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Voting as a Signaling Device

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Abstract

In this paper, citizens vote in order to influence the election outcome and in order to signal their unobserved characteristics to others. The model is one of rational voting and generates the following predictions: (i) The paradox of not voting does not arise, because the benefit of voting does not vanish with population size. (ii) Turnout in elections is positively related to the importance of social interactions. (iii) Voting may exhibit *bandwagon effects* and small changes in the electoral incentives may generate large changes in turnout due to signaling effects. (iv) Signaling incentives increase the sensitivity of turnout to voting incentives in communities with low opportunity cost of social interaction, while the opposite is true for communities with high cost of social interaction. Therefore, the model predicts less volatile turnout for the latter type of communities.

Keywords: electoral incentives, signaling, social interaction, turnout, voting
JEL Classification: C70, D72, D80

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1 Introduction

What motivates citizens to vote is one of the fundamental questions of political science and public economics. Since the early writings of Downs (1957) and later on Ledyard (1984), the rational-choice theory puts the desire of citizens to affect the election outcome as the main driving factor of their voting behavior. But, since the probability to actually change the outcome is very small, the instrumental view of voting generates the *paradox of not voting*,[1] which has led many researchers to propose different reasons that drive voting incentives.

The purpose of this paper is to provide a formal model of voting as a signaling device, and, in doing so, to provide a rational choice model which does not generate the paradox of not voting. Moreover, by integrating the instrumental view and signaling in a coherent framework, we aim at analyzing how these two motives interact. The main idea is that citizens possess unobserved characteristics, such as their preferences for public goods or their degree of altruism, which they signal to others through voting. If informative, these signals benefit both the sender and the receiver, because they facilitate the creation of mutually beneficial cooperations or because they increase the trust in an already given relation. Hence, in addition to standard *electoral incentives* of the instrumental view of voting, citizens have also *signaling incentives*.

More specifically, we build upon the model of voting in a finite-agent economy proposed by Börgers (2004). We consider a two-period extension of this model, where individuals are divided into neighborhoods. In the first period citizens decide to vote or not and they also observe whether their neighbors voted. In the second period, after mutual agreement, each citizen can form partnerships with any of her neighbors.[2] These partnerships represent, in a stylized way, social interactions which, by their nature, have to take place in the neighborhood, and which are not easily replaced by anonymous market exchange. We mainly think of two kinds of examples for such interactions. Firstly, notice that neighbors often cooperate to provide local public goods such as a sports club, a recreation facility or the care and maintenance of communal spaces. Secondly, our model also captures mutual exchanges of favors such as providing information about job opportunities, or taking kids to school.

Citizens derive utility from both the outcome of the election, as in the instrumental

[1]For a formal treatment, see Palfrey and Rosenthal (1985).

[2]An alternative interpretation of the second stage is that each citizen has already a network of friends and each one of them decides whether to increase the degree of interaction with her friends or not.

view, and the formation of partnerships in the second stage. Their utilities, however, are a function of two unobservable characteristics: (i) their cost of voting and (ii) a preference parameter, the latter affecting the utility from both the election outcome and the partnership. Referring to the examples mentioned above, the parameter can be interpreted as either representing the intensity of preferences for public goods or as representing the degree of one's altruism. The crucial assumption is that the utility of the election outcome is correlated with the utility of the partnership. This captures the idea that preferences for national and local public goods are aligned, and that the willingness to incur private costs to promote an outcome which also benefits others should be the same no matter whether the benefit is local or national. Thus, our preference parameter should broadly be interpreted as a measure of 'public-mindedness' of the individual, which is expressed both in the national election and in everyday social interaction.

Because it is costly to engage in partnerships, a citizen is willing to cooperate with her neighbor only if the latter is sufficiently attractive as an interaction partner. For example, in the case of the provision of public goods, this requires that the potential partner has a high intensity of preferences for public goods, since otherwise, the partner is likely to behave as a free rider. Similarly, engaging in an exchange of favors with a very selfish person leaves one prone to be exploited. Therefore, signaling one's 'public-mindedness' can thus have significant value when compared with relatively low cost activities, like voting. As a result, citizens' voting incentives are enhanced by their willingness to signal their preference for cooperation to their neighbors. Our model formalizes this intuition and shows that the effects on direct electoral incentives can actually be large.

In the two-stage game so defined, we find the perfect Bayesian equilibria, and we analyze the most interesting case: stable interior equilibria with signaling, that is stable equilibria where a fraction of agents from every type votes. We show that such equilibria exist and we compute their comparative statics. The main results are as follows:

1. The presence of signaling strictly increases voting incentives and electoral turnout when compared to models without signaling effects.

2. Even in economies with very large populations, the value of signaling does not tend to zero and therefore the paradox of not voting does not arise.

3. Communities with closer personal ties and higher level of social interaction present

higher turnout.

4. Due to signaling, electoral incentives may exhibit "bandwagon" effects: The benefit of voting may increase with turnout, so that one's willingness to vote increases if the expected participation rate increases. To the best of our knowledge, this is in contrast to existing papers on rational voting, where the benefit of voting is always decreasing with turnout due to the decreasing pivotal probability.

5. Signaling incentives interact with direct electoral incentives so that even a small change in the importance of the election may generate a sizable increase in turnout. This is because turnout may be highly sensitive to signaling effects. In terms of empirical predictions, the model suggests that communities with high cost of social interaction should have *lower* volatility of turnout in response to changes in the importance of elections than communities with lower costs of social interactions. In terms of policy, the model predicts that increasing the value of the election (through increasing the awareness of citizens about the policy agenda or through political advertising) has a higher impact on electoral turnout in communities with lower interaction costs and closer community ties.

In order to put these results into perspective, it is worth discussing in what kind of societies we expect the key elements of our model, observability of the act of voting and neighborhood interactions, to be particularly important. Concerning the first element, it appears that in small communities, like villages, citizens are more likely to observe each other voting than in big cities. However, in most countries, elections are organized locally so that a polling station only serves a narrowly defined neighborhood. Therefore, as long as citizens cast their vote in person and not online or by post, even in large cities, voting is observable for neighbors at least to some extent.

Second, social interactions clearly are of prominent importance in traditional, rural societies where markets are under-developed and where every member strongly depends on the co-operation with others. Conversely, anonymous markets are more widespread and may to some extent supplant personalized interactions in sophisticated, urban environments. Thus, it seems that in a modern society, signaling one's characteristics is more important in small communities, say villages, where personal interaction is more common than in big cities.[3] We maintain, however, that local social interactions as we describe them have not lost relevance in modern and urban societies. Rather,

[3] See also the empirical result by Funk (2010) discussed below.

we think that in suburban environments and even in big cities, there is still substantial scope for the kind of local public goods and personal favors for which signaling is relevant. To take the examples given above, volunteering in a sports club, cleaning a neighborhood park, or taking kids to school will be important whatever the level of economic development. Since such neighborhood interactions are much easier if they take place inside a network of trust, a locally produced signal remains valuable in an urban context, albeit it is likely to be still more important in traditional societies or small communities.

Our model captures in a simple way the interaction between electoral and social incentives, which we believe is an important driving force of voting incentives. This view corresponds to a growing number of papers where it is argued that social considerations and pressures play an important role in citizens' voting decisions. Overbye (1995), Posner (1998) and Bufacchi (2001) also argue that reputation and signaling reasons can account for the voting behavior of citizens in modern democracies, but they provide no formal analysis. By constructing a rigorous model formalizing this idea, we are able to make testable predictions which relate the voting behavior to the social conditions of individuals.

Funk (2005) analyzes a voting model with signaling incentives. However, there are two main differences between her paper and ours. First, in her model voting takes place in order to signal one's willingness to comply with social norms which are assumed to be exogenous, whereas in our model social interactions arise endogenously from an agreement among individuals. In that sense, one may interpret the second stage of our model as a micro-foundation of the kind of 'civic duty' used in Funk (2005). Second, the main focus of our analysis is the interaction between electoral and signaling incentives, while Funk (2005) ignores electoral incentives and focuses on the impact of new technologies, which reduce the cost of voting, on signaling incentives and turnout.

Other papers, such as Edlin, Gelman, and Kaplan (2007), Fowler (2006) and Rotemberg (2009), argue that social preferences and altruism are the main driving forces of voting behavior. While our model does not focus on this explanation, one of the interpretations of the citizens' unobserved parameter is that it represents altruism. However, this parameter generates two voting effects in our model: one direct and one indirect, through signaling. The second channel, which is our main focus of study, is absent from the social preferences literature.

There exist several other theoretical approaches to voting incentives. According to the *ethical voting* literature (Harsanyi 1980, Coate and Conlin 2004, Feddersen and

Sandroni 2006) voters decide on the ground of moral principles and they derive utility from adhering to them. The *leader-follower* theories (Uhlaner 1989, Morton 1991, Shachar and Nalebuff 1999, Herrera and Martinelli 2006) emphasize the role of leaders and their ability to impose sanctions or to provide rewards in motivating social groups to participate in elections. Fowler (2005) argues that individuals imitate the voting behavior of their social circle, which can lead to turnout cascades. Castanheira (2003) points out that voting benefit can be high, since the implemented platform after the elections depends not only on the winner, but also on the margin of victory. Papers on *expressive voting* (Brennan and Hamlin 1998, Engelen 2006, Kamenica and Egan Brad 2012, Degan 2013) assert that voting is a consumption good in itself, because it allows one to affirm her own beliefs and values. In a similar approach, Aldashev (2010) argues that individuals become politically informed in spite of low pivotal probability, because they have both consumption (political discussions within their social circle) and investment (meeting new people through a common discussion topic) benefits. Contributions to the literature on *social norms* (e.g., Coleman 1990) point out that voting is a public good in itself and show how social norms are used to overcome the associated free-rider problem.[4]

We do not question the relevance of these approaches. Rather, the theory presented here provides an additional rationale for voting, which may complement the arguments put forward in existing literature, and which has not been analyzed so far.

In the empirical and experimental research on voter participation, there is a number of results which are consistent with the predictions generated by our model. An increasing number of papers finds that social pressure, close community ties and voter participation increase the voting incentives for community members. Gerber, Green, and Larimer (2008) show through a large-scale field experiment that turnout was substantially higher among people who received a letter before the elections, which was explaining that whether they voted or not would be made public among the neighbors. Funk (2010) finds that voter turnout was negatively affected in small communities of Switzerland after the introduction of postal voting. Her explanation is that although postal voting decreased the voting costs, it also removed signaling benefit of voting, which was substantial in small communities. Gerber and Rogers (2009) find that a message publicizing high expected turnout is more effective at motivating people to vote than a message publicizing low expected turnout. This result, which obtains in

[4]For more complete surveys, see Aldrich (1993), Blais (2000), Dhillon and Peralta (2002), Feddersen (2004).

spite of lower pivotal probability with higher turnout, is consistent with the signaling benefit and the bandwagon effect of our model. Similarly, an experiment of sequential voting by Großer and Schram (2006) shows that high turnout of early voters increases late voters' turnout.

Several papers find evidence of a positive relationship between the size of social network or formal group memberships of an individual on the one hand, and voting or other forms of political participation of this individual on the other hand (Lake and Huckfeldt 1998, Leighley 1996, Knack 1992, Kenny 1992, McClurg 2003).[5] Last but not least, there is empirical evidence in favor of our result that communities with closer personal ties and higher level of social interaction present higher turnout: Oliver (2000) finds that city size decreases civic involvement and turnout in local elections in the United States, controlling for individual characteristics. Cox, Rosenbluth, and Thies (1998) show empirically for Japan that social density increases turnout in close elections, and as a reason they argue that party campaigns focus on close elections and on socially dense communities where campaign efforts are more productive thanks to denser social networks. Remmer (2010) shows that turnout decreases with community size both in presidential and mayoral elections in Costa Rica. In the same vein, Monroe (1977) finds higher turnout in rural areas than in urban areas in the state of Illinois.

The paper proceeds as follows. Section two presents the model, Section three provides the equilibrium analysis, Section four presents the main comparative statics and results and Section five includes the final comments and conclusions. Most proofs are relegated to the Appendix.

2 The model

There are N individuals, $i = 1, 2, ..., N$, and two political parties, A and B. Each individual is summarized by three characteristics. The first one is the preferred party of the individual i: $R_i \in \{A, B\}$. The second one is her cost of voting, $c_i \in [c_{min}, c_{max}]$ with $0 \leq c_{min} < c_{max}$. The last characteristic is whether she is of high or low type, $\tau(i) \in \{H, L\}$, which refers to the importance the individual i attaches to decisions taken in the public domain. Each characteristic of any individual i is a random variable. All three characteristics are independently distributed for each individual and across individuals. The preferred party of any individual i is A with probability $1/2$ and B with

[5]For other papers which study the relation between social interactions and political participation, see for instance Schlozman, Verba, and Brady (1995) and Schram and Sonnemans (1996).

probability 1/2.[6] The cost of voting c_i of any individual i is distributed according to the cdf F on the support $[c_{min}, c_{max}]$ with the pdf f which is positive on all of the support. Finally, any individual is of high type, $\tau(i) = H$, with probability q and of low type, $\tau(i) = L$, with probability $1 - q$. Each individual privately knows her characteristics. The distributions of individuals' characteristics are common knowledge.

There are two periods. In the first period, the election occurs in which an individual chooses to vote for her preferred party or to abstain.[7] The winner is determined by a simple majority rule. In case of a tie, each party wins with probability 1/2.

An individual i's payoff from the first period is as follows: Her benefit is $w_1\alpha_{\tau(i)}$ if her preferred party wins and 0 otherwise. w_1 is a parameter which measures the importance of the election, such as the value of the public decision to be determined by the winner of the election. We assume that both types care about the result of the election, as measured by the parameter $\alpha_{\tau(i)}$, and that a high type individual cares more about it than a low type individual, i.e. $\alpha_H > \alpha_L > 0$. Her cost is c_i if she votes and 0 otherwise. Hence, if she votes and her preferred party wins, her payoff is $w_1\alpha_{\tau(i)} - c_i$. If she abstains and her preferred party wins, her payoff is $w_1\alpha_{\tau(i)}$. If she votes and her preferred party loses, her payoff is $-c_i$. If she abstains and her preferred party loses, her payoff is 0.

In the second period, social interactions occur in neighborhoods in the form of pairwise matches. All neighborhoods are of equal size and each one of them contains n individuals. Therefore, each voter has $n - 1$ neighbors. After observing whether each one of her neighbors voted or not, an individual i chooses to match or not with each individual $j = 1, 2, ..., n$, $j \neq i$. If both i and j agree to match with each other, they match together. Otherwise, a match does not occur. Matches are assumed to be independent and non-exclusive. This means that each agent can potentially interact with all of her neighbors if they also want to interact with her, and that the utility of each match is not affected by the other matches.

Every individual wants to interact only with neighbors who have the same party preference as her. That is, e.g., a Democrat receives utility only from interacting with other Democrats and a Republican from interacting with other Republicans. Indeed, as most people usually interact with people of the same ideology (or similar ideologies), this

[6] In Subsection 4.3, we discuss implications of relaxing this assumption.

[7] Since voting for the other party is a weakly dominated strategy, we do not consider this strategy.

assumption is empirically plausible,[8] but it is not crucial for our results.[9] We assume that each individual does not know their neighbors' party identity before voting. Only after the second stage starts they find out each other's party identities and choose to interact among similarly-minded neighbors. This is motivated by the fact that people usually do not advertise their political preferences publicly. However, when individuals consider with whom to enter into close social contact, they typically will learn the political views of the other person. In the context of the present model, this will arise in a game where neighbors inform each other about their party preferences just before they decide to interact. Since each individual benefits only from interacting with neighbors of the same party, everyone has an incentive to reveal this information truthfully.

Formally, individuals with different party preferences receive a negative payoff from the interaction, irrespectively of their types. Contrary to that, individual i's payoff from a match with an individual j, conditional on both supporting the same party, depends both on her own type and her neighbor's type. We adopt the following simple functional representation for the interaction payoff:

$$w_2 \alpha_{\tau(i)} (\alpha_{\tau(j)} - d) \tag{1}$$

where d is the cost of the social interaction and w_2 measures the importance of social interactions. Therefore, d is the cost that one bears in order to carry out the interaction with her neighbor (e.g. the cost of time for cleaning up communal spaces). We assume that $\alpha_L < d < \alpha_H$, so that it is beneficial for everyone to interact with high types and it is detrimental to interact with low types. Hence, in the perfect information case (when an individual knows the type of all her neighbors), i would agree to match with an individual j if and only if j prefers the same party and is of high type. Moreover, since $\alpha_H > \alpha_L$, if a match has a positive expected payoff, a high type individual has a higher expected payoff from this match than a low type individual.

So, equation (1) captures in a simple way the net benefits of the social interaction: High (low) types generate positive (negative) payoff externalities and even more so for

[8] For example, Huckfeldt, Johnson, and Sprague (2002) observe that the social network of an individual consists largely of people with similar political views. Mutz (2002) shows that people whose social networks involve more political disagreement are less likely to vote.

[9] In an earlier version of the paper (see Aytimur, Boukouras, and Schwager 2012) we assumed that individuals derive utility from interacting with all neighbors, irrespectively of their party preference, and we obtained the same results.

other high types. This is a reasonable assumption, as we should expect people who care more about local public goods, e.g. those who have higher marginal utility from a cleaner public space, to benefit more from interacting with like-minded individuals. Similarly, such agents tend to suffer more when they interact with disinterested individuals since the latter behave as free riders, or do not return favors.[10]

Equation (1) provides i's payoff from a match with j, when j's type is known to i. However, since j's type is private information, i needs to evaluate her expected payoff, after she has updated her belief about j's type. Since a high type individual gets a higher benefit in case of the victory of her preferred party, her voting behavior can be a signal about her type, given that she is more likely to vote than a low type individual.[11] The signal can be valuable since, because of the payoff externalities, agents want to match with a high type individual, and not with a low type individual. Therefore, agents interact with each other if and only if they have posterior beliefs that the other one is of high type with a high enough probability. The formulation of beliefs and expected payoffs, and the analysis of best responses are provided in the following section.

As in Börgers (2004), we make two symmetry assumptions about the voting strategy. We assume that it does not depend on the individual's preferred party[12] and that all individuals play the same strategy of the form $s : \{H, L\} \times [c_{min}, c_{max}] \rightarrow \{0, 1\}$ where $s_i(\tau(i), c_i) = 0$ (respectively 1) means that an individual i abstains (respectively votes) if she is of type $\tau(i)$ and her cost of voting is c_i.

We assume that every individual i plays the same matching strategy of the form[13] $I : \{0, 1\} \times \{A, B\} \times \{A, B\} \rightarrow \{0, 1\}$ with regards to an individual j, $i \neq j$. Thus, $I(s_j, R_i, R_j) = 0$ (respectively 1) means that an individual i does not agree (respectively agrees) to match with an individual j if her party preference is R_i, the individual j's party preference is R_j and her voting decision is s_j. Hence, a match between individuals i and j occurs if and only if $I(s_j, R_i, R_j)I(s_i, R_j, R_i) = 1$.

[10]While the formulation in (1) is chosen to capture the main features of a social interaction, it also helps to simplify the algebra that follows substantially. We should note, however, that our results do not depend critically on this specific formulation of the second-stage payoff; see Subsection 4.3.

[11]Using the same $\alpha_{\tau(i)}$ in both periods means that the preferences for the election outcome and social interactions are perfectly correlated. While this appears to be a strong assumption, relaxing it would make the analysis much more involved, without being likely to yield interesting additional insights. The reason is that, as long as there is enough correlation between both preference parameters, the first period behavior still has some informative value for the second period, and hence signaling is useful.

[12]This is a standard and natural assumption as long as individuals are ex-ante equally likely to prefer either party. See also Goeree and Großer (2007).

[13]The assumption that the matching strategy does not depend on the individual's own type (high or low) and own voting decision is not a restriction. The proof is available upon request.

Our equilibrium concept is perfect Bayesian equilibrium. Hence, we proceed by backward induction.

3 Equilibrium analysis

We first analyze the second stage of the game where agents decide whether to interact with each of their neighbors or not, after observing their voting behavior. Subsequently, we will use the equilibria of the second stage in order to analyze the first stage.

3.1 Second-stage equilibrium

Recall from the previous section that equation (1) provides i's payoff from a match with j, conditional on both supporting the same party. If i and j support different parties, they do not match. Hence, in this subsection, we consider only individuals i and j supporting the same party, i.e. $R_i = R_j$. The expected payoff of i from a match with j, when j's type is private information and conditional on j's voting decision, is given by:

$$w_2\alpha_{\tau(i)}\left[\lambda(s_j)(\alpha_H - d) + (1-\lambda(s_j))(\alpha_L - d)\right] I(s_i, R_j, R_i) I(s_j, R_i, R_j) \tag{2}$$

Here, $\lambda(s_j)$ is the posterior belief that a neighbor who voted ($s_j = 1$) or did not vote ($s_j = 0$) is of type H. Notice that we do not need to define party-specific posterior beliefs since voting strategies are assumed to be symmetric with respect to preferred party. For later use, we define $\lambda(1) = \lambda_H$, which is the posterior belief that a neighbor, who voted, is of high type, and $1 - \lambda(0) = \lambda_L$, which is the posterior belief that a neighbor, who did not vote, is of low type. $I(s_j, R_i, R_j)$, as given in the previous section, denotes the decision of agent i whether to match with neighbor j or not, conditional on the latter's voting behavior and on both individuals' preferred parties. The overall second stage utility of i from all her neighbors is simply the summation over all possible interactions in her neighborhood:

$$\sum_{j=1, j\neq i}^{n} \left\{ w_2\alpha_{\tau(i)}\left[\lambda(s_j)(\alpha_H - d) + (1-\lambda(s_j))(\alpha_L - d)\right] I(s_i, R_j, R_i) I(s_j, R_i, R_j) \right\}$$

The best response of i in the second stage of the game depends on the voting behavior of her neighbors and her posterior beliefs regarding their type. By (2), it is clear that the best response for i is to match with every neighbor who generates a positive interaction payoff and not to interact if the expected payoff is negative. Therefore, conditional on $R_i = R_j$, her best response is to interact if $[\lambda(s_j)(\alpha_H - d) + (1-\lambda(s_j))(\alpha_L - d)]\, I(s_i, R_j, R_i) > 0$, not to interact if $[\lambda(s_j)(\alpha_H - d) + (1-\lambda(s_j))(\alpha_L - d)]\, I(s_i, R_j, R_i) < 0$ and either if the expression is zero.

The above analysis suggests that, depending on the beliefs and the parameters α_H, α_L and d, there will be different equilibria of the second stage, which depend on the signs of the expressions $\lambda_H\alpha_H + (1-\lambda_H)\alpha_L - d$ and $(1-\lambda_L)\alpha_H + \lambda_L\alpha_L - d$. For the remainder of the paper we focus on the most interesting of these equilibria, the one where agents choose to interact with only those neighbors who voted, again conditional on both supporting the same party. This is the case when $\lambda_H\alpha_H + (1-\lambda_H)\alpha_L \geq d$ and $(1-\lambda_L)\alpha_H + \lambda_L\alpha_L \leq d$.[14]

3.2 First-stage equilibrium

In this subsection, we compute the expected benefit of voting, given the second period equilibrium. Then, we show the existence of the most interesting type of equilibrium.

In equilibrium, an individual votes if her expected benefit from voting exceeds her cost of voting. Since the benefit of voting is independent of the cost, an equilibrium voting strategy must be a threshold strategy like in Börgers (2004). So, there is some c_H^* such that $s(H, c_i) = 1$ if $c_i < c_H^*$ and $s(H, c_i) = 0$ if $c_i > c_H^*$. Similarly, there is some c_L^* such that $s(L, c_i) = 1$ if $c_i < c_L^*$ and $s(L, c_i) = 0$ if $c_i > c_L^*$. Hence, the ex ante probability that any individual votes is $p = qF(c_H^*) + (1-q)F(c_L^*)$. For $0 < p < 1$, the posterior beliefs that a neighbor who voted is of high type, i.e. λ_H, and that a neighbor who did not vote is of low type, i.e. λ_L, are then given as follows by Bayes' rule:

$$\lambda_H = \frac{qF(c_H^*)}{qF(c_H^*) + (1-q)F(c_L^*)} \tag{3}$$

$$\lambda_L = \frac{(1-q)(1-F(c_L^*))}{(1-q)(1-F(c_L^*)) + q(1-F(c_H^*))} \tag{4}$$

The expected benefit of voting is the payoff difference between voting and abstaining from voting and it is composed of two parts. The first one which we call the expected

[14]The analysis on all possible equilibria of the second stage game is given in Aytimur, Boukouras, and Schwager (2012). We omit the analysis of all other cases here either because they involve no signaling benefit (agents interact either with all agents or none) or because they are not possible when the first stage is considered (agents interact only with those who did not vote).

electoral benefit arises because one's vote can possibly change the electoral outcome. This is the standard benefit of voting in the literature. The second one which we call as the expected *signaling* benefit arises because one's vote can possibly change one's outcome from the social interaction stage.

The expected electoral benefit of voting of an individual i is positive only if individual i is pivotal. This happens if her preferred party receives either the same number of votes as the other party or receives one less vote than the other party among the voters but her. In both cases, by voting for her preferred party, she increases the probability that her preferred party wins by 1/2. Taking into account that her benefit is $\alpha_{\tau(i)} w_1$ if her preferred party wins and 0 otherwise, we get that the electoral benefit of voting is equal to $\frac{1}{2}\alpha_{\tau(i)} w_1 \Pi(p)$, where $\Pi(p)$ is the probability that individual i is pivotal. Börgers (2004) gives the exact expression for $\Pi(p)$ and shows that it is a differentiable and decreasing function for all $p \in (0, 1)$.[15]

With respect to the expected signaling benefit, we should keep in mind that only voters match among each other, conditional on preferring the same party. Hence, if an individual votes, she matches with all the same party voters in her neighborhood. Her expected payoff from a single match is $w_2 \alpha_{\tau(i)}[\lambda_H \alpha_H + (1 - \lambda_H)\alpha_L - d]$ and the expected number of the same party voters (and so of matches) in her neighborhood but her is $p(n-1)/2$. Hence, if she votes, this gives her an expected payoff of $w_2 \alpha_{\tau(i)}[p(n - 1)/2][\lambda_H \alpha_H + (1 - \lambda_H)\alpha_L - d]$ in the second period. If she does not vote, she does not match with anyone, so her payoff is 0 in the second period. The payoff difference between the two cases where she votes or does not vote gives the expected signaling benefit of voting.

We denote by $B_{\tau(i)}(c_H, c_L)$ the total expected benefit of voting of an individual i with type $\tau(i)$ as a function of the thresholds c_H and c_L. An equilibrium is given by thresholds c_H^* and c_L^* such that $B_{\tau(i)}(c_H^*, c_L^*) \geq c_i$ for all i who vote and $B_{\tau(i)}(c_H^*, c_L^*) \leq c_i$ for all i who abstain.

For the second period equilibrium described in Section 3.1 (where only same party voters match among each other), we have the following total expected benefit of voting, where the ex ante voting probability of an individual, p, and posterior probabilities that a voter is of high type, λ_H, and that a non-voter is of low type, λ_L, are functions of c_H

[15]Since it is enough for our purposes to know that $\Pi(p)$ is differentiable and decreasing for all $p \in (0, 1)$, in order to save space, we do not reproduce it here and we refer the interested reader to Börgers (2004).

and c_L:

$$B_{\tau(i)}(c_H, c_L) = \alpha_{\tau(i)} \left\{ \frac{w_1}{2}\Pi(p) + \frac{1}{2} w_2 p(n-1)[\lambda_H \alpha_H + (1-\lambda_H)\alpha_L - d] \right\} \tag{5}$$

We observe that $B_L = \mu B_H$ where $\mu = \alpha_L/\alpha_H < 1$. Depending on the levels of c_{min} and c_{max}, there are many possible first-period equilibria. However, since $B_H > B_L$, turnout ratio of high type individuals is at least as high as turnout ratio of low type individuals in any equilibrium.

More specifically, there are six possible types of first period equilibria: equilibria where (i) everyone votes, (ii) nobody votes, (iii) all high type individuals vote and none of low type individuals votes, (iv) all high type individuals vote and some of low type individuals vote, (v) some of high type individuals vote and none of low type individuals votes, (vi) some of high type individuals and some of low type individuals vote.

However, since we are interested in the signaling value of voting, the most interesting implications of the model come from the last type of equilibrium, where a fraction of each type, strictly between zero and one, of individuals vote. We call these equilibria as *interior equilibria*. Moreover, if one makes the plausible assumption that the costs of voting are distributed between zero and infinity for both types, then we can show that our model permits only interior equilibria. Within the class of interior equilibria, we focus on interior equilibria where only voters who prefer the same party match among each other in the second period. We call these equilibria as *interior equilibria with signaling*.

An interior equilibrium implies $c_L^* = \mu c_H^*$ since $B_L = \mu B_H$. Then, we can summarize the condition for an interior equilibrium as follows:

$$B_H(c_H^*, \mu c_H^*) = c_H^* \tag{6}$$

where $c_{min}/\mu < c_H^* < c_{max}$. Then, $B_L(c_H^*, c_L^*) = c_L^*$ and $c_{min} < c_L^* < c_{max}$ follow immediately. Such an equilibrium is stable if after a slight increase (decrease) in c_H, and the corresponding increase (decrease) in $c_L = \mu c_H$, the benefit from voting falls short of (exceeds) the cost so that the share of voters falls (rises) back to the equilibrium. Formally, defining $\mathcal{B}_H(c_H) \equiv B_H(c_H, \mu c_H)$ for all c_H, we we can write the expected benefit for type H as a function of only the cutoff c_H. With this definition, the equilibrium is stable if $\frac{\partial \mathcal{B}_H}{\partial c_H} - 1 < 0$.

In order to show that the subsequent analysis of stable interior equilibria is well founded, we complete this section by proving that such an equilibrium exists for some parameter values of the model. For this purpose, consider the following inequalities:

$$\begin{aligned} B_H(c_{min}/\mu, c_{min}) = \alpha_H \Big\{ & \frac{w_1}{2}\Pi(qF(c_{min}/\mu)) \\ & + \frac{1}{2} w_2 qF(c_{min}/\mu)(n-1)[\alpha_H - d] \Big\} > c_{min}/\mu \end{aligned} \tag{7}$$

$$\begin{aligned} B_H(c_{max}, \mu c_{max}) = \alpha_H \Big\{ & \frac{w_1}{2}\Pi(q + (1-q)F(\mu c_{max})) \\ & + \frac{1}{2} w_2 (n-1)[q(\alpha_H - d) - (1-q)F(\mu c_{max})(d - \alpha_L)] \Big\} < c_{max} \end{aligned} \tag{8}$$

$$\frac{(1-q)F(\mu c_H)}{qF(c_H)} \le \frac{\alpha_H - d}{d - \alpha_L} \le \frac{(1-q)(1-F(\mu c_H))}{q(1-F(c_H))} \tag{9}$$

Note that the inequalities in (9) are equivalent to the inequalities, $\lambda_H \alpha_H + (1-\lambda_H)\alpha_L \ge d$ and $(1-\lambda_L)\alpha_H + \lambda_L \alpha_L \le d$, which ensure that only neighbors who voted and who support the same party match among each other in the second period. Inequalities (7) and (8) are boundary conditions requiring that the benefit of voting exceeds (falls short of) the cost of voting if the turnout is very low (very high).

Proposition 1

(i) If inequality (9) holds for all $c_H \in [c_{min}/\mu, c_{max}]$, and inequalities (7) and (8) hold, then a stable interior equilibrium with signaling exists.

(ii) There exist parameter values of the model which satisfy simultaneously the above inequalities.

4 Comparative statics

In this section, we provide the main comparative statics of stable interior equilibria with signaling, which have been shown to exist in the previous section, and discuss some possible extensions of the model.

4.1 Direct effects

By substituting the posterior beliefs (3) and (4) in equation (5) and by linking the cut-off value of low types to the cut-off value of high types via $c_L = \mu c_H$, the equilibrium condition (6) can be formulated as:

$$\begin{aligned}\mathcal{B}_H(c_H^*) &\equiv B_H(c_H^*, \mu c_H^*)\\ &= \alpha_H\Big\{\frac{w_1}{2}\Pi\left[qF(c_H^*) + (1-q)F(\mu c_H^*)\right]\\ &\quad + \frac{1}{2}w_2(n-1)[qF(c_H^*)(\alpha_H - d) + (1-q)F(\mu c_H^*)(\alpha_L - d)]\Big\} = c_H^* \end{aligned} \tag{10}$$

By using the implicit function theorem one can compute the effect of a change of a parameter, say x, on the equilibrium cutoff c_H^*:

$$\frac{dc_H^*}{dx} = -\frac{\frac{\partial \mathcal{B}_H}{\partial x}}{\frac{\partial \mathcal{B}_H}{\partial c_H} - 1} \tag{11}$$

with

$$\begin{aligned}\frac{\partial \mathcal{B}_H}{\partial c_H} =&\alpha_H\Big\{\frac{w_1}{2}\Pi'(p)\left[qf(c_H^*) + (1-q)\mu f(\mu c_H^*)\right]\\ &+ \frac{1}{2}w_2(n-1)[qf(c_H^*)(\alpha_H - d) + (1-q)\mu f(\mu c_H^*)(\alpha_L - d)]\Big\}\end{aligned} \tag{12}$$

Since we are considering a stable equilibrium of the game, we know that $\partial \mathcal{B}_H/\partial c_H < 1$, so that the denominator of (11) is negative. Therefore, the change of the equilibrium cutoff c_H^* has the same sign as the change of the total expected utility ($\mathcal{B}_H$) with respect to the parameter x. Also, recall that $p^* = qF(c_H^*) + (1-q)F(\mu c_H^*)$. As a consequence, we have the following comparative statics of the model:

(i) $\frac{dp^*}{dd} < 0$: An increase in the cost of the second stage interaction decreases the value of signaling and equilibrium turnout.

(ii) $\frac{dp^*}{dw_1} > 0$ and $\frac{dp^*}{dw_2} > 0$: Directly increasing the significance that voters put in the election or in the neighborhood interactions increases equilibrium turnout.

(iii) $\frac{dp^*}{dN} < 0$ but $\frac{dp^*}{dn} > 0$: Increasing the size of the electorate reduces the probability of being pivotal and hence the electoral benefit and thus equilibrium turnout decrease. However, due to the value of signaling, the *paradox of not voting* does not arise even if N is arbitrarily large. This is because, even though agents cannot affect the outcome of the election, they receive strictly positive utility by signaling their type to other agents. On the other hand, an increase in the number of neighbors increases the value of signaling and equilibrium turnout.

(iv) $\frac{dp^*}{dq} > 0$:[16] Since in equilibrium, high type individuals are more likely to vote than low type individuals, shifting the prior towards the high type tends to increase total turnout. This affects electoral and signaling benefits so that the cutoffs c_H^* and c_L^* may decrease. However, as shown in the Appendix, this can never outweigh the direct impact of higher q on total turnout.

(v) $\frac{dp^*}{d\alpha_H} > 0$, but $\frac{dp^*}{d\alpha_L}$ cannot be signed: If α_H increases, the benefit from voting of a high type agent rises directly with α_H. Moreover, since the ratio of low to high type individuals among the voters is reduced along with μ, the signaling benefit increases. Therefore, the turnout of high types unambiguously rises after an increase in α_H. The low type agents will also enjoy a higher signaling benefit, but their electoral benefit decreases because of the increase in turnout by the high type individuals. If this impact is large enough, turnout of low types may decrease. This can, however, not go so far that total turnout were to decrease, since then the electoral benefit of low types would be higher than in the original equilibrium, which would contradict the fact that their turnout decreases. Thus, an increase in α_H may decrease the turnout of the low type, but not total turnout.

An increase in α_L has the same kind of effects on the turnout of low type agents as α_H has on high types. However, one of these effects is negative: Along with μ, the ratio of low to high types among the voters now increases, thereby reducing the signaling benefit. If this effect is strong, we cannot rule out that total benefit of low type agents decreases when α_L increases. If this occurs, the turnout of low type agents, and with it also the turnout of high types, decrease so that total turnout may decrease as a response to a higher α_L.

4.2 Interaction of signaling and electoral incentives

After discussing these direct comparative static effects, we turn to the more subtle, and possibly even more interesting, indirect effects. Specifically, we want to investigate whether our model can generate a *bandwagon effect*, i.e. whether a voter is more likely to vote when there is higher turnout. Note that in the absence of signaling, this is

[16] The computations and more detailed explanations for (iv) and (v) are in the Appendix.

impossible, since higher turnout decreases the pivotal probability of a voter, who is then less likely to vote. In addition, we show that the bandwagon effect can be substantial: A small increase of the election's significance (w_1) can cause a substantial increase in the turnout ratio. Note again that this cannot be the case in the absence of signaling, since the effect of w_1 is downgraded by small pivotal probabilities.

In order to show these results, we need to examine the interaction between electoral and signaling incentives in our model: How does the presence of signaling change the sensitivity of turnout to the importance of the election outcome? In other words, we would like to investigate the conditions under which the presence of signaling in a voting game *reinforces* or *dampens* the sensitivity of turnout to the electoral incentives. This is an interesting question on its own right, both in terms of empirical implications (are countries with better connected communities expected to have more volatile turnout?) and in terms of policy implications (should governments adopt community friendly policies to increase the sensitivity of voters to political issues?). For brevity, whenever the sensitivity of the turnout to electoral incentives increases with signaling we say that we have a *reinforcing signaling* effect, while whenever the sensitivity of the turnout to electoral incentives decreases with signaling we say that we have a *dampening signaling* effect.

4.2.1 Reinforcing or dampening signaling effects

In terms of formal analysis, we study whether signaling is reinforcing or dampening by examining how the change of the equilibrium cutoff c_H^* due to an increase in the significance of the elections is affected by an increase in the value of signaling. Therefore, if $\frac{d^2 c_H^*}{dw_1 dw_2} > 0$ we have reinforcing signaling and if $\frac{d^2 c_H^*}{dw_1 dw_2} < 0$ we have dampening signaling. Since an increase in the equilibrium cut-off value c_H^* always increases the equilibrium turnout p^* for given values of q, α_H and α_L, examining the effect on c_H^* also gives us the impact on p^*. By setting $x = w_1$ and by taking the derivative of (11) with respect to w_2 we find:

$$\frac{d^2 c_H^*}{dw_1 dw_2} = \frac{\frac{\partial^2 \mathcal{B}_H}{\partial c_H \partial w_2} \frac{\partial \mathcal{B}_H}{\partial w_1}}{\left(\frac{\partial \mathcal{B}_H}{\partial c_H} - 1\right)^2}$$

Since the denominator and $\frac{\partial \mathcal{B}_H}{\partial w_1}$ are both positive, the sign of the expression above has the same sign as $\frac{\partial^2 \mathcal{B}_H}{\partial c_H \partial w_2}$. By computing the latter cross-derivative from equation (12) and rearranging we find that we have reinforcing signaling if and only if (recall that

$\mu = \alpha_L/\alpha_H$):

$$(\alpha_H - d)qf(c_H^*) + (\alpha_L - d)(1-q)\mu f(\mu c_H^*) > 0 \tag{13}$$

Inequality (13) illustrates the interaction of electoral and signaling incentives. When the election importance (w_1) increases, there are $qf(c_H^*)/2$ additional individuals of high type per party, and $(1-q)\mu f(\mu c_H^*)/2$ additional individuals of low type per party who decide to vote. Inequality (13) states that the expected payoff of matching with these additional voters is positive. In this case, the expected signaling benefit of voting increases, which reinforces the increase in turnout due to the higher importance of the election.

Solving inequality (13) for the parameter d, the cost of social interaction, we find a critical threshold value (let us call it $\tilde{\alpha}$), such that if d is below this threshold, then we have reinforcing signaling, while if d is above this threshold we have dampening signaling. We summarize this result in the following proposition, which is directly derived from the analysis so far:

Proposition 2 *In any stable interior equilibrium with signaling, we have a reinforcing signaling effect whenever the cost of social interaction d is below the threshold value $\tilde{\alpha}$ and dampening signaling otherwise, with*

$$\tilde{\alpha} \equiv \frac{\alpha_H qf(c_H^*) + \alpha_L(1-q)\mu f(\mu c_H^*)}{qf(c_H^*) + (1-q)\mu f(\mu c_H^*)} \tag{14}$$

Note that, if we define $\frac{1}{2}w_2 p(n-1)[\lambda_H\alpha_H + (1-\lambda_H)\alpha_L - d]$ in equation (5) as the signaling benefit of voting, then it is easy to show that:

$$\frac{\partial^2 \mathcal{B}_H}{\partial c_H \partial w_2} = \frac{1}{w_2}\frac{\partial(\text{signaling benefit})}{\partial c_H}$$

Hence, if an increase in the total turnout has a positive effect on the value of signaling, then this implies that signaling has a reinforcing effect on voting. The interpretation is that if the significance of the elections increases (w_1 increases) then turnout will increase because the overall expected benefit for voters increases. But whether this effect is larger or smaller than in a society where the signaling benefit is absent (i.e. Börgers 2004) or where communities are less important (lower value of w_2), depends on the impact of the increased turnout on the signaling benefit. If turnout has a positive impact on signaling then the increase in turnout will be greater in the society with stronger community ties ($\frac{d^2 c_H^*}{dw_1 dw_2} > 0$), because the initial increase in the value of voting is further reinforced by the fact that voting is also more beneficial for signaling one's type to her neighbors. Of course, the opposite is true if the signaling benefit is negatively affected by higher turnout.

Proposition 2 makes clear that in a society where the cost of social interactions is low ($d < \tilde{\alpha}$), for instance due to inadequate substitutes to social interactions or because of well-established communication channels, signaling has a reinforcing effect, while the opposite is true for a society with high cost of social interactions. Hence, we expect the turnout ratio to be more sensitive to the importance of the election outcome in societies with low cost of social interactions.

Beyond this general result, it is worthwhile to investigate in more detail whether, and in what circumstances, the condition $d < \tilde{\alpha}$ is likely to be satisfied in an equilibrium with signaling. To answer this question, we relate $\tilde{\alpha}$ to the inequalities laid down in Section 3.1: $\lambda_H \alpha_H + (1 - \lambda_H)\alpha_L \geq d$ and $(1 - \lambda_L)\alpha_H + \lambda_L \alpha_L \leq d$. These inequalities implicitly define an interval $[d_L, d_H]$, within which the cost d of the match must lie for an equilibrium with signaling to obtain. If $\tilde{\alpha}$ is greater than the upper bound of the interval $[d_L, d_H]$, i.e. $\tilde{\alpha} > d_H$, then signaling has a reinforcing effect on voting irrespectively of the other parameters of the model. If $\tilde{\alpha}$ is lower than the lower bound of the interval, i.e. $\tilde{\alpha} < d_L$, then signaling has a dampening effect on voting, irrespectively of the other parameters of the model, and if $\tilde{\alpha}$ is in the interior of the interval, the effect of signaling is either reinforcing or dampening, depending on the other parameters of the model. The following proposition relates these cases to the distribution of voting costs:[17]

Proposition 3 *Consider an interior equilibrium with signaling. If for all* $c_H \in [c_{min}, c_{max}]$*:*

(i) $\frac{f(c_H)}{F(c_H)} > \frac{\mu f(\mu c_H)}{F(\mu c_H)}$*, then the effect of signaling is reinforcing;*

(ii) $\frac{f(c_H)}{1-F(c_H)} > \frac{\mu f(\mu c_H)}{1-F(\mu c_H)}$ *and* $\frac{f(c_H)}{F(c_H)} < \frac{\mu f(\mu c_H)}{F(\mu c_H)}$*, then the effect of signaling is reinforcing for some parameter values and dampening for the rest;*

(iii) $\frac{f(c_H)}{1-F(c_H)} < \frac{\mu f(\mu c_H)}{1-F(\mu c_H)}$*, then the effect of signaling is dampening.*

[17] As can be seen in the proof, the conditions mentioned in (i) to (iii) actually need only be satisfied at the cutoff value for the high types corresponding to the equilibrium under consideration. However, to facilitate interpretation, we state these inequalities globally.

Note that the first condition of part (ii) in Proposition 3 is implied by the increasing hazard rate property. This means that, if the distribution of voting costs displays an increasing hazard rate, then signaling has a reinforcing effect at least if the cost of social interactions, d, is small enough. On the other hand, ensuring that all the stable interior equilibria of the model for any set of parameter values exhibit reinforcing signaling requires the condition of part (i). This condition, which is a weaker version of the increasing "reverse" hazard rate, is stronger than condition (ii). If (i) fails but the first condition in (ii) holds, then whether signaling has a reinforcing or dampening effect depends on d, as given in Proposition 2.

To see which is the most relevant case, observe that the most commonly used distributions in the literature, such as the uniform, the normal and the exponential distribution, do not satisfy the increasing reverse hazard rate property, but satisfy the condition of part (ii). Thus, it is reasonable to expect case (ii) to occur, which means that the cost of social interaction is indeed crucial for signaling to have a reinforcing effect on electoral incentives.

4.2.2 Bandwagon effect

Next, we investigate whether there can be a bandwagon effect in our model. Mathematically, a bandwagon effect exists if and only if[18] $\frac{\partial \mathcal{B}_H}{\partial c_H} > 0$, i.e. higher turnout increases the voting benefit of a voter. Recall that $\frac{\partial \mathcal{B}_H}{\partial c_H}$ is given by (12), which is reproduced below for convenience:

$$\begin{aligned}\frac{\partial \mathcal{B}_H}{\partial c_H} =& \alpha_H \Big\{ \frac{w_1}{2} \Pi'(p) \left[q f(c_H^*) + (1-q)\mu f(\mu c_H^*) \right] \\ &+ \frac{1}{2} w_2 (n-1) [q f(c_H^*)(\alpha_H - d) + (1-q)\mu f(\mu c_H^*)(\alpha_L - d)] \Big\}\end{aligned}$$

Since $\Pi'(p)$ is negative, the first term in the curly brackets is negative. This term shows that electoral benefit decreases with higher turnout. The second term, which corresponds to the change of signaling benefit, is positive if and only if signaling is reinforcing, i.e. inequality (13) holds. Hence, a necessary condition for a bandwagon effect ($\frac{\partial \mathcal{B}_H}{\partial c_H} > 0$) is reinforcing signaling. Given that signaling is reinforcing, a bandwagon effect exists as long as the second term is higher in absolute value than the first term. This arises, for instance, if w_2 is high relative to $w_1 \Pi'(p)/2$, that is, if social interactions

[18] Expressing this condition in terms of the voting benefit of a high type agent is sufficient, since the voting benefit of a low type agent is proportional.

are important compared to the impact of an increase in turnout on the electoral benefit.

The intuition is as follows: With a higher turnout, electoral benefit of a voter decreases due to a smaller pivotal probability. However, if signaling benefit increases with a higher turnout, or equivalently if signaling is reinforcing, then the bandwagon effect may arise. The bandwagon effect exists when the increase in signaling benefit is higher in magnitude than the decrease in electoral benefit.

4.2.3 Magnitude of dc_H^*/dw_1

Until here, we were interested in the sign of various effects. Finally, we analyze the magnitude of the increase in turnout ratio due to a small increase in the election's significance (w_1). Note that in a model of voting which does not include signaling benefit, the response of turnout to changes of w_1 is small due to low pivotal probabilities for voters. Therefore, it is important to see whether the inclusion of the signaling benefit can change this result.

As we showed earlier, the election's significance becomes more important for turnout ratio when signaling is reinforcing. Indeed, if this reinforcement is strong enough so that there exists an important bandwagon effect, a small change in the importance of the election may have a large impact on equilibrium turnout. Mathematically, replacing x by w_1 in equation (11) gives:

$$\frac{dc_H^*}{dw_1} = -\frac{\frac{\partial \mathcal{B}_H}{\partial w_1}}{\frac{\partial \mathcal{B}_H}{\partial c_H} - 1} \tag{15}$$

where $\frac{\partial \mathcal{B}_H}{\partial c_H}$ is given in equation (12) and $\frac{\partial \mathcal{B}_H}{\partial w_1}$ is given by $\frac{\partial \mathcal{B}_H}{\partial w_1} = \frac{\alpha_H}{2}\Pi(p)$. Since $\Pi(p)$ is relatively small, the numerator in equation (15) is expected to be small. In the absence of signaling benefit ($w_2 = 0$), the denominator in absolute value is higher than 1, since $\frac{\partial \mathcal{B}_H}{\partial c_H}$ is negative. This leads to a low magnitude of $\frac{dc_H^*}{dw_1}$. However, in the presence of signaling, if signaling is reinforcing, $\frac{\partial \mathcal{B}_H}{\partial c_H}$ can be arbitrarily close to 1 (a stable equilibrium implies that $\frac{\partial \mathcal{B}_H}{\partial c_H} < 1$). From (12), one sees again that this occurs if the importance of social interactions w_2 is large relative to $w_1\Pi'(p)/2$, the change in electoral benefit induced by an increase in turnout. If this is the case, one has a small denominator in absolute value and therefore an important magnitude of $\frac{dc_H^*}{dw_1}$.

The intuition behind this result is that, if social interactions are very important for voters relative to turnout-induced changes in electoral benefit (high w_2 and low $w_1\Pi'(p)/2$), then even a small increase in the importance of the election may generate a large increase in turnout, because of the importance of signaling effects. In other words, since voters expect other voters to turn out in higher numbers, their own incentive to vote increases significantly due to signaling purposes and this may generate a substantial increase on total turnout.

4.3 Extensions and discussion

To conclude the analysis, we discuss two assumptions of our model, and consider possible extensions along these lines.[19] First, the present paper considers symmetric party support in the sense that every voter prefers each party with probability 1/2. This choice is motivated, like in Börgers (2004), by our focus on total turnout, and by our aim to highlight the implications of signaling on aggregate voting incentives. Moreover, the case of symmetric party support appears to be of particular political relevance, since in many countries, most notably in the U.S., the electorates are almost evenly split between left and right wing political camps, and elections are consequently tight.

Nevertheless, it is interesting to discuss how signaling might affect turnout in a model with asymmetric party support. To get a feeling for the forces at work in such a model, assume that an exogenous shock makes the election more important, thereby raising the incentives to turn out for supporters of both parties. However, when supporters of the majority party vote in larger numbers, supporters of the minority party are less likely to be pivotal, because their expected number of votes falls even farther behind the expected number of votes for the majority (see Taylor and Yildirim 2010, Lemma 1 (ii), p. 460). This decreases the incentives for the minority to turn out, and even more so if the marginal voters of the minority party are valuable interaction partners, i.e., whenever an inequality like (13) holds for these voters. Thus, the initial increase in turnout of the minority is dampened by a feedback of the majority's turnout on the minority's pivotal probability. As a consequence, a condition like (13) is not sufficient any more for a reinforcing effect of signaling.

In order for such a feedback effect to overturn the result of Proposition 2, however, the asymmetry has to be large. In fact, one can show that signaling has a reinforcing effect on turnout if for supporters of both parties conditions analogous to (13) hold, provided that the ex ante support for the parties is close enough to 1/2. Thus, our analysis is robust to small deviations from the assumption of symmetric party support, thereby covering the empirically relevant case of tight elections.

[19]Details are available from the authors upon request.

As a second modification, one could think of formulating an interaction payoff different from (1). We experimented with (i) a Cobb-Douglas formulation: $w_2(\alpha_i^\gamma \alpha_j^{1-\gamma} - d)$, $\gamma < 1/2$, and (ii) a linear formulation such that for high types: $w_2(\gamma\alpha_H\alpha_j - d)$, for low-types: $w_2(\alpha_L\alpha_j - d)$, with $\alpha_L/\alpha_H < \gamma < 1$. Now if (i) in the Cobb-Douglas specification, γ is close to 1/2, and (ii) in the linear specification, γ is close to 1, then the decision whether to interact or not is almost entirely driven by one's own rather than the partner's type. As a consequence, signaling will not occur since it is not relevant whether one is considered to be an attractive partner. Conversely, in these specifications, analogous versions of Proposition 2 and the ensuing bandwagon effect can be derived, provided that the partner's type is sufficiently relevant for the interaction benefit, that is, γ is low enough.

5 Conclusion

The paper presents a formal model of voting as signaling device. By observing the voting behavior of others in their social circle, voters receive a signal about their 'neighbor's' value in social interactions. This generates an additional incentive to vote, apart from affecting the outcome of the election, as the early rational voting theory predicts. This additional incentive can account for the paradox of not voting in large societies and the role of social pressures in electoral turnouts. Moreover, the model generates several predictions which are consistent with empirical findings.

We believe that the model can be extended in order to shed light on the interaction between voting incentives and the role of political parties. In our model, the importance of the election is taken as an exogenous parameter. In reality it is affected by political campaigns and advertising.[20] If social interactions can have a substantial impact on voting incentives and electoral turnout, as our model suggests, how do political parties strategically allocate their resources to mobilize their voters? And how is the degree of contestability in a constituency related to the importance of social interactions? Our analysis suggests that signaling incentives may be an important factor in such considerations.

[20]For some recent papers on these topics see Iaryczower and Mattozzi (2012) and Morton and Myerson (2012).

Appendix

A First-stage equilibrium

Proof of Proposition 1

(i) When we plot $\mathcal{B}_H(c_H)$ on $c_{min}/\mu < c_H < c_{max}$, the intersection c_H^* with the 45° line would be an interior equilibrium satisfying (6). By the continuity of $\mathcal{B}_H(c_H)$ on the interval $[c_{min}/\mu, c_{max}]$, if $\mathcal{B}_H(c_{min}/\mu) > c_{min}/\mu$ (i.e. the starting point is above the 45° line) and $\mathcal{B}_H(c_{max}) < c_{max}$ (i.e. the ending point is below the 45° line), then at least one such intersection exists. Moreover, since at least one intersection is such that $\mathcal{B}_H(c_H)$ cuts the 45° line from above, a stable interior equilibrium exists if these two conditions are satisfied. In an interior equilibrium with signaling, the second period benefit is $\frac{1}{2}w_2 p(n-1)[\lambda_H\alpha_H + (1-\lambda_H)\alpha_L - d]$. With the cutoff points $c_H = c_{min}/\mu$ and $c_L = c_{min}$, p is equal to $p = qF(c_{min}/\mu)$ and λ_H is equal to $\lambda_H = 1$. With the cutoff points $c_H = c_{max}$ and $c_L = \mu c_{max}$, p is equal to $p = q + (1-q)F(\mu c_{max})$ and λ_H is equal to $\lambda_H = \frac{q}{q+(1-q)F(\mu c_{max})}$. Replacing p and λ_H in (5) and rearranging, one finds that $\mathcal{B}_H(c_{min}/\mu) > c_{min}/\mu$ and $\mathcal{B}_H(c_{max}) < c_{max}$ are equivalent to inequalities (7) and (8).

In addition, we have to make sure that this intersection c_H^* gives an equilibrium with signaling. This is the case if the two conditions $\lambda_H\alpha_H + (1-\lambda_H)\alpha_L \geq d$ and $(1-\lambda_L)\alpha_H + \lambda_L\alpha_L \leq d$ hold for all $c_H \in [c_{min}/\mu, c_{max}]$ (i.e. for all possible intersection points). These two conditions are equivalent to (9) holding for all $c_H \in [c_{min}/\mu, c_{max}]$.

(ii) The lhs of inequality (7) is always positive. Hence, this inequality is satisfied for low enough c_{min}. The lhs of inequality (8) is bounded above by $\alpha_H\big\{\frac{w_1}{2} + \frac{1}{2}w_2(n-1)q(\alpha_H - d)\big\}$. Hence, this inequality is satisfied for high enough c_{max}.

The lhs of inequality (9) is lower than $(1-q)/q$ since $F(\mu c_H) < F(c_H)$ for all $c_H \in [c_{min}/\mu, c_{max}]$. Similarly, the rhs of inequality (9) is greater than $(1-q)/q$ since $1 - F(\mu c_H) > 1 - F(c_H)$ for all $c_H \in [c_{min}/\mu, c_{max}]$. Then, for instance, if d is such that $\frac{\alpha_H - d}{d - \alpha_L} = \frac{1-q}{q}$ (equivalently $q\alpha_H + (1-q)\alpha_L = d$), both conditions are satisfied. Hence, there is a neighborhood of values of d around $q\alpha_H + (1-q)\alpha_L$ in which both conditions are satisfied. Note that this neighborhood for d is consistent with the fact that inequalities (7) and (8) hold for some parameter values, since the latter inequalities are satisfied by appropriate choice of c_{min} and c_{max}, irrespective of d. ■

B Comparative statics

In this subsection of the Appendix, for ease of exposition, we write c_H and c_L to denote the equilibrium cutoffs instead of c_H^* and c_L^*.

Claim (iv): $\frac{dp^*}{dq} > 0$.

Proof: dp^*/dq is given by

$$\frac{dp^*}{dq} = F(c_H) - F(\mu c_H) + \frac{dc_H}{dq}\left[qf(c_H) + (1-q)\mu f(\mu c_H)\right]$$

We can compute dc_H/dq by using equations (11) and (12) where $\partial \mathcal{B}_H/\partial q$ is given by

$$\frac{\partial \mathcal{B}_H}{\partial q} = \alpha_H \left\{ \frac{w_1}{2}\Pi'(p)[F(c_H) - F(\mu c_H)] + \frac{w_2}{2}(n-1)\big[F(c_H)(\alpha_H - d) - F(\mu c_H)(\alpha_L - d)\big] \right\}$$

Notice that the first term in $\partial \mathcal{B}_H/\partial q$ is negative, while the second term is positive. If, for example, w_2 (w_1) is sufficiently large, one obtains $dc_H/dq > 0$ (< 0).

However, we now show that total turnout always increases. Replacing the value of dc_H/dq in the above expression for dp^*/dq, we find that dp^*/dq has the same sign as

$$\begin{aligned}
&\Big[F(c_H) - F(\mu c_H)\Big]\Big[1 - \alpha_H \Big\{ \frac{w_1}{2}\Pi'(p)\big[qf(c_H) + (1-q)\mu f(\mu c_H)\big] \\
&+ \frac{w_2}{2}(n-1)\big[qf(c_H)(\alpha_H - d) + (1-q)\mu f(\mu c_H)(\alpha_L - d)\big]\Big\}\Big] \\
&+ \Big[qf(c_H) + (1-q)\mu f(\mu c_H)\Big]\Big[\alpha_H \Big\{ \frac{w_1}{2}\Pi'(p)\big[F(c_H) - F(\mu c_H)\big] \\
&+ \frac{w_2}{2}(n-1)\big[F(c_H)(\alpha_H - d) - F(\mu c_H)(\alpha_L - d)\big]\Big\}\Big]
\end{aligned}$$

By lengthy but simple algebraic manipulations, it can be shown that the above expression and hence dp^*/dq are always positive. ■

Claim (v): $\frac{dp^*}{d\alpha_H} > 0$ but $\frac{dp^*}{d\alpha_L}$ *cannot be signed.*

Proof: $\frac{\partial \mathcal{B}_H}{\partial \alpha_H}$ is given by

$$\begin{aligned}\frac{\partial \mathcal{B}_H}{\partial \alpha_H} =& \Big\{ \frac{w_1}{2}\Pi(p) + \frac{w_2}{2}(n-1)[qF(c_H)(\alpha_H - d) + (1-q)F(\mu c_H)(\alpha_L - d)] \Big\} + \\ & \alpha_H \Big\{ \frac{w_1}{2}\Pi'(p)(1-q)f(\mu c_H)\Big(-\frac{\alpha_L c_H}{\alpha_H^2}\Big) + \frac{w_2}{2}(n-1)\Big[qF(c_H) + (1-q)f(\mu c_H)(\alpha_L - d)\Big(-\frac{\alpha_L c_H}{\alpha_H^2}\Big)\Big]\Big\}\end{aligned}$$

The term in the first bracket is the impact through the individual's own preference parameter, and the term $\frac{w_2}{2}(n-1)qF(c_H)$ is the impact of the partners' parameter on the signaling benefit. The terms involving $-\frac{\alpha_L c_H}{\alpha_H^2}$ are the effects of a decrease in the cutoff c_L on the electoral and signaling benefits, which occurs so as to maintain the relationship $c_L = \mu c_H$ which must always hold in an equilibrium. Since all terms are positive, one has $dc_H/d\alpha_H > 0$.

Similar to $\mathcal{B}_H(c_H)$, we define $\mathcal{B}_L(c_L)$ as

$$\begin{aligned}\mathcal{B}_L(c_L) &\equiv B_L(c_L/\mu, c_L) \\ &= \alpha_L \Big\{ \frac{w_1}{2}\Pi(p) + \frac{w_2}{2}(n-1)\big[qF(c_L/\mu)(\alpha_H - d) + (1-q)F(c_L)(\alpha_L - d)\big]\Big\}\end{aligned} \tag{B.1}$$

The second term in this benefit is the signaling benefit which increases after an increase in α_H. The electoral benefit in the first term decreases if and only if $\Pi(p)$ increases. Thus, $dc_L/d\alpha_H$ may be negative. However, if total turnout p were to decrease, then $\Pi(p)$, and hence all terms in (B.1), would increase, which together with $dc_H/d\alpha_H > 0$ yields a contradiction.

From (B.1), we obtain

$$\begin{aligned}\frac{\partial \mathcal{B}_L}{\partial \alpha_L} =& \Big\{ \frac{w_1}{2}\Pi(p) + \frac{w_2}{2}(n-1)[qF(c_L/\mu)(\alpha_H - d) + (1-q)F(c_L)(\alpha_L - d)] \Big\} + \\ & \alpha_L \Big\{ \frac{w_1}{2}\Pi'(p)qf(c_L/\mu)\Big(\frac{-c_L\alpha_H}{\alpha_L^2}\Big) + \frac{w_2}{2}(n-1)\Big[(1-q)F(c_L) + qf(c_L/\mu)(\alpha_H - d)\Big(\frac{-c_L\alpha_H}{\alpha_L^2}\Big)\Big]\Big\}\end{aligned} \tag{B.2}$$

The last term in (B.2) expresses the impact of an increase in α_L via the associated change in the share of high type agents among the interaction partners, and is negative. If the weight w_2 on signaling is large and if the density of cost $f(c_L/\mu)$ happens to be large at the original equilibrium, then (B.2) may turn negative, so that $dc_L/d\alpha_L$ need not be positive. ■

Proof of Proposition 3: First we derive the thresholds d_H and d_L from the two conditions given at the end of Subsection 3.1 as a function of the cutoff value c_H for the high types in the equilibrium under consideration. To do this, we substitute the relevant values for λ_H and λ_L into $\lambda_H\alpha_H+(1-\lambda_H)\alpha_L \geq d$ and $(1-\lambda_L)\alpha_H+\lambda_L\alpha_L \leq d$:

$$
\begin{aligned}
d_H &= \lambda_H\alpha_H + (1-\lambda_H)\alpha_L \\
\Rightarrow d_H &= \frac{qF(c_H)}{qF(c_H)+(1-q)F(\mu c_H)}\alpha_H + \left(1-\frac{qF(c_H)}{qF(c_H)+(1-q)F(\mu c_H)}\right)\alpha_L \\
\Rightarrow d_H &= \frac{\alpha_H qF(c_H)+\alpha_L(1-q)F(\mu c_H)}{qF(c_H)+(1-q)F(\mu c_H)}
\end{aligned}
$$

Similarly:

$$
d_L = (1-\lambda_L)\alpha_H + \lambda_L\alpha_L \;\Rightarrow\; d_L = \frac{\alpha_H q(1-F(c_H))+\alpha_L(1-q)(1-F(\mu c_H))}{q(1-F(c_H))+(1-q)(1-F(\mu c_H))}
$$

For part (i), suppose that $f(c_H)/F(c_H) \geq \mu f(\mu c_H)/F(\mu c_H)$. One has

$$
\frac{f(c_H)}{F(c_H)} > (=)\frac{\mu f(\mu c_H)}{F(\mu c_H)} \;\Leftrightarrow\; (\alpha_H-\alpha_L)f(c_H)F(\mu c_H) > (=)(\alpha_H-\alpha_L)\mu f(\mu c_H)F(c_H)
$$

$$
\Leftrightarrow\; \alpha_H f(c_H)F(\mu c_H) + \alpha_L\mu f(\mu c_H)F(c_H) > (=)\alpha_H\mu f(\mu c_H)F(c_H) + \alpha_L f(c_H)F(\mu c_H)
$$

Multiplying both sides by $q(1-q)$ and adding $\alpha_H q^2 f(c_H)F(c_H)$ and $\alpha_L(1-q)^2\mu f(\mu c_H)F(\mu c_H)$ on both sides yields:

$$
\begin{aligned}
&\alpha_H q^2 f(c_H)F(c_H) + \alpha_H q(1-q)f(c_H)F(\mu c_H) \\
&\qquad +\alpha_L q(1-q)\mu f(\mu c_H)F(c_H) + \alpha_L(1-q)^2\mu f(\mu c_H)F(\mu c_H) \\
&\quad > (=) \quad \alpha_H q^2 f(c_H)F(c_H) + \alpha_H q(1-q)\mu f(\mu c_H)F(c_H) \\
&\qquad +\alpha_L q(1-q)f(c_H)F(\mu c_H) + \alpha_L(1-q)^2\mu f(\mu c_H)F(\mu c_H) \\
&\Leftrightarrow \big[\alpha_H q f(c_H) + \alpha_L(1-q)\mu f(\mu c_H)\big]\big[qF(c_H)+(1-q)F(\mu c_H)\big] \\
&\quad > (=) \quad \big[\alpha_H qF(c_H)+\alpha_L(1-q)F(\mu c_H)\big]\big[qf(c_H)+(1-q)\mu f(\mu c_H)\big] \\
&\Leftrightarrow \frac{\alpha_H q f(c_H)+\alpha_L(1-q)\mu f(\mu c_H)}{qf(c_H)+(1-q)\mu f(\mu c_H)} \; > (=) \; \frac{\alpha_H qF(c_H)+\alpha_L(1-q)F(\mu c_H)}{qF(c_H)+(1-q)F(\mu c_H)} \\
&\Leftrightarrow \tilde{\alpha} \; > (=) \; d_H
\end{aligned}
$$

From the lines above, we conclude more specifically that

$$\frac{f(c_H)}{F(c_H)} \;>(=)\; \frac{\mu f(\mu c_H)}{F(\mu c_H)} \Leftrightarrow \tilde{\alpha} \;>(=)\; d_H$$

When $\tilde{\alpha}$ is greater than (resp. equal to) d_H, this implies that any value of d that satisfies the equilibrium conditions also satisfies $d < \tilde{\alpha}$ (resp. $d \leq \tilde{\alpha}$) . Hence $\frac{d^2 c_H^*}{dw_1 dw_2} > 0$ (resp. ≥ 0).

For part (ii), note first that the above argument implies $\tilde{\alpha} < d_H$. Furthermore, substitute in the proof above the terms $1 - F(c_H)$ and $1 - F(\mu c_H)$ for the terms $F(c_H)$ and $F(\mu c_H)$ respectively and iterate the same steps. Then we obtain:

$$\begin{aligned} \frac{f(c_H)}{1 - F(c_H)} \;&>(=)\; \frac{\mu f(\mu c_H)}{1 - F(\mu c_H)} \\ \Leftrightarrow \frac{\alpha_H q f(c_H) + \alpha_L (1-q) \mu f(\mu c_H)}{q f(c_H) + (1-q)\mu f(\mu c_H)} \;&>(=)\; \frac{\alpha_H q (1 - F(c_H)) + \alpha_L (1-q)(1 - F(\mu c_H))}{q(1 - F(c_H)) + (1-q)(1 - F(\mu c_H))} \\ \Leftrightarrow \tilde{\alpha} \;&>(=)\; d_L \end{aligned}$$

When $\tilde{\alpha}$ is greater than d_L, the cost of the match d may satisfy $d < \tilde{\alpha}$ or not. This depends on the other parameters of the model. Hence, either $\frac{d^2 c_H^*}{dw_1 dw_2} \geq 0$ or $\frac{d^2 c_H^*}{dw_1 dw_2} < 0$. When $\tilde{\alpha}$ is equal to d_L, $d \geq \tilde{\alpha}$. Hence, $\frac{d^2 c_H^*}{dw_1 dw_2} \leq 0$.

Finally, part (iii) follows from part (ii). This is because when the initial condition of part (ii) does not hold, then $\tilde{\alpha} < d_L$, which implies that the condition $d \leq \tilde{\alpha}$ is mutually exclusive with the equilibrium conditions.

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