance of the election.

We now turn to the investigation of the relationship between voting cost and equilibrium voter turnout. Here, our results are more limited in scope. Intuitively, since voters base their decisions on comparison between their voting cost and expected regret, if the cost of voting becomes higher, turnout should become lower. However, since lower turnouts may result in a closer election, which increases voters’ anticipated regret, the eventual effect of an increase in the cost of voting is not clear-cut. Below, we provide sufficient conditions for turnouts to decrease as voting becomes more costly.

**Theorem 5.** *Assume distribution function  $F$  is a rightward shift of  $G$ , that is,  $F(c) = G(c - \varepsilon)$  for some  $\varepsilon > 0$  and all  $c$  in the support of  $F$ . Then, turnouts for  $A$ -voters and  $B$ -voters are both lower under  $F$  than under  $G$ .*

*Proof.* Denote the equilibrium margins of victory for candidate  $A$  under  $F$  and  $G$  respectively by  $m^*$  and  $m'$ , and similarly the equilibrium turnouts for  $J$ -voters ( $J = A, B$ ) by  $\tau_J^*$  and  $\tau_J'$ .

First, we argue that  $m^* < m'$ . By assumption, for all  $m$ ,

$$\alpha G(\eta r(m)) - (1-\alpha)G(\eta r(-m)) > \alpha G(\eta r(m) - \varepsilon) - (1-\alpha)G(\eta r(-m) - \varepsilon),$$

because (i)  $r(m) < r(-m)$  by Assumption 2; (ii)  $G$  satisfies Assumption 4; (iii)  $\alpha > \frac{1}{2}$ . But, the right-hand side of the inequality is equal to  $\alpha F(\eta r(m)) - (1-\alpha)F(\eta r(-m))$ . This means

that compared to  $G$ ,  $F$  shifts  $\mu$  downward in Figure 1. As a result, the equilibrium winning margin must be lower under  $F$  than under  $G$ .

Second, we argue that  $\tau_A^* < \tau_A'$  and  $\tau_B^* < \tau_B'$ . Suppose instead either  $\tau_A^* \geq \tau_A'$  or  $\tau_B^* \geq \tau_B'$ . Note

$$\begin{aligned}\tau_A^* &= F(\eta r(m^*)) = G(\eta r(m^*) - \varepsilon), & \tau_A' &= G(\eta r(m')); \\ \tau_B^* &= F(\eta r(-m^*)) = G(\eta r(-m^*) - \varepsilon), & \tau_B' &= G(\eta r(-m')).\end{aligned}$$

Thus, either  $\eta r(m^*) - \varepsilon \geq \eta r(m')$  or  $\eta r(-m^*) - \varepsilon \geq \eta r(-m')$ . But given  $m^* < m'$ ,

$$(\eta r(m^*) - \varepsilon - \eta r(m')) - (\eta r(-m^*) - \varepsilon - \eta r(-m')) = \eta \int_{m'}^{m^*} r'(m) + r'(-m) dm > 0,$$

by the second part of Assumption 2. Thus,

$$\eta r(m^*) - \varepsilon - \eta r(m') \geq \max\{\eta r(-m^*) - \varepsilon - \eta r(-m'), 0\}.$$

Since  $r(-m') > r(m')$ ,  $\alpha > 1/2$ , and  $G$  satisfies Assumption 4, we have

$$\alpha G(\eta r(m^*) - \varepsilon) - (1 - \alpha)G(\eta r(-m^*) - \varepsilon) > \alpha G(\eta r(m')) - (1 - \alpha)G(\eta r(-m')),$$

or  $m^* > m'$ , contradicting our conclusion above. Thus,  $\tau_J^* < \tau_J'$  for  $J = A, B$ .  $\square$

We now present an example that illustrates the voting equilibrium of our model.

**Example 1.** Suppose the regret function takes the following form:

$$r(m) = \begin{cases} 1 - 2m, & \text{if } m \in [0, \frac{1}{2}], \\ 1 + m, & \text{if } m \in [-1, 0], \\ 0, & \text{otherwise.} \end{cases}$$

In addition, assume that voting cost is uniformly distributed on  $[0, C]$  with  $C \geq \eta$  (this is to ensure no corner solutions exist in which all  $B$ -voters vote). Substituting these into the equilibrium equations, we obtain

$$\begin{aligned}m &= \frac{(2\alpha - 1)\eta}{C + (3\alpha - 1)\eta}, \\ \tau_A &= \eta \frac{1 + (1 - \alpha)\eta/C}{C + (3\alpha - 1)\eta}, \\ \tau_B &= \eta \frac{1 + \alpha\eta/C}{C + (3\alpha - 1)\eta}.\end{aligned}$$

The equilibrium margin of victory is decreasing in  $C$  and increasing in  $\alpha$ . Both turnouts increase with  $\eta$ , and increase as  $\alpha$  approaches  $\frac{1}{2}$ , which confirms Theorems 3 and 4. Note distributions with higher  $C$  first-order stochastically dominate distributions with lower  $C$ . The turnouts are decreasing with  $C$ , which means higher voting costs induces lower turnouts.

## 5 Uncertainty about the Electorate's Political Preferences

In the previous sections, we have introduced an essentially deterministic model. In equilibrium, a voter correctly anticipates the outcome of the election and the exact value of his regret if he fails to vote. We believe the model captures the idea that voter participation is driven by anticipated regret from not voting. In reality, of course, voters are uncertain about the election outcome. To encompass this in our model, we may allow  $\alpha$  to be uncertain to each voter, while maintaining our assumptions about the regret function.

To be specific, let  $G$  be the distribution of  $\alpha$  and  $g$  its corresponding density function.

**Assumption 5.** The density function  $g$  is symmetric around  $\frac{1}{2}$ , nondecreasing in  $[0, \frac{1}{2}]$ , and nonincreasing in  $[\frac{1}{2}, 1]$ .

Note that this implies that  $G$  second-order stochastically dominates the uniform distribution ( $G$  can be the uniform distribution itself). We may write the equilibrium equations as

$$\begin{aligned}\tau_A &= F(c_A), \\ \tau_B &= F(c_B), \\ c_A &= \eta \int_0^1 r(\alpha\tau_A - (1-\alpha)\tau_B)G(d\alpha), \\ c_B &= \eta \int_0^1 r((1-\alpha)\tau_B - \alpha\tau_A)G(d\alpha).\end{aligned}$$

Our next theorem demonstrates that a unique positive-turnout equilibrium exists in the voting game with uncertainty about  $\alpha$ .

**Theorem 6.** *Suppose Assumptions 2 and 5 hold. Then, in the voting game with uncertainty, there exists a unique equilibrium with positive turnout, in which  $\tau_A = \tau_B = \tau^*$ , where  $\tau^*$  satisfies*

$$F^{-1}(\tau) = \eta \int_0^1 r((1-2\alpha)\tau)G(d\alpha). \quad (11)$$

*Proof.* First, we show that in equilibrium,  $\tau_A = \tau_B$ . Suppose instead  $\tau_A > \tau_B$ . With a change of variables in the equilibrium characterization above, we have

$$\begin{aligned}c_A - c_B &= \frac{\eta}{\tau_A + \tau_B} \int_{-\tau_B}^{\tau_A} [r(m) - r(-m)] g\left(\frac{\tau_B + m}{\tau_A + \tau_B}\right) dm \\ &= \frac{\eta}{\tau_A + \tau_B} \int_{\tau_B}^{\tau_A} [r(m) - r(-m)] g\left(\frac{\tau_B + m}{\tau_A + \tau_B}\right) dm \\ &\quad + \frac{\eta}{\tau_A + \tau_B} \int_{-\tau_B}^{\tau_B} [r(m) - r(-m)] g\left(\frac{\tau_B + m}{\tau_A + \tau_B}\right) dm.\end{aligned}$$

The first term on the right hand side is negative by our “winner regrets less” assumption (Assumption 2). The second term can be rewritten as

$$\frac{\eta}{\tau_A + \tau_B} \int_0^{\tau_B} [r(m) - r(-m)] \left[ g\left(\frac{\tau_B + m}{\tau_A + \tau_B}\right) - g\left(\frac{\tau_B - m}{\tau_A + \tau_B}\right) \right] dm.$$

By Assumption 5 and the assumption  $\tau_A > \tau_B$ , we have  $g(\frac{\tau_B + m}{\tau_A + \tau_B}) - g(\frac{\tau_B - m}{\tau_A + \tau_B}) > 0$  for all  $m \in (0, \tau_B]$ . Therefore, the second term is also negative by Assumption 2. Hence  $c_A < c_B$ , which contradicts our assumption that  $\tau_A > \tau_B$ . Thus, in equilibrium,  $\tau_A = \tau_B$ .

Now, we demonstrate that a unique equilibrium exists. Let  $\tau$  denote the turnout level for both groups. The equilibrium condition becomes (11). The left-hand side is strictly increasing and the right-hand side strictly decreasing in  $\tau$ . Furthermore, when  $\tau = 0$ ,  $F^{-1}(\tau) = 0$ , while the right hand side is strictly positive; when  $\tau \rightarrow 1$ ,  $F^{-1}(\tau)$  approaches  $\infty$  if the voting cost  $c$  has an unbounded support,<sup>12</sup> while the right hand remains bounded. Therefore, there exists a unique  $\tau^*$  that satisfies the equilibrium condition.  $\square$

The following two corollaries consider how voting cost and the importance of the election affect turnout. The higher the voting cost, the lower the turnout; the more important the election is, the higher the turnout. The former is different from our result in the deterministic case, mainly because here the two groups are ex ante symmetric while this is not the case when the model is deterministic.

**Corollary 6.1.** *Let  $\tilde{F}$  and  $F$  be two distributions of voting cost,  $c$ , such that  $\tilde{F}$  first order stochastically dominates  $F$ . Then, the equilibrium voter turnout is lower under  $\tilde{F}$  than that under  $F$ .*

**Corollary 6.2.** *The equilibrium voter turnout is increasing in  $\eta$ , the importance of the election.*

The proofs are straightforward and are omitted here. The arguments are similar to those in the proof of Corollary 6.3.

Our next result concerns how voter turnouts are affected by voters’ uncertainty about  $\alpha$ .

**Corollary 6.3.** *Let  $G$  and  $\tilde{G}$  be two distributions of  $\alpha$  that satisfy Assumption 5 and let  $\tilde{G}$  second-order stochastically dominate  $G$ . Then, the equilibrium voter turnout under  $\tilde{G}$  is higher than that under  $G$ .*

*Proof.* Note that the equilibrium turnout is the  $\tau$  at which the left hand and right hand sides of (11) intersect. Also, the left hand side is increasing while the right hand side is decreasing

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<sup>12</sup>If  $c$  has a bounded support, we need to make the assumption that the upper bound is large enough.



in  $\tau$ . Thus, it suffices to show that under  $\tilde{G}$ , the right hand side of (11) is shifted upward from that under  $G$ . Using integration by parts, we have

$$\begin{aligned} & \int_0^1 r((1-2\alpha)\tau)\tilde{G}(d\alpha) - \int_0^1 r((1-2\alpha)\tau)G(d\alpha) \\ &= r((2\alpha-1)\tau)[\tilde{G}(\alpha) - G(\alpha)] \Big|_{\alpha=0}^1 - \int_0^1 [\tilde{G}(\alpha) - G(\alpha)]dr((2\alpha-1)\tau)d\alpha. \end{aligned}$$

The first term is equal to zero. The second term can be rewritten

$$- \int_0^{\frac{1}{2}} [\tilde{G}(\alpha) - G(\alpha)]2\tau r'((2\alpha-1)\tau)d\alpha - \int_{\frac{1}{2}}^1 [\tilde{G}(\alpha) - G(\alpha)]2\tau r'((2\alpha-1)\tau)d\alpha.$$

Using Assumption 5 and the assumption that  $\tilde{G}$  second order stochastically dominates  $G$ , we have

$$\begin{aligned} \tilde{G}(\alpha) - G(\alpha) &< 0 \text{ when } \alpha \in (0, \frac{1}{2}); \\ \tilde{G}(\alpha) - G(\alpha) &> 0 \text{ when } \alpha \in (\frac{1}{2}, 1). \end{aligned}$$

Combining these with the assumption that  $r'(m)$  is positive for  $m < 0$  and negative for  $m > 0$ , we conclude

$$\int_0^1 r((1-2\alpha)\tau)\tilde{G}(d\alpha) - \int_0^1 r((1-2\alpha)\tau)G(d\alpha) > 0.$$

Hence, the equilibrium turnout under  $\tilde{G}$  is higher than that under  $G$ .  $\square$

The above corollary shows that if the population shares of voters supporting either candidate are anticipated to be close, then voter turnout is higher, again echoing our result in the deterministic case. The reason is that as population shares become closer, a voter is more likely to experience high regret if he does not vote.<sup>13</sup>

The following example illustrates the voting equilibrium under uncertainty about  $\alpha$ .

**Example 2.** Consider the regret function

$$r(m) = \begin{cases} 1+m, & \text{if } m \in [-1, 0], \\ 0, & \text{otherwise.} \end{cases}$$

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<sup>13</sup>A similar result is obtained by Taylor and Yildirim (2005). They show that when voters are strategic, giving them more information about the composition of the voting population increases turnout. But, it also increases the possibility that the election outcome is in favor of the minority candidate.

Again, the cost distribution is uniform on  $[0, C]$ , where  $C \geq \frac{\eta}{2}$ . In addition, we assume that it is common knowledge that  $\alpha$  is uniformly distributed on  $[0, 1]$ . Thus,

$$\begin{aligned} c_A = C\tau_A &= \eta \int_{\alpha\tau_A - (1-\alpha)\tau_B \leq 0} 1 + (\alpha\tau_A - (1-\alpha)\tau_B) d\alpha, \\ c_B = C\tau_B &= \eta \int_{\alpha\tau_A - (1-\alpha)\tau_B \geq 0} 1 + ((1-\alpha)\tau_B - \alpha\tau_A) d\alpha. \end{aligned}$$

Again, we can show that in equilibrium  $\tau_A = \tau_B$  by deriving a contradiction from supposing they are not equal. Solving the equations gives us

$$\tau_A = \tau_B = \frac{2\eta}{4C + \eta}.$$

Clearly, the turnout is increasing in the importance of the election  $\eta$ . In addition, it is decreasing in the upper bound of the cost,  $C$ , which implies that in this case higher voting cost causes lower turnout.

## 6 The Concept of Regret

In this section, we elaborate on the concept of regret used in our model, and compare our use with its use in the literature.

Regret is a widely observed psychological phenomenon. According to Landman (1993),

Regret is a more or less painful cognitive and emotional state of feeling sorry for misfortunes, limitations, losses, transgressions, shortcomings, or mistakes. It is an experience of felt-reason or reasoned- emotion. The regretted matters may be sins of commission as well as sins of omission; they may range from the voluntary to the uncontrollable and accidental; they may be actually executed deeds or entirely mental ones committed by oneself or by another person or group; they may be moral or legal transgressions or morally and legally neutral. . . .(p. 36)

It is commonly known that regret tends to have an unpleasant emotional effect on an individual's mind. Therefore, it is natural to expect that while making decisions, people take anticipated regret into account, at least, in situations where they are frequently involved.

Some economic and decision theorists have emphasized the role of anticipated regret in decision making. Loomes and Sugden (1982) and Bell (1982) propose decision regret as explanations of paradoxical behavior that cannot be accommodated by expected utility theory. The concept of regret in these models is very narrowly defined. For example, Bell (1982) defines it as “the difference in value between the actual assets received and the highest level of assets produced by other alternatives.” As a result, application of their theory to economic models is quite limited.

In psychological research, by contrast, regret has increasingly become recognized as an important factor in decision making.<sup>14</sup> One of the first such studies is by Kahneman and Tversky (1982). Subsequent studies have revealed many interesting characteristics of regret. For example, people regret less about choices with justifications (Inman and Zeelenberg (2002)); they regret more about behavior inconsistent with their intentions (Pieters and Zeelenberg (2005)); they regret more about inactions than actions in the long run and vice versa in the short run (Gilovich and Medvec (1995)); and so on. Connolly and Zeelenberg (2002) propose Decision Justification Theory to explain many empirical phenomena related to regret and decision making. They break down regret into bad-outcome regret and self-blame regret. A person suffers the former if, as a result of this person’s action or inaction a bad outcome occurs, and suffers the latter if the action was unjustified or unwise, regardless of what outcome occurs.

In our model, we introduce regret as an enhancement of Riker and Ordeshook’s civic-duty model. We believe that the “warm glow” utility received by a voter as a result of fulfilling his civic duty should be independent of the election outcome. In addition to this type of utility, we believe voters’ psychological involvement in the success or failure of their favored candidates or alternatives is a significant factor in driving voter participation decisions. Abstaining voters suffer regret because not voting is deemed ethically wrong in democratic societies and disappoints peers from the same partisan group.<sup>15</sup> We make the assumption that an abstaining voter’s regret on the winning side is less than that on the losing side. In addition, such regret increases as the election result becomes close. We believe these assumptions are plausible and intuitively appealing. Though empirical evidence that supports them is not widely available, they can be readily tested with surveys of potential voters. As we discuss below, the experimental study conducted by Pieters and Zeelenberg (2005) does provide evidence in support of the existence of voter regret.

In the following discussion, we want to address the concern that voters in our model experience regret even though they know their votes do not affect the outcome. It is our contention that people frequently regret their decisions because they deem them ethically and morally questionable and not because outcomes would have been different if they had acted differently. First, this fits into the broad definition by Landman (1993) above. In particular, regret can be caused by feeling sorry for “transgressions, shortcomings, or mistakes,” none of which automatically implies real consequences. Second, examples of people feeling regret abound where their actions are not decisive in the outcomes. Many lawmakers (for example, Senator Robert Byrd, Congressmen Bob Barr and Don Young) said they regretted their votes for the Patriot Act, even though the vote of each of them would not have altered the outcome

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<sup>14</sup>The psychologist Neal Roese at University of Illinois maintains a web site “Counterfactual Research News,” where an extended list of references can be found. The URL is <http://www.psych.uiuc.edu/~roese/cf/cfbib.htm>. In his book, Roese (2005) describes the relation between regret and decision making to the general public.

<sup>15</sup>Surveys consistently show that roughly 90 percent of Americans believe they should vote even if their preferred candidate is certain to lose (Brody (1978)).

of the vote since the results were so lopsided. According to an ABC News report (January 5, 2007), of the 77 senators who voted to give President George W. Bush war powers, 34 (including John Kerry, John Edwards, Gordon Smith) expressed regret for voting that way. As widely reported in the media, many voters say they regret their vote or abstention in the 2000 election, even though each of them would not have altered the outcome of the election.<sup>16</sup> Third, Pieters and Zeelenberg (2005) provide some further evidence with an experiment in a real election. They conducted a study of the Dutch national elections in which they asked voters to express regret for their various actions (voting, abstention, voting for a particular party, etc.). Again, in such elections, each individual's vote does not affect the outcome of the elections. Nevertheless, their results showed that voters regretted their intention-action inconsistencies, like intending to vote but failing to do so, or intending to vote for  $x$  but voting for  $y$  instead. Though intention-action inconsistencies were their focus, their results also showed that voters who did not vote experienced higher regret than those that did: those who intended to vote but failed to do so experienced the strongest regret among all groups; those who intended not to vote and did not vote (therefore does not commit intention-action inconsistency) nevertheless experienced higher regret than those who intended to vote for  $x$  and voted for  $x$  in the election (see Table 1, p. 22 of their paper).

## 7 Conclusion and Further Research

In this paper, we have introduced a two-candidate model of electoral competition in which potential voters are ethical in that they experience regret after the election if they did not vote. The regret is inversely related to the margin of victory. Furthermore, voters on the winning side experience less regret than those on the losing side. We show that there is a unique equilibrium with strictly positive turnout. Further, voter turnout is positively related to the importance of the election, and negatively related to the perceived lopsidedness of the competition. These are true both when voters are sure about the proportion of voters that favor each candidate and when they are not.

We view our current research as laying a tractable framework in which many interesting issues can be studied. In our model, the positions of candidates and voters are exogenously given, so are the proportions of voters who would vote for either candidate. Therefore, we see many directions in which this model can be extended. First, candidates may position themselves to appeal to a larger proportion of potential voters. Second, the potential voter population may be affected by election campaigns. A candidate's campaign may disseminate information to voters, attract one's own voters, or discourage his opponent's voters. Recent presidential and congressional campaigns in the United States have seen the rise of negative tactics. An extended version of our model may be suitable to analyze the effect of such tactics on election outcomes. To be sure, many of the same issues have been studied using the pivotal-voter model, and many insights have been derived from these studies.

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<sup>16</sup>See, in addition to the poll we cited at the beginning of our paper, the book by Patterson (2002) (p. 3).

However, as the pivotal-voter model fails to account for significantly positive turnout in large elections, arguably a crucial feature of democratic elections, a model that does capture this phenomenon is valuable at least as a device with which to verify the validity of those theoretical findings.

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