



Ethical Voting in Heterogenous Groups

Alberto Grillo

► **To cite this version:**

| Alberto Grillo. Ethical Voting in Heterogenous Groups. 2020. halshs-02962464v1

HAL Id: halshs-02962464

<https://halshs.archives-ouvertes.fr/halshs-02962464v1>

Preprint submitted on 9 Oct 2020 (v1), last revised 16 Apr 2021 (v2)

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Ethical Voting in Heterogenous Groups

Alberto Grillo

WP 2020 - Nr 34

Ethical Voting in Heterogenous Groups

Alberto Grillo *

Aix Marseille Univ, CNRS, AMSE, Marseille, France

October 8, 2020

Abstract

Voting in large elections appears to be both ethically motivated and influenced by strategic considerations. One way to capture this interplay postulates a rule-utilitarian calculus, which abstracts away from heterogeneity in the intensity of support (Feddersen and Sandroni 2006, Coate and Conlin 2004). I argue that this approach is unsatisfactory when such heterogeneity is considered, since it implies that idiosyncratic preferences are irrelevant for participation, in contrast to the empirical evidence. A model of Kantian optimization à la Roemer (2019), based on the maximization of individual utility under a universalization principle, predicts instead differential participation and links ethical motivation to the spatial theory of voting.

Keywords: Voting, Turnout, Ethical Voter, Rule-utilitarian, Kantian Optimization

JEL Classification: D72

*Contact: [alberto.grillo\[at\]univ-amu.fr](mailto:alberto.grillo[at]univ-amu.fr). This work was supported by the French National Research Agency Grants ANR-17-EURE-0020. Part of this work was done during my Ph.D. at the Toulouse School of Economics. I thank Philippe De Donder, Karine Van der Straeten, Ingela Alger, David Austen-Smith, Micael Castanheira, Thomas Christiano, Arianna Degan, Arnaud Dellis, François Maniquet, Thomas Mariotti, Massimo Morelli, John Roemer, Nicolas Werquin, seminar participants at AMSE in Marseille, at TSE and IAST in Toulouse, at UQAM in Montreal, at the SCSE conference in Québec City, at the X IBEO workshop in Alghero, at the Max Planck Institute for tax law and public finance in Munich, at ECARES in Brussels, and at CUNEF in Madrid for their helpful comments.

1 Introduction

Explaining voting in large elections has proven difficult. The instrumental model, with citizens motivated only by the desire to affect the outcome, clashes against the probability of being pivotal becoming negligible as the number of voters grows. Hence, even small voting costs bound the predicted turnout rate to be close to zero. To resolve the impasse, previous research has suggested a prominent role for citizens' ethical motivation to vote, fulfilling what many consider not only a right but also a civic duty (Blais 2000, François and Gergaud 2019, Blais and Daoust 2020). Ethics, in turn, explains little alone, as voter turnout does vary in ways that suggest the presence of strategic considerations. For example, participation is typically increasing in the expected closeness of the election (Cox and Munger 1989, Shachar and Nalebuff 1999, Fauvelle-Aymar and François 2006, Arnold 2018). The challenge posed by the empirical evidence consists thus in capturing the interaction between voters' ethical and strategic reasoning.

In two seminal contributions, Feddersen and Sandroni (2006) and Coate and Conlin (2004) proposed to do so through a rule-utilitarian calculus of voting. Rule-utilitarian voters follow the turnout rule that maximizes aggregate utility. Such a rule takes the form of an endogenous threshold, dictating participation from all supporters with voting costs below it. Hence, voter turnout is ethically motivated but responds strategically to the characteristics of the election, in line with the empirical patterns at the aggregate level. The standard rule-utilitarian model, however, features two assumptions that it is interesting to question. The first is that the groups of supporters are given exogenously, which ignores citizens' choice of which candidate they support. The second is that groups are homogenous, in that all supporters of a candidate obtain the same benefit from the outcome of the election. This paper studies voter turnout in a *spatial* framework, in which the two previous assumptions are relaxed. Citizens have idiosyncratic preferences on a policy space and form supporters' groups endogenously, as a function of the distance between their preferred policy and the one proposed by the candidates. As a consequence, the intensity of support differs among supporters of the same candidate. How does such heterogeneity affect citizens' turnout decisions?

I argue that the rule-utilitarian approach is unsatisfactory when it comes to explain participation within heterogenous groups. The specific predictions depend on the nature of the voting costs. If they differ and are ex-ante unknown, as typically assumed, the optimal turnout rule is independent of voters' preferences and thus of the intensity of

support. The maximization of aggregate utility, indeed, requires that aggregate voting costs be minimized by disregarding any heterogeneity in preferences. The result, however, clashes with the evidence of differential turnout along a spatial dimension. Specifically, it is incompatible with the findings that citizens who feel equally close to the competing candidates or too far from all of them are less likely to vote (Zipp 1985, Plane and Gershtenson 2004, Adams et al. 2006).¹ The implications are as well troubling under the assumption of fixed and identical voting costs. In this case, the optimal rule pins down only the aggregate number of votes and an infinity of participation patterns emerge at the individual level. Such a loose prediction, due again to the irrelevance of idiosyncratic preferences for a utilitarian calculus, practically fails to answer the research question of the paper.

In light of the previous results, I examine then an alternative model of ethical voting, in which the underlying principle consists in maximizing individual utility under a constraint of universalization of behavior. Specifically, I follow Roemer’s Kantian optimization (2010, 2015, 2019) in assuming that citizens evaluate deviations from a participation rule by the consequences resulting if all supporters in their group deviate similarly. The model yields unique predictions with both fixed and heterogenous voting costs. Crucially, the supporters’ probability of voting depends on their policy preferences and is increasing in the intensity of support, as given by the difference in utility from the candidates’ policies. The results are then consistent with the evidence of differential participation mentioned above. Moreover, if the voting cost is fixed, the aggregate number of votes are the same as those derived from the rule-utilitarian calculus. In this case, thus, Kantian optimization solves the multiplicity of equilibria by specifying a unique rule at the individual level on which even rule-utilitarian supporters can coordinate. Overall, the model offers a very tractable way to study ethical participation in a spatial setting.

The rule-utilitarian approach builds on the work by Harsanyi (1977, 1980). I follow Coate and Conlin (2004) in considering *group rule-utilitarian* agents who maximize group utility.² Ali and Lin (2013) enrich the framework with social incentives and contrast true rule-utilitarians with pragmatic voters who wish to appear ethical. Bierbrauer et al. (2019) study how candidates’ choices of tax policies respond to participation from rule-utilitarian voters. The theoretical foundations of the rule-utilitarian calculus rely on the

¹The previous literature has named these patterns of abstention as due to indifference and alienation, respectively.

²In Feddersen and Sandroni (2006), instead, agents maximize a more aggregate welfare measure that includes all social costs of voting. The results and insights of this paper are analogous in the two cases.

thought experiment of choosing under a *veil of ignorance*, which concerns the realizations of the costs of voting. In the standard model, the cost of voting is the only dimension of (ex-post) heterogeneity; hence, all agents within a group are ex-ante identical and benefit equally from maximizing aggregate utility. As such, the rule-utilitarian model works best when the analysis focuses on aggregate turnout, whose empirical patterns are well captured by the comparative statics results. In a spatial framework, instead, the policy space represents the conflict of interests inherent to politics, and thus a heterogeneity in preferences for which the application of the veil of ignorance becomes less plausible. In this case, Kantian optimization outperforms the rule-utilitarian model because agents maximize their individual utility. As such, idiosyncratic preferences, which determine the intensity of support, are taken into account in the ethical calculus and translate into heterogeneous participation behavior.

Roemer presents Kantian optimization as a cooperative protocol that yields Pareto-efficient outcomes. Early references to the underlying principle of universalization include Laffont (1975) and Sugden (1984). Alger and Weibull (2013, 2016) investigate the evolutionary foundations of morality and characterize stable preferences as partially *Kantian*. Two different applications of Kantian optimization to political competition and voting are in Roemer (2006, 2010). De Donder and Roemer (2016) apply it to lobbying in order to study the evolution of the income distribution. Grafton et al. (2017) use a similar model to study the dynamics of climate change mitigation, while Eichner and Pethig (2020) examine the implications on tax competition. Sher (2020) provides a valuable critical discussion of the normative aspects of Roemer's theory.

The remainder of the paper is organized as follows. Section 2 lays down the spatial framework and shows the limitations of the rule-utilitarian approach in such a setting. Section 3 develops the Kantian optimization model and presents the main results. Section 4 discusses the endogenization of candidates' policies, the possibility of amending the rule-utilitarian calculus, and the Kantian label that economists typically assign to the universalization principle. Section 5 concludes.

2 Voting in a spatial setting

2.1 Framework

The policy space is the interval $[0, 1]$. Two candidates, A and B, compete by proposing policies a and b . The electorate is composed of a continuum of citizens, distributed according to a density function $f(z)$, where z denotes their preferred policy (or bliss point). Each citizen z evaluates any policy x with a utility function $u(z - x)$, denoted shortly $u_z(x)$. That is, the policy benefits $u_z(a)$ and $u_z(b)$ depend on the distance between the bliss point z and the proposed policies a and b .

Assumption 1. *The utility function $u_z(x)$ is continuous, single-peaked around the bliss point z , and the same for all citizens.*

Denote the groups of supporters $\mathcal{Z}_A = \{z : u_z(a) > u_z(b)\}$ and $\mathcal{Z}_B = \{z : u_z(b) > u_z(a)\}$. Assumption 1 guarantees that the two groups are separated on the policy space by an indifferent citizen z^* . If without loss of generality $a \leq b$, then $\mathcal{Z}_A = [0, z^*)$ and $\mathcal{Z}_B = (z^*, 1]$.³

The consequences of the election are probabilistic and depend on the number of votes v_a and v_b targeted by the two groups. Specifically, policy a is implemented with some probability $P(v_a, v_b)$, while policy b is implemented with probability $1 - P(v_a, v_b)$. Because voting only affects the probability of either policy a or b to be implemented, the vote choice is sincere in favor of the preferred candidate. The participation behavior is described by two functions $p_a(z) : \mathcal{Z}_A \rightarrow [0, 1]$ and $p_b(z) : \mathcal{Z}_B \rightarrow [0, 1]$ giving the probability of voting for each supporter in each group, which we are ultimately interested in deriving endogenously. The number of votes are then obtained by aggregating the probability of voting within each group, i.e. $v_a = \int_{\mathcal{Z}_A} p_a(z)f(z)dz$ and $v_b = \int_{\mathcal{Z}_B} p_b(z)f(z)dz$.

Assumption 2. (i) $P(v_a, v_b)$ is increasing in v_a , decreasing in v_b , and equal to $\frac{1}{2}$ if $v_a = v_b$.
(ii) $P(v_a, v_b)$ is concave in v_a and convex in v_b .

Assumption 2(i) is standard. Assumption 2(ii) is more restrictive but guarantees the tractability of the model, as the first order conditions imply optimality. A natural candidate for $P(v_a, v_b)$ is a *contest success function* $\frac{v_a^\gamma}{v_a^\gamma + v_b^\gamma}$ with noise parameter $\gamma > 0$. Note that, in this case, Assumption 2(ii) is satisfied only for $\gamma \leq 1$, although in general an optimal solution exists also if $\gamma > 1$.

³If $u_z(x)$ is also symmetric around the bliss point z , then $z^* = \frac{a+b}{2}$.

The uncertainty can arise at the legislative stage, because the probability of passing either policy depends on the number of votes obtained by each candidate. Or it can arise at the voting stage, because *targeted* votes do not map perfectly into *effective* votes. As an example of a stochastic voting stage, assume that for targeted votes v_a and v_b in the two groups, the effective number of votes are

$$\frac{v_a + v_b}{\theta_a v_a + \theta_b v_b} \theta_a v_a \quad , \quad \frac{v_a + v_b}{\theta_a v_a + \theta_b v_b} \theta_b v_b \quad (1)$$

for group A and B respectively, with θ_a, θ_b iid $\sim \exp(\lambda)$. That is, the total number of votes is deterministic but the shares of votes for the two groups are affected by two aggregate shocks. Then, the probability that the effective number of votes for A is greater than the effective number of votes for B is given by a *Tullock contest success function* (i.e. $\gamma = 1$). Indeed

$$P(v_a, v_b) = P(\theta_a v_a > \theta_b v_b) = \frac{v_a}{v_a + v_b}$$

since the shocks are independent and exponentially distributed (see Konrad 2007 for a proof).⁴ In the next sections, I use this example to derive closed-form solutions and comparative statics results.

Finally, each citizen has a positive cost of voting. The standard model assumes heterogeneous costs, drawn independently from a uniform distribution $c \sim \mathcal{U}[0, \bar{c}]$. Citizens decide their participation behavior before learning the realizations of their costs. The turnout rule in each group is thus given by a threshold cost: supporters vote if their realization is below the threshold and abstain if it is above. In our spatial framework, voting costs are also independent of policy preferences. But the threshold costs in both groups shall be allowed to vary as a function of the supporters' preferences and are thus functions $c_a(z)$ and $c_b(z)$. Moreover, since results change in interesting ways, I compare the analysis under heterogeneous voting costs with the simpler case of a fixed voting cost equal to c for all citizens.⁵

⁴Note that the term $\frac{v_a + v_b}{\theta_a v_a + \theta_b v_b}$ in (1) serves only a normalization purpose. Note also that the expected values of the effective number of votes are v_a and v_b for any value of the exponential distribution's parameter λ .

⁵Considering different distributions from the uniform does not yield, instead, additional insights.

2.2 The limitations of the rule-utilitarian approach

I now derive the implications of the rule-utilitarian calculus in our spatial framework. I consider *group* rule-utilitarians supporters, who set the turnout rule in order to maximize the group aggregate utility. Given a threshold cost function $c_a(z)$ under a uniform distribution of voting costs $c \sim \mathcal{U}[0, \bar{c}]$, the probability of voting for a supporter z in group A is given by the cumulative distribution function evaluated at the threshold, i.e. $p_a(z) = \frac{1}{\bar{c}}c_a(z)$. The expected voting cost is $\int_0^{c_a(z)} \frac{1}{\bar{c}}c \, dc = \frac{1}{2\bar{c}}c_a(z)^2$ and the supporter's expected utility is then

$$P(v_a, v_b)u_z(a) + (1 - P(v_a, v_b))u_z(b) - \frac{1}{2\bar{c}}c_a(z)^2$$

where $v_a = \int_{\mathcal{Z}_A} \frac{1}{\bar{c}}c_a(z)f(z)dz$ and $v_b = \int_{\mathcal{Z}_B} \frac{1}{\bar{c}}c_b(z)f(z)dz$. By aggregation, group A utility is given by

$$P(v_a, v_b) \int_{\mathcal{Z}_A} u_z(a)f(z)dz + (1 - P(v_a, v_b)) \int_{\mathcal{Z}_A} u_z(b)f(z)dz - \frac{1}{2\bar{c}} \int_{\mathcal{Z}_A} c_a(z)^2 f(z)dz \quad (2)$$

The first result is that, despite the presence of heterogenous policy preferences, the turnout rule maximizing aggregate utility must necessarily be constant among supporters, i.e. independent of their bliss points z .

Lemma 1. *Consider the group rule-utilitarian model with heterogenous voting costs. If there exists $c_a(z)$ such that group A utility in (2) is maximized, then $c_a(z) = k$. Hence, the probability of voting is the same for all supporters in a group.*

A proof is provided in the appendix. To grasp the intuition, consider the case of a non-constant $c_a(z)$. Clearly, equalizing the threshold costs across different supporters z while keeping the same aggregate number of votes v_a lowers the expected costs, since group members voting with high costs are substituted by members with low costs. Hence, the model's prediction is stark: supporters should ignore their idiosyncratic preferences in order to make sure that aggregate voting costs are minimized. This conclusion follows from the nature of the rule-utilitarian approach, which maximizes aggregate utility: what matters for group utility is only the number of votes v_a and the aggregate voting costs.

Let us now compare the previous framework to the simpler case of a fixed cost of voting c for all citizens. Consider again group A . To facilitate the comparison, assume that in this case each supporter z chooses directly a probability of voting $p_a(z)$ in $[0, 1]$.

The individual expected utility is then

$$P(v_a, v_b)u_z(a) + (1 - P(v_a, v_b))u_z(b) - c p_a(z)$$

and group A aggregate utility is

$$P(v_a, v_b) \int_{\mathcal{Z}_A} u_z(a) f(z) dz + (1 - P(v_a, v_b)) \int_{\mathcal{Z}_A} u_z(b) f(z) dz - c v_a \quad (3)$$

where $v_a = \int_{\mathcal{Z}_A} p_a(z) f(z) dz$ by aggregation. As we see from equation (3), the aggregate utility depends now on the function $p_a(z)$ only through the number of votes v_a . Hence, the maximization of group utility determines only an optimal v_a . Clearly, insofar as the optimal v_a is an interior solution, there exists an infinity of different functions $p_a(z)$ that are compatible with it. That is, in the case of a fixed voting cost, the rule-utilitarian calculus pins down only the aggregate number of votes, but not the individual probability of voting given by $p_a(z)$.

Lemma 2. *Consider the group rule-utilitarian model with a fixed voting cost. If an interior equilibrium for the number of votes v_a and v_b exists, there exists an infinity of equilibria for the probability of voting $p_a(z)$ and $p_b(z)$ at the individual level, i.e. all those for which the aggregate relations $v_a = \int_{\mathcal{Z}_A} p_a(z) f(z) dz$ and $v_b = \int_{\mathcal{Z}_B} p_b(z) f(z) dz$ hold.*

Hence, with a fixed voting cost the problem is one of equilibrium selection. The model does not yield any specific prediction on the relationship between policy preferences and participation at the individual level. Again, this is due to its utilitarian nature: what matters for the aggregate group utility is now only the number of votes, while how supporters share the voting costs is irrelevant.

Let me summarize the two previous results. If voting costs are heterogenous, group utility maximization requires the threshold cost (and thus the probability of voting) to be the same among supporters of the same candidate, independently of their idiosyncratic preferences. Solving for the optimal constant threshold c_a pins down the optimal constant probability of voting p_a and the optimal number of votes v_a . Instead, if the voting cost is identical among supporters, the model pins down the optimal number of votes v_a but is silent on the individual probability of voting: an infinite number of functions $p_a(z)$ is compatible with the optimal v_a , with the model giving no further prediction. Both results are clearly unsatisfactory. The first depicts participation behavior as independent of voters' distance from the candidates, in contrast with the paradigm of spatial voting and

the evidence of differential participation in line with it (Zipp 1985, Plane and Gershtenson 2004, Adams et al. 2006). The second, while not being necessarily incompatible with such evidence, is too loose and thus offers no specific answer to the research question of the paper.

3 An alternative model

Let us then investigate the extent to which a model of Kantian optimization (Roemer 2010, 2015, 2019) delivers better predictions than the rule-utilitarian approach on the relationship between supporters' idiosyncratic preferences and their probability of voting.

3.1 The Kantian Optimization Protocol

Kantian optimization prescribes that ethical agents envision a universalization of their behavior. This universalization concerns potential deviations from a turnout rule, which are evaluated by the consequences that would result if other agents deviated similarly. An important aspect is what a similar way of deviating means: in the model, deviations are represented by a multiplicative factor and a similar deviation is one by the same factor. The universalization principle applies only within groups of supporters, while the voting behavior in the opposing group is taken as given, as in Nash optimization. Following Roemer's terminology, I call the solution concept a (multiplicative) Nash-Kantian equilibrium. This is thus characterized by the absence of profitable collective deviations, i.e. by the condition that no group member would want to deviate by any scalar factor, given all other members would also deviate by the same factor.⁶ Hence, while rule-utilitarian agents are ethical in that they maximize aggregate utility, here agents maximize an hypothetical individual utility, which results when behavior is universalized within their group. It is by keeping the focus on each individual utility that such a model overcomes the limitations of the rule-utilitarian approach described in the previous section.

Consider again the case of a fixed voting cost, in which citizens choose directly a probability of voting. An additional technicality concerns the fact that citizens have compact strategy sets, which requires the use of a generalized definition of the equilibrium concept (Roemer 2010). To ensure that probabilities remain lower than 1, assume that, for

⁶Roemer (2015, 2019) studied also deviations in the form of additive factors and a simpler notion of Kantian Equilibrium that applies in symmetric frameworks of identical agents, for which the universalization concerns actions and not deviations.

a deviation factor σ , all supporters z will deviate from their voting probability $p(z)$ by the $\min\{\sigma, \frac{1}{p(z)}\}$. Moreover, since different voters (might) vote with different probabilities, assume that each supporter z , when evaluating potential deviations, considers only deviation factors that are bounded above by $\frac{1}{p(z)}$.⁷ It is then useful to state a precise definition of the equilibrium concept. An equivalent definition holds, after minimal adjustments, for the case of heterogenous voting costs.

Definition. *A Nash-Kantian voting equilibrium is a pair of probability functions $p_a(z), p_b(z)$ in which*

- *for every candidate $X \in \{A, B\}$ proposing policy $x \in \{a, b\}$, $p_x(z) : \mathcal{Z}_X \rightarrow [0, 1]$ is a function associating to each citizen $z \in \mathcal{Z}_X$ the probability of voting (in favor of X)*

and such that

- *given the voting behavior in the opposing group, no voter $z \in \mathcal{Z}_X$ would prefer all voters $z' \in \mathcal{Z}_X$ to vote with probability $\min\{\sigma p_x(z'), 1\}$, for any deviation factor $\sigma \in [0, \frac{1}{p_x(z)}]$, $\sigma \neq 1$.*

This can be expressed concisely as

$$\begin{aligned} \forall z \in \mathcal{Z}_A \quad \arg \max_{\sigma \in [0, \frac{1}{p_a(z)}]} U_z(\min\{\sigma p_a, 1\}, p_b) &= 1 \\ \forall z \in \mathcal{Z}_B \quad \arg \max_{\sigma \in [0, \frac{1}{p_b(z)}]} U_z(p_a, \min\{\sigma p_b, 1\}) &= 1 \end{aligned}$$

where U_z is supporters' expected utility and $\min\{\sigma p_x, 1\}$ is the function $\min\{\sigma p_x(\cdot), 1\} : \mathcal{Z}_X \rightarrow [0, 1]$.

As a final remark, note that the pair of probability functions $p_a(z) = 0, p_b(z) = 0$ for all supporters in each group is always a Nash-Kantian equilibrium, as multiplicative deviations are in this case ineffective. In the following sections, uniqueness of the equilibrium will be claimed by restricting the analysis to positive probability functions.

3.2 Fixed Cost of Voting

Equipped with the previous definition of Nash-Kantian equilibrium, let us first reconsider the model with a fixed cost of voting equal to c for all citizens. Recall that, in this case,

⁷This assumption prevents a voter who is voting with a high probability from proposing a high deviation factor, which would be less costly for himself than for voters who vote with lower probability, because his probability of voting would be bounded at 1.

the expected utility of a supporter z in group A is

$$U_z = P(v_a, v_b)u_z(a) + (1 - P(v_a, v_b))u_z(b) - c p_a(z)$$

By definition, in equilibrium z would not want all supporters $z' \in \mathcal{Z}_A$ to deviate from their voting probability $p_a(z')$ by any factor $\sigma \in [0, \frac{1}{p_a(z)}]$. For technical convenience, however, we can neglect the fact that other voters z' would deviate by $\min\{\sigma, \frac{1}{p_a(z')}\}$ and work out the analysis assuming that all voters would deviate by σ , i.e. as if voters could vote with probability higher than 1. Intuitively, indeed, the benefit of a deviation by a factor σ is greater for a voter z when the constraint given by $\min\{\sigma, \frac{1}{p_a(z')}\}$ is not considered; hence if such a deviation is not profitable, it won't be when the probability of voting is bounded by 1. If a deviation by σ is followed by all voters in \mathcal{Z}_A , then, as $\int_{\mathcal{Z}_A} \sigma p_a(z) f(z) dz = \sigma v_a$, the expected utility of supporter z as a function of the deviation factor σ is equal to

$$P(\sigma v_a, v_b)u_z(a) + (1 - P(\sigma v_a, v_b))u_z(b) - c \sigma p_a(z) \quad (4)$$

The solution concept requires the expression in (4) to be maximized at $\sigma = 1$. Note that, since $P(\cdot)$ is concave in σv_a , the previous expression is concave in σ , hence the optimality condition is given by the first order condition evaluated at $\sigma = 1$, that is

$$\frac{\partial}{\partial v_a} P(v_a, v_b) \cdot v_a [u_z(a) - u_z(b)] - p_a(z)c = 0 \quad (5)$$

Equation (5) does not pin down $p_a(z)$ directly, as v_a also depends on the function $p_a(\cdot)$. However, since v_a is a definite integral over \mathcal{Z}_A , the equation implies that $p_a(z)$ has to be proportional to the utility differential $u_z(a) - u_z(b)$, with the coefficient of proportionality to be determined in equilibrium. A similar analysis for any voter $z \in \mathcal{Z}_B$ yields analogous results and implications due to the complete symmetry of the framework. This yields the following result.

Proposition 1. *Consider the Kantian optimization model with a fixed voting cost. At the Nash-Kantian equilibrium, the probability of voting of each supporter in both groups is proportional to the utility differential from the candidates' policies. That is*

$$\begin{aligned} p_a(z) &= \pi_a [u_z(a) - u_z(b)] \\ p_b(z) &= \pi_b [u_z(b) - u_z(a)] \end{aligned} \quad (6)$$

By aggregation, the number of votes are then

$$\begin{aligned} v_a &= \pi_a u_{\mathcal{Z}_A} \\ v_a &= \pi_b u_{\mathcal{Z}_B} \end{aligned} \tag{7}$$

where the terms $u_{\mathcal{Z}_A} = \int_{\mathcal{Z}_A} [u_z(a) - u_z(b)] f(z) dz$ and $u_{\mathcal{Z}_B} = \int_{\mathcal{Z}_B} [u_z(b) - u_z(a)] f(z) dz$ denote the aggregate utility differentials in group A and B, respectively. Finally, the equilibrium values of the proportionality coefficients π_a and π_b are obtained by substituting (6) and (7) into the first order conditions, which can be rewritten as

$$\begin{aligned} \frac{\partial}{\partial v_a} P(v_a, v_b) \cdot u_{\mathcal{Z}_A} &= c \\ -\frac{\partial}{\partial v_b} P(v_a, v_b) \cdot u_{\mathcal{Z}_B} &= c \end{aligned} \tag{8}$$

Thus, unlike the rule-utilitarian model, Kantian optimization yields a unique and intuitive prediction for participation behavior at the individual level. Citizens' probability of voting is proportional to the utility differential from the two candidates' policies: the higher the intensity of support for a candidate, measured by the utility differential, the higher the contribution to the group in terms of probability of voting. The result recovers a dependence of voters' behavior on the utility differential from candidates' policies, which is at the core of the spatial theory of voting. This relationship, however, has been typically established in a framework of instrumental voting, in which the utility differential is crucially discounted by the probability of being pivotal. Kantian optimization endogenizes it in a model of ethical participation that overcomes the issue of pivotality. The dependence on the utility differential is what makes the predictions consistent with the patterns of differential participation observed empirically. The shape of the function $u_z(x)$ determines how the intensity of support relates spatially to the distance between supporters and candidates and accounts for voters' abstention motivated by indifference or alienation.⁸

Moreover, an important link between Kantian optimization and the rule-utilitarian model emerges under the assumption of a fixed cost of voting. Indeed, the first equation in (8) coincides with the first order condition from the maximization of group utility in equation (3) with respect to v_a . The same holds in group B. This implies that the solutions for the aggregate number of votes v_a and v_b are the same in the two models. In a sense, if

⁸See Grillo (2020) for an analysis of how convexity of voters' utility function $u_z(x)$ captures citizens' propensity to political alienation.

the cost of voting is fixed, Kantian optimization can complement the group rule-utilitarian model by specifying how heterogeneous supporters share the burden of voting in order to maximize group utility.

Proposition 2. *Consider the Kantian optimization model with a fixed voting cost. At the Nash-Kantian equilibrium, the aggregate number of votes v_a and v_b in the two groups correspond to the solutions of a group rule-utilitarian calculus.*

Let us then calculate the Nash-Kantian equilibrium for the example introduced in section 2, in which the uncertainty takes the form of a Tullock contest success function $P(v_a, v_b) = \frac{v_a}{v_a + v_b}$. We readily obtain the following unique pair of positive solutions for the probability of voting in the two groups

$$\begin{aligned} p_a(z) &= \frac{u_{z_A} u_{z_B}}{c(u_{z_A} + u_{z_B})^2} [u_z(a) - u_z(b)] \\ p_b(z) &= \frac{u_{z_A} u_{z_B}}{c(u_{z_A} + u_{z_B})^2} [u_z(b) - u_z(a)] \end{aligned}$$

By aggregation, the number of votes v_a and v_b are equal to

$$v_a = \frac{u_{z_A}^2 u_{z_B}}{c(u_{z_A} + u_{z_B})^2}, \quad v_b = \frac{u_{z_A} u_{z_B}^2}{c(u_{z_A} + u_{z_B})^2} \quad (9)$$

Hence, for a Tullock contest success function, the coefficient of proportionality is the same for all supporters in both groups.⁹ Both the coefficient of proportionality and the aggregate number of votes v_a , v_b are decreasing in the cost of voting and increasing in both groups' aggregate utility differentials. These comparative statics results are intuitive but offer nonetheless additional insights with respect to the standard ethical voter model. The spatial framework, indeed, allows for a richer analysis of participation behavior, as a function of candidates' proposed policies a and b , voters' policy preferences $u_z(x)$, and their distribution on the policy space $f(z)$. These elements are all captured by the aggregate utility differentials u_{z_A} and u_{z_B} .

3.3 Heterogenous Costs of Voting

Let us consider now the case of heterogenous costs of voting, iid drawn from a uniform distribution, $c \sim \mathcal{U}[0, \bar{c}]$. I show that the predictions are consistent with those in the

⁹Note that, being probability functions, $p_a(z)$ and $p_b(z)$ should not be greater than 1, but to this end it suffices to assume that the voting cost c is big enough.

case of a fixed cost of voting, although the equivalence result for the aggregate number of votes given by Proposition 2 fails to hold. Under heterogenous costs, a turnout rule in group A is given by a threshold cost function $c_a(z)$. Given the uniform distribution, the probability of voting is then $p_a(z) = \frac{1}{\bar{c}}c_a(z)$. Thus, it still holds that for a multiplicative deviation factor σ applied to the threshold cost, the number of votes v_a scales up by σ . The expected utility of a supporter $z \in \mathcal{Z}_A$, when a deviation by σ is followed by all voters in group A , is equal to

$$P(\sigma v_a, v_b)u_z(a) + (1 - P(\sigma v_a, v_b))u_z(b) - \frac{1}{2\bar{c}}(\sigma c_a(z))^2$$

where the last term is the expected cost of voting for a member. Taking the first order condition with respect to σ and imposing $\sigma = 1$ yields

$$\frac{\partial}{\partial v_a}P(v_a, v_b)v_a[u_z(a) - u_z(b)] - \frac{1}{\bar{c}}c_a(z)^2 = 0$$

By comparing the previous expression with the one in (5), we see that under uniformly distributed costs, the threshold cost must now be proportional to the square root of the utility differential. Given $p_a(z) = \frac{1}{\bar{c}}c_a(z)$, we thus have

$$p_a(z) = \tilde{\pi}_a \sqrt{[u_z(a) - u_z(b)]}$$

and by aggregation

$$v_a = \tilde{\pi}_a \tilde{u}_{\mathcal{Z}_A}$$

where $\tilde{u}_{\mathcal{Z}_A} = \int_{\mathcal{Z}_A} \sqrt{[u_z(a) - u_z(b)]}f(z)dz$ denotes an aggregate utility differential which is ‘adjusted’ by taking the square root within the integral. As before, an equivalent calculation concerns group B and the proportionality coefficients $\tilde{\pi}_a, \tilde{\pi}_b$ are determined by solving jointly the following first order conditions

$$\begin{aligned} \frac{\partial}{\partial v_a}P(v_a, v_b) \cdot \frac{\tilde{u}_{\mathcal{Z}_A}}{\tilde{\pi}_a} &= \bar{c} \\ -\frac{\partial}{\partial v_b}P(v_a, v_b) \cdot \frac{\tilde{u}_{\mathcal{Z}_B}}{\tilde{\pi}_b} &= \bar{c} \end{aligned} \tag{10}$$

given $v_a = \tilde{\pi}_a \tilde{u}_{\mathcal{Z}_A}$ and $v_b = \tilde{\pi}_b \tilde{u}_{\mathcal{Z}_B}$. The conditions in (10), however, are different than what would result from the maximization of group utility. To compare the two, let me first define the size of the two groups as $|\mathcal{Z}_A| = \int_{\mathcal{Z}_A} f(z)dz$ and $|\mathcal{Z}_B| = \int_{\mathcal{Z}_B} f(z)dz$, i.e. the shares

of population belonging to each group. In light of Lemma 1, rule-utilitarian members of group A would target v_a votes by setting a constant threshold equal to $c_a = \frac{\bar{c}v_a}{|\mathcal{Z}_A|}$. We can then substitute this voting rule into (2) and proceed similarly for group B to obtain the following pair of first order conditions for the rule-utilitarian calculus

$$\begin{aligned} \frac{\partial}{\partial v_a} P(v_a, v_b) \cdot \frac{u_{\mathcal{Z}_A} |\mathcal{Z}_A|}{v_a} &= \bar{c} \\ -\frac{\partial}{\partial v_b} P(v_a, v_b) \cdot \frac{u_{\mathcal{Z}_B} |\mathcal{Z}_B|}{v_b} &= \bar{c} \end{aligned} \quad (11)$$

Technically, the difference between (10) and (11) arises because in the Kantian optimization model the voting probabilities are aggregated after taking the square root of the utility differential, while the aggregation occurs before in the rule-utilitarian model. The solution is not invariant to the order of the two operations. I summarize the results as follows.

Proposition 3. *Consider the Kantian optimization model with heterogenous voting costs $c \sim \mathcal{U}[0, \bar{c}]$. At the Nash-Kantian equilibrium, the supporters' probability of voting is proportional to the square root of the utility differential from the candidates' policies. The aggregate number of votes in the two groups do not correspond, in this case, to the solutions from a rule-utilitarian calculus.*

Let us turn again to the example of a Tullock contest success function $P(v_a, v_b) = \frac{v_a}{v_a + v_b}$. The unique positive Nash-Kantian equilibrium is given by

$$\begin{aligned} p_a(z) &= \frac{\sqrt{\tilde{u}_{\mathcal{Z}_A} \tilde{u}_{\mathcal{Z}_B}}}{\sqrt{\bar{c}}(\tilde{u}_{\mathcal{Z}_A} + \tilde{u}_{\mathcal{Z}_B})} \sqrt{[u_z(a) - u_z(b)]} \\ p_b(z) &= \frac{\sqrt{\tilde{u}_{\mathcal{Z}_A} \tilde{u}_{\mathcal{Z}_B}}}{\sqrt{\bar{c}}(\tilde{u}_{\mathcal{Z}_A} + \tilde{u}_{\mathcal{Z}_B})} \sqrt{[u_z(b) - u_z(a)]} \end{aligned}$$

As with a fixed cost of voting, the coefficient of proportionality is the same for all supporters in both groups, it is positively related to the aggregate utility differential in both groups and negatively to the cost of voting. The aggregate number of votes are in this case

$$v_a = \frac{\sqrt{(\tilde{u}_{\mathcal{Z}_A})^3 \tilde{u}_{\mathcal{Z}_B}}}{\sqrt{\bar{c}}(\tilde{u}_{\mathcal{Z}_A} + \tilde{u}_{\mathcal{Z}_B})}, \quad v_b = \frac{\sqrt{\tilde{u}_{\mathcal{Z}_A} (\tilde{u}_{\mathcal{Z}_B})^3}}{\sqrt{\bar{c}}(\tilde{u}_{\mathcal{Z}_A} + \tilde{u}_{\mathcal{Z}_B})}$$

which, despite being analytically different from the rule-utilitarian solutions¹⁰, offer however the same comparative statics properties. In all cases, the number of votes in both groups is increasing in the aggregate utility differentials and decreasing in the cost of voting. The results confirm the insights of the model with a fixed voting cost and thus the advantage of Kantian optimization for studying electoral participation in a spatial framework.

4 Discussion

I address here a few relevant issues, before concluding. I first discuss the endogenization of candidates' proposed policies a and b . I then examine whether one could amend the rule-utilitarian approach, instead of abandoning it, in order to improve its predictions at the individual level. Finally, I offer a critical perspective on the *Kantian* label that economists usually assign to agents' reasoning based on a universalization principle.

4.1 Candidates' Choice of Policies

In order to focus on citizens' participation behavior, I have taken as given candidates' policies a and b . The advantage of a spatial framework, however, is also to study how candidates choose their platforms on the policy space. While determining policies endogenously is beyond the focus of this paper, I sketch here some preliminary considerations. An equilibrium analysis of policy choices requires assumptions on candidates' objective. In the classical Downsian model, candidates are purely office-motivated and maximize therefore their probability of winning. In the framework of this paper, this corresponds to maximizing $P(v_a, v_b)$ for candidate A and to minimizing it for candidate B . Note that candidates care only about the aggregate number of votes v_a and v_b and not about the specific distribution of individual voting probabilities given by $p_a(z)$ and $p_b(z)$.

In our analysis, independently of citizens' ethical calculus and in both cases of fixed and heterogenous voting costs, the aggregate number of votes v_a and v_b depend crucially on the groups' aggregate utility differentials. Consider the example of a Tullock contest function $P(v_a, v_b) = \frac{v_a}{v_a + v_b}$ in the case of a fixed cost of voting, whose solutions for the number

¹⁰The rule-utilitarian solutions under heterogenous costs of voting are

$$v_a = \frac{(u_{\mathcal{Z}_A}|\mathcal{Z}_A|^{\frac{3}{4}})(u_{\mathcal{Z}_B}|\mathcal{Z}_B|^{\frac{1}{4}})}{\bar{c}(\sqrt{u_{\mathcal{Z}_A}|\mathcal{Z}_A|} + \sqrt{u_{\mathcal{Z}_B}|\mathcal{Z}_B|})}, \quad v_b = \frac{(u_{\mathcal{Z}_A}|\mathcal{Z}_A|^{\frac{1}{4}})(u_{\mathcal{Z}_B}|\mathcal{Z}_B|^{\frac{3}{4}})}{\bar{c}(\sqrt{u_{\mathcal{Z}_A}|\mathcal{Z}_A|} + \sqrt{u_{\mathcal{Z}_B}|\mathcal{Z}_B|})}$$

of votes are given in (9). It is easy to check that candidates' maximization problems correspond to

$$\max_a \frac{u_{Z_A}}{u_{Z_A} + u_{Z_B}} \quad , \quad \max_b \frac{u_{Z_B}}{u_{Z_A} + u_{Z_B}}$$

The aggregate utility differentials u_{Z_A} and u_{Z_B} , in turn, depend on the primitive elements of the model, such as citizens' distribution on the policy space $f(z)$ or the shape of their utility function $u_z(x)$. In general, thus, also the existence and features of the political equilibrium for candidates' policies a and b depend on such primitive elements. In a companion paper (Grillo 2020), I examine in more detail candidates' strategies and provide conditions on $f(z)$ and $u_z(x)$ for a result of turnout-driven polarization, occurring when candidates pursue a strategy of mobilization. Bierbrauer et al. (2019), instead, study a similar model of voter turnout which yields convergence of the two candidates to the same position, because the favorite candidate has an incentive to demobilize voters.

4.2 Why not *subgroup* rule-utilitarianism?

Could we amend somehow the rule-utilitarian approach in order to obtain heterogeneity of supporters' turnout behavior as a function of their preferences without resorting to Kantian optimization? The answer is in some sense affirmative, although ultimately it implies moving to a lesser degree in the same direction, i.e. reducing the level at which supporters' utility is aggregated from group utility to a finer dimension. Consider for example a simpler model in which each group is further divided in two subgroups: a subgroup supports the candidate strongly, while the other only weakly. In this case, *subgroup* rule-utilitarians agents would maximize the aggregate subgroup utility taking as given the voting behavior both in the other subgroup of supporters of the same candidate and in the two subgroups of supporters of the opposing candidate. Under the same assumptions as in the previous sections, one can easily conjecture that the logic behind Lemma 1 makes the probability of voting constant among members of a subgroup but does not prevent different threshold costs between subgroups. In this case, strong supporters could vote with a higher probability than weak supporters, showing a positive relationship between participation and the intensity of support for a candidate.

There are, however, two inconveniences of a *subgroup* rule-utilitarian model. The first is the analytical complexity, as already in our simple example the strategic interaction involves four different maximization problems. The second is that when the reduction of the level of aggregation is taken to the limit, one stumbles back to the issue of pivotality.

If the distribution of citizens over the policy space is continuous, as in the model of this paper, every set of citizens sharing the same bliss point has mass zero. Hence, one cannot take the level of aggregation down to voters' bliss point, because the aggregate utility would then coincide with the individual utility and supporters within a subgroup would even collectively be unable to affect the outcome of the election. Kantian optimization, instead, provides a very tractable model to account for voters' idiosyncratic preferences, even in the presence of a continuous distribution.

4.3 On the *Kantian* Label

A reference to Kant is customary in the economic literature to denote the type of counterfactual reasoning that agents display in the model when they envision a universalization of their behavior.¹¹ With respect to the ethical voting model, it is interesting to note that an analogous mention of Kant is made by Feddersen (2004) in justifying the rule-utilitarian approach, which follows Harsanyi's (1977) tribute to Kant's intellectual tradition of claiming a requirement of universality for moral rules. Indeed, while the universalization principle is explicit in Roemer's Kantian optimization protocol, it is nonetheless implicit in the rule-utilitarian calculus, as the prescribed rule is optimal only when followed by everyone.

Such an explicit Kantian label, however, also risks generating some misunderstanding. Indeed, while Kantian moral philosophy is generally understood as non-consequentialist, all previous approaches clearly build on a consequentialist interpretation of the universalization principle. I content myself with warning for the potential misreading, without offering an alternative label. Hare (1993) is a useful reference for an attempt to strike a balance between Kant and consequentialism, while White (2004, 2019) discusses how the paradigm of homo economicus can relate to Kantian moral philosophy in its orthodox deontological interpretation.

5 Conclusion

I have argued in favor of a Kantian optimization model of electoral participation within heterogeneous groups, in which supporters share a preference for a candidate but have different intensities of support. In a spatial framework, the difference in intensities comes from voters' underlying idiosyncratic preferences on the policy space. A rule-utilitarian

¹¹Roemer acknowledges using the term for its suggestive meaning and not to imply a deeper Kantian justification (Roemer 2019, Ch.1).

model of voter turnout, typically praised for its ability to generate good comparative statics properties on aggregate participation, fails to account for the heterogeneity of behavior at the individual level. Kantian optimization, instead, predicts participation as an increasing function of the utility differential from candidates' policies. The results are consistent with the theoretical and empirical literature on spatial voting showing how citizens' perceived distance from candidates affect their likelihood of voting. Furthermore, if citizens' voting costs are identical, an equivalence result emerges for the solutions of the aggregate number of votes in both Kantian optimization and the rule utilitarian model. In this case, Kantian optimization can be interpreted as a selection device for a turnout rule on which rule-utilitarian supporters can coordinate.

What makes Kantian optimization deliver better predictions at the individual level is its focus on individual utility. Indeed, while rule-utilitarians follow the rule that maximizes aggregate utility, Kantian optimizing agents maximize their individual utility. Their ethical principle consists in constraining such optimization by universalizing potential deviations from any participation rule. In line with the positive, rather than normative, perspective of the analysis, the model calls then for empirical evidence that could more precisely associate voters' actual reasoning to either of the two ethical principles. With respect to Roemer's broader approach, I have only considered deviations in a multiplicative form. A credible application of the model clearly depends on how reasonably same scalar deviations represent the same behavior for different agents. From a theoretical standpoint, considering the case in which the universalization does not imply the same deviation for all concerned agents but allows for heterogeneity in deviations also represents an interesting direction for future research.

References

- [1] Adams, J. F., Dow, J., & Merrill III, S. (2006). The political consequences of alienation-based and indifference-based voter abstention: applications to presidential elections. *Political Behavior*, 28(1), 65-86.
- [2] Alger, I. & Weibull, J. W. (2013). Homo Moralis - Preference Evolution under Incomplete Information and Assortative Matching. *Econometrica*, 81(6), 2269-2302.
- [3] Alger, I., & Weibull, J. W. (2016). Evolution and Kantian morality. *Games and Economic Behavior*, 98, 56-67.
- [4] Ali, S. N., & Lin, C. (2013). Why people vote: Ethical motives and social incentives. *American economic Journal: microeconomics*, 5(2), 73-98.

- [5] Arnold, F. (2018). Turnout and closeness: evidence from 60 years of Bavarian mayoral elections. *The Scandinavian Journal of Economics*, 120(2), 624-653.
- [6] Bierbrauer, F., Tsyvinski, A., & Werquin, N. (2019). Taxes and Turnout. Working Paper.
- [7] Blais, A. (2000). *To vote or not to vote?: The merits and limits of rational choice theory*. University of Pittsburgh Press.
- [8] Blais, A., & Daoust, J. F. (2020). *The Motivation to Vote: Explaining Electoral Participation*. UBC Press.
- [9] Coate, S. & Conlin, M. (2004). A group rule-utilitarian approach to voter turnout: theory and evidence. *American Economic Review*, 94(5), 1476-1504.
- [10] Cox, G. W., & Munger, M. C. (1989). Closeness, expenditures, and turnout in the 1982 US House elections. *American Political Science Review*, 83(1), 217-231.
- [11] De Donder, Ph., & Roemer, J. E. (2016). An allegory of the political influence of the top 1%. *Business and Politics*, 18(1), 85-96.
- [12] Eichner, T., & Pethig, R. (2020). Kant–Nash tax competition. *International Tax and Public Finance*, 1-40.
- [13] Feddersen, T. (2004). Rational choice theory and the paradox of not voting. *Journal of Economic Perspectives*, 18(1), 99-112.
- [14] Feddersen, T., & Sandroni, A. (2006). A theory of participation in elections. *American Economic Review*, 96(4), 1271-1282.
- [15] Fauvelle-Aymar, C., & François, A. (2006). The impact of closeness on turnout: An empirical relation based on a study of a two-round ballot. *Public Choice*, 127(3-4), 461-483.
- [16] François, A., & Gergaud, O. (2019). Is civic duty the solution to the paradox of voting?. *Public Choice*, 180(3-4), 257-283.
- [17] Grafton, R. Q., Kompas, T., & Van Long, N. (2017). A brave new world? Kantian–Nashian interaction and the dynamics of global climate change mitigation. *European Economic Review*, 99, 31-42.
- [18] Grillo, A. (2020). Political competition with endogenous turnout: participation, abstention, and voter mobilization. Unpublished Working Paper.
- [19] Hare, R. M. (1993). Could Kant have been a utilitarian? *Utilitas*, 5(1), 1-16.
- [20] Harsanyi, J. C. (1977). Morality and the theory of rational behavior. *Social Research*, 44(4), 623-656.
- [21] Harsanyi, J. C. (1980). Rule utilitarianism, rights, obligations, and the theory of rational behavior. *Theory and Decision*, 12, 115-133.
- [22] Laffont, J. J. (1975). Macroeconomic constraints, economic efficiency and ethics: an introduction to Kantian economics. *Economica*, 42(168), 430-437.

- [23] Plane, D. L., & Gershtenson, J. (2004). Candidates' ideological locations, abstention, and turnout in US midterm Senate elections. *Political Behavior*, 26(1), 69-93.
- [24] Roemer, J. E. (2006). Party competition under private and public financing: a comparison of institutions. *Advances in Theoretical Economics*, 6(1).
- [25] Roemer, J. E. (2010). Kantian equilibrium. *Scandinavian Journal of Economics*, 112(1), 1-24.
- [26] Roemer, J. E. (2015). Kantian optimization: A microfoundation for cooperation. *Journal of Public Economics*, 127, 45-57.
- [27] Roemer, J. E. (2019). *How we cooperate: a theory of Kantian optimization*. Yale University Press.
- [28] Shachar, R., & Nalebuff, B. (1999). Follow the leader: Theory and evidence on political participation. *American Economic Review*, 89(3), 525-547.
- [29] Sher, I. (2020). Normative aspects of Kantian Equilibrium. Unpublished Working Paper.
- [30] Sugden, R. (1984). Reciprocity: the supply of public goods through voluntary contributions. *The Economic Journal*, 94(376), 772-787.
- [31] White, M. D. (2004). Can homo economicus follow Kant's categorical imperative?. *The Journal of Socio-Economics*, 33(1), 89-106.
- [32] White, M. D. (2019). A Kantian Approach to Economics. *The Oxford Handbook of Ethics and Economics*, 54.
- [33] Zipp, J. F. (1985). Perceived Representativeness and Voting: An Assessment of the Impact of "Choices" vs. "Echoes". *American Political Science Review*, 79(1), 50-61.

A Appendix

Proof of Lemma 1:

Consider any non-constant continuous $c_a(z)$ and the resulting aggregate number of votes $v_a = \int_{\mathcal{Z}_A} \frac{1}{c} c_a(z) f(z) dz$. Then there exists a constant turnout rule k that yields the same number of votes v_a but lower aggregate voting costs, i.e. such that $\int_{\mathcal{Z}_A} \int_0^{c_a(z)} \frac{1}{c} c dz f(z) dz > \int_{\mathcal{Z}_A} \int_0^k \frac{1}{c} c dz f(z) dz$. Hence the aggregate group utility is higher under the voting rule k than under the voting rule $c_a(z)$. One can alternatively solve the corresponding calculus of variations problem

$$\min_{c_a(z) \in \mathcal{C}} \int_{\mathcal{Z}_A} F(z, c_a(z)) dz \quad \text{sub} \quad \int_{\mathcal{Z}_A} G(z, c_a(z)) dz = v_a$$

where $F(z, c_a(z)) = \int_0^{c_a(z)} \frac{1}{\bar{c}} c \, dc$ and $G(z, c_a(z)) = \int_0^{c_a(z)} \frac{1}{\bar{c}} dc$. The augmented Lagrangian is $\int_{\mathcal{Z}_A} F(z, c_a(z)) dz + \lambda \int_{\mathcal{Z}_A} G(z, c_a(z)) dz$ and the Euler-Lagrange equation gives

$$\frac{\partial F}{\partial c_a(z)} + \lambda \frac{\partial G}{\partial c_a(z)} = \frac{(c_a(z) + \lambda)}{\bar{c}} = 0$$

from which we obtain that $c_a(z)$ is constant. Note that the second variation equals $\int_{\mathcal{Z}_A} \frac{1}{\bar{c}} v^2 dz$ which is positive definite for all variations $v(z)$, and hence the solution is indeed a minimizer.