Adaptive voting: an empirical analysis of participation and choice

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Abstract.

Dynamic models of learning and adaptation have provided realistic predictions in terms of voting behavior. This study aims at contributing to their empirical verification by investigating voting behavior in terms of participation as well as choice. We test through panel data methods an outcome-based learning mechanism based on the following assumptions: (a) people expect that the party they do not support will be unable to bring economic improvements; (b) 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) they tend to discard choices associated to an inconsistent feedback. Results show that feedbacks of this sort affect persistence of voting behavior, interpreted as participation and voting choice. Age and trade union affiliation reinforce this adaptive behavior. The analysis also investigates the intensity of the learning feedback, differentiating between a strong inconsistent feedback, which leads to a vote switch in favor of the opponent party, and a weak inconsistent feedback, which induces just abstention rather than a vote switch.

Keywords: voting, bounded rationality, learning, political accountability.

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1. Introduction

The analysis of voting behavior focuses on two main questions, *why* people vote and - if they do vote - *how* they vote. The first question leads to the well-known voting paradox (Downs, 1957; Riker and Ordeshook, 1968). If individuals are rational and voting is purely instrumental, voting turnout should be negligible since the probability of casting the decisive vote and then the expected benefits from voting are close to nil, for non-negligible voting costs. An extensive literature, both theoretical and empirical, has investigated different ways to go around this dilemma and to explain observed voting turnout that is sensibly higher than predicted by the so-called calculus of voting. Two main approaches emerge. One maintains the assumption of fully rational forward-looking voters and tries to escape from the voting paradox by making endogenous either the benefits of voting or the probability of a voter to be decisive.[1] A second approach, followed in this study, presumes bounded rationality and adaptive behavior. Within the latter class of voting models, learning voting (LV) and evolutionary voting (EV) models have in common bounded rationality and time-dependence: they assume that agents learn how to behave from past experiences.[2] In LV models, agents are autonomous and adaptation is driven at the individual level (see, e.g.: Sieg and Schulz, 1995; Kanazawa 1998, 2000; Bendor 2001; Bendor et al., 2003): agents adapt over time according to their and others' experience (Selten, 1991; Fudenberg and Levine, 1998). EV models, on the contrary, assume that evolution is driven at an aggregate level (see Linzer and Honaker, 2003 and Conley and Toossi, 2006). LV and EV models have received a growing attention for their ability to overcome part of the limits showed by traditional, static, rational models in predicting observed turnout levels. Both classes of models share with voting participation models the assumption that individual preferences for candidates are exogenous. Therefore, their focus is almost exclusively on the act of voting. However, in a dynamic perspective, a perfectly reasonable

[1] With fully rational voters, a simple solution to the paradox would be that individuals are driven by a consumption benefit associated to the act of voting itself This approach has some conceptual limits, in spite of the received empirical support (Blais and Young, 2000). Mueller (2003) and Aldrich (1993; 1997) argue that this solution is inevitably tautological, as individuals end up voting when they feel they should vote. Alternatively, rational individuals may also regret not having voted. The minimax regret (Ferejohn and Fiorina, 1974) states that individuals try to minimize the regret they could have by choosing the wrong option. However, the minimax regret leads to rather unrealistic, ultra-cautious individual behavior. Other solutions predicting a positive levels of turnout, within the fully rational framework, include game-theoretical models (Ledyard, 1984; Palfrey and Rosenthal, 1983, 1985) and group-based models (Ulhaner, 1989; Coate and Conlin, 2004; Fowler, 2005; Feddersen and Sandroni, 2006). Theoretical and empirical surveys of rational solutions are provided, among others, by Blais (2000), Blais and Young (2000), Mueller (2003), Feddersen (2004) and Geys (2006).

[2] A well-known example of individual-based stochastic learning process is developed by Macy (1990, 1993, 1995).

presumption would be that people could adjust both their willingness to vote and voting preferences along successive elections.

That leads to the second question regarding the variables influencing the way in which people vote. If people vote and are not fully partisan – in which case they will never switch to a different party – we can again distinguish two basic hypotheses about the perspective adopted when they cast their vote: prospective versus retrospective voting.[3] With prospective voting, individuals vote according to the expectations about future conditions. This behavior, consistent with the hypothesis of fully rational voters, is particularly relevant when voters have little experience about the performance of the candidates or when they are unable to attribute the responsibility of previous outcome to specific political actors. On the contrary, retrospective voting assumes that voters evaluate the performance of the past government. This is the hypothesis behind LV and EV models as well as pocketbook voting, which presumes that voters reward (punish) the incumbent with their vote when they are (dis)satisfied with their individual or household economic conditions (see Lewis-Beck and Stegmaier, 2007).[4] The model used in the present study refers to such conditions.

In general, it is reasonable to expect that the previous two questions regarding voting behavior intertwine. The decision of abstaining rather than voting may well depend on the alternatives the voters face and the preferences they intend to express. For example, this is what the well-known hypotheses of abstention for alienation or indifference suggest, assuming prospective voting by rational voters (see Mueller, 2003). From a standpoint of retrospective voting and adaptive behavior, a voter reacts to feedbacks coming from the previous period. For example, dissatisfaction about politics or a party previously supported may induce a 'partisan' voter to abstain as a form of punishment.

In this paper, we investigate voting behavior in terms of participation as well as choice. To reach this goal we test an outcome-based learning mechanism, sharing the assumption of bounded rationality and the focus on individual choices with LV models. In particular, we make three conjectures: (a) people expect that the party they do not support will be unable to bring economic improvements (and this applies also to those who abstained); (b) people receive a feedback whose impact depends on the consistency between their last voting behavior - including abstention - and personal economic improvements (or worsening) from last election; (c) people tend not to replicate

[3] A vast number of econometric studies have compared prospective versus retrospective voting providing support for both hypotheses (see, for example, Lewis-Beck and Stegmaier, 2007).

[4] The link between political decision-making and economic performance is central in the political economy literature. Here we do not deal with the determinants of political accountability. We just admit that individual (dis)satisfaction with a party politics may affect voting. Moreover, the voter may refer, both in prospective and retrospective voting, either to individual (egotropic voting) or to social economic conditions (sociotropic voting).

the choice associated to an inconsistent feedback. In conclusion, we suggest a dynamic model where voters are retrospective adapters and behave according to the pocketbook voting assumption.

An encompassing model of voting behavior, including both the decision of voting and the choice of candidate has hardly been analyzed empirically. An exception is Fort and Bunn (1998) showing that the presence of sensible hurdles to overcome in order to cast a vote in referenda on nuclear power supply causes a selection of voters with strong (anti-nuclear) preferences. Unlike that study, we consider national elections that may not elicit massive participation of specific narrow interest groups and do not imply special procedures increasing voting costs. Data are from the British Household Panel Survey (BHPS). This is a longitudinal study of individuals in household units in Great Britain. It includes more than 9000 individuals and households for eighteen waves (1991-2008). The BHPS does not provide as many information about political attitudes as Political datasets usually do, but it allows us to employ a panel analysis including four election years (1992, 1997, 2001, 2005) and three electoral cycles. According to Uhrig (2008), attrition occurs mainly between the first two waves while it is negligible in the rest of the panel set. However, as our research question refers to elections according to in-time characteristics there are no reasons for using information belonging to the first wave.

Results show that voting behavior has an adaptive component that depends on a feedback linked to past voting behavior and changes in individual economic status. A consistent feedback does increase (decrease) the probability of confirming (changing) a previous choice. Age and trade union affiliation reinforce this adaptive behavior. Interestingly, positive economic feedbacks are not sufficient to affect future behavior. Individuals do compare this outcome with their previous behavior and take into account the consistency between the two. Notice that consistency is a positive feedback that does not imply that individual economic conditions have improved for the voter. For example, a worsening of her economic status reinforces the choice of not having voted for the incumbent, or of not having voted at all. Correspondingly, for such a voter, individual economic improvements represent an inconsistent feedback encouraging a switch of her behavior. Moreover, we investigate the intensity of the learning feedback, differentiating between a strong (inconsistent) feedback that implies a vote for the opponent party and a weak feedback inducing just abstention rather than a vote switch. This analysis represents an additional novel aspect that relates this study also to expressive voting (Hillman, 2010). Results show that age and union membership increase the preference for switching rather than abstaining, in presence of inconsistent feedback. Moreover, high-educated people prefer the strong punishment while low-educated people tend to abstain rather than voting for another party.

Relatively to the methodology, we employ an econometric model that meets Greene (2009) suggestions about consistency in turnout models; namely that they are biased because the fail linking the decisions of whether and how to vote.[5]

The model of voting behavior that we estimate relates to two dynamic analyses of turnout that evoke the learning mechanism due to Bush and Mosteller (1955) and offering empirical support for retrospective and adaptive voting. Firstly, the analysis by Kanazawa (1998, 2000) applies the stochastic learning model developed by Macy (1990, 1993, 1995), which in turn relates to Bush and Mosteller (1955). Voters are assumed to see a correlation - but not a causality - between the collective action outcome (in this case, voting turnout) and their contribution. Following a "win-stay" "lose-shift" strategy, voters are more likely to vote when they voted for the winning candidate and previous non-voters are more likely to vote when they did not support the winning candidate. Stochastic learning of normative behavior provides a behavioral underpinning to the 'civic duty' explanation for voting participation by rational actors. Kanazawa (1998; 2000) finds empirical support for this model by examining the USA Presidential elections. Secondly, our paper relates to Bendor, et al. (2003) and Collins et al. (2009). In particular, Bendor et al. (2003) aspiration-based-adaptation rule (ABAR), described in further detail in the next section, inspires the model presented and tested in this paper. In Bendor et al. (2003), adaptively rational individuals are today more (less) likely to repeat actions that were (un)successful yesterday. Adaptation proceeds through the comparison between the outcome of an action and an aspiration level. This comparison produces a feedback for future propensity and adjustment of aspirations. By simulation, the Authors show a substantial turnout. Collins et al. (2009) present a similar model but exclude adaptive aspirations in order to obtain explicit solutions. Voters and non-voters (shirkers) are assumed to have a propensity to vote or not depending on whether their party won previous election. Changes in propensity to vote are determined by adjustments in the subjective probability to be pivotal, since voters cannot change their preferences.

Comparing with the above studies, ours introduces a richer choice set for the voters, who may switch their voting preferences but also abstain (or vote for a third party). Those decisions are then evaluated with respect to the outcome of previous elections. Two important implications derive. First, we presume that people decide to vote, rather than to abstain, having in mind their voting preferences. Second, both participation and preferences are viewed as influenced by past politics, under a dynamic perspective: preferences may vary along successive elections and voters may

[5] Few works on voter behavior meet such condition. See for example Jones and Hudson (2000) and Adams et al. (2005).

decide to change the behavior if they are dissatisfied with party politics. For the above reasons, we think that our study offers a fresh view to the analysis of adaptive voting behavior.

The paper is organized as follows. Section 2 illustrates the characteristics of the dynamic approach of learning and adaption used in the econometric model. Section 3 presents the model based on an outcome-based learning algorithm. In section 4, we discuss our findings. In section 5, we explore the intensity of the learning feedback, differentiating between strong and weak feedbacks by adopting a sequential logit approach. Few comments in Section 6 conclude the paper.

2. A dynamic approach to the empirical analysis of voting behavior

Solutions with full or bounded rational voters generally fail modeling the act of voting as an outcome-based process. In contrast with this tendency, Bendor et al. (2003) develop a model where each individual i, at time t, has a starting propensity to vote denoted by p_{it} and an aspiration level a_{it}. Individuals compare the payoffs obtained at time t, namely π_{it}, with the exogenous aspiration levels a_{it} and eventually adjust their propensity and aspiration in the next stage. For a winning candidate j, an individual i has voting costs c_{ij} and a payoff: $b_{ij} > 0$ if the candidate j wins, and zero otherwise. The adjustment direction depends on the received feedback, according to the following aspiration-based adjustment rule (ABAR):

(1)

From (1), voting behavior depends on an adaptive process that confronts the election outcome with aspirations affected by the incumbent's policy in the previous period. This effect adds to an inertial component that reminds of habitual voting (HV).[6]

In the next section, we explore this hypothesis and show that voters may change their habits when they receive feedbacks in contrast with their previous choices. Following Bendor et al. (2003; 2008), we develop a dynamic learning algorithm where voting choices are driven by individual ex-

[6] HV can be interpreted as an alternative dynamic explanation for voting still based on a reinforcement rule, although not based on a learning process, as in our study, but rather on voting reinforcement itself. In spite of some empirical evidences (Green and Shachar, 2000; Gerber et al., 2003), confirming that individual behavior follows a dynamic process, HV presents a major shortcoming because it disregards the relation between voting and the political and economic situation. Our analysis offers a generalization that aims at overcoming this limit.

post perceptions about parties' platforms and policies. Moreover, we adopt a model specification that introduces a proxy for (π_{it}-a_{it}).

Generally, empirical voter models are developed in a cross sectional static settings as either turnout models, which endogenize the individual decision of voting or abstaining for given preferences about parties, or voter choice models, which examine the choice of a voter over the alternatives for given preferences about participation.[7] In these studies, decisions on *whether and how* to vote are neither simultaneous nor correlated. A similar assumption is clearly unrealistic (see Tillman, 2008). A correct analysis on voting behavior should take into account that individuals face these two problems at the same time, and they choose whether voting or not also according to their evaluation of the alternatives (see Fort and Bunn, 1998). The same problem can be explored from an econometric point of view, by using Greene's (2009) remark: a discrete choice model choice assumes that individuals make always a choice when they face a choice situation. This is a basic and strong statement assumption, which leads to biased results if violated. At election time, individuals face the choice between abstaining or voting for one of the available options. Thus, turnout models (overlooking the available alternatives, should a vote be cast) or electoral models of party choice (overlooking the option of abstaining) are biased. In order to study voting behavior we need another dependent variable.

Although Multinomial responses are commonly explored by using Multinomial *Logit* (MNL) or *Probit* (MNP), these methods only work in a cross-sectional setting. We choose to use a dependent variable that directly refers to the response reinforcement process, presuming that individuals confirm their party choice or abstention, in two consecutive elections, if they think they made the best choice; otherwise they change their choice, if that contributed to a disappointing outcome. Such dependent variable (persistence) is a dummy taking the value 1 if a voter confirms previous choice (either voting for the Labour party, or for the Conservative party, or for a third party – such as Liberal Democrats - or abstaining) and 0 if she changes her choice.

We borrow from learning models the assumption that individuals learn through trial and error. In general, a learning process should work better when individuals play a reasonable number of games, or elections in this case. Young voters are expected to change their behavior more often than elders, for a given political context. Thus, the probability of confirming the previous choice is increasing in individual lifetime.[8] However, we argue that voting behavior reflects more than just habitual behavior. According to an outcome based reinforcing process, the probability of confirming a previous voting choice depends retrospectively on a feedback whose sign is determined by the

[7] Exceptions are Plutzer (2002) and Denny and Doyle (2009) analyzing turnout in a dynamic setting.
[8] For the positive impact of age on participation, see Meredith (2009).

consistency between the voter's expectations of economic outcome in between elections, and the actual (or perceived) variation in the voter's economic status. Voters expect that an incumbent they voted will determine an improvement, unlikely an incumbent they have not voted.

There are several available measures of economic status. We adopt objective as well as subjective indicators. According to Sieg and Schulz (1995), who suggest that voters vary their strategy to obtain higher *relative* income, we consider a move to a higher quintile or decile of the income distribution of population equivalent to an economic improvement. In addition, we conduct our analysis also using a subjective perception of a change in personal wellbeing. This additional source could be more relevant for voting behavior than the previous ones, if voters miscalculate changes in their economic status or if they evaluate the past with a systematic bias in line with their political preferences, as indicated by Anderson et al. (2004).[9] Notice that our learning mechanism does not explain why people start voting. It only addresses the dynamics of voters' participation, conjecturing that people tend to replicate actions that are related to personal improvements and to abandon those actions that are linked to reduction of personal wellbeing. Because of this presumption, we do not need to specify whether individuals believe their behavior at previous elections *actually caused* the subsequent economic outcome.

The evaluation of past policies in terms of individual wellbeing seems reasonable when we think of the bulk of laws targeting income redistribution, directly or indirectly. Voting behavior linked to income variations is also consistent with the assumption of instrumental voting of traditional models with rational voters. However, instrumental voting is measured as the benefit expected in the future from the winner of current elections. In a bounded-rationality context, though, voters do not perform a "forward-looking" *cost-benefit* calculus but adjust their behavior according to feedbacks.

3. The model

Consider any individual i in a population N facing $E=(e_0, \ldots, e_t, \ldots, e_T)$ consecutive elections. At election e_0 (year 1992, in our study) individual i faces the problem of deciding whether voting or not and, eventually, how to vote. In line with the ABAR of Bendor et al. (2003), we assume that voters adaptively adjust their behavior depending on a feedback they receive from previous behavior and social characteristics, like age. Assume the following model

[9] See also Lewis-Beck and Stegmaier (2007) for the potential endogeneity of perceptions.

(2)

where is the latent unobserved individual propensity to confirm her previous choice (i.e., the propensity that individual *i*'s choice at e_{t-1} is confirmed at e_t). The variable is the feedback for *i* at time *t*, namely a binary variable evaluated according to the consistency between *i*'s voting behavior in the previous election and the variation of *i*'s economic condition between e_{t-1} and e_t (see below). Moreover, is the age of *i* at e_t, as a proxy for the number of elections faced, and a set of individual characteristics and is the error term. The error term can be decomposed in an individual unobservable heterogeneity (u_i) and a random term ( ), which is assumed to be normally distributed and independent of x_{it}. In order to treat such unobservable element we adopt a Mundlak approach consisting in approximating u_i as a function of the individual means of time-varying covariates (x_{it}), as suggested by Denny and Doyle (2009); that is:

(3)

In conclusion, the latent variable model is:

where (4)

and *i* confirms her previous choice if her latent propensity is positive; that is , if >0 and 0 otherwise, namely:

(5)

where F(·) is the distribution function of the error term that we assume to be logistic. In addition, we estimate bootstrapped standars errors with 100 replications. To map the effect of election outcomes into individual welfare, we define the feedback index $f_{i,t}$. This index is outcome based since it depends on the comparison between the voting behavior in the last election and the variation in the economic condition of *i* in between two consecutive elections. We adopt three different measures of economic variation, deriving three alternative feedback indexes. The first measure is "perception-based" and defines income deviation as the difference in individual perceptions about economical

status between the year of election and the previous year.[10] The second ("quintile-based") measure of change in *i*'s economic condition indicates a move, between the years of two consecutive elections, of *i*'s income to a different quintile of income distribution. The last ("decile-based") measure differs from the previous one only because it considers changes in income decile, focusing on less significant income variations.[11] This outcome is then confronted with *i*'s voting behavior in previous election to determine a predictor for electoral behavior (see also Kanazawa 1998, 2000). Thus, voting does not depend exclusively on previous voting behavior, as in HV models for example. The feedback index $f_{i,t}$ assumes the following values:

1) $f_{i.t}=1$ (*consistent feedback*) if *i* voted for the winner and her income variation is not negative; or if *i* either voted for the loser and her income variation is not positive; or if *i* voted for a third party or abstained and income decreased.

2) $f_{i,t}=0$ (*inconsistent feedback*) if *i* voted for the winner and her income variation is negative; or if *i* voted either for the loser or a third party or abstained and her income variation is positive; or if *i* voted for a third party or abstained and there is not variation in income.

Values of the feedback index are then summarized in Table 1. Rows indicate the change in income, which can be either perceived (with respect to the previous year) or effective (in between elections). Columns refer to voting in the previous election: a subject either voted for the winning party/candidate or for the loser one or she abstained.

Table 1: outcome-based feedback index.

	Winner	**Third/abstain**	**Loser**
Increased income	1	0	0
Unchanged income	1	0	1
Decreased income	0	1	1

It is evident that if *i* voted for the winner (first column) and income has increased, this economic variation provides a consistent feedback as it reinforces *i*'s voting choice or, at least, does not rebuff

[10] Survey respondents are asked to answer the question: "Would you say that you yourself are better off or worse off financially than you were a year ago?"

[11] We refer to nominal income variatons because we focus on improvements of income class (by quintile or decile). A substantial difference exists between subjective variation in perceived wellbeing and changes in the income distribution quintile (or decile). It is uncertain whether the first measure refers to changes in absolute or relative terms, as it depends on the way people form their judgement. However the quintile-based measure indicates a change in relative terms by construction. Martorana (2011) shows that material and perception based measures of economic deviation are both relevant and determine almost equivalent impacts.

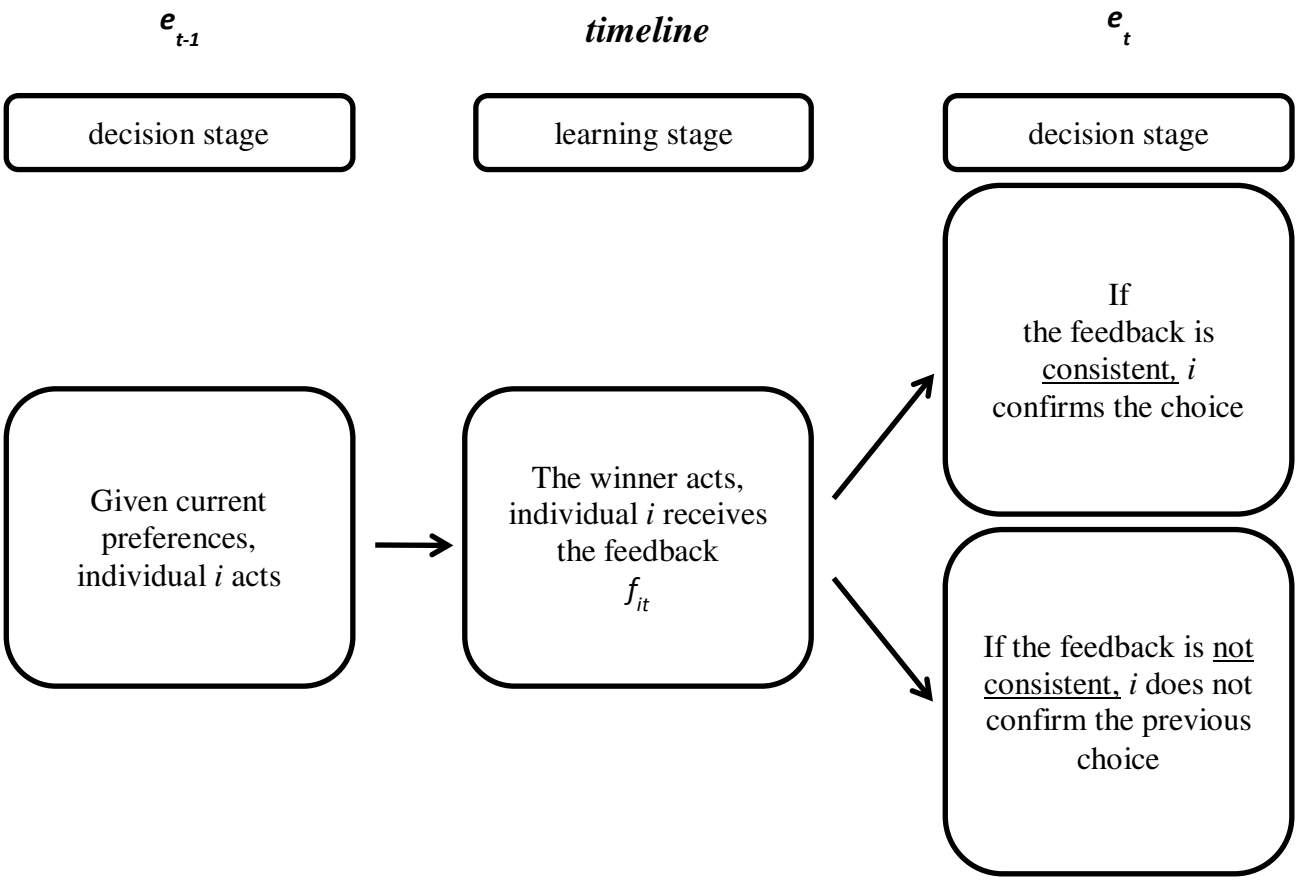
that choice in case of unchanged income.[12] The same reasoning applies if *i* voted for the loser (third column) and income has not increased: she did not pick the winner who was –in her mind- indeed unable or unwilling to choose a favorable policy. On the contrary, the feedback is inconsistent if *i* did not vote for the winner and yet experienced an (unexpected) improvement in income. Finally, in case that *i* voted for a third party or abstained (second column), it is reasonable to think that she did not expect anything but bad news from both potential winners; therefore the feedback is considered inconsistent if income has improved.[13]

We would like to highlight two important aspects of the feedback mechanism. First, the feedback concerns three choices previously made by the individual, namely voting conservative, voting Labour, or abstaining (or voting Liberal). Here voting behavior is richer than previous models on voting, as it includes not only participation but also party choice. In the previous section we explained why assuming that individuals decide to participate to voting disregarding from the political options in the election would lead to a biased result, in addition to seem unrealistic. Second, the feedback is a positive reinforcement only if it is consistent with previous choices. An implication is that even a negative outcome can determine a positive feedback, as in the case when a subject did not vote for the winner of previous elections and thereafter experienced an economic worsening. This outcome reinforces the action in previous election.[14]

[12] The extension of positive sign also to the case of unchanged income is justified by the idea that negligible variations in income distribution do not affect individual political preferences. We argue that political affection may not be modified unless significant income variations occurred, in line with the expressive voter paradigm.

[13] Individuals may learn how to act if facing the same context in repeated rounds. Of course, it does not mean that people do not understand how to move in time-varying world, but we should put this condition for isolating the learning effect. This is rather unrealistic in most countries but probably not in the UK where the political context is relatively stable.

[14] It is useful to emphasize that if a subject abstains at period *t-1* and votes for the third (Liberal) party at period *t*, this behavior is not codified as persistent in our analysis. On the other hand, abstention or a vote for the third party at period *t-1* are considered equivalent when confronted to a (non persistent) vote for the two main parties, at period *t*. Similarly, if a subject votes for one of the two main parties, at period *t-1*, and either abstains or votes for a third party at period *t*, the last choice is anyway codified as a switch.



Our hypothesis about voting behavior has evident links with the ABAR procedure in Bendor et al. (2003). Similarly to the adaptive mechanism described above, they assume that the probability that an individual *i* takes an action at any election round depends on an outcome based feedback elaborated from the comparison between payoff (*w*) and aspirations (*a*) in between elections. In fact, the probability that individual *i*'s choice at election *t-1* is confirmed at time *t* depends on a positive feedback and is equal to 1 and , where is equivalent to the latent variable in (1). Yet there are some differences with respect to that study. Our model mainly focuses on voting persistency rather than participation. Therefore, we also allow voters to switch their voting choice (including abstention) between elections, while Bendor et al. (2003) exogenously attribute a benefit *b* from elections restricted to those who have preferences aligned to the winner, whether they voted or not. An additionl difference is our use of explicit aspiration levels determined by individual economic status and voting behavior at *t-1*. We present estimation outcomes from three models. Model 1 is a voting model including only the perception-based feedback ( ):

(6)

Model 2 includes only quintile-based feedback ( ):

(7)

Model 3 includes only decile-based feedback ( ):

(8)

We apply the Mundlak procedure to these models, controlling for unobservable heterogeneity. Table 2 includes descriptive statistics and the definition of variables.

Table 2. Descriptive statistics and variables description.

Variable	Obs	Mean	Std.dev	Min-max	Variable description
Persistence	21627	.6705	.4700	(0,1)	Dummy variable taking value 1 if *vote at time t-1=vote at time t* and 0 otherwise.
Perception-based feedback ($f^{p}_{i,t}$)	21627	.2892	.8320	(0,1)	See table 1. Economic measure: individual perceptions about variation in economic status in the last year, coded positively (negatively) if individual perceive an improvement (worsening) at time *t*; null otherwise
Quintile-feedback ($f^{q}_{i,t}$)	21627	.3049	.8374	(0,1)	See table 1. Economic measure: coded positively (negatively) if individual quintile$_t$ > (<) individual quintile$_{t-1}$; null otherwise.
Decile-feedback ($f^{d}_{i,t}$)	21627	.2074	.9060	(0,1)	See table 1. Economic measure: coded positively (negatively) if individual decile$_t$ >(<)individual decile$_{t-1}$; null otherwise.
Political attitudes controls	21627			(1,5)	A set of 2 variables based on Likert scale defining individual political attitudes and opinions
Union membership	21627	.1765	.3813	(0,1)	-
Age	21627	47.97	13.91	(21,80)	-
Female	21627	.5474	.4978	(0,1)	-
Region dummies	21627	2.006	.8240	(1,3)	A set of three dummies coding people living in: *north*, *midlands* and *walsct* (Wales and Scotland).
Education dummies	21627	2.094	.5989	(1,3)	Coded as a set of three dummies: *high education* (ISCED 5-6), *intermediate* (ISCED 3-4), *low education* (ISCED 0-2).
Marital status	21627	2.008	1.686	(1.6)	Set of six dummies for marital status.

Persistence (section 5)	21627	1.556	.8368	(1, 2, 3)	variable taking value 1 if vote at time *t-1*=vote at time *t*; value 2 if vote at time *t-1*=vote at time *t* and vote at time *t* =abstention*;* value 3 if vote at time *t-1*=vote at time *t* and vote at time *t* ≠abstention.

4. Results and discussion.

The results of the econometric analysis confirm the main hypothesis regarding the impact of the feedback index on persistency of voting behavior. From Table 3, the feedback shows a significant reinforcing effect in all models. Consistency between previous voting choice and changes in the economic status do affect the probability of confirming the former choice. This feedback on persistency exists both with perceived and effective income changes.

Age shows to have a positive and significant effect on persistency. We expect that habit formation to build up with time and the number of elections a subject experiences. Therefore, voting habit reinforces through time. This result is in line with Meredith (2009) showing that eligibility to vote in US presidential elections has a positive effect on future participation to voting lasting for several elections. In addition, union membership has a positive and significant impact on the probability of confirming previous choice. We expect that union members have a higher propensity to vote and persist than others as shown by the literature on turnout and groups (see, e.g., Uhlaner, 1989; Feddersen and Sandroni, 2006). Common wisdom suggests that unions are a homogeneous entity and often establish a durable alliance with a party (think of some workers' unions and the Labour party, for example).

Other control variables such as gender and education show no significant impact on the probability of confirming previous behavior.

Table 3. Random effects logit estimates: persistence models.

VARIABLES	Model1 (perceived) Pers	Model2 (quintile) pers	Model3 (decile) Pers
Perceived feedback	0.183***		
	(0.0365)		
Quintile feedback		0.188***	
		(0.0366)	
Decile feedback			0.117***
			(0.0363)

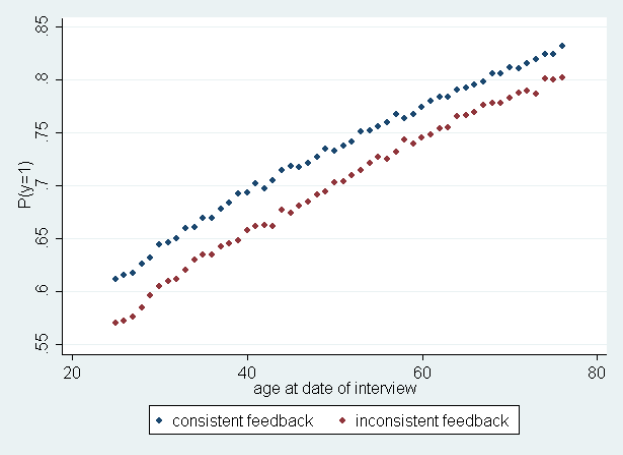
Age	0.0252***	0.0237***	0.0236***
	(0.00654)	(0.00654)	(0.00655)
Union membership	0.131**	0.132**	0.137***
	(0.0517)	(0.0517)	(0.0517)
Female	-0.0518	-0.0487	-0.0497
	(0.0457)	(0.0457)	(0.0458)
High education	-0.0752	-0.0712	-0.0748
	(0.0617)	(0.0617)	(0.0618)
Low education	0.0368	0.0400	0.0389
	(0.0550)	(0.0550)	(0.0551)
Regional dummies	YES	YES	YES
Other controls	YES	YES	YES
Mundlak	YES	YES	YES
Observations	21627	21627	21627
P	.2883	.2867	.2887
χ^2	1716.16	1722.62	1711.06

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

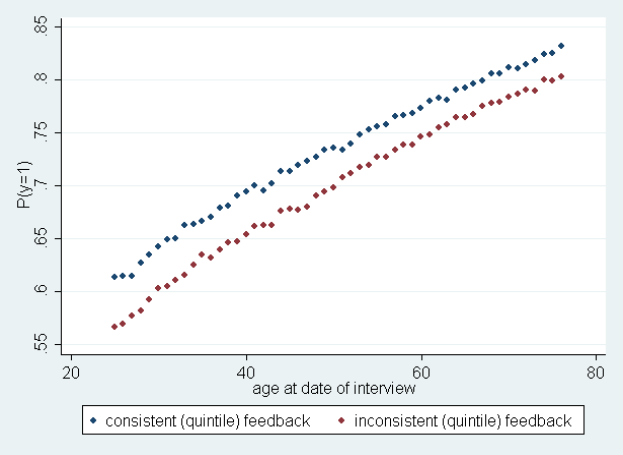
Graphs mapping the predicted probability of a positive outcome on age and feedbacks further describe the main findings. Since results are consistent with respect to all the three measures, we limit ourselves to first two models so that we can compare between the subjective and effective ones. Graph 1A refers to model 1 (with *perception-based* feedback) and Graph 1B to model 2 (*quintile-based* feedback). Blue dots indicate the predicted probability of confirming the previous election's choice for a consistent feedback, while the red dots refer to inconsistent feedback. The vertical distance captures the effect of learning from the feedback on individual propensity. We see that a consistent feedback has an evident larger impact on the probability of repeating the voting behavior of the previous election than an inconsistent feedback, *for any class of age*. This result, summarized below, confirms our predictions about the existence of adaptive behavior in voting driven by economic feedbacks.

Result 1. *For each class of age, the predicted probability of confirming the previous choice, associated to a consistent feedback is higher.*

Graph 1A: perceptions-based.



Graph 1B: quintile-based.



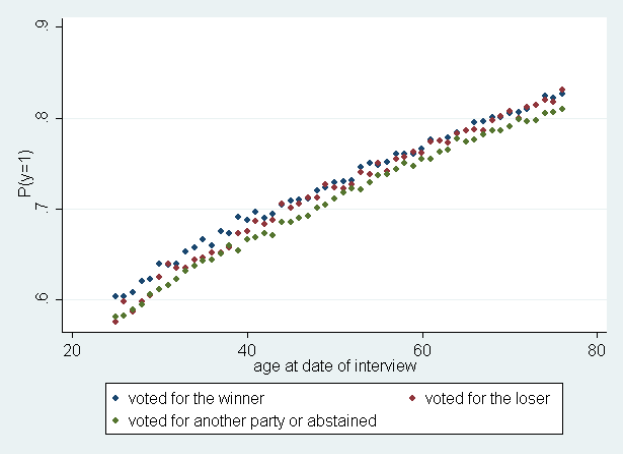
The estimated coefficients show a remarkable similarity between the feedback from perceived economic improvements and that from quintile-based income improvements. In principle, the subjective measure could refer to changes in absolute or relative terms, depending on the criterion people follow to evaluate changes in their wellbeing. On the contrary, the quintile-based measure definitely refers to *relative* advancements in the income distribution. Thus, even a true perception of economic enhancement, for example due to economic growth, does not necessarily imply an increase in the second measure. The strong correspondence between perceptions and income quintile improvements is useful to derive insights regarding the influence of economic trends on elections. In fact, a common tenet is that domestic economic growth will strengthen the candidacy of the incumbent. Since economic growth is likely to contribute to improving the perceptions that people have about their economic conditions (although it may not affect relative positions), the results of our analysis would confirm that tenet. In fact, those who voted for the winner in the previous election will receive a consistent feedback from economic growth contributing to make them confirm hoer previous choice. On the contrary, those who did not vote for incumbent will receive an inconsistent feedback that reduces the persistency of their choices.

In order to qualify Result 1, we verify whether persistency of choice changes according to previous voting preferences, namely if the voter supported in the last election the winner, or the loser (Conservative or Labour) or a third party (or abstained). Since results are very similar among all three models, from now on we limit our analysis to model 1 for simplicity's sake. From Graph 2a we find no relevant difference emerging among the impacts of the three options of voting behavior on persistency. This result should not be surprising. The feedback index is defined in a way that

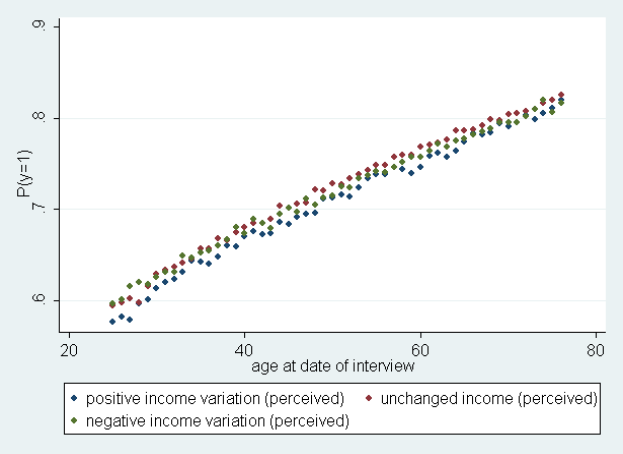
does not make those who voted for the winner more or less likely to confirm their choice than those who voted for the looser, if both parties have equal chance to win next election.
Interestingly, also perceived variation in economic status alone does not seem to have an impact on persistency, as shown by Graph 2b. Combining these two findings, we obtain the following result.

Result 2. *The probability of persisting in choices depends neither on past voting behavior nor on economical variation but only on their interaction*.

Graph 2A. Persistence and past behavior.



Graph 2B. Persistence and perceived variation.

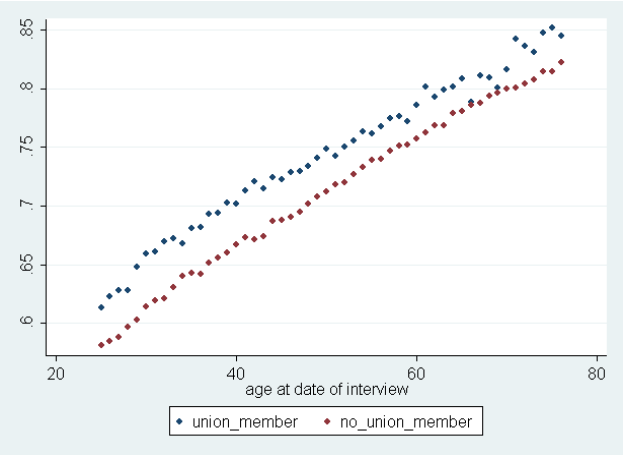


Comparison between Result 1 and Result 2 proves that economic variations alone are not fundamental to ascertain persistency. These results show an adaptive behavior of voters, along elections, influenced by the *consistency* between the economic outcome under the previous legislature and voters' expectations depending on previous voting preferences.
An additional result concerns the effects of unionization on persistence of voting choices. We would expect this impact to be positive from the indications of the studies showing, both theoretically and empirically, how group participation may explain voting participation (see Introduction). If participation to groups compels group members to vote, it is also likely that it will induce voting behavior homogeneous to that of the group and we expect groups to have less volatile voting preferences than individuals. Thus, we expect voters to persist more in their choices when they are union members. This hypothesis corresponds to our findings.

RESULT 3. *Trade union membership positively affects individual probability of persisting in choices.*

Graph 3 shows the relevant impact of union membership on voting persistence. As mentioned, in line with the analysis provided by group-based models, a union member is likely to find more difficult to change her choice because of the homogeneity of interests, the high interior organization and the generally well-defined political representation of the group, often concentrating in one party.

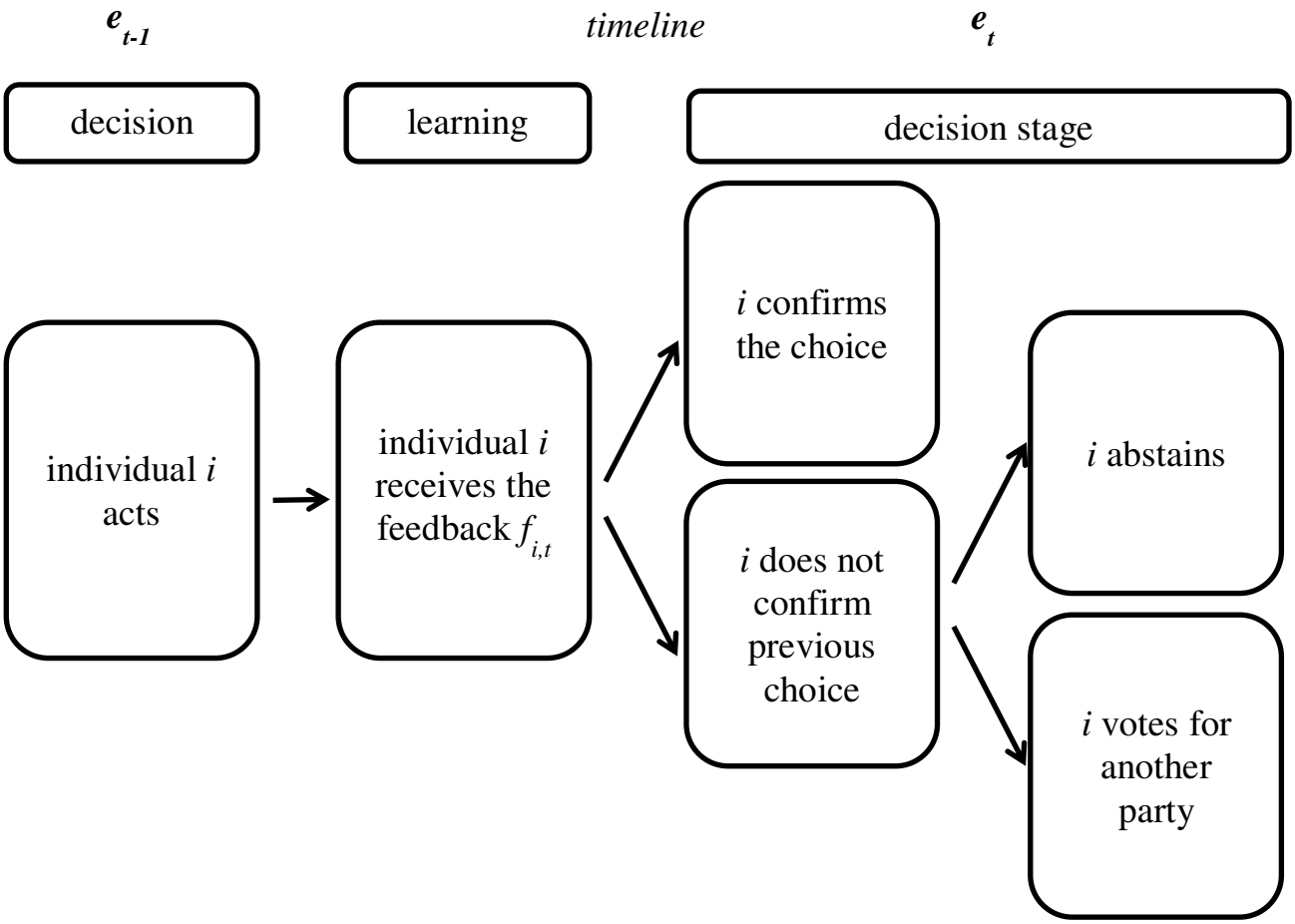
Graph 3. Union membership and persistence.



In conclusion, we can affirm that there is evidence of an adaptive learning process. Results show that voting is more than a habit or a simple self-reinforcing process. The econometric analysis provides strong evidence that previous economic performance has an impact on the decision of voting *and* on the choice of the candidate. Personal economic improvements are judged against previous voting choices. They encourage to confirm previous behavior when this could be considered consistent with the obtained outcome, and to change it when not consistent.

5. Reaction to a feedback.

The results shown so far indicate that individuals tend to confirm their previous choice when they receive a feedback that is consistent with that choice. On the other hand, when feedbacks are inconsistent, previous voters may choose to punish their party for bad policies or to abandon a new party to come back to the old one. While confirming a choice is the only way to express endorsement, voters may choose to abstain *or* swing when they aim at punishing the party they voted in the previous election. In this section, we investigate this option to understand how feedbacks may affect such a decision.



In the model presented in section 3, the feedback is defined in a way to influence the first decision, whether to confirm or not the previous voting (or abstaining) choice. In section 4 we show that this influence is significant.

The timeline described in this section shows a sequence of events including an additional step in the decision stage. With respect to the previous timeline we now have the choice between abstaining and voting for another party (considering that we now restrict our analysis to previous voters only). This additional decision goes beyond the learning process adopted here, with voters adapting their behavior to a binary feedback. The choice of the type of reaction abstracts from adaptive learning and represents an 'expression' of the intensity of reaction. This expressive behavior is likely to depend on personal characteristics whose impact is investigated here.

We fit a sequential logit by using the SEQLOGIT command, developed by Buis (2010), which estimates simultaneously the effect of an explanatory variable on the probabilities of passing a set of transitions. In our decision problem, voters (may) go through a sequence of two transitions. Firstly, they choose between confirming previous choice or not. Secondly, if they do not confirm, they have to choose between abstaining and swinging. While the first decision problem is the one

that we have studied in previous sections, the latter allow us to explore *how* individuals punish their party. We define 'weak punishment' the decision of abstaining at time *t+1* (assuming that the individual voted at time t), while a 'strong punishment' occurs if the voter chooses to vote for a different party. The reason why we distinguish between strong and a weak punishment is quite intuitive: if the voter does not confirm past behavior, as a result of an inconsistent feedback, she can either abstain and reduce by one vote the electoral support for the party supported at time *t* or she can increase the votes for a competitor.

The choice between strong and weak punishment may depend not only on the personal characteristics of the voters, as suggested earlier, but also on the personal bond with the party voted before. A traditional supporter of that party may find 'morally' difficult to adopt a strong punishment and vote for the opponent. On the contrary, voters without personal attachment for that party may more easily opt for a 'strong' punishment. Notice, moreover, that this 'expressive' behavior may also be in contrast with the 'material' utility of the voter (Hillman, 2010).

For the reasons just described, and for the fact that the feedback index is not designed to make a difference between weak and strong punishment we expect that feedbacks have an impact on the first transition (confirm/do not confirm) but not on the second transition (abstain/switch).

Moreover, we expect that elders opt for a stronger punishment. The reason is that voting is positively related to age, possibly because of higher sense of civic duty (see Martorana and Mazza, 2011), and then elders tend to switch preferences rather than abstaining, in presence of inconsistent feedbacks. Education, on the other hand, may imply more 'sophisticate' voting, with voters behaving strategically and sending a signal through a strong punishment.

The sequential logit model performs multiple logit estimations according to a transition tree that summarizes the decision path for each individual. We can then modify the decision tree by including the new transition. Unobserved heterogeneity is modeled by assuming a fixed (between transitions) and normally distributed effect with mean 0 and standard deviation 0.05 and estimate clustered (by households) standard errors.[15]

We restrict our analysis on the perceived-based feedback since, as shown in previous sections, results are consistent with both perceived and objective feedbacks. The dependent variable in this section is defined in a way to distinguish between weak and strong punishment: y_{it} takes value 1 if the voter confirms the choice, value 2 if the voter does not confirm and abstains, value 3 if the voter switches. Table 3 shows the two transitions: the first one replicates previous estimation on persistence (value 1 against value 2 and 3), the last one estimates the effect of covariates on those who do not confirm (value 2 against value 3). Notice that we estimate the model on the subsample

[15] In appendix A(4) we show how results are sensitive to different hypothetical values of standard deviation.

of those who did not abstain at t-1. Finally, unlike the previous section, where we estimate a random effects logit model, here we fit a pooled logit.

Table 3. Sequential pooled logit estimates

VARIABLES	(1) Persist vs not persist	(2) Abstain vs vote for another party
Perceived feedback	0.0636***	-0.0224
	(0.0207)	(0.0358)
Age	0.0250***	-0.0372***
	(0.00169)	(0.00295)
Union membership	0.245***	-0.274***
	(0.0460)	(0.0824)
Female	-0.00576	-0.170***
	(0.0353)	(0.0615)
High education	0.147***	-0.358***
	(0.0533)	(0.0937)
Low education	0.0110	0.521***
	(0.0476)	(0.0828)
Regional dummies	YES	YES
Other controls	YES	YES
Observations	17077	17077

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Results in the first column confirm those discussed in the previous section. The only difference is given by the variable high education that now turns out to be significant. This discrepancy is due the fact that now we consider a subsample of voters (those who abstained at e_{t-1}) that is not stochastic as previously. Commenting the results of the second transition, we see that the negative sign for age means that elders, who do nor persist in their choice, prefer switching to abstaining. This outcome is consistent with the general result that voting participation increases with age and can be interpreted as the effect of a sense of civic duty pushing for voting anyway, even when the result from previous election did not go in the expected direction.

Union membership shows an impact with the same (negative) sign as age, in the second transition. In our view, this result is consistent with the strong link between politicians and trade unions. In a situation when a trade union feels dissatisfied with the previous political patron then will seek for another one, rather than protesting through abstention.

The variable high education is statistically significant on the punishment decision. Consistent with a hypothesis of sophisticate voting, high-educated voters strongly prefers the full punishment and

low-educated individuals tend to abstain rather than of voting for a different party. Finally, it is interesting to notice that the gender variable has a positive impact on the likelihood to choose a strong punishment in presence of an inconsistent feedback.

6. Concluding comments

This study has provided an empirical analysis of a dynamic model of voting as an outcome based process. Voters learn and adapt from a feedback determined by a combination of previous voting, the electoral outcome of past elections and the changes in economic satisfaction associated to the period between elections. Regarding the feedback, a distinction has been made between perceived variation in individual economic conditions and real changes of income quintile.

This study presents two main novelties with respect to most models on voting behavior. First, it allows voting preferences to adapt along elections, according to a feedback derived from the consistency between previous voting behavior and personal economic changes in between elections. This contrasts with previous analysis generally presuming given preferences. Second, the presented dynamic model connects the decisions of voting participation with those concerning the support for a party. In this way, it deals with the criticism of Greene (2009) about consistency in turnout models. This approach may also provide new interesting insights for further explorations on the voting paradox. In particular, the outcome of previous elections is likely to affect the benefits of voting and then represents a determinant of abstention whose relevance requires additional empirical investigation.

The results confirm the existence of retrospective voting and adaptation of voters along elections according to a feedback that depends on correlation between voting behavior in previous election and personal economic improvements. In particular, a feedback consistent with the previous choice is an incentive to confirm that choice. This result provides an interesting insight concerning a central issue in the literature on electoral competition. In an influential paper, presenting a model with probabilistic voting, Lindbeck and Weibull (1987) show that competition induces the opponent parties to redistribute wealth in favor of the swing voters rather than the loyal ones, because the former are more responsive to transfers than the latter. On the contrary, Cox and McCubbins (1986) show that the optimal strategy for the parties is to target their core supporters, because it is less to redistribute in their favor. Several empirical studies have tried to verify these hypotheses with a mixed support (see Londregan, 2006). Our study suggests that, if voting is an adaptive outcome

based process, an incumbent would prefer targeting core voters rather than swing voters. The reason is that targeting them increases the probability they confirm their choice, while targeting the opponent supporters just increases the probability they do not vote for the opponent, but it does not avoid abstention. Interestingly, also those who abstain because dissatisfied by the major parties or overall politics represent a main target, together with voter supporters, as an economic improvement would represent an inconsistent feedback and induce them to vote for incumbent.

The analysis also highlights that the impact of the incumbent's performance on voting participation is ambiguous. After a good performance of the economy, we expect that supporters of the incumbent would receive a (subjective) feedback reinforcing their previous choice against abstention. Moreover, who abstained is now more induced to vote as the feedback is not consistent with their previous choice. On the other hand, a supporter of the party that lost previous elections may now abstain for a feedback that is not consistent with their previous choice.

Finally, the analysis of the reaction to inconsistent feedbacks has provided interesting insights regarding the determinants, also in view of the hypothesis of expressive voting.

Appendix A: Robustness check.

We employ several tests to verify the accurateness of estimation outcomes and the correctness of our conclusions. Firstly, we compare our random effects results with pooled logit estimation. Then, we re-estimate the model on the balanced subsample. Then, we check outcomes robustness with respect to the assumption about the distribution of the error term. Finally, we check for the sensitivity of the feedback with respect to different technical values of the standard error.

1) The LR *chibar* test on *rho* provided in previous tables compares pooled versus panel solution. Technically, if the test does not reject the H0, the panel solution diverges from the pooled one, which is inconsistent due to the omission of the individual effect. However, in the next table, we present pooled estimation outcomes in order to verify the estimation outcomes previously shown are not affected by such a choice. Effectively, our conclusions are consistent with both pooled and random effects estimations. Both The Hosmer-Lemeshow test (p=.1158) and the Pearson test (p=.1130) show that the model fits reasonably well.

Table 2. Pooled logit estimation outcomes.

VARIABLES	Model 1 Perceived Pers	Model 2 quintile pers	Model 3 decile pers
Perceived feedback	0.187***		
	(0.0315)		
Quintile feedback		0.189***	
		(0.0307)	
Decile feedback			0.123***
			(0.0299)
age	0.0212***	0.0196***	0.0195***
	(0.00621)	(0.00621)	(0.00622)
Union membership	0.126***	0.128***	0.133***
	(0.0406)	(0.0406)	(0.0405)
Female	-0.0437	-0.0410	-0.0417
	(0.0316)	(0.0315)	(0.0315)
High education	-0.0519	-0.0488	-0.0519
	(0.0465)	(0.0465)	(0.0465)
Low education	0.0361	0.0389	0.0381
	(0.0417)	(0.0416)	(0.0416)
Regional dummies	YES	YES	YES
Other controls	YES	YES	YES
mundlak	YES	YES	YES
Observations	21,627	21,627	21,627
Chi2	2294.25	2298.05	2277.82

Standard errors in parentheses
p<0.01, ** p<0.05, * p<0.1

2) Estimation outcomes may be biased when the panel is not balanced. In order to verify that our results do not depend on that, we re-estimate the models on the balanced subsample that includes only those individuals that we observe continuously over all four elections (three electoral cycles). In this case, all our predictions are confirmed.

3) A robustness check should involve the assumption about the distribution of the error term. Both Random effects and pooled probit estimations, run on the sample and on the balanced subsample[16] - assuming the error term to be normally distributed – confirm our results about learning determinants.

4) As far as the sequential logit estimation is concerned, we summarize how the estimated effect of feedbacks is sensible to different values of *sd* in Table 4. For each value of *sd* we present the estimated effect of feedback for both the transition and $Cor(u_i,x_i)$. The table shows that $Cor(u_i,x_i)$ is minimized for *sd*=0.05.

Table 4. Estimated effect for different values of *sd*

2,3 vs 1	Sd=0.05	Sd=0.5	Sd=1	Sd=1.5	Sd=2
f^p	.0636**	.0669**	.0756**	.0877**	.1018**
$Cor(u_i, x_i)$	0	0	0	0	0
3 vs 2	Sd=0.05	Sd=0.487	Sd=0.910	Sd=1.256	sd=1.545
f^p	-.0224	-.0204	-.0140	.0038	.0083
$Cor(u_i, x_i)$	.001	.006	.012	.018	.023

Stars: * p<0.05; ** p<0.01; *** p<0.001

[16] Probit Random effects estimations may be provided under request.

Data source.

University of Essex. Institute for Social and Economic Research, British Household Panel Survey: Waves 1-15, 1991-2006 [computer file]. 3rd Edition. Colchester, Essex: UK Data Archive [distributor], June 2007. SN: 5151.

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