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Can non-expected utility theories explain the paradox of not voting?

Serge Blondel
GRANEM (University of Angers)

Louis Lévy-garboua
CES (University Paris 1 Panthéon-Sorbonne)

Abstract

Many people vote in large elections with costs to vote although the expected benefits would seem to be infinitesimal to a rational mind. We exhibit two necessary conditions that a theory of rational decision must satisfy in order to solve the paradox. We then show that prospect and regret theories cannot solve it because each theory meets either one or the other necessary condition, but not both. However, the paradox of not voting is consistent with an amended version of third-generation prospect theory in which the reference is merely to vote or abstain.

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Contact: Serge Blondel - serge.blondel@univ-angers.fr, Louis Lévy-garboua - llg@univ-paris1.fr.
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1. Introduction

The expected utility (EU) from the act of voting in a large election is infinitesimal because the probability of a single vote being decisive (or pivotal) is infinitesimal. Consequently, the rational voter hypothesis first developed by Downs (1957) has been unable to explain why *rational* people vote to bring about the victory of their preferred candidate if the act of voting has a positive cost[1]: the expected benefit from voting would be of a smaller order of magnitude than the cost. People should never vote on rational grounds unless they have a taste for casting their ballot into an urn. Fortunately for democracy, few citizens never vote even though many occasionally abstain. This is the well-known 'paradox of not voting' (PNV).

In his review, Feddersen (2004) notes that previous attempts to solve this paradox have concentrated on the game-theoretic approach by lack of a canonical rational choice model of voting. However, embedding the decision to vote within a game (Ledyard 1984, Palfrey and Rosenthal 1983) has not yielded a convincing solution to the PNV so far when uncertainty about the actual number of voters is introduced (Palfrey and Rosenthal 1985), or even when voters are structured in groups of supporters of the candidates who will cast their ballot if and only if they receive a consumption benefit from doing so (see Feddersen 2004 for references).

This paper revisits the decision-theoretic approach to the PNV by considering whether it can be explained in a non-EU framework[2]. This is a rather natural idea since EU has raised many other paradoxes of decision under risk and uncertainty, like Allais and Ellsberg paradoxes, which can be solved by non-EU theories (see the review of Starmer (2000)). Two prominent non-EU theories which have fared well in other risky contexts are prospect theory (Kahneman and Tversky 1979) and rank-dependent EU (Quiggin 1982) on one hand, or regret theory (Bell 1982; Loomes and Sudgen 1982) on the other hand. For our present purpose, the distinguishing feature of these theories is that prospect theory and rank-dependent EU transform probabilities while regret theory modifies the utility function. A recent development, called third-generation prospect theory (Schmidt et al., 2008), assumes that the reference point could be a risky prospect and has some common points with regret theory.

In short, amongst the possible explanations of the PNV, as the taste of voting or the civil duty (see Mueller, 2003, chapter14, for a survey), we focus on the traditional case where a citizen vote to bring about the victory of her preferred candidate, given that she knows that this act has a positive cost and the probability of being decisive is infinitesimal.

The paper proceeds as follows. We elicit necessary conditions for voting in section 2. Section 3 shows that prospect and regret theories cannot solve the PNV because they don't respect these two conditions together. However, an amended version of third-generation prospect theory is consistent with the PNV. Concluding remarks appear in section 4.

2. Necessary conditions for voting

Let us briefly set up the notations that will be used here. The act of voting in a two-candidate election is viewed as a rational individual choice under uncertainty. It will be assumed throughout that individual voters have no power to form coalitions, an assumption that can be taken as a definition of a "large" election. This is the "one vote-one voice" motto of

[1] Without denying the fact that people may enjoy some aspects of voting, we rule out assumptions of a negative cost of voting due to a taste for voting (Riker and Ordeshook 1968), or to a taste for participation to collective actions, as in expressive voting theory (e.g., Schuessler 2000).

[2] Chew and Konrad (1998) is an exception for calling upon uncertainty aversion to justify bandwagon effects on voting behaviour. However, they don't address the question of why people decide to vote.

democracy. If the individual votes, he bears a cost, noted *C* in utility terms. We set up a level *B* (benefit) for the difference in utilities from the policies of the two candidates. The individual may vote (*V*) or abstain (*A*), and his preferred candidate can be elected or not. This leads to four possible utility levels. The cost is positive, but typically small in comparison with the benefit from winning the election, so that:

$$-C < 0 < B - C < B \quad (1)$$

Obviously, if decisions to vote had no influence whatsoever on the electoral outcome, the individual would never vote because *A* would then strictly dominate *V*. Thus rational citizens who bear a cost of voting must perceive a positive probability of casting a decisive ballot in order to decide to vote. No citizen can be persuaded to vote if there is a cost to vote unless she perceives that the election outcome partly depends on her own participation. Thus, *v*oting should be framed as an act of political participation under individual control which can turn defeat into victory. Consequently, the decision problem is better described by table I, which assumes that three states of the world are distinguished. The individual's act of voting or abstention has no influence on the electoral outcome in state 1 (victory if I don't vote, with probability *q*) and in state 2 (defeat if I don't vote), but it is decisive in the third state (voting is responsible for victory and abstention is responsible for defeat, with probability ε). Thus, *A* no longer dominates *V*. Potential voters will reason: 'If I do not vote, I can always save the cost of voting *C* but there is a possibility that I lose the (much) greater benefit of victory $B-C$ if my vote were to be decisive'. It is worth noticing that democratic values emphasize the notion that individual political participation is important and each vote matters[3]. The argument stating that each voter perceives that her ballot might be decisive must be quite persuasive since it is commonly found that rather large majorities of voters do vote.

Table I Gambling between vote (V) and abstention (A)

	The vote is not decisive		The vote is decisive
	Victory: State 1	Defeat: State 2	State 3
	$\Pr[\text{state } 1] = q$	Pr[state 2] =1-q-ε	Pr[state 3] =ε
A	B	0	0
V	$B-C$	$-C$	$B-C$

However, the decisiveness of a single vote is so unlikely in a large election that it will not persuade many to vote if there is a cost to vote. Several attempts have been made to evaluate such probability ε[4]. For instance, Owen and Grofman (1984) provide the following approximation formula:

[3] An experiment by Blais and Young (1999) confirms that an emphasis on the economic reasons for not voting during the 1993 Canadian federal election campaign had a negative influence on turnout for a group of students (and potential voters) by inhibiting their perception of the positive reasons for voting. Framing matters.

[4] Given all other votes, a single vote will change the electoral outcome if and only if either one of the two conditions below occurs when all other ballots:

(1) are evenly split between the candidates (probability ε_1) so that an additional vote determines the winner. This occurs when there are an odd number of voters;

(2) give victory to one's less preferred candidate by a margin of one vote. An additional vote for this candidate determines a draw, and the electoral outcome is eventually decided by an arbitrary criterion (probability $\varepsilon_2 \approx \frac{1}{2}\varepsilon_1$). This occurs when there is an even number of voters.

$$\varepsilon = 1.5\frac{\exp\left[-2(N-1)(p-0.5)^2\right]}{\sqrt{2\pi(N-1)}}\ , \qquad (2)$$

in which p is the expected percentage score for one's preferred candidate and N is the number of potential non-indifferent voters. The difference $|p-0.5|$ measures the expected "closeness" of an election. The probability that any single vote be decisive sharply declines with the size of the electorate and with the numerical imbalance between the two competing factions (the inverse of closeness). It becomes infinitesimal in large elections. For example, even under extremely tight competition ($p \approx 0.5$), ε is only 0.019% with 10 Million voters.

Myerson (2000) gave an alternative expression for the probability a vote is pivotal. Fischer (1999) pointed out that ε is sensitive to the approximation formula being used. This brief discussion suggests that the estimates of ε are imprecise and that the only thing we know for sure of this probability is that it should be infinitesimal in large elections.

EU theory fails to predict that many people vote because $\varepsilon.B < C$ if ε is infinitesimal. Thus, potential voters must greatly overestimate the decisiveness of their own ballot in order to decide to vote.

To summarize the above discussion, any rational solution to the PNV implies two necessary conditions:

(NC1) *Rational citizens who bear a cost of voting must perceive voting as an individual act of political participation which can turn defeat into victory. Thus the decision to vote or abstain is framed in table I as a choice among two acts with three (voter-specific) states of the world.*

(NC2) *The perceived probability of casting a decisive ballot must be substantially overestimated in comparison with* ε .

Clearly, EU fails on both accounts. Framing the decisive state does not make a difference on preferences[5]: only victory or defeat matter, notwithstanding whatever caused them (NC1); and probabilities of victory and defeat are not distorted (NC2).

Not surprisingly, the celebrated solution proposed by Ferejohn and Fiorina (1974) exactly meets the two conditions: voting and abstention are framed as actions, and the probability of casting a decisive ballot is substantially overestimated. This arises from their assumption that uncertainty about the decisiveness of one's vote is total so that individuals are unable to calculate probabilities and simply adopt Minimax-regret decisions that do not require probability judgments. Potential voters decide to vote if and only if the regret of bearing an avoidable cost C (states 1 and 2 if V) is smaller than the regret of feeling responsible for defeat $B-C$ (state 3 if A). Evidently, the calculation of regret implies the framing of a decisive vote, as shown by table II. Furthermore, the decision rule under total uncertainty implies that the two states are given equal weights, which greatly overestimates the likelihood of a decisive vote. In our view, Ferejohn and Fiorina (1974) capture essential components of a solution to the PNV. However, they go too far in saying that voters have no information at all to make their own *subjective* evaluation. It would be more accurate to say that voters'

We can use $\varepsilon = \frac{1}{2}\varepsilon_1 + \frac{1}{2}\varepsilon_2 \approx \frac{3}{4}\varepsilon_1$ to assess the subjective probability that an individual's vote decide the victory of his preferred candidate (Mueller 2003, chap. 14).

[5] With the "act of political participation frame" depicted by table 1, an individual will vote if $EU(V) > EU(A) \Leftrightarrow (q+\varepsilon)(B-C) + (1-q-\varepsilon)(-C) \equiv (q+\varepsilon)B - C > qB.$ Under EU, this condition for voting would be unaffected by a change of frame. For instance, with the conventional "win-lose" frame, the condition for voting immediately coincides with the last inequality. For both frames, this implies $\varepsilon.B > C$ in contradiction with the infinitesimal value of ε.

information is *imprecise*[6]. Moreover, the assumption of total ignorance does a poor job in predicting turnout because it implicitly assigns a uniform probability of one-half to subjective decisiveness, which underscores the heterogeneity of individual behaviour.

3. Can non-EU theories solve the paradox?

Now, we ask whether non-EU theories provide a solution to the PNV. Indeed, prospect theory assumes an overweighting of small probabilities (Kahneman and Tversky 1979), and regret theory suggests that independent prospects be framed as actions with common states of the world. Thus these prominent non-EU theories satisfy either NC1 or NC2. However, third-generation prospect theory satisfies both conditions.

3.1. *Regret theory*

Regret theory (Bell 1982; Loomes and Sudgen 1982) contends that people, when making a decision, anticipate the regret, and conversely the rejoicing, that their choice might generate after the resolution of uncertainty. Thus EU is modified by the addition of a regret/rejoicing function which relates possible outcomes of the chosen action to outcomes of the non chosen one. The regret/rejoicing function R is strictly increasing in the absolute value of regret, positive for rejoicing and negative for regret, and such that $R(0)=0$. The expected regret from one choice is symmetric to the expected rejoicing from its alternative choice. Table II shows that an individual expects to experience regret C with probability $1-\varepsilon$ if he decides to vote and to experience regret $R(B-C)$ with probability ε if he decides to abstain. He maximises the sum of his EU (table I) and expected regret/rejoicing (table II).

Table II Anticipation of regret/rejoicing in the decision to vote (*V*) or abstain (*A*)

	$\Pr\left[state\,1 \text{ or } state\,2\right]=1-\varepsilon$	$\Pr\left[state\;3\right]=\varepsilon$
A	rejoicing: $R(C)$	regret: $R(C-B)$
V	regret: $R(-C)$	rejoicing: $R(B-C)$

According to regret theory, an individual decides to vote if and only if:

$$\varepsilon.B-C+(1-\varepsilon)[R(-C)-R(C)]+\varepsilon[R(B-C)-R(C-B)]>0 \tag{3}$$

The second term in brackets is always negative and the third term in brackets is always positive. Since only the latter is infinitesimal, the sum of the two bracketed terms must be negative in a large election with costs to vote. Hence, since it is not EU-rational to vote (*i.e.*, $\varepsilon B-C<0$), it cannot be rational *a fortiori* to vote for regret theory; and the PNV is aggravated in comparison with EU. What goes on here is that regret theory satisfies NC1, but not NC2. Although the options of voting and abstention are perceived as actions with a decisive state, the probability of a decisive vote ε is not overestimated.

3.2. *Prospect theory*

We use indifferently cumulative prospect or rank-dependent EU theories (Tversky and Kahneman 1992, Quiggin 1982) which respect dominance and extend to elections with more than two candidates. Both theories transform probabilities by substituting rank-dependent decision weights (which add up to one) for the expected percentage score of a candidate. States are ranked from worst to best, and aggregated if they yield a common outcome.

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6 Indeed, the probability q of "winning if I don't vote" measures my confidence in the expected score p for my preferred candidate; q is sharply increasing function of p in the vicinity of $p=0.5$.

In the two-candidate election case, the decision to vote will be simply determined by:

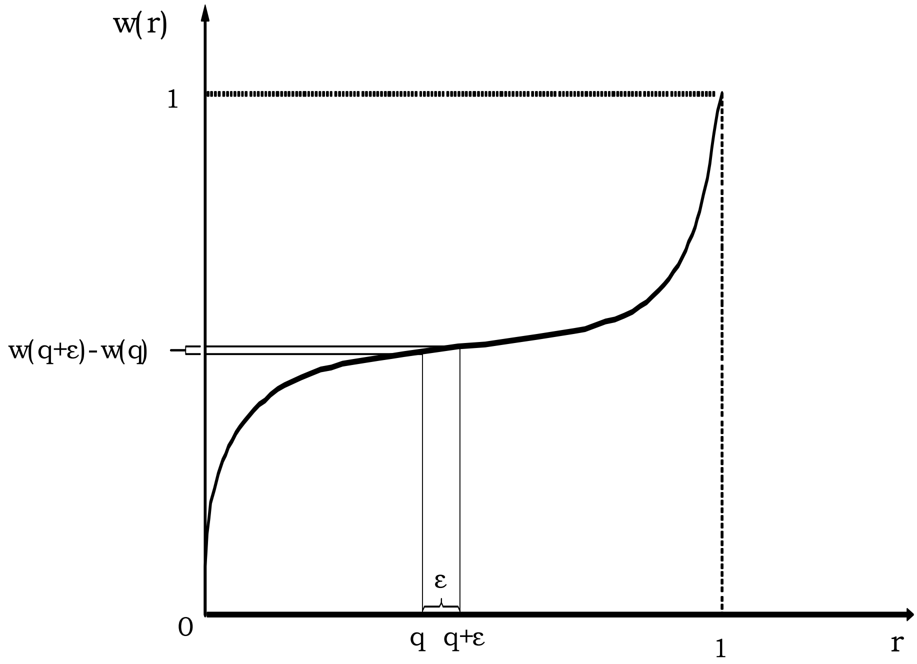
$$w(q+\varepsilon)B - C > w(q)B\,, \quad (4)$$

or:

$$[w(q+\varepsilon) - w(q)]B > C \quad (5)$$

Since ε is infinitesimal in a large election, prospect theory solves the PNV if and only if $w(q+\varepsilon) - w(q)$ is of a higher order of magnitude than ε for all values of q in a non-empty interval. However, this requires a discontinuity of the weighting function $w(r)$ at all values of *r* in a non-empty set. Thus prospect theory cannot solve the PNV. For example, the weighting function which is most widespread in the literature assumes overweighting of small probabilities and underweighting of large probabilities. It is illustrated by figure 1.

Figure 1 A typical weighting function in prospect theory



If this weighting function was adopted, $w(r)$ would be continuous and might even increase more slowly than *r* in the vicinity of one-half, so that: $w(r+\varepsilon) - w(r) < \varepsilon$. The PNV would then be aggravated by the use of prospect theory. The only cases in which prospect theory might predict voting concern values of *r* very close to 0 or 1, which contradicts intuition and empirical findings that closeness of election has a weak but positive effect on voter turnout[7]. Notice that we did not explicitly account for loss aversion: doing this would reinforce the PNV by increasing the cost of voting in utility terms (see (5)), since the latter is a loss.

Prospect theory fails to solve the PNV because it satisfies NC1, but not NC2. ε is not significantly overestimated because, under the specific framing postulated by this theory, it will be aggregated with the much larger probability *q* of winning without voting. Casting a decisive ballot is not isolated as an act that may change defeat into victory.

3.3. *Third-generation prospect theory*

Third-generation prospect theory (PT3 - Schmidt et al., 2008) was introduced recently to explain the preference reversal phenomenon and the disparity between selling and buying

[7] Mueller (2003) contains a survey of studies bearing on this point, both on aggregate and individual data.

prices. It maintains that all values are relative to a reference point but innovates on PT1 (Kahneman and Tversky 1979) and PT2 (Tversky and Kahneman 1992) by assuming that the reference point need not be a sure outcome and may be a lottery. Thus, if *RP* is the reference point, the value of lottery *V*, for instance, would simply be *v(V)-v(R)*, where *v* stands for a utility function. Note that the reference is neutral, with a value equal to 0. In the context of their paper, Schmidt et al., (2008) select the status quo 0 in choice situations. Doing this would merely replicate the negative conclusion holding for the earlier version of prospect theory. Having said this, it is natural to take either lottery *V* or *A* as the reference here. However, the so amended theory does not give a clue for choosing between the two, so that, quoting Wakker (2010, p. 241), "In the absence of a theory of reference points, hypotheses about their location have to be based on pragmatic heuristics in applications". For instance, the reference could be simply the individual's decision to vote or to abstain in the last election. In light of the indeterminacy of the reference, we consider here these two possibilities.

Since all values are relative to the decision to vote or abstain, citizens who respect the PT3 rule will perceive voting as an individual act which can turn defeat into victory if their reference is to abstain, and abstention as an individual act which can turn victory into defeat if their reference is to vote. Thus, in contrast with PT1 and PT2, NC1 is verified by PT3 thanks to this specific frame. Moreover, being pivotal is perceived alternatively as a gain or as a loss depending on whether the reference was to abstain or to vote. This suggests that loss aversion may play a role here so that the loss aversion parameter λ (≥ 1) of prospect theory is worth considering explicitly. Both insights are reported in table III.

Table III Reference point and values of gains and losses in the decision to vote or abstain

Reference point	Decision	$\Pr[state\ 1 \text{ or } state\ 2] = 1-\varepsilon$	$\Pr[state\ 3] = \varepsilon$
A	A	No loss, no gain: 0	No loss, no gain: 0
	V	Loss: $-\lambda C$	Gain: $B-C$
V	A	Gain: C	Loss: $\lambda(C-B)$
	V	No loss, no gain: 0	No loss, no gain: 0

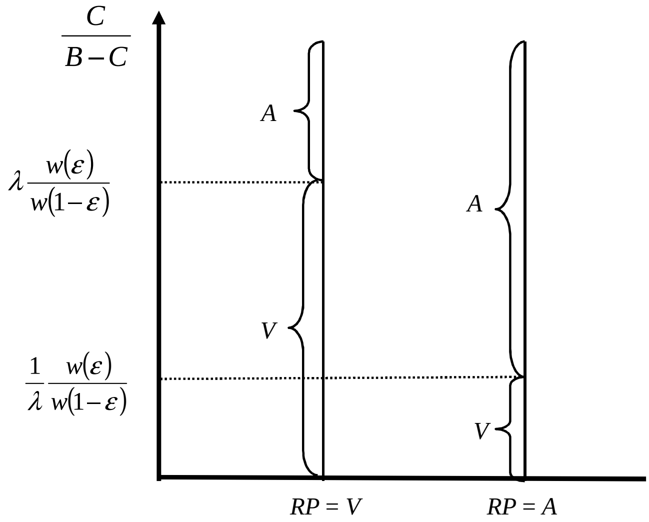
According to PT3, an individual decides to vote if and only if:

$$\begin{cases} w(\varepsilon)\lambda(C-B)+w(1-\varepsilon)C<0 & if \quad R=V \\ w(\varepsilon)(B-C)+w(1-\varepsilon)\lambda(-C)>0 & if \quad R=A \end{cases} \tag{6}$$

The PT3 rule of decision is conditional on the reference point and derived from equations (6). The two conditional rules are summarized in figure 2.

Figure 2 shows that voter turnout is decreasing in the cost-benefit ratio *C/B* and increasing in the relative weight of casting a decisive ballot *w(ε)/w(1-ε)* whereas loss aversion has a reference-dependent effect, positive if the reference is to vote and negative if the reference is to abstain. The negative effect of the cost-benefit ratio is rather obvious and was already predicted by EU and earlier versions of prospect theory. The reference-dependence of the loss aversion effect means that, in the present state of PT3, loss aversion alone cannot offer a reliable explanation for the PNV. Thus, the burden of the proof rests essentially on the extent of overweighting of small probabilities relative to large probabilities. Since prospect theory does not specify the weighting function, the resolution of the PNV by PT3 becomes an empirical question.

Figure 2 Rules of decision conditional on the reference point



To see this, let us take one of the most popular weighting functions in the PT literature, which is an inverse S-shaped weighting function suggested by Tversky and Kahneman (1992):

$$w(r) = \frac{r^\eta}{\left(r^\eta + (1-r)^\eta\right)^{1/\eta}} \quad , 0 < \eta \leq 1 \tag{7}$$

Which leads to (8)

$$\frac{w(\varepsilon)}{w(1-\varepsilon)} = \left(\frac{\varepsilon}{1-\varepsilon}\right)^\eta = F(\varepsilon, \eta) \tag{8}$$

Probabilities are not distorted when $\eta = 1$ ($i.e.\ w(r) = r$) and small probabilities are overweighted when η<1. Tversky and Kahneman (1992) have estimated $\eta = .61$ for gains and $\eta = .69$ for losses. Later, most of the empirical studies using this function have obtained values between .56 and .74[8] (Neilson and Stowe, 2002, pages 35-36). It can be shown from figure 2 and (8) that voter participation rises with *ε*[9] (and thus with *p* – see eq. (2)) and declines with *η*, that is, with the degree of overweighting of small probabilities[10].

The following example, under extremely tight competition ($p = 0.5$) and with 10 Million voters, will illustrate how PT3 may explain the voting behaviour. From (2), ε is only 0.019%. With (7) and the value estimated by Tversky and Kahneman (1992), $\eta = .61$, the probability weights in (6) are respectively .53% and 99.13%, both weights being different from 0.019% and 99.98%. We retain the usual value 2 for the loss aversion parameter λ. (6) predicts a voting behaviour if $B/C > 94.52$, if voting is the reference point. If *A* is the reference point, there is less chance that the citizen will vote since it requires $B/C > 375.08$. In both cases, however, these thresholds are way above Bendor *et al.*'s (2003) central value: *B/C*=4. Thus, PT3 is not inconsistent with the PNV but requires stronger overweighting of very low probabilities than found in most empirical studies which have used the Tversky and

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[8] Note that $\eta \geq .28$: for smaller values, the function is not strictly increasing (Wakker, 2010, page 206).

[9] $\frac{\partial F}{\partial \varepsilon} = \frac{\eta}{(1-\varepsilon)^2}\frac{\varepsilon}{1-\varepsilon} > 0$ since $0 < \varepsilon < 1$.

[10] $\frac{\partial F}{\partial \eta} = \left(\frac{\varepsilon}{1-\varepsilon}\right)^\eta \log\left(\frac{\varepsilon}{1-\varepsilon}\right) < 0 \Leftrightarrow \varepsilon < \frac{1}{2}$: always true since ε is infinitesimal.

Kahneman's (1992) weighting function. For example, if we take a lower value for η, 0.4, (6) predicts voting if $B/C > 16.40C$ when the reference is to vote, and $B/C > 62.59$ when the reference is to abstain.

4. Concluding remarks

In the American presidential election which opposed George W. Bush to Al Gore in 2000, the margin of votes between the two candidates was extremely narrow and votes in Florida were presented *ex post* as being decisive. Tight elections of this kind have been observed in other democratic nations as well. For example, in Italy, Romano Prodi beat Silvio Berlusconi in 2006 by a tiny difference of 0.07%. These rare events entertain the democratic belief that each vote matters and can be decisive. Indeed, if the probability to be decisive is infinitesimal, it is not zero. This difference is essential in a democracy and it legitimates the framing of the decision to vote in a large election.

Rational citizens who bear a cost of voting must perceive voting as an act under individual control which can turn defeat into victory. Moreover, they must substantially overweight the probability of casting a decisive ballot.

We demonstrated that prospect and regret theory, which are the most cited non-expected utility theories, both fail to predict rational voting because they respect either NC1 or NC2 but not these two necessary conditions together. However, the PNV is consistent with an amended version of third-generation prospect theory in which the reference is merely to vote or abstain.

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