Voting Behaviour in a dynamic perspective: a survey

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Abstract. Traditional rational choice theories of voting state that, in a scenario with positive voting costs, people will vote only when they are pivotal. This hypothesis is contradicted by the frequent observation of relatively high rates of electoral turnout. Over the last few decades, several approaches have been developed in attempts to explain the *paradox of not voting* and to define more realistic behavioural rules, both within the rational voter framework and in opposition to that paradigm. This study offers a critical review of bounded rationality-based dynamic models. This class of model seems to be more promising than previous models in that it offers results consistent with observed voting patterns and investigates voter choices while assuming that social processes develop continuously.

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1. Rational theories of electoral behaviour and turnout: the paradox of not voting.

Traditional rational choice theories of voting state that, given positive voting costs, people will vote for their preferred candidate only when their vote affects election outcomes. This is the so-called instrumental voter approach, whereby individuals are assumed to act in politics as they do in the market in order to obtain the maximum utility level according to a cost-benefit evaluation.

In the Downs (1957) model, each voter *i,* preferring candidate *j,* votes if and only if her expected utility is higher than voting costs:

where is the probability of the vote being pivotal, is the net individual utility the voter gets in the event that her preferred candidate is elected and is the cost of voting. Because falls to zero as the number of voters increases, the turnout level in large elections should be very low when voting costs are positive.

In fact, relatively high levels of electoral participation have often been reported in democratic countries. This is the so-called *paradox of not voting* that several researchers have studied in the last decade. Within the rational agent framework, Riker and Ordeshook (1968) included the *D*-term to suggest that individuals vote out of a sense of civic duty. Another approach has included other sources of individual utility within the B-term in order to capture some aspects of the turnout pattern in both cross-sectional and time-series analyses. Additionally, empirical works have shown that individuals perceive the act of voting not to be costly or even that the *C*-term matters only for those who have a weak sense of duty with regard to voting (Blais 2000, Blais and Young 2000, Knack 1994). Finally, Palfrey and Rosenthal (1983, 1985) started another line of research involving the *p*-term.

Considering the rational model and its developments, one can note a few broadly accepted predictions (Levine and Palfrey 2007): the negative correlation between the size of the electorate and turnout rates (the size effect); the higher turnout rates associated with closer elections (the competition effect); and finally, the higher turnout propensity among supporters of the less preferred candidate (the underdog effect).

Despite these points of consensus, there is no broadly accepted model of voter behaviour. One might even argue that theoretical sophistications, so far, have only led to a view of the act of voting that is not terribly rich in its predictive ability. See, for example, the lower turnout rates reported among students who were exposed to a presentation about rational models of turnout, in the experiment run by Blais and Young (1999).

Recently, however, other scholars have modelled opposing approaches excluding or redefining rationality assumptions in a dynamic setting (the learning and evolutionary models). These models suggest that voting can be viewed as a dynamic process based on adaptation and driven either at the individual level—in learning voting (LV) models—or the aggregate level—in evolutionary game-theoretic voting (EV) models. Although it has scarcely been tested, the dynamic approach seems to be more promising than the static one in terms of producing results consistent with observed voting patterns. This study, then, offers a critical review of dynamic and bounded rational models, both from the theoretical and empirical points of view.

2. Dynamic voting: LV vs. EV.

Learning voting models (LV) and evolutionary voting models (EV) differ from traditional rational theories of voter behaviour in assuming individual rationality to be bounded and in modelling individual behaviour in a dynamic sense. As opposed to the rational agent approach, both LV and EV suggest that individuals behave over time according to an adaptation algorithm. Such an adaptation process may occur either at the individual (LV) or the aggregate level (EV).

In EV, individuals are programmed with certain strategies. These strategies compete in the evolutionary process on the basis of the relative fitness they confer on individuals. LV, meanwhile, assumes that individuals adapt their behaviour over successive elections on the basis of a satisfaction level. Voters learn how to play on the basis of their own past experience or that of others.

Evolutionary game theory was initially developed by a biologist (Smith 1982) who introduced the Evolutionary Stable Strategy (EES), which can be viewed as a refinement of the Nash Equilibrium in a dynamic (evolutionary) sense. In political behaviour applications, voters are assumed to be backward-looking and adaptive instead of utility maximizing. Neither LV nor EV requires the rationality assumption, as individuals do not maximize any utility function. These approaches seem to be the most promising for solving the paradox of not voting.

3. Evolutionary Game Theory: an overview.

While in biological evolutionary games individuals are programmed to play a fixed strategy, economic models focus attention on how individuals behave - or in other words, how they choose the best strategy. Thus, in EV models, strategies compete, and those strategies associated with higher payoffs (fitness) survive.

As has been stated, fitness measures the success of a strategy. A fitness function maps the payoffs structure derived by a symmetric game with respect to the shares of types within the population (Linzer and Honaker 2003). A fitness function is a probabilistic payoff function that predicts the expected payoff for given a type's share.

The basic intuition behind EV is that individual behaviour cannot be restricted in a one-shot choice because social processes are not fixed but rather vary with respect to starting conditions and population structure. The EV faces the problem of a world where social processes continuously develop. In EV, the dynamic process depends on a selection mechanism. The most common dynamic process is the so-called Replicator Dynamics or Proportional Fitness Rule (PFR), which was proposed by Taylor (1978). The PFR is based on the idea that the growth rate of each type/strategy ( ) is proportional to its fitness compared with the average fitness in the population :

Considering multiple rounds, the share of a type/strategy for each round is defined by:

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where is the share of type *I* at time *t*; and are, respectively, the share of type *i* and its share in the population in the previous year; is the average fitness in the population calculated at time (. Although several specifications of the dynamic process exist, the payoff monotonicity is a basic assumption.

3.1 An evolutionary theory of voting

Linzer and Honaker (2003) generalize the classic EV in allowing both full rationality and a non-random pairing. The second feature, specifically, has a massive consequence in that it allows for group membership to have an effect on the evolution dynamics. Linzer and Honaker develop two models, both predicting a positive level of turnout in the long run, that diverge in considering individuals to be either rational or else pure automata.

In the non-rational game, the population is divided into types, each of which is defined by its turnout probability. For each pair of population types interacting (τ_1,τ_2), the fitness function maps $F(\tau_1,\tau_2)$ for a given cost of voting c, representing the fitness payoffs to type τ_1 when interacting with τ_2. Each type's growth dynamic is assumed to be proportional to the difference between the type's fitness and the average fitness in the population (PFR). Evolution is allowed over periods. Under random pairing, the evolution of types converges to zero turnout. A positive turnout equilibrium occurs when pairing is assumed to be correlated among like types, i.e., including group dynamics into the participation game. The authors allow for spatial correlation and show that for given levels of voting costs, there are some values of spatial correlation that are associated with positive turnout. Moreover, equilibria do not depend on the initial distribution of turnout probabilities. Then, in the second model, Linzer and Honaker consider a one-dimensional policy space, wherein each individual has political preferences (f_i) correlated with her fitness. Individuals also have political preferences (u_i) that do not necessarily depend on fitness. Individuals may vote for party L or R or abstain. For instance, a voter votes for if:

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where and are party positions, and represent Gaussian noise depending on individual information stock and is an indifferent (positive) margin that captures the perceived cost of voting. They vote for R if the right-hand side is higher and abstain otherwise. A voter's fitness depending on the outcome of the election is defined as:

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where is a positive constant. Then, individuals whose fitness levels are low change their political preference. Assuming a random distribution of fitness values over the policy space, the model predicts a bimodal distribution of preferences. Furthermore, those voters with high d and low info stock are more likely to abstain. Finally, turnout probability is not homogeneous with respect to political preferences because it is higher in centrist voters than it is in right- or left-wing voters.

Conley and Toossi et al. (2006) adopt the evolutionary *memetic*[2] approach in order to endogenise the civic duty sense through modelling a two-group dynamic system. They model a world where groups are heterogeneous in values and ideas and compete to affect the social value system. They find that public-spirited groups may have an advantage in the long run when voting costs are lower than the benefits of winning. Groups are characterized by different likelihoods of voting and by preferences regarding public expenditures, and individuals (within groups) act in a non-rational manner. More specifically, the authors distinguish between the *high type* group that can be viewed as the mainstream of society, whose benefits/costs deriving from public proposals are distributed uniformly within the interval [-1,1], and the *low type* group that is partially integrated into society and thus, is only partially affected by established public policies. Formally, the benefits of *low type* voters are represented by the random variable:

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[2] The *memetic* approach refers to imitation processes based on cultural transmission developed by Dawkins (1978).

where is distributed uniformly and independently over the interval [-1,1] and is the preference correlation parameter. That is, the distribution of benefits among *low type* citizens occurs when *low type* agents are totally correlated or uncorrelated. In other words, *low types* suffer a disadvantage from not being fully integrated within the economic context, in contradistinction to the mainstream type.

Then, citizens belonging to the two groups vote directly for a proposal.

The voting propensities of the two types are defined as and and

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represents the relative public spirit, so that the turnout rate among type *j* is equal to

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where is the share of type *j* within the population.

Assuming positive and constant voting costs, the adaptive dynamics follow the PFR over a continuous period.

The EES concept is used in order to derive long-run stable states that, in turn, depend on the values of the three parameters: α, β and C. There are three possible equilibria: the *high type* wins (is globally stable); the *Low type* wins (is globally stable); the large population wins (in this case there are three steady states: , but the latter is unstable and the final outcome depends on the length of attraction basins). The authors prove that under the third equilibrium, increasing voting costs result in a disadvantage for the *high type* group in an evolutionary sense. In other words, with relatively high voting costs, the initial population share of the *high type* group must be large in order to avoid long-run defeat.

However, when costs are extremely high, voting is disadvantageous in the long run because *high type* voters' expected benefits are lower than are those of *low type* individuals. Public spirit, on the other hand, always results in an advantage under low voting costs. Moreover, when α falls to 0, types with higher voting propensities win.

Sieg and Schulz (1995) initially defined the Evolutionary Voting Equilibrium (EVE) as a refinement of the Symmetric Evolutionary Equilibrium that was developed by Schaffer (1989). They consider a population split into two groups and playing a strategy $q_i \in (0,1)$ with the relative expected payoff π_i.

A deviant player is one employing some other strategy $p_i \in (0,1)$. Individuals in the game are anonymous, as are preferences and costs, such that a single voter's fitness is the proxy of income compared with the total population. That is, individuals may learn a deviant strategy in order to increase their relative income. A voter *i* may learn the deviant strategy if:

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where is the set of strategies played by all other players. Thus, individuals have an incentive to learn a deviant strategy in order to increase their social position with respect to the rest of the population. The adaptation process continues until an EVE is reached.

An EVE occurs, then, whenever there is no deviant strategy with a higher payoff than . The turnout dynamics depending on voting costs prove to be ambiguous because voters in the same group facing different voting costs may act differently. Finally, in a context of varying voting costs and varying group size, the no-voting condition is not an EVE and the paradox of not voting disappears. Because individuals are allowed to learn deviant strategies, the Sieg and Schultz (1995) model has some aspects in common with LV.

Evolutionary models are able to explain reported fluctuations in actual turnout levels in a time series analysis but fail to explain why electoral participation varies between different election types. Furthermore, because the adaptive process requires numerous iterations, this class of models cannot easily be tested econometrically and experimentally.

4. Learning theory: an overview.

As distinct from EV, LV is characterized by considering agents behaviour to not be fixed because individuals are assumed to learn on the basis of their own experience (or the experiences of others). Hence, individuals may receive feedback on their own past behaviour and may use that feedback through a learning algorithm as a basis for choosing actions in the future. Another key feature is the concept of optimal choice under LV assumptions. Basically, in the LV world, individuals may reach the optimal choice as a consequence of a trial and error process. Until the optimal point is reached, individuals reasonably reach suboptimal points. That is, under LV assumptions, individuals try to achieve some satisfaction level (defined by a minimum threshold) rather than strictly optimizing utility (Simon 1957).

The learning process is defined as an algorithm mapping individual behaviour on the basis of past experience. According to Selten (1991), learning processes may be distinguished as

a) *belief learning*, whereby individuals reinforce or weaken prior beliefs through new experiences;

b) *imitation of others' success*, whereby individuals utilize the experience of others; and

c) *response reinforcement*, whereby individuals confirm previous choices in cases of positive outcomes and change preferences according to negative outcomes over successive rounds.

Although even some rational models have considered such behaviours, learning theory as applied to voters' choices has been developed recently as an independent explanation.

The simplest algorithm in this framework is that of reinforcement learning. This algorithm assumes that individuals look to their past experiences in order to confirm or inform changes in their behaviour. More specifically, for a given aspiration level, individuals are more likely to choose strategies that produce satisfactory payoffs. Such a process does not require individuals to have full information about the game structure or about the behaviour of other players.

4.1 Learning models and turnout.

Learning theory differs from traditional rational theories of voting behaviour in assuming that individuals adapt their behaviour over successive elections on the basis of a level of satisfaction. Kanazawa (1998) builds on the Flache and Macy (Flache and Macy 2002, Macy 1990, 1993, Macy and Flache 1995) studies of bounded rationality and stochastic learning processes. Flache and Macy strongly challenge the rational framework, arguing that, generally, many individuals are not fully capable of performing a rational calculus. To the contrary, they suggest that individual choices may stem from the observation of past experience and the outcome of collective actions. Under this assumption, they model the stochastic learning process as a generalization of the Bush and Mosteller (1955) model applied to collective actions. Individuals are assumed to be backward-looking learners rather than forward-looking maximisers. This implies that individuals perceive the correlation between actions and outcomes rather than the causal link. They simply understand outcomes as a reinforcement or punishment for their behaviour. Kanazawa applies this framework to voting behaviour, trying to find a link between Macy's point and traditional rational choice theory. According to Kanazawa, individuals adapt their behaviour depending on election outcomes, on one hand, and on the other hand, these individuals still perform an instrumental calculus. That is to say, Kanazawa (1998) models the traditional calculus of voting by redefining the p and D term and applying the stochastic learning process, defined as "Win-stay, Lose-shift" (or stochastic learning in voting). He argues that because individuals may not calculate *ex ante* the probability of being pivotal voters, their true p is the probability that their previous behaviour was associated with a win. At the same time, election outcomes reinforce or weaken individual senses of civic duty (the D term). Hence, the adjustment process works for both p and D but at different speeds. As a consequence, voters who have voted for the winning candidate will increase their probability of turning out for the next election, while those who voted for the loser will decrease their propensity to vote (and the same logic governs the behaviour of individuals who abstain). Finally, Kanazawa (1998, 2000) provides econometrical evidence for the stochastic learning model. Kanazawa (2000) presents results from a logistic regression using pooled data from the GSS dataset (USA). Unfortunately, the regression outcome looks ambiguous, and Martin and Shieh (2003) suggest that Kanazawa's (1998) findings critically depend on coding irregularities and sample selection. They replicate Kanazawa's estimations but do not find evidence of Stochastic Learning in voting.

As in Kanazawa (2000), the learning process described by Collins and Kumar et al. (2009) depends on whether individuals have previously voted and whether their party won. Equilibria are derived by aggregating the corresponding variables. Positive turnout levels are confirmed, but there is no link with the traditional rational framework.

Bendor and Diermeier (2003) model an adaptation process that combines reinforcement learning and endogenous aspiration. Here, voters are split into two groups with regard to political preferences. Each individual, at time t, has a starting propensity to vote denoted by p_{it} and an aspiration level a_{it}. Propensity probabilistically determines who votes and who is the winner at time t. Then, given positive voting costs and a benefit b>c for the winners, individuals compare obtained payoffs (π_{it}) and aspiration levels and eventually adjust their propensities in the next stage. The adjustment direction depends on the received feedback. The aspiration-based adjustment rule (ABAR) is defined as follows[3]:

In their computational application, the authors also allow for individuals to be partially or fully inertial. That is, individuals adjust aspiration with exogenous defined probability and propensity with an exogenous probability . Previous election feedback affects individual propensity through a reinforcement mechanism that was first derived by Bush and Mosteller (1955).

Further, they run computational simulations in order to determine long-run equilibria. Positive turnout levels result, even when considering positive voting costs. The model is able to capture and explain a broader set of stylized facts, dealing also with civic duty and unrealistic aspirations. Nevertheless, Fowler (2006) rejects the use of the Bush-Mosteller reinforcement rule because it leads to a biased outcome. The reinforcement rule, indeed, has incoherent effects on the individual propensity to vote so that individuals engage in casual voting. This bias occurs because adaptation varies with the initial level of . Moreover, casual voting conflicts with empirical evidence on habitual voting. The latter can be viewed as an alternative dynamic explanation for voting still based on a reinforcement rule (Plutzer 2002). In this case, however, the reinforcement rule is based not on a learning process but rather on voting reinforcement. Voters do not learn the best strategy

[3] This is a simplified version of the adaptation conditions. In the original version, the adjustment process is limited by some exogenous propensity barriers.

based on the effect that voting has on their psychological status or through an evolutionary process. Under HV assumptions, voting is a process of habit formation, and past experience in voting reinforces individual behaviour. If a voter has previously voted then she will increase her propensity to vote, and the converse holds if she has abstained. Thus, HV suffers from the same limitation in its civic duty solution, simply allowing civic duty to be a dynamic process increasing (or decreasing) over time. Although this solution has received much empirical support both through econometrical models (Plutzer 2002, Gerber et al. 2003) and experiments (Gerber et al. 2008, Green and Sachar 2000), it remains poor in explanatory power. On one hand, it confirms individual behaviour as an evolving process where dynamics play a relevant role. On the other hand, it definitively rejects the hypothesis of a relationship between voting and the political sphere, thus considering only the psychological effect. This occurs for two reasons. First, although a reinforcement process is confirmed, it is not related to the political context or to the feedback effect of the political outcome of individual behaviour. And secondly, by considering individual choices to be restricted to only two alternatives (voting or abstaining), it totally excludes the possibility that individual behaviour could somehow depend on a fuller range alternatives. According to Tillman (2008) and Greene (2009), all the solutions that do not allow the act of voting to depend on a full set of choices are biased because they indirectly assume that all the solutions are equivalent for all individuals.

However, the concept of habitual voting may helps as it confirms the need for a dynamic modelling of voter behaviour.

Martorana and Mazza (2012) provide an empirical work exploring voters' persistence in choices. Voters are backward-looking adapters and behave on the basis of variations in their economic status. The authors derive an outcome-based learning mechanism based on the following assumptions: (a) people expect that the party they (do not) support will be (un)able to bring economic improvements; (b) In between elections they receive a feedback whose impact depends on the consistency between their last voting behavior and personal economic improvements (or worsening) from the last election; (c) a consistent feedback occurs when, as a result of incumbent's policies, income variation in between elections meets individual aspirations; (d) In turn, voters confirm their previous voting choices if the feedback is consistent and tend to discard choices associated to an inconsistent feedback. Assuming political preferences not to be exogenous, the authors show that individual choices can be modelled by linking the adjustment of preferences to variations in individual economic wellbeing.

Diermeier and Mieghem (2008) and Demichelis and Dhillon (2010) are examples of game theoretical models that apply a learning voter approach. In both models, individuals use past election outcomes or polls in order to estimate the behaviour of other voters and then act accordingly, still performing the instrumental (cost-benefit) calculus. In both the models, individuals have only bounded rationality. In Diermeier and Mieghem (2008), agents receive noisy signals through opinion polls. The results show that even a relatively small amount of noise is critical and may generate substantial turnout levels. However, turnout levels are not monotonic in terms of noise level, so turnout may fall considerably in the presence of high noise in polls. In large populations and in the absence of any uncertainty, the participation game leads to vanishing turnout, as in the classic game-theoretical models (except in the case of exactly equal factions). Substantial turnout levels, in this case, require a high level of noise, a low cost-benefit ratio and some degree of closeness in the election. The model also explores the hypothesis, suggested by Aldrich (1993), that individual behaviour may not fully respond to cost-benefit calculations. The results show that action noise, as well as polling noise, leads to positive and high turnout levels. Moreover, a key insight of this model, for our purposes, is that the bounded rationality assumption is not sufficient, in a game-theoretical setting, to solve the paradox of not voting. High levels of turnout require a stochastic component in voter modelling.

The Demichelis and Dhillon (2010) model is based on the calculus of voting, and voting propensity strictly depends on the probability of the vote being pivotal. Individuals use past election outcomes or opinion polls to adjust their expectations about the closeness of elections. Generally, the model predicts multiple equilibria: full turnout, high turnout, low turnout and zero turnout. It compares mixed strategy equilibria under both complete and incomplete information. In both cases, positive (but low) turnout levels may occur according to the values of parameters. Strategies are evaluated in terms of stability in the long run. While this model, like many game theoretic models, is not suited to large populations, it gives many interesting insights and explains several stylized facts. Turnout is decreases with voting costs and population size. Moreover, the model's predictions are consistent with the observed decline of turnout levels in western democracies.

Landi and Sodini (2010) apply the insights of previous papers and add social conformism to the calculus. In their dynamic model (like the previous two models), individuals use past turnout in order to generate expectations regarding turnout in the next election. In turn, individuals measure both the marginal costs and benefits of voting on the basis of these expectations. Final voting decisions may also depend on individual preferences regarding conformism. Conformist behaviour may act as a counterforce with respect to the traditional cost-benefit analysis.

These last three models represent two alternative ways of modelling voter behaviour as a participation game under bounded rationality, by assuming some learning mechanism. Although these models are quite different, they explore the voting paradox from the same point of view, and they both predict positive turnout levels under specific conditions.

5. Concluding remarks.

Rational models of turnout apply an economic approach to political behaviour. To date, many improvements in modelling have been proposed in attempts to solve the paradox of not voting that occurs as a result of the apparent fact that the low probability of casting a pivotal vote in a large electorate means that voting costs will always overcome benefits. That is, individuals should rationally abstain from voting. Some researchers suggest that individuals may receive a consumption benefit from the act of voting itself. Others have focused their attention on the empirical realization of C and p.

Two other solutions, recently developed, explain the reported positive turnouts. These are the Evolutionary and Learning voting models. The dynamic approach sheds a new light on political participation because it captures the time-varying aspect of political preferences and provides realistic predictions about how individuals will behave.

Although EV and LV are not without limits in modelling such a complex phenomenon, they seem to be the most promising frameworks for predicting consistent levels of turnout and explaining several noted stylized facts.

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