Committee Composition: The Impact of Diversity and Partisanship on Voting Behavior^{*}

Anne-Katrin Roesler[†]

September 15, 2023

Abstract

We propose and analyze a committee voting model in which players with interdependent values take a binary decision. Each player holds two-dimensional private information: a private signal about the payoff state and a private preference type that captures their level of partisanship. Each player's payoff is a linear combination of their own signal and the average of the others' signals, with the relative weights determined by their preference type. We show that, in equilibrium, committee members adopt cutoff strategies that are monotone in preference types. We identify how a committee's composition, captured by the distribution of private preference types, impacts its decisions. As committee members are drawn from increasingly partisan populations, equilibrium cutoffs move away from the sincere voting threshold. Conversely, when committee members originate from more diverse populations, equilibrium cutoffs move closer to the sincere voting threshold. We discuss implications for the set of alternatives that different committees accept.

1 Introduction

In most organizations, complex decisions are made by committees, not by individuals. Corporate boards decide how to invest, whom to hire, and whether or not to adopt a new technology. Similarly, the allocation of research grants, the approval of new drugs by the FDA, and academic hiring are typically committee decisions, and these decisions are reached by voting. Due to the complexity of matters that are voted upon, committee members often cannot assess all information about the proposal. Rather, they pay attention to the details that are most important to them, but acknowledge that other aspects—and hence the signals (i.e., information) held by other committee

^{*}An early version of this paper has been circulated with the title *Preference Uncertainty and Conflict of Interest* in Committees.

[†]Department of Economics, University of Toronto, 150 St George St, Toronto, Canada. ak.roesler@utoronto.ca. I thank Benny Moldovanu, Heski Bar-Isaac, Dirk Bergemann, Rahul Deb, Daniel Krähmer, Marcin Peski, Huseyin Yildirim and various seminar and conference audiences for helpful comments and discussion. I thank the Social Sciences and Humanities Research Council for their continued and generous financial support. The most recent version of this paper is available at here.

members—also contain relevant information. In such situations, members typically put (weakly) more weight on their own signal than on information held by others. That is, members differ in how they aggregate available information into preferences. Even if members have the same information, they may disagree on whether a proposal should be accepted or not. Therefore, committee members typically have interdependent, but not purely common, preferences.¹

In this paper, we propose a model that captures such settings in which members have twodimensional private information: First, they possess a private signal about the proposal to be voted upon, which is payoff-relevant to all players. Second, players also have private information about their *preference type*, which determines how they aggregate available information about the proposal into preferences.

In our model, n players vote whether to accept a proposal $x = (x_1, \ldots, x_n)$ or to stick to the status quo. The decision is made by generalized majority voting. The private signals $x_i \in [x_i^\ell, x_i^h]$, with $x_i^\ell \leq 0 \leq x_i^h$, are determined by independent draws from commonly known distributions F_i , for all $i = 1, \ldots, n$. Players have interdependent preferences and private preference types: Player i evaluates proposal x at $\theta_i x_i + (1 - \theta_i) \frac{1}{n-1} \sum_{j \neq i} x_j$, where $\theta_i \in [1/n, 1]$ is the player's (private) preference type, which is drawn from a commonly known distribution G_i . All players value the status quo at zero.

We assume that x_i and θ_i are private information of player *i*. Here, x_i is a private signal about the payoff-relevant state, and the preference type θ_i can be interpreted as the player's level of *partisanship*, which is the extent to which they favor their own private signal over the average of signals held by other players. One can interpret this model as a committee of partisan experts who can each evaluate the proposal in their field of expertise and each favor their own field. An alternative behavioral interpretation is that by assessing the proposal players obtain a private signal, and the private preference type captures their excess confidence in their own assessment abilities relative to the abilities of others.² Private preference types capture the idea that the partisanship level of an individual is intrinsic in nature, and this can be regarded as part of a player's personality. The distribution of private preference types represents the *population* from which committee members are drawn. Note that, there is conflict of interest among committee members, and additionally there is uncertainty about the extent of the conflict. Since players hold two-dimensional private information, even if all private signals about the state were made public, players would still hold private information about how they aggregate these signals into preferences; therefore, we say there is *preference uncertainty*.

Our goal in this paper is to understand how private preference types, preference uncertainty, and the composition of the committee impact equilibrium voting behavior and outcomes in committee decisions. We focus on two novel questions that we can address with this framework: 1) How does the level of partisanship of the population from which committee members are drawn affect voting

¹This is in contrast to the traditional assumption in the voting literature that players share a common interest.

²Interestingly, Malenko et al. (2023) find that such a model with $\theta_i = 1/n$ is most consistent with their survey evidence of information held by members in venture capital investment committees.

behavior? 2) What can we say about committee decisions when the committee diversity is increased by drawing members from a more heterogeneous population?

Our analysis is motivated by the observation that committees differ significantly in their composition.³ The distribution of partisanship levels of committee members naturally varies across committees, and is influenced by factors including cultural background or organizational culture. Members hailing from individualistic cultures often exhibit higher levels of partisanship compared to their counterparts from collectivist, socially-oriented cultural backgrounds.⁴ Consequently, we investigate voting patterns across committees when the populations from which members are drawn (represented by the distributions of private preference types) differ by a first-order stochastic dominance shift.

Another important aspect of committee composition is the diversity of the population from which the committee's members originate. Even when two committees have members with identical average levels of partisanship, they may still differ in terms of the heterogeneity of preference types represented within their membership. Committees may be composed of individuals from more or less diverse populations. When committee members originate from a group with diverse backgrounds, it is expected that this population will exhibit a higher degree of preference heterogeneity. Understanding how increased preference heterogeneity in the population influences the voting behavior of committee members is particularly relevant nowadays in light of the prevalence of diversity initiatives. These initiatives contribute to greater preference heterogeneity within organizations, which, in turn, extends to the composition of committees within those organizations. Similarly, committees or parliamentary bodies from smaller countries such as Luxembourg, Monaco, or the Netherlands are less likely to demonstrate substantial preference heterogeneity in comparison to those in larger countries like the United States, Canada, or multinational assemblies like the European Union or the United Nations General Assembly.

Our results provide insights into how the composition of committees, in terms of the distribution and the heterogeneity of preference types of its members, affects voting behavior. We first establish equilibrium existence and show that, in equilibrium, players adopt cutoff strategies. That is, for every preference type θ_i of player *i* there exists a cutoff $c(\theta_i) \in \mathbb{R}$, such that this type votes affirmatively if and only if they observe a signal above this cutoff, $x_i \geq c(\theta_i)$. As such, the cutoffs (*acceptance standards*) reflect a player's level of partianship. Players take into account the information about the other players' signals that they can derive from the event of being pivotal, which—depending on the majority rule—is either good news or bad news. Hence, players adjust their acceptance thresholds accordingly, thus moving away from the sincere voting threshold of zero.⁵ The amount of weight that players place on the information held by other players depends

 $^{^{3}}$ In existing voting models with interdependent values (e.g. Yildirim (2012), Moldovanu and Shi (2013), and Name-Correa and Yildirim (2021)), all committee members have the same level of partianship and hence the effect of changes in the distribution of committee members cannot be studied.

 $^{^{4}}$ Hofstede (1991) identifies individualism vs. collectivism as one dimension along which cultural differences can be analyzed, and Triandis (2001) links this cultural dimension to differences in personality and behavior.

⁵The model is normalized such that $\mathbb{E}(x_i) = 0$ for all $i \in \mathcal{I}$. Hence, a sincere player—who does not take into account the information from the event of being pivotal when casting their vote in contrast to the strategic players in

on their level of partisanship. Strongly partisan players base their votes primarily on their own observed signal, such that they adopt an acceptance threshold close to the sincere voting threshold of zero. For example, if a large enough majority is required to accept the alternative (e.g. under unanimity voting), being pivotal is good news. Hence, acceptance thresholds are non-positive where more partisan players adopt higher acceptance standards.

For the comparative statics exercise of analyzing behavior across committees from different populations, we consider a symmetric environment. We establish the existence of a unique symmetric voting equilibrium, which we focus on throughout the analysis. We find that players in committees originating from more partisan populations, captured by a first-order stochastic dominance shift of the type distribution, adopt cutoffs that are further away from the sincere voting threshold of zero compared to those within committees from less partisan populations. For intuition about this result, consider a majority rule when being pivotal is good news, that is, the expected average signal of others conditional on being pivotal is positive. Recall that more partisan players base their vote more on their own signal. Consequently, being in a committee from a more partisan population makes being pivotal more informative about the average signal of others (for a fixed profile of strategies), resulting in an increase of the expected value of the average signal of others, conditional on being pivotal. In response, players adjust (lower) their acceptance standards to a greater extent. We will show that this counteracts, but does not completely offset, the initial effect that results in the event of being pivotal being better news—in equilibrium players adopt lower cutoffs when in a committee from a more partisan population.

How do players react if they find themselves in a committee composed of members from a more diverse population? In this case there is greater preference uncertainty. One might expect that this increased uncertainty leads to a player adopting a more lenient acceptance standard in order to avoid proposals being rejected too frequently. However, this is not necessarily the case. For intuition, consider again a majority rule for which being pivotal is good news. Notice that greater heterogeneity of preference types leads to more uncertainty regarding why players vote affirmatively: Is it because they observed a high signal? Or, did they observe an intermediate signal but still vote affirmatively since they are a less partisan preference type? In other words, the event of being pivotal is less informative about the other players' signals. As we will show, in equilibrium, this results in players basing their vote more on their own signal and adopting a cutoff closer to the sincere voting threshold.

Related Literature. Broadly, this paper ties into the voting literature that goes back to Condorcet (1785). Building on seminal works such as Austen-Smith and Banks (1996) and Feddersen and Pesendorfer (1998), there is now extensive literature on collective decision making, which typically focuses on strategic voters who update their beliefs about the information held by other players conditional on the event of being pivotal. Li and Suen (2009) provide an excellent survey. Most of the traditional theoretical voting models study settings in which individuals share a common

our model—will vote affirmatively when they observe a positive signal, and they will reject the proposal otherwise. This corresponds to an acceptance threshold of zero.

interest such that committee members would agree on the best outcome if they knew the state.⁶

Specifically, this paper contributes to the relatively small literature on committee voting models with heterogeneous preferences, in particular interdependent values. Similar models where committee members have interdependent preferences and their level of partisanship determines their bias towards their own information are studied in Yildirim (2012), Moldovanu and Shi (2013), and Name-Correa and Yildirim (2021).⁷ In these models all committee members possess the same preference type, which determines the conflict of interest among committee members. Our model departs from existing models in two ways. First, we assume that players have *individual* preference types. Second, these individual preference types are *private* to the players, and thus there is preference uncertainty. We use this model in which players hold two-dimensional private information to study new questions such as: How do individual preference types differ in their equilibrium decisions, and how does the composition of a committee impact voting behavior?⁸

The aforementioned papers and ours therefore focus on different questions. Name-Correa and Yildirim (2021) study how majority rules and the level of conflict of interest in a committee (captured by the level of partisanship of all committee members) affect collective decisions. For different majority rules they identify the optimal level of conflict—which they refer to as the composition of the committee—that a biased principal would choose if they had to delegate a decision to a committee.⁹ By contrast, we allow for *individual* and *private* preference types and consider how the distribution of the population (which we refer to as committee composition) from which committee members are drawn affects committee decisions. Moldovanu and Shi (2013) consider a dynamic search model in which the decision to stop is made by a committee by unanimity voting. They characterize a stationary equilibrium in cutoff strategies. In this equilibrium, acceptance standards increase and welfare decreases in the level of conflict among committee members.¹⁰

Other interdependent values models that study collective decision making include Grüner and Kiel (2004) and Rosar (2015). They consider a different functional form of utilities (quadratic losses) and continuous collective decisions whereas we focus on a binary decision problem. Grüner and Kiel (2004) show that, with an unrestricted report space and from a utilitarian perspective, the average mechanism performs better in the common values case whereas the median mechanism is preferable for the private values case. By contrast, Rosar (2015) finds that with an optimally designed report space and for uniformly distributed information or large electorates, the average mechanism performs better for any degree of interdependence.

⁶There is also a strand of literature that considers private value models and typically studies questions such as costly voting and voter turnout (e.g Börgers, 2004).

⁷Name-Correa and Yildirim (2019) study secret voting versus public voting when experts are concerned about being blamed. Their main model considers a private values setting but they discuss how their insights generalizes to an interdependent values setting.

⁸A loosely related paper is Bardhi and Bobkova (2023) who study the selection of the composition of minipublics by policymakers and find that moderate political uncertainty leads to inefficiently low diversity.

⁹Yildirim (2012) identifies time-consistent majority rules, i.e., majority rules that a designer can implement if they cannot commit to a rule prior to observing the votes.

¹⁰Meyer and Strulovici (2015) extend some of the results of Moldovanu and Shi (2013) to more general preference structures.

Li et al. (2001) choose a different approach to introduce heterogeneity among voters. They relax the assumption that players' preferences are perfectly aligned, but they still assume that players share a common objective. If there is uncertainty about the state there may be conflict of interest, but disagreement vanishes if all uncertainty is resolved. The authors discuss how the (known) level of conflict among committee members affects their incentives to strategically misrepresent their information and thus hinder information aggregation.¹¹

Given our focus on how the source population of committee members affects voting behavior and outcomes, this paper may also speak and contribute to the nascent literature on how board composition affects corporate board decisions (e.g Chemmanur and Fedaseyeu, 2018; Kim and Starks, 2016). This literature aims to understand how increased diversity in corporate boards affects a firm's value. An increase in diversity may stem, for example, from increasing the ratio of independent board members to insider directors, or from increasing the gender/cultural diversity of board members. As Kim and Starks (2016) point out, an important yet little understood aspect is understanding through which mechanisms increased diversity influences a firm's value. The results presented in this paper study one specific pathway and explain how increased diversity directly affects the voting behavior of members in corporate boards.

The rest of this paper is structured as follows. The model is introduced in Section 2. In Section 3 we establish equilibrium existence and characterize fundamental properties of equilibrium strategies. The comparative static results regarding the partial properties and the heterogeneity of preference types in the population of committee members are presented in Section 4. Section 5 discusses some generalizations and concludes. All proofs are relegated to the appendix.

2 The Model

Consider a committee of n players, $\mathcal{I} = \{1, \ldots, n\}$, who take a binary decision of either accepting a proposal or staying with the status quo. A proposal is characterized by an n-dimensional vector $x = (x_1, \ldots, x_n)$. Values x_i are determined by independent random draws from the interval $\mathcal{X}_i = [x_i^{\ell}, x_i^{h}] \subset \mathbb{R}$ with $x_i^{\ell} < 0 < x_i^{h}$ and commonly known (cumulative) distributions F_i . The CDFs F_i are twice continuously differentiable with positive density $f_i > 0$ for all $x_i \in \mathcal{X}_i, i \in \mathcal{I}$. The realization x_i is private information to player i. The set of proposals, $\mathcal{X} = \times_{i=1}^n \mathcal{X}_i$ and the joint CDF of proposals, $F = \prod_{i=1}^n F_i$, are common knowledge.

Each player has an individual private preference type, $\theta_i \in \Theta_i \subseteq [1/n, 1]$. Preference types θ_i are independently distributed on $\Theta_i = [\underline{\theta}_i, 1]$ with $\underline{\theta}_i \geq 1/n$, commonly known CDFs G_i , and densities $g_i > 0$ for all $\theta_i \in \Theta_i$. Preference type θ_i is private information to player *i*. As such, players hold two-dimensional private information where (θ_i, x_i) is private information to player *i*.

Payoffs. A player's preference type determines how they aggregates payoff-relevant information into preferences. For player *i* with preference type θ_i , the payoff of proposal $x = (x_1, \ldots, x_n)$ is

$$v_i((\theta_i, x_i); x_{-i}) = \theta_i x_i + (1 - \theta_i) \frac{1}{n - 1} \sum_{j \neq i} x_j.$$
(1)

¹¹We discuss details of the relation and differences of their model and ours in Section 2.

The payoff of the status quo is 0 for all members. We assume $\mathbb{E}(x_i) = 0$ for every $i \in \mathcal{I}$. That is, ex-ante, players favor neither the status quo nor the proposal.

Decision Rule. The committee decision is made by generalized majority voting. The majority rule, which is characterized by an integer $k \in \{1, ..., n\}$, is publicly announced. Players indicate whether they want to accept or reject the proposal. The proposal is adopted if and only if there are at least k affirmative votes. Here, $k = \lfloor \frac{n+1}{2} \rfloor$ corresponds to simple majority and k = n to unanimity.

Discussion of the Model. The individual components x_1, \ldots, x_n of a proposal can be interpreted as values of different aspects of the proposal, for example, technical specifications, marketing potential, etc. of a new product. The model then represents a committee of experts where each expert can assess the quality of the proposal with respect to their own area of expertise. The payoff function (1) captures that players have interdependent preferences where they place a (weakly) higher weight on the value of the proposal in their own field. A player's type captures the level of interdependency, i.e. the level of partisanship of an expert. A higher θ_i represents a higher level of partisanship. A player with type $\theta_i = 1$ has *private values* and is the most partisan; the pure common values case is captured by $\theta_i = \frac{1}{n}$ for all $i = 1, \ldots, n$.

Alternatively, the values x_i can be interpreted as the signals that each committee member obtains from paying attention to the evidence presented about the proposal.¹² The payoff function (1) then captures that committee members are aware that their signal is noisy and they hence take other members' signals into account. Preference types θ_i represent the level of overconfidence of each committee member in their own signal, where higher private types reflect a higher level of overconfidence.

To clarify, let us briefly discuss the differences in modeling preference heterogeneity in the present model relative to that used by Li et al. (2001) and related papers (e.g. Austen-Smith and Feddersen (2006) and Li and Suen (2009)). In the model in Li et al. (2001), players have different preferences for type-I and type-II errors, and hence require different levels of evidence to prefer the alternative over the status quo. This specification of heterogeneity implies that between any pair of players there is only one direction of disagreement; if a pair of players disagrees, it is always the same player who supports the proposal whilst the other favors staying with the status quo. Moreover, if all uncertainty is resolved, that is, if the payoff state is known, then all players agree on what is the best outcome.

By contrast, in the present model, even if the payoff state $x = (x_1, \ldots, x_n)$ was known, players may not agree on the best outcome. Here, the conflict of interest arises from different preferences of committee members. Moreover, the heterogeneity among players is such that the direction of conflict depends on the realization of x. If players disagree, it is not always the same player who favors the proposal. For any two players i and j, with different preference types $\theta_i \neq \theta_j$, there are proposals x that player i wants to accept while player j prefers the status quo, and other proposals

¹²This interpretation captures the idea that when listening to information we are unable to process all of it. Hence, when listening to the same evidence, committee members obtain different (conditionally independent) signals.



Figure 1: Agreement and disagreement sets in our model and in Li et al. (2001) if $x = (x_1, x_2)$ is common knowledge. Here "yn" denotes the set of x for which player 1 votes y(es) and player 2 votes n(o).

x' that only player j wants to accept but player i prefers the status quo. The differences in modeling conflict of interest and heterogeneity among players are illustrated in Figure 1.

Strategies. A pure¹³ strategy for player i is a measurable function:

$$\sigma_i: \ \Theta_i \times \mathcal{X}_i \to \{0, 1\},\$$

where $\sigma_i(\theta_i, x_i) = 1$ if player *i* votes affirmatively when their type is θ_i and their private signal is x_i . The strategy of a given type θ_i of player *i* is denoted by $\sigma_{\theta_i} : \mathcal{X}_i \to \{0, 1\}$ where $\sigma_{\theta_i}(x_i) := \sigma_i(\theta_i, x_i)$.

A pure strategy for a player characterizes, for each of their preference types θ_i , a corresponding *acceptance set*:

$$A_{\sigma_i}(\theta_i) := \sigma_{\theta_i}^{-1}(1) \subseteq \mathcal{X}_i.$$
⁽²⁾

This is the set of private signals $x_i \in \mathcal{X}_i$ that will induce the player to vote affirmatively. A strategy of player *i* thus corresponds to a collection of acceptance sets $\{A_{\sigma_i}(\theta_i)\}_{\theta_i \in \Theta_i}$.

A cutoff strategy of player *i* is a strategy σ_i in which, for every $\theta_i \in \Theta_i$, the acceptance set is of the form $A_{\sigma_i}(\theta_i) = [c_i(\theta_i), x_i^h]$ for some cutoff value $c_i(\theta_i) \in [x_i^\ell, x_i^h]$.¹⁴ A cutoff strategy σ_i of player *i* thus corresponds to a cutoff function $c_i : \Theta_i \to \mathcal{X}_i$ such that type θ_i votes affirmatively if and only if they observes a signal $x_i \ge c_i(\theta_i)$. Here, $c_i(\theta_i) = x_i^h$ represents the case that type θ_i rejects the proposal with probability one.¹⁵

¹³Restricting attention to pure strategies is without loss. It is straightforward to show that for any preference type of any player, it is a best-response to adopt a cutoff strategy. Since we consider a continuum of types and no atoms, the decision of an indifferent type is inconsequential since this is a zero probability event.

¹⁴To be precise, we would also have to consider acceptance sets $A_{\sigma_i}(\theta_i) = \emptyset$. However, note that since $\{x_i \in \mathcal{X}_i : x_i = x_i^h\}$ is a zero probability event, whenever $A_{\sigma_i}(\theta_i) = [x_i^h, x_i^h]$ or $A_{\sigma_i}(\theta_i) = \emptyset$, player type θ_i accepts the proposal with probability zero. Hence, we identify acceptance set $A_{\sigma_i}(\theta_i) = \emptyset$ with the cutoff $c_i(\theta_i) = x_i^h$. Doing so is without loss since it does not change the expected values or payoffs of players.

¹⁵Hence, we define $\mathbb{E}[x_i|x_i = x_i^h] := 0.$

Equilibrium Concept. We employ the concept of undominated Bayes Nash equilibrium. That is, we restrict attention to equilibria in which no player plays a weakly dominated strategy.¹⁶ As is standard in the voting literature, we refer to this as a *voting equilibrium*.¹⁷

3 Equilibrium Characterization

In a voting game, a strategic player conditions their decision on the event of being pivotal: the event in which the player's own vote determines the outcome. For a given majority rule $k \in \{1, ..., n\}$, this is the event in which exactly k - 1 of the other players vote affirmatively.

Now, consider some majority rule $k \in \{1, \ldots, n\}$. Recall that every strategy profile σ corresponds to a collection of acceptance sets (2), $\{A_{\sigma_i}(\theta_i)\}_{\theta_i \in \Theta_i, i \in \mathcal{I}}$. Now define:¹⁸

$$A_{\sigma_{-i}}^{k-1}(\theta_{-i}) := \{ x_{-i} : |\{j \in \mathcal{I} \setminus \{i\} : x_j \in A_{\sigma_j}(\theta_j)\}| = k-1 \} \subseteq \mathcal{X}_{-i}.$$

$$(3)$$

For player *i*, this is the set of signal profile realizations x_{-i} for which exactly k - 1 of the other players vote affirmatively given strategy profile σ_{-i} and type-profile realization θ_{-i} . Equilibrium acceptance sets $A_{\sigma_{-i}}^{k-1}(\theta_{-i})$ from (3) are illustrated in Figure 3(a) for player 3 in a three-member committee, for each of the majority rules k = 1, 2, 3, for some cutoff strategies and type-profile realization $\theta_{-3} = (\theta_1, \theta_2)$.

Since preference types are private information, player *i* does not know the type realization of other players when casting their vote. Hence, conditional on being pivotal, player *i*'s expectation of the average signal of the other players, $\overline{x}_{-i} := \frac{1}{n-1} \sum_{j \neq i} x_j$, given strategy profile σ_{-i} , is:

$$\mathbb{E}\left[\overline{x}_{-i} \mid piv_k(\sigma_{-i})\right] := \mathbb{E}_{\Theta_{-i}}\left[\mathbb{E}_{\mathcal{X}_{-i}}\left[\overline{x}_{-i} \mid A^{k-1}_{\sigma_{-i}}(\theta_{-i})\right]\right];$$
(4)

and for player *i* with private information (θ_i , x_i), the expected payoff from implementing the alternative, conditional on being pivotal, is:

$$V_i\left((\theta_i, x_i); \sigma_{-i}\right) = \theta_i x_i + (1 - \theta_i) \cdot \mathbb{E}\left[\overline{x}_{-i} \mid piv_k(\sigma_{-i})\right].$$
(5)

We now establish equilibrium existence.

Theorem 1 (Equilibrium Existence).

In a committee of n members, for any generalized majority rule $k \in \{1, ..., n\}$, there exists a voting equilibrium σ^* . In every voting equilibrium, players adopt cutoff strategies given by:

$$c_i^*(\theta_i) = \max\left\{x_i^{\ell}, \ \min\left\{-\frac{1-\theta_i}{\theta_i}\mathbb{E}\left[\overline{x}_{-i} \mid piv_k(\sigma_{-i}^*)\right], \ x_i^h\right\}\right\} \quad \forall i \in \mathcal{I}, \theta_i \in \Theta_i.$$
(6)

In equilibrium, players form beliefs about the expected average signal of other players conditional on being pivotal. Since player's expected payoffs conditional on being pivotal (5) are linear in their own signals, it follows immediately that, in equilibrium, players adopt cutoff strategies.

¹⁶This eliminates trivial equilibria where all players play extreme strategies, i.e., always accept the proposal or always reject the project.

 $^{^{17}\}mathrm{See}$ e.g. Feddersen and Pesendorfer (1997) and related literature.

¹⁸Here, |S| denotes the cardinality of the set S.

As one can easily see from (6), the most partial (or private values) type $\theta_i = 1$ adopts a cutoff of 0. For this type, their preferences do not depend on the signals of the other players, and thus the information derived from the event of being pivotal does not affect their decision. In other words, such a player votes *sincerely*, i.e. solely based on their own private signal x_i .

Every other type (with interdependent values) takes into account the information that can be gained from the event of being pivotal about the average signal of other players. In particular, being pivotal is either good news (if $\mathbb{E}\left[\overline{x}_{-i} \mid piv_k(\sigma^*_{-i})\right] > 0$) or bad news (if $\mathbb{E}\left[\overline{x}_{-i} \mid piv_k(\sigma^*_{-i})\right] < 0$). If being pivotal is good (bad) news, a player will require weaker (stronger) evidence to accept an alternative, and hence adopt a negative (positive) cutoff. The expected information derived from the event of being pivotal is the same for all types of player *i*, the sign depends on the majority rule.¹⁹ Consequently, the sign of equilibrium cutoffs does not change across preference types, such that all types $\theta_i \neq 1$ adopt a positive, or all adopt a negative, cutoff. Moreover, since moderate types put more weight on the information held by other players, the information they derive about other players' signals from the event of being pivotal is reflected to a greater extent in their cutoffs (6). In other words, their cutoffs are further from the sincere voting threshold of zero than the cutoff of the more partisan committee members.

The following proposition summarizes these equilibrium properties.

Proposition 1. In any voting equilibrium, for all $i \in \mathcal{I}$, the cutoff functions $c_i^*(\cdot)$ are continuous ous in the player's preference type θ_i , and are twice continuously differentiable almost everywhere. Moreover, either $c_i^*(\theta_i) \ge 0$ for all $\theta_i \in \Theta_i$ or $c_i^*(\theta_i) \le 0$ for all $\theta_i \in \Theta_i$; $|c_i^*(\theta_i)|$ is non-increasing in θ_i , and $c_i^*(1) = 0$.

An immediate corollary of this result is that, in equilibrium, there are always some responsive types, i.e. types whose vote depends on the realization of their private signal. Formally, we say that type θ_i of player *i* is responsive given cutoff strategy $c_i(\cdot)$ if they adopt an interior cutoff $c_i(\theta_i) \in (x_i^{\ell}, x_i^{h})$. A strategy of player *i* is responsive if there is a positive measure of preference types that are responsive given cutoff strategy $c_i(\cdot)$.

Corollary 1. In any voting equilibrium, players' cutoff strategies are responsive. Moreover, there exists some type $\hat{\theta}_i \in [\underline{\theta}_i, 1)$ such that all types $\theta_i \geq \hat{\theta}_i$ are responsive, and all types $\theta_i < \hat{\theta}_i$ adopt the same extreme cutoff, which is either x_i^{ℓ} or x_i^{h} .

In equilibrium, for each player, there is a positive measure of responsive preference types whose decision to vote affirmatively or not depends on their private signal. Responsiveness of players' equilibrium strategies is a necessary condition for information aggregation. While we do not focus on information aggregation in this paper, the corollary shows that in equilibrium some information aggregation occurs.

¹⁹Roughly put, for more stringent majority rules (when more affirmative votes are required for approval), in equilibrium, a player's conditional expectation of the other players' average signal is larger, which results in the best-response of the player being to choose a lower cutoff.



Figure 2: Equilibrium cutoff functions for n = 5, for different majority rules, for $x_i \stackrel{iid}{\sim} U[-1, 1]$, $\theta_i \stackrel{iid}{\sim} U[1/5, 1]$.

Whether all types of a player adopt cutoffs that are non-negative or non-positive depends on the majority rule and the distribution of types and signals. As the next result shows, if equilibrium cutoffs are non-positive (non-negative), then the corresponding cutoff function is concave (convex) on the set of responsive types. Possible shapes of the equilibrium cutoff functions are illustrated in Figure 2.

Proposition 2. In any voting equilibrium, every cutoff function with non-positive cutoffs $c_i^*(\theta_i) \leq 0$ (non-negative cutoffs $c_i^*(\theta_i) \geq 0$) is concave (convex) on the set of responsive types $[\hat{\theta}_i, 1]$. Equilibrium cutoff functions satisfy:

$$(c_i^*)' \cdot (c_i^*)''(\theta_i) \le 0 \quad \forall i \in \mathcal{I}, \ \theta_i \in \Theta_i.$$

$$\tag{7}$$

We conclude this section by discussing an example to illustrate equilibrium properties. We will build on this example in Section 4 and use it to illustrate our results about committee composition.

Example. Consider a two-member committee that must decide whether to accept or reject a proposal. Say a technology and a media expert decide on whether to bring a product update to market or to stick with the current product version. Acceptance of the proposal requires unanimity (k = 2). Attribute values and preferences types are independently and uniformly distributed with $x_i \stackrel{iid}{\sim} U[-1, 1]$ and $\theta_i \stackrel{iid}{\sim} U[1/2, 1]$ for i = 1, 2. Here, x_1 could represent the quality of the product and x_2 its marketability.

Theorem 1 establishes that, in equilibrium, both experts will use cutoff strategies. Under the unanimity rule, an expert's vote only matters if the other expert votes affirmatively. Thus, conditional on being pivotal, the expected payoff of the proposal for expert i with private information (θ_i, x_i) is:

$$V_i((\theta_i, x_i); c_j) = \theta_i x_i + (1 - \theta_i) \mathbb{E}_{\Theta_j} \left[\mathbb{E}_{\mathcal{X}_j} \left[x_j | x_j \ge c_j(\theta_j) \right] \right].$$





(a) Illustration of acceptance sets of player 3 for n = 3: (b) Equilibrium acceptance probabilities for n = k = 2 and sets of signals for which exactly 0 (white), 1 (light blue), uniformly distributed signals and types. Darker shading repor 2 (dark blue) of players 1 and 2 vote affirmatively for a resents a higher acceptance probability. given cutoff strategy profile $c = (c_1, c_2)$ and type realization $\theta_{-3} = (\theta_1, \theta_2).$

Figure 3: Illustrations of acceptance sets for given type realizations and different majority rules (a), and equilibrium acceptance sets/probabilities (b).

Solving for the equilibrium cutoff functions (6) yields:

$$c_i^*(\theta_i) = -\frac{1-\theta_i}{\theta_i} \cdot \frac{1}{1+\ln 4} \quad \text{for } i \in \{1, 2\}.$$

Equilibrium cutoffs range from $c_i^*(1/2) = -\frac{1}{1+\ln 4} \approx -0.42$ for the most moderate type to $c_i^*(1) = 0$ for the most partial type. Calculating the probability p(x) that, in equilibrium, an alternative $x = (x_1, x_2) \in [-1, 1]^2$ is accepted by the committee yields:

$$p(x_1, x_2) = \begin{cases} \min\left\{1, \left|\frac{(1+x_1+x_1\ln(4))}{(1-x_1-x_1\ln(4))}\right|\right\} \cdot \min\left\{1, \left|\frac{(1+x_2+x_2\ln(4))}{(1-x_2-x_2\ln(4))}\right|\right\} & \text{if } (x_1, x_2) \in \left[-\frac{1}{1+\ln(4)}, 1\right]^2, \\ 0 & \text{otherwise.} \end{cases}$$

These acceptance probabilities are illustrated in Figure 3(b) where lighter shading represents a lower acceptance probability. For $(x_1, x_2) \in (-\frac{1}{1+\ln 4}, 1]^2$, the acceptance probabilities are strictly positive (equal to one in the upper right quadrant) and they are zero otherwise.

4 Comparative Static Effects of Committee Composition

We now explore how the composition of committees affects voting behavior. Specifically, we will compare the equilibrium acceptance cutoffs of individual committee members across committees. Here, we compare committees comprised of members from more partian versus more moderate backgrounds, as well as committees that vary in their levels of diversity. Additionally, we will discuss how these factors influence the set of alternatives that committees ultimately accept.

The model introduced in Section 3 serves as the foundation for investigating these questions.

In our analysis, a more partian population is characterized by a first-order stochastic dominance shift of the distribution of private preference types. In turn, a mean-preserving spread of the distribution of private preference types introduces more heterogeneity of preference types, which can be interpreted as a more diverse population.

4.1 Symmetric Environment, Equilibrium Uniqueness

For the sake of simplicity, we present the results in this section for a symmetric setting. In this setting, the players' signals about the proposal are uniformly distributed, $x_i \stackrel{iid}{\sim} U[-1,1]$, and the distributions over preference types are identical for all players, $G_i = G_j$, for all $i, j \in \mathcal{I}$. Therefore, we drop the subscript and denote the CDF of players' preference types as G, the corresponding density is g.

We focus on symmetric equilibria, in which all players adopt the same cutoff function. Therefore, instead of the subscript of the equilibrium function indicating the player i, we incorporate the majority rule and the preference type distribution into our notation. For all players $i \in \mathcal{I}$, a cutoff function is denoted by $c_{k,G} : \Theta_i \to \mathcal{X}_i$ when the majority rule is $k \in \{1, \ldots, n\}$ and committee members' preference types are drawn from distribution G.

Focusing on this simplified setting enables us to provide a clear and concise analysis that highlights the primary economic forces at play, while avoiding unnecessary technical complexities. A brief discussion of how this intuition generalizes beyond uniformly distributed signals is provided in Section 5.

As the next result shows, for each majority rule, there exists a unique equilibrium.

Proposition 3 (Symmetric Equilibrium – Uniqueness).

Consider a symmetric setting with iid preference types, $\theta_i \stackrel{iid}{\sim} G$ and independently and uniformly distributed signals, $x_i \stackrel{iid}{\sim} U[-1,1]$, for all $i \in \mathcal{I}$. Then for any majority rule $k \in \{1,\ldots,n\}$, there exists a unique symmetric voting equilibrium. In equilibrium all players adopt cutoff strategies.

Notice that in a symmetric equilibrium, even though all players adopt the same cutoff function $c_{k,G}^*(\cdot)$, for a given realization of private types $(\theta_1, \ldots, \theta_n)$, the realized cutoffs $\left(c_{k,G}^*(\theta_1), \ldots, c_{k,G}^*(\theta_n)\right)$ are typically not identical.

The next result established some properties of equilibrium cutoff functions. Additionally, it provides a closed form solution when all preference types adopt interior cutoffs.²⁰

Corollary 2. In a symmetric equilibrium all players adopt cutoff functions that are non-positive for $k \ge \frac{n+1}{2}$ and non-negative otherwise:

$$c_{k,G}^*(\theta_i) \begin{cases} \geq 0 & \text{if } k < \frac{n+1}{2}, \\ \leq 0 & \text{if } k \geq \frac{n+1}{2}. \end{cases} \quad \forall \theta_i \in \Theta_i, \ i \in \mathcal{I}.$$

²⁰That is, whenever $c_{k,G}^*(\theta_i) \in (0,1) \ \forall \theta_i \in \Theta_i$.

Moreover, when all cutoffs are interior, then cutoffs are given by

$$c_{k,G}^*(\theta_i) = -\frac{2k - n - 1}{(n - 1)(2 + I_{\Theta})} \cdot \frac{1 - \theta_i}{\theta_i}, \quad \text{with } I_{\Theta} = \int_{\Theta_j} \frac{1 - \theta_j}{\theta_j} \, dG(\theta_j). \tag{8}$$

Recall, that depending on the majority rule, being pivotal is either good news (when $\mathbb{E}\left[\bar{x}_{-i}|piv_k(\sigma_{-i}^*)\right] \geq 0$) or bad news (when $\mathbb{E}\left[\bar{x}_{-i}|piv_k(\sigma_{-i}^*)\right] \leq 0$). In the current setting, if accepting the proposal requires at least a simple majority, that is if $k \geq \frac{n+1}{2}$, then being pivotal is good news. Consequently, a player will require weaker evidence to accept an alternative, and hence adopts a negative cutoff. Voting rules that require at least a simple majority are the most prevalent majority rules adopted in practice. Therefore, in what follows, when interpreting and providing intuition for the results, we will focus on this case with $k \geq \frac{n+1}{2}$.

4.2 Extent of Partisanship in the Population

We now turn to the analysis of how acceptance standards depend on a committee's population (the distribution of preference types). We begin by investigating voting behavior across committees whose members originate from populations with more or less partisan (extreme) preference types. Formally, when comparing two populations G and H from which committee members' preference types are drawn, we say that H is a more partisan population if the distribution H first-order stochastically dominates²¹ G, denoted by $H \succeq_1 G$. That is, distribution H puts more mass on higher (i.e. more partisan) types than G.

Our first result shows that equilibrium cutoffs move away from the sincere voting threshold of zero, if players find themselves among fellow committee members from a more partial population. This is true for each preference type θ_i .

Proposition 4 (More Partisan Populations).

For any given majority rule $k = \{1, ..., n\}$, when comparing symmetric voting equilibria across committees, each preference type adopts a cutoff further away from the sincere voting threshold of zero when being in a committee with members from a more partial population than when in a committee with more moderate members:

$$If H \succeq_1 G, \quad then \quad \begin{cases} c_{k,H}^*(\theta_i) \le c_{k,G}^*(\theta_i) & \text{if } k \ge \frac{n+1}{2} \\ c_{k,H}^*(\theta_i) \ge c_{k,G}^*(\theta_i) & \text{if } k \le \frac{n+1}{2} \end{cases} \quad \forall \theta_i \in \Theta_i, \ \forall i \in \mathcal{I}.$$

The result shows that, for majority rules with $k \ge \frac{n+1}{2}$, every preference type adopts a less stringent acceptance standard (cutoff) when they are part of a committee composed of members from a more partisan population, as opposed to a committee with more moderate members. In particular, one can interpret this result as players acting more leniently when they expect their fellow committee members to be opinionated (i.e. drawn from a more partisan population) than if they were in a committee with members originating from a more moderate population. For instance, consider a partisan member (with a preference type θ_i close to one) who, in a committee

²¹Formally, a distribution *H* first-order stochastically dominates *G*, if $H(\theta_i) \leq G(\theta_i)$ for all $\theta_i \in \Theta_i$.

formed from a moderate population, sets a high acceptance standard for proposals within their area of expertise. Consequently, only proposals excelling in this expert's domain may gain approval. Conversely, placing the same expert in a committee formed from a more partisan population would result in them acting more leniently, allowing a broader range of proposals to pass. In other words, partisan committee members act more leniently among their peers.

To gain intuition for the result, consider a first-order shift in the distribution of preference types of the committee members. From Proposition 1, we know that individuals with more partisan preferences adopt cutoffs closer to the sincere voting threshold of zero than their more moderate committee members. These more partisan individuals largely rely on their own signal when casting their votes. Consequently, if the cutoff strategies remain unchanged, for an individual facing fellow committee members from a more partisan population, being pivotal is more informative about other members' signals than if their peers were from a more moderate population. Under a voting rule with $k \ge \frac{n+1}{2}$, being pivotal is good news about the average signal of other players. When the cutoff function remains fixed, this conditional expected value increases when moving to a more partisan population. Consequently, each preference type would best-respond by lowering their acceptance standard, counteracting the initial effect. As Proposition 4 shows, in equilibrium, the lower cutoffs do not completely offset that being pivotal is better news when facing a more partisan population. Therefore, equilibrium cutoff functions shift downwards.

4.3 Level of Preference Heterogeneity of the Populations

Another important aspect in how populations differ is their preference heterogeneity or diversity. A natural question arises: how does the diversity of the population from which committee members are selected impact voting behavior and outcomes? This question gains importance in today's context of increased global mobility, the prevalence of diversity initiatives, and the resulting rise in diversity within organizations, including their committees.

We model this scenario by comparing equilibrium behavior across two committees drawn from populations with the same expected level of partisanship but differing in preference heterogeneity. Formally, when comparing two committees whose members' preference types are drawn from distributions H and G, we say that population H is more heterogeneous than G, if H is a mean-preserving spread²² of G, denoted by $H \succeq_{MPS} G$. As the following result shows, players who find themselves in a committee with members from a more heterogeneous population, adopt cutoffs closer to the sincere voting threshold than when in a committee from a more homogeneous population.

Proposition 5 (More Heterogeneous Populations).

For any given majority rule $k = \{1, ..., n\}$, when comparing symmetric voting equilibria across committees, each preference type adopts a cutoff closer to the sincere voting threshold of zero when being in a committee with members from a more heterogeneous population than when in a committee

²²Formally, a distribution H is a mean-preserving spread of G, if $\int_{\underline{\theta}_i}^x H(\theta_i) d\theta_i \ge \int_{\underline{\theta}_i}^x G(\theta_i) d\theta_i$ for all $x \in \Theta_i$ with equality for $x = \overline{\theta}_i$.

with more homogeneous members:

$$If H \succeq_{MPS} G, \quad then \quad \begin{cases} c_{k,H}^*(\theta_i) \ge c_{k,G}^*(\theta_i) & \text{if } k \ge \frac{n+1}{2} \\ c_{k,H}^*(\theta_i) \le c_{k,G}^*(\theta_i) & \text{if } k \le \frac{n+1}{2} \end{cases} \quad \forall \, \theta_i \in \Theta_i, \, \forall \, i \in \mathcal{I}.$$

Let us provide some intuition for the result. The more heterogeneous the population from which committee members are drawn, the more uncertainty there is for each player about other members' preferences. In other words, the event of being pivotal is less informative for a player; that is, it is harder for a player to infer whether fellow committee members vote affirmatively because of a high signal or because they have a low preference type resulting in a low acceptance standard.²³ In the latter case, a player may vote affirmatively even though they observe a relatively low signal (cf. Proposition 1). Consequently, a player in a diverse committee bases their vote more on their own private signal than a player who finds themself in a committee with members from a less heterogeneous population. For majority rules with $k \geq \frac{n+1}{2}$, this implies that players adopt higher acceptance standards when in a committee composed from a more diverse population than if they are part of a more homogeneous committee.

One implication of this result is, that for majority and super-majority rules, more diverse committees will impose higher minimal acceptance standards in each dimension. The set of proposals that are accepted in equilibrium with positive probability is reduced to include only less risky alternatives. In other words, such committees engage in less risk-taking, which is in line with findings in Chen et al. (2019).

Example: (continued) We revisit our example of a two-member committee and unanimity voting (n = k = 2) with uniformly distributed signals $x_i \stackrel{iid}{\sim} U[-1,1]$. We compare our initial committee in which the members are drawn from a population with uniformly distributed preference types $\theta_i \stackrel{iid}{\sim} U[1/2,1]$ for i = T, M to a committee whose members stem from a more partial population $\theta_i \stackrel{iid}{\sim} H$ on [1/2, 1] with increasing density $h(\theta_i) = \frac{5}{8}(\theta_i - \frac{1}{2})$. By construction H first-order stochastically dominates the uniform distribution U[1/2, 1]. Solving for a symmetric equilibrium, we obtain the equilibrium cutoff function $c_H^*(\theta_i) = -\frac{1-\theta_i}{\theta_i} \cdot \frac{1}{5-2\ln(4)}$. As illustrated in Figure 4(a), for any type $\theta_i < 1$ this cutoff is lower than cutoff $c_U^*(\theta_i) = -\frac{1-\theta_i}{\theta_i} \cdot \frac{1}{1+\ln 4}$ which would be adopted in a committee with uniformly distributed preference types—a less partian population.

Similarly, we can compare the behavior across committees whose members stem from populations with either more or less preference heterogeneity. Here, we compare our initial example with $\theta_i \stackrel{iid}{\sim} U[1/2, 1]$ to a committee with $\theta_i \stackrel{iid}{\sim} H$ on [1/2, 1] with density²⁴ $h(\theta_i) = \frac{2\Gamma(\frac{2}{5})}{\left(-4\theta_i^2 + 6\theta_i - 2\right)^{4/5}\Gamma(\frac{1}{5})^2}$. Here, by construction, H is a mean-preserving spread of the uniform distribution on [1/2, 1]. That is, we compare the committee from our initial example in Section 3 to a committee whose members are drawn from a more diverse population H. Solving for a symmetric equilibrium, we obtain cutoff function $c_H^*(\theta_i) \approx -0.41 \cdot \frac{1-\theta_i}{\theta_i}$, which is illustrated in Figure 4(b). As can be seen, every preference

²³Recall, that here we focus on the case with $k \ge \frac{n+1}{2}$. ²⁴This distribution is constructed from the Beta(1/5, 1/5) distribution, in particular, $\theta_i = (X + 1)/2$ with $X \sim Beta(1/5, 1/5).$



Figure 4: Effect of increase in partianship (a) and diversity (b) on equilibrium cutoff functions. Here, U is the uniform distribution on [1/2, 1].

type adopts a higher cutoff when they are part of a more diverse committee compared to when they are part of a committee constituted of members from a more homogeneous population.

5 Discussion and Concluding Remarks

We have proposed a model of committee voting in which each player obtains a private payoffrelevant signal about the proposal that is up for vote. The model features two novelties: 1) How a player aggregates this information into preferences depends on their *individual* preference type, and 2) this preference type is private information to the player.

First, we establish equilibrium existence and show that, in equilibrium, players adopt cutoff strategies where a player's preference type is reflected in their individual acceptance standard (cutoff). Equilibrium strategies are monotone in a player's preference type. Partisan players base their vote largely on their own private signal, whereas more moderate types place more weight on the information that they derive from being pivotal such that their acceptance standard moves away from the sincere voting threshold of zero.

Next, we identified how acceptance standards react to changes in the distribution of preference types of committee members. For majority rules that require at least a simple majority, $k \ge \frac{n+1}{2}$, we find that: 1) Players adopt lower acceptance standards when in a committee with members from a more partisan population, and 2) greater preference type heterogeneity, and hence greater uncertainty about other committee members' preference types, leads players to act more cautiously and utilize their own privately observed signal to a greater extent when making a decision. In other words, they adopt more stringent acceptance standards; cutoffs are closer to zero—the sincere voting threshold.

More general utility functions: The specific parametric form of (1) is not crucial for the results. The equilibrium characterization results of Section 3 extend to utility functions that are additively separable in x, continuously increasing in x_i for all $i \in \mathcal{I}$ and that satisfy the following

single-crossing property:

Assumption 1 (SC): For all $i, j \in \mathcal{I}, j \neq i$:

$$\frac{\partial v_i}{\partial x_i}((\theta_i, x_i); x_{-i}) \geq \frac{\partial v_j}{\partial x_i}((\theta_j, x_j); x_{-j}) \quad \forall x \in \mathcal{X}, \ (\theta_i, \theta_j) \in \Theta_i \times \Theta_j$$

For the parametric form of (1), this is equivalent to $\theta_i \geq \frac{1}{n-1}(1-\theta_j)$ for all $(\theta_i, \theta_j) \in \Theta_i \times \Theta_j$, $j \neq i$, which implies $\Theta_i \subseteq [1/n, 1]$ for every $i \in \mathcal{I}$.

Generalization of the comparative statics results: Before concluding, it is worth providing a brief discussion of how the intuition from the results in Section 4 generalizes beyond the case of uniformly iid signals. Let me summarize the driving forces behind the comparative statics results to illustrates how the results should generalize.

For any generalized majority rule, the number of affirmative votes required to adopt the alternative determines whether cutoff functions are non-positive or non-negative in the symmetric equilibrium. If a large majority k is required to approve the proposal, then being pivotal is good news about the expected average signal of other players. Consequently, players react by adopting an acceptance standard that is lower than the sincere voting threshold of zero. By contrast, if the number of affirmative votes necessary to adopt the alternative is small, then being pivotal is bad news about the average expected signal of other players, and committee members react by adopting positive cutoffs.

As discussed, if we consider a first-order shift in the preference type distribution of the population of committee members, we move to a committee constituted of members from a more partisan population. Recall that partian players adopt acceptance standards closer to the sincere voting threshold. Thus, keeping cutoff strategies fixed, if being pivotal is good (bad) news about the average expected signal of other players, then being pivotal is better (worse) news when facing a more partisan population. Hence, each individual preference type will adjust their acceptance standard to a greater extent. This will counteract but not completely offset the initial effect. Consequently, equilibrium cutoffs move away from the sincere voting threshold of zero such that the equilibrium cutoff function moves upwards if it is non-negative and downwards if it is non-positive.

For the case of committee members originating from a population with more heterogeneous preference types (captured by a mean-preserving spread of the distribution of preference types), the event of being pivotal becomes less informative about the other players' preferences, when keeping cutoff strategies fixed. As a result, each player best-responds by basing their vote more on their own private signal. Again, this does counteract but not completely offset the initial effect. For each individual preference type, equilibrium cutoffs move closer to zero such that the equilibrium cutoff function shifts upwards if it is non-positive and downwards if it is non-negative.

This general intuition does not rely on the assumption that signals are uniformly iid. The current analysis in Section 4 with uniform iid signals already captures the main economic forces and insights, whereas the generalization would be more technically involved and hence come at the cost of neatness and simplicity without providing additional economic insights.

Finally, the results of this work may provide insights into how decisions may be influenced by the member composition of a committee or by how well committee members know each other.²⁵ For example, a CEO who seeks approval for a new product version, but is less concerned about the approval standard in each dimension, may prefer a less diverse and overall more moderate committee composition. This results in members adopting lower acceptance standards, which yields a higher probability of approval.

Our result in Subsection 4.3 suggests that for decisions that require majority or super-majority, individual members will raise their acceptance standards when diversity in a committee increases. Hence, such a committee only accepts alternatives that are of sufficiently high quality in each dimension. This is in line with the finding that having women on a board results in less aggressive risk-taking (e.g. Chen et al., 2019). When diversity in a committee increases, committee members adopt higher acceptance standards and the required quality to pass in each dimension increases. The set of proposals that are accepted in equilibrium with positive probability is reduced to include only less risky alternatives.

 $^{^{25}}$ This will implicitly determine the heterogeneity of the population, i.e. the uncertainty of players about other members' preference types.

Appendix

Proof of Theorem 1. Consider player $i \in \mathcal{I}$. Given majority rule $k \in \{1, \ldots, n\}$, suppose all other players follow strategy profile σ_{-i} . A best-response of type θ_i of player i is to vote for the alternative if and only if the expected payoff of the alternative conditional on them being pivotal (5), is greater than the payoff of the status quo. Consequently, type θ_i 's best response is to vote affirmatively if and only if $V_i((\theta_i, x_i); \sigma_{-i}) \geq 0$.

It is easy to see from (5) that $V_i((\theta_i, x_i); \sigma_{-i})$ is continuous and strictly increasing in x_i . Consequently, player *i*'s best response is to follow a cutoff strategy corresponding to the cutoff function c_i^{BR} given by:²⁶

$$c_{i}^{BR}(\theta_{i}) = \begin{cases} x_{i}^{\ell} & \text{if } V_{i}\left((\theta_{i}, x_{i}); \sigma_{-i}\right) \geq 0 \ \forall x_{i} \in \left[x_{i}^{\ell}, x_{i}^{h}\right] \\ x_{i}^{h} & \text{if } V_{i}\left((\theta_{i}, x_{i}); \sigma_{-i}\right) < 0 \ \forall x_{i} \in \left[x_{i}^{\ell}, x_{i}^{h}\right) \\ -\frac{1-\theta_{i}}{\theta_{i}} \mathbb{E}\left[\overline{x}_{-i} \mid piv_{k}(\sigma_{-i})\right] & \text{otherwise,} \end{cases}$$
(9)

where type θ_i votes affirmatively if and only if he observes a signal $x_i \ge c_i^{BR}(\theta_i)$.

For each $i \in \mathcal{I}$, let \mathbb{R}^{Θ_i} be the space of functions $f: \Theta_i \to \mathbb{R}$ endowed with the product topology (i.e. the topology of pointwise convergence) and let $\mathcal{X}_i^{\Theta_i} \subseteq \mathbb{R}^{\Theta_i}$ be the subset of functions with range \mathcal{X}_i . With this topology, \mathbb{R}^{Θ_i} is locally convex.²⁷ We represent cutoff strategies by their corresponding cutoff functions and denote player *i*'s best response function by $\phi_i^{BR} : \mathcal{X}_1^{\Theta_1} \times \cdots \times \mathcal{X}_n^{\Theta_n} \to \mathcal{X}_i^{\Theta_i}$, where ϕ_i^{BR} identifies, for every cutoff function profile (c_i, c_{-i}) , a corresponding cutoff-function $\phi_i^{BR}(c_i, c_{-i}) \in \mathcal{X}_i^{\Theta_i}$ that is a best-response of player *i*. Notice that ϕ_i^{BR} is constant in c_i .

The best response correspondence can be characterized as:

$$\Phi: \mathcal{X}_{1}^{\Theta_{1}} \times \cdots \times \mathcal{X}_{n}^{\Theta_{n}} \longrightarrow \mathcal{X}_{1}^{\Theta_{1}} \times \cdots \times \mathcal{X}_{n}^{\Theta_{n}}$$
$$\boldsymbol{c} = (c_{1}, \dots, c_{n}) \longmapsto \left(\phi_{i}^{BR}\left(\boldsymbol{c}\right), \dots, \phi_{n}^{BR}\left(\boldsymbol{c}\right)\right).$$

By Tychonoff's theorem, since Θ_i and \mathcal{X}_i are compact, so is $\mathcal{X}_i^{\Theta_i}$ for all $i \in \mathcal{I}$, and hence $\mathcal{X}_1^{\Theta_1} \times \cdots \times \mathcal{X}_n^{\Theta_n}$ is compact. It is easily verified that $\mathcal{X}_1^{\Theta_1} \times \cdots \times \mathcal{X}_n^{\Theta_n}$ is non-empty and convex.

The best response function Φ is continuous since each of its coordinate functions is continuous. Indeed, for every $i \in \mathcal{I}$, Φ_i^{BR} is constant in c_i . Moreover, Φ_i^{BR} is continuous in c_{-i} since the expectation operator is linear and bounded in the given setting (cf. (9)). The *Brouwer-Schauder-Tychonoff fixed-point theorem*²⁸ thus establishes existence of a fixed point and hence equilibrium existence, which completes the proof.

²⁶As discussed in Section 2, each cutoff strategy σ_i of player *i* corresponds to a cutoff function $c_i : \Theta_i \to \mathcal{X}_i$ where $c_i(\theta_i)$ is the cutoff that player *i* adopts if his type is θ_i . Moreover, each such cutoff function corresponds to a cutoff strategy where type θ_i accepts iff $x_i \ge c(\theta_i)$.

²⁷See e.g. Aliprantis and Border (2006), Lemma 5.74.

²⁸cf. Aliprantis and Border (2006), Corollary 17.56

Proof of Proposition 1. Consider any (equilibrium²⁹) strategy profile σ^* . Continuity follows immediately from (6) since $\mathbb{E}\left[\overline{x}_{-i} \mid piv_k(\sigma^*_{-i})\right]$ is constant in θ_i for any $i \in \mathcal{I}$, $-\frac{1-\theta_i}{\theta_i}$ is continuous in θ_i on [1/n, 1], and the min/max of two continuous functions is continuous. Additionally, since $\mathbb{E}\left[\overline{x}_{-i} \mid piv_k(\sigma^*_{-i})\right]$ is constant and $-\frac{1-\theta_i}{\theta_i}$ is twice continuously differentiable in θ_i , it follows that $c_i^*(\theta_i)$ is twice continuously differentiable in θ_i whenever the cutoffs are interior, $c_i^*(\theta_i) \in (x_i^\ell, x_i^h)$. Now, if $c_i^*(\hat{\theta}_i) \in \{x_i^\ell, x_i^h\}$ for some $\hat{\theta}_i \in \Theta_i$, then it is easy to see from (6) that all types $\theta_i \leq \hat{\theta}_i$ adopt the same extremal cutoff. Thus, if any types of player *i* adopt extremal cutoffs in $\{x_i^\ell, x_i^h\}$ in equilibrium, then the set of types that do so is a closed interval $[\underline{\theta}_i, \hat{\theta}_i]$. The equilibrium cutoff function is constant on this set and is thus twice continuously differentiable on $\left(\underline{\theta}_i, \hat{\theta}_i\right)$. However, $c^*(\theta_i)$ is not differentiable at $\hat{\theta}_i$, and hence equilibrium cutoff functions are only differentiable almost everywhere.

Moreover, since $\mathbb{E}\left[\overline{x}_{-i} \mid piv_k(\sigma_{-i}^*)\right]$ is constant in θ_i , and $-\frac{1-\theta_i}{\theta_i} < 0$ for all $\theta_i \in [1/n, 1)$, it follows directly that equilibrium cutoffs $c_i^*(\theta_i)$ given by (6) have the same sign for all types $\theta_i \in \Theta_i \setminus \{1\}$:

$$sign c_i^*(\theta_i) = -sign \mathbb{E}\left[\overline{x}_{-i} \mid piv_k(\sigma_{-i}^*)\right].$$

Next, notice that since $\mathbb{E}\left[\overline{x}_{-i} \mid piv_k(\sigma_{-i}^*)\right]$ is constant in θ_i for any strategy profile σ_{-i} , we obtain:

$$\frac{\mathrm{d} |c_i^*|}{\mathrm{d} \theta_i}(\theta_i) = -\frac{1}{\theta_i^2} \cdot \left| \mathbb{E} \left[\overline{x}_{-i} \mid piv_k(\sigma_{-i}^*) \right] \right| \le 0,$$

for all θ_i with $c_i^*(\theta) \in (x_i^{\ell}, x_i^{h})$. It follows that $|c_i^*(\theta_i)|$ is non-increasing in θ_i whenever cutoffs are interior. Moreover, as shown above, $|c_i^*(\theta_i)|$ is constant on the (possibly empty) set of types $[\underline{\theta}_i, \hat{\theta}_i]$ that adopt extremal cutoffs. Since $c_i^*(\cdot)$ is continuous, this completes the proof that $|c_i^*(\theta_i)|$ is non-increasing in θ_i .

Finally, a player with preference type $\theta_i = 1$ has private values, and hence $V_i((1, x_i); \sigma_{-i}^*) = x_i$, $\forall x_i \in X_i$. Thus, from (9) it follows directly that $c_i^*(1) = 0$. That is, in equilibrium, preference type $\theta_i = 1$ always votes sincerely.

Proof of Corollary 1. The result follows directly from Proposition 1, specifically $c_i^*(1) = 0$ and continuity of $c_i^*(\cdot)$.

Proof of Proposition 2. By Proposition 1, $c_i^*(\cdot)$ is twice continuously differentiable on $(\hat{\theta}_i, 1)$ and from (6) we obtain:

$$(c_i^*)' \cdot (c_i^*)''(\theta_i) = -\frac{2}{\theta_i^5} \mathbb{E}\left[\overline{x}_{-i} \mid piv_k(\sigma_{-i}^*)\right]^2 \le 0 \quad \forall \ \left(\hat{\theta}_i, 1\right).$$

The result about concavity/convexity of equilibrium cutoff functions follows by combining this with the result of Proposition 1. $\hfill \Box$

Proof of Proposition 3 and Corollary 2. For a given distribution of preference types, G, consider

²⁹Many of the statements in this proof hold more generally for any given strategy profile σ .

any majority rule $k \in \{1, ..., n\}$. Define the function

$$\Gamma_{k,G}: \ \mathcal{X}_{i}^{\Theta_{i}} \to \mathbb{R}$$

$$c_{k,G} \mapsto \mathbb{E}\left[\bar{x}_{-i}|piv_{k}(c_{k,G})\right]$$

$$(10)$$

that maps a cutoff function $c_{k,G}: \Theta_i \to \mathcal{X}_i$ to the expected value of the average signal of other players conditional on being pivotal (4), when all other players adopt a cutoff strategy that corresponds to the cutoff function $c_{k,G}$.

Notice that for a symmetric cutoff strategy profile with corresponding cutoff function c, the expected average signal of other players conditional on being pivotal is the same for all committee members. That is, every cutoff strategy induces a unique $\Gamma_{k,G}(c) = \mathbb{E}\left[\bar{x}_{-i}|piv_k(c)\right] \in \mathcal{X}_i$. For uniformly distributed signals $x_i \stackrel{iid}{\sim} U[-1,1]$, for a given cutoff strategy $c: \Theta_i \to \mathcal{X}_i$, we obtain (for notational simplicity we consider agent i = n which is without loss in our symmetric setting):

$$\begin{split} \Gamma_{k,G}(c) &= \mathbb{E}\left[\bar{x}_{-i}|piv_k(c)\right] = \mathbb{E}\left[\bar{x}_{-n}|piv_k(c)\right] \\ &= \mathbb{E}_{\Theta_{-n}}\left[\mathbb{E}_{\mathcal{X}_{-n}}\left[\bar{x}_{-n}|x\in\mathcal{A}_c^{k-1}(\theta_{-n})\right]\right] \\ &= \mathbb{E}_{\Theta_{-n}}\left[\frac{1}{2(n-1)}\left(\sum_{j\neq n}c(\theta_j)+2k-n-1\right)\right]. \end{split}$$

Now, define the function:

$$\begin{aligned}
\Lambda : & \mathcal{X}_i \to \mathcal{X}_i^{\Theta_i} \\
\gamma &\mapsto c_\gamma : \Theta_i \to \mathcal{X}_i \\
with & c_\gamma(\theta_i) := \max\left\{x_i^\ell, \min\left\{-\frac{1-\theta_i}{\theta_i} \cdot \gamma, x_i^h\right\}\right\},
\end{aligned} \tag{11}$$

that maps an expected value of the average signal conditional on being pivotal, γ , to a cutoff function that represents a best-response of a player to γ (cf. (6)).

Now, consider the composite function:

$$\Psi_{k,G}: \mathcal{X}_i \xrightarrow{\Lambda} \mathcal{X}_i^{\Theta_i} \xrightarrow{\Gamma_{k,G}} \mathcal{X}_i$$
$$\gamma \longmapsto c_\gamma \quad \longmapsto \mathbb{E}\left[\bar{x}_{-i}|piv_k(c_\gamma)\right].$$

For uniformly distributed signals $x_i \stackrel{iid}{\sim} U[-1, 1]$, for any $\gamma \in [-1, 1]$, we obtain:

$$\begin{split} \Psi_{k,G}(\gamma) &= \Gamma_{k,G}(\Lambda(\gamma)) = \mathbb{E}_{\Theta_{-n}} \left[\frac{1}{2(n-1)} \left(\sum_{j \neq n} c_{\gamma}(\theta_j) + 2k - n - 1 \right) \right] \\ &= \frac{2k - n - 1}{2(n-1)} + \frac{1}{2(n-1)} \cdot \mathbb{E}_{\Theta_{-n}} \left[\sum_{j \neq n} \max\left\{ -1, \ \min\{-\frac{1 - \theta_j}{\theta_j} \cdot \gamma, \ 1\} \right\} \right] \\ &= \frac{2k - n - 1}{2(n-1)} + \frac{1}{2} \cdot \mathbb{E}_{\Theta_j} \left[\max\left\{ -1, \ \min\{-\frac{1 - \theta_j}{\theta_j} \cdot \gamma, \ 1\} \right\} \right]. \end{split}$$

Notice that for a given $\gamma \in [-1,1]$, $c_{\gamma}(\theta_j) = \max\left\{-1, \min\left\{-\frac{1-\theta_j}{\theta_j} \cdot \gamma, 1\right\}\right\}$ has the same sign for

all $\theta_j \in \Theta_j$. Moreover,

$$\mathbb{E}_{\Theta_j}\left[\max\left\{-1, \min\left\{-\frac{1-\theta_j}{\theta_j} \cdot \gamma, 1\right\}\right\}\right] = \begin{cases} \in [-1,0] & \text{if } \gamma \ge 0, \\ \in [0,1] & \text{if } \gamma \le 0, \end{cases}$$

with $\mathbb{E}_{\Theta_j}\left[\max\left\{-1, \min\left\{-\frac{1-\theta_j}{\theta_j}\cdot\gamma, 1\right\}\right\}\right] = 0$ iff $\gamma = 0$ since G is non-degenerate.

To prove equilibrium uniqueness, we now show that, for a given majority rule $k \in \{1, ..., n\}$, the function $\Psi_{k,G}(\cdot)$ has a unique fixed point $\gamma_{k,G}^*$. Notice that here we use that focusing on a symmetric model and equilibrium makes the problem of finding an equilibrium one-dimensional (in contrast to the existence proof of Theorem 1).

First, it is easy to see that Λ and $\Gamma_{k,G}$ are each continuous, and hence $\Psi_{k,G}$ is continuous in γ .³⁰ Consequently, $\Psi_{k,G}$ is a continuous function between compact convex spaces and hence Brouwer's fixed point theorem establishes the existence of a (not necessarily unique) fixed point. In the onedimensional case that we consider, these fixed points correspond to intersection points of the graph of $\Psi_{k,G}$ with the 45°-line (i.e. the graph of the function $f(\gamma) = \gamma$).

Observe that $\frac{2k-n-1}{2(n-1)} \ge 0$ for $k \ge \frac{n+1}{2}$. Therefore, any fixed point of $\Psi_{k,G}(\cdot)$. must be nonnegative, $\gamma_{k,G}^* \ge 0$. Indeed, suppose by contradiction that there were a fixed point of $\Psi_{k,G}(\cdot)$ with $\gamma < 0$. Then this would imply $\mathbb{E}_{\Theta_j}\left[\max\left\{-1, \min\left\{-\frac{1-\theta_j}{\theta_j} \cdot \gamma, 1\right\}\right\}\right] > 0$ and consequently $\Psi_{k,G}(\gamma) > 0$ which shows that $\gamma < 0$ cannot be a fixed point. A similar argument shows that when $k \le \frac{n+1}{2}$, then any fixed point of $\Psi_{k,G}(\cdot)$ is non-positive, $\gamma_{k,G}^* \le 0$. This also implies $\gamma_{(n+1)/2}^* = 0$ for n odd which completes the proof of Corollary 2.

To obtain equilibrium uniqueness, we show that $\Psi_{k,G} : \mathcal{X}_i \to \mathcal{X}_i$ is weakly decreasing and hence crosses the 45°-line only once. Indeed, if we restrict attention to $k \geq \frac{(n+1)}{2}$, we know that $c(\theta_i) \leq 0$ for all $\theta_i \in \Theta_i$ or equivalently $\gamma \geq 0$. We obtain

$$\Psi_{k,G}(\gamma) = \frac{2k-n-1}{2(n-1)} + \frac{1}{2} \int_{\Theta_j} \max\left\{-1, \ -\frac{1-\theta_j}{\theta_j} \cdot \gamma\right\} \, \mathrm{d}G_j(\theta_j),\tag{12}$$

Observe that for $\gamma \in [0,1]$, $-\frac{1-\theta_j}{\theta_j} \cdot \gamma$ is decreasing in γ and hence max $\left\{-1, -\frac{1-\theta_j}{\theta_j} \cdot \gamma\right\}$ is weakly decreasing in γ for every $\theta_j \in \Theta_j$. From this it follows directly that

$$\int_{\Theta_j} \max\left\{-1, \ -\frac{1-\theta_j}{\theta_j} \cdot \gamma\right\} \, \mathrm{d}G_j(\theta_j)$$

and hence $\Psi_{k,G}(\gamma)$ is (weakly) decreasing in $\gamma \in [0,1]$. Since a fixed point of $\Psi_{k,G}(\gamma)$ is an intersection point of $\Psi_{k,G}(\gamma)$ with the 45°-line, it follows that $\Psi_{k,G}(\gamma)$ has a unique fixed point $\gamma_{k,G}^*$. The proof of such a unique fixed point for the case $k < \frac{n+1}{2}$ follows from analogous arguments.

Now, notice that any fixed point γ^* of $\Psi_{k,G}(\cdot)$ uniquely determines a cutoff function $c_{\gamma^*}(\cdot) = \Lambda(\gamma^*)$ that is a fixed point of $\Lambda \circ \Gamma_{k,G}$ and hence corresponds to a symmetric equilibrium in cutoff strategies. Moreover, it is straightforward to verify that for any fixed point c^* of the mapping $\Lambda \circ \Gamma_{k,G}$,

³⁰Recall that $\mathcal{X}_i^{\Theta_i}$ is the space of functions endowed with the product topology, i.e. the topology of pointwise convergence.

 $\Gamma_{k,G}(c^*)$ is a fixed point of $\Psi_{k,G}$. In other words, there is a one-to-one relation between fixed points of $\Psi_{k,G}$ and fixed points of $\Lambda \circ \Gamma_{k,G}$, where the latter are cutoff functions that characterize a symmetric equilibrium in cutoff strategies.

Finally, for the case of interior cutoffs, that is when $c_{k,G}(\theta_i) \in (-1,1)$ for all $\theta_i \in \Theta_i$, observe that we obtain:

$$\Psi_{k,G}(\gamma) = \frac{2k-n-1}{2(n-1)} - \frac{\gamma}{2(n-1)} \cdot (n-1) \int_{\Theta_j} \frac{1-\theta_j}{\theta_j} \,\mathrm{d}G_j(\theta_j).$$

This implies that for interior cutoffs $\gamma_{k,G}^*$ is a fixed point of $\Psi_{k,G}(\cdot)$ if

$$\gamma_{k,G}^* = \frac{2k - n - 1}{2(n - 1)} - \frac{1}{2} \cdot \gamma_{k,G}^* \cdot I_{\Theta}.$$

where

$$I_{\Theta} := \int_{\Theta_j} \frac{1 - \theta_j}{\theta_j} \, \mathrm{d}G(\theta_j).$$

From this it follows that

$$\gamma_{k,G}^* := \frac{2k - n - 1}{(n - 1)(2 + I_{\Theta})}$$

which in turn yields

$$c_{k,G}^*(\theta_i) = -\frac{2k-n-1}{(n-1)(2+I_{\Theta})} \cdot \frac{1-\theta_i}{\theta_i}, \quad \text{with } I_{\Theta} = \int_{\Theta_j} \frac{1-\theta_j}{\theta_j} \, \mathrm{d}G(\theta_j).$$

Proof of Proposition 4. Let $H \succeq_1 G$ be two preference type distributions and let $\gamma_{k,G}^*$, $\gamma_{k,H}^*$ be the corresponding expected values of the average signals of other players conditional on being pivotal in other words the corresponding fixed points of $\Psi_{k,G}(\cdot)$, $\Psi_{k,H}(\cdot)$ for the respective distributions.

A defining property of first-order stochastic dominance is that if H first-order stochastically dominates G, then for any non-decreasing function $u: \mathbb{R} \to \mathbb{R}$, it holds that

$$\mathbb{E}_{\Theta \sim H}[u(\theta)] \ge \mathbb{E}_{\Theta \sim G}[u(\theta)].$$

Consider the case $k \geq \frac{n+1}{2}$ in which $\gamma_{k,G}^*, \gamma_{k,H}^* \geq 0$ and cutoffs are non-positive. Now, as above, for every $\gamma \geq 0$, let $c_{\gamma}(\theta_j) = \max\left\{-1, -\frac{1-\theta_j}{\theta_j} \cdot \gamma\right\}$, for $\theta_j \in \Theta_j$, which is weakly increasing in θ_j (cf. Proposition 1). This implies

$$\mathbb{E}_{\Theta_j \sim H}[c_\gamma(\theta_j)] \ge \mathbb{E}_{\Theta_j \sim G}[c_\gamma(\theta_j)].$$

Recall that, $\Psi_{k,G}(\gamma) = \frac{2k-n-1}{2(n-1)} + \frac{1}{2} \mathbb{E}_{\Theta_j \sim G}[c_\gamma(\theta_j)]$. We thus obtain that if $H \succeq_1 G$, then $\Psi_{k,H}(\gamma) \ge \Psi_{k,G}(\gamma) \quad \forall \gamma \in [0,1]$. By Proposition 3, we know that each $\Psi_{k,G}(\cdot)$ has a unique fixed point (which is the intersection of $\Psi_{k,G}(\cdot)$ with the 45°-line), from which it follows that $\gamma_{k,H}^* \ge \gamma_{k,G}^*$. This implies

$$c_{k,H}^*(\theta_i) = \max\{-1, \ -\frac{1-\theta_i}{\theta_i} \cdot \gamma_{k,H}^*\} \le \max\{-1, \ -\frac{1-\theta_i}{\theta_i} \cdot \gamma_{k,G}^*\} = c_{k,G}^*(\theta_i) \quad \forall \theta_i \in \Theta_i.$$

Analogous arguments for the case $k \leq \frac{n+1}{2}$, in which cutoffs are non-negative, shows that if $H \succeq_1 G$ then $c_{k,H}^*(\theta_i) \geq c_{k,G}^*(\theta_i)$, for all $\theta_i \in \Theta_i$, which completes the proof.

Proof of Proposition 5. Suppose $H \succeq_{MPS} G$ are two preference type distributions and let $\gamma_{k,G}^*$, $\gamma_{k,H}^*$ be the corresponding fixed points of $\Psi_{k,G}(\cdot)$, $\Psi_{k,H}(\cdot)$ for the respective distributions.

A defining property of H being a mean-preserving spread of G is that both distributions have equal means and for any non-decreasing and (not necessarily strictly) concave function $u: \mathbb{R} \to \mathbb{R}$, it holds that³¹

$$\mathbb{E}_{\Theta \sim H}[u(\theta)] \le \mathbb{E}_{\Theta \sim G}[u(\theta)]. \tag{13}$$

Consider the case $k \geq \frac{n+1}{2}$ in which $\gamma_{k,G}^*, \gamma_{k,H}^* \geq 0$ and cutoffs are non-positive. As before, for every $\gamma \geq 0$, let $c_{\gamma}(\theta_j) = \max\left\{-1, -\frac{1-\theta_j}{\theta_j} \cdot \gamma\right\}$, for $\theta_j \in \Theta_j$. Then for $H \succeq_{MPS} G$, we obtain:

$$\begin{split} \mathbb{E}_{\Theta_{j}\sim H}[c_{\gamma}(\theta_{j})] &= \int_{\Theta_{j}} \max\{-1, \ \frac{1-\theta_{j}}{\theta_{j}} \cdot \gamma\} \,\mathrm{d}H(\theta_{j}) = \int_{\underline{\theta}_{j}}^{\frac{\gamma}{1+\gamma}} -1 \,\mathrm{d}H(\theta_{j}) + \int_{\frac{\gamma}{1+\gamma}}^{1} -\frac{1-\theta_{j}}{\theta_{j}} \cdot \gamma \,\mathrm{d}H(\theta_{j}) \\ &\leq \int_{\underline{\theta}_{j}}^{\frac{\gamma}{1+\gamma}} -1 \,\mathrm{d}G(\theta_{j}) + \int_{\frac{\gamma}{1+\gamma}}^{1} -\frac{1-\theta_{j}}{\theta_{j}} \cdot \gamma \,\mathrm{d}G(\theta_{j}) \\ &= \int_{\Theta_{j}} \max\{-1, \ \frac{1-\theta_{j}}{\theta_{j}} \cdot \gamma\} \,\mathrm{d}G(\theta_{j}) = \mathbb{E}_{\Theta_{j}\sim G}[c_{\gamma}(\theta_{j})], \end{split}$$

where the inequality follows from (13), since for $\gamma \ge 0$, $-\frac{1-\theta_j}{\theta_j} \cdot \gamma$ is non-decreasing and concave in θ_i , and -1 is constant (and as such non-decreasing and concave as well).

With this, we obtain that for any $k \geq \frac{n+1}{2}$, if $H \succeq_{MPS} G$, then

$$\Psi_{k,H}(\gamma) \le \Psi_{k,G}(\gamma) \quad \forall \gamma \in [0,1],$$

where again, recall that $\Psi_{k,G}(\gamma) = \frac{2k-n-1}{2(n-1)} + \frac{1}{2}\mathbb{E}_{\Theta_j \sim G}[c_{\gamma}(\theta_j)]$. Since for every given distribution of private preference types, there exists a unique symmetric equilibrium, in other words, a unique fixed-point of $\Psi_{k,G}$: $[0,1] \rightarrow [0,1]$, it follows that

$$\gamma_{k,H}^* \le \gamma_{k,G}^*$$

and hence

$$c_{k,H}^{*}(\theta_{i}) = \max\{-1, \ -\frac{1-\theta_{i}}{\theta_{i}} \cdot \gamma_{k,H}^{*}\} \ge \max\{-1, -\frac{1-\theta_{i}}{\theta_{i}} \cdot \gamma_{k,G}^{*}\} = c_{k,G}^{*}(\theta_{i})$$

for all $\theta_i \in \Theta_i$.

Analogous arguments for the case $k \leq \frac{n+1}{2}$, in which cutoffs are non-negative, show that if $H \succeq_{MPS} G$ then $c_{k,H}^*(\theta_i) \leq c_{k,G}^*(\theta_i)$, for all $\theta_i \in \Theta_i$, which completes the proof. \Box

³¹This is based on $H \succeq_{MPS} G$ iff they have equal means and G second-order stochastically dominates H of which (13) is a defining property.

References

- Aliprantis, Charalambos D. and Kim C. Border (2006), Infinite Dimensional Analysis: A Hitchhiker's Guide. Springer, Berlin.
- Austen-Smith, David and Jeffrey S. Banks (1996), "Information Aggregation, Rationality, and the Condorcet Jury Theorem." The American Political Science Review, 90, 34–45.
- Austen-Smith, David and Timothy J. Feddersen (2006), "Deliberation, Preference Uncertainty, and Voting Rules." American Political Science Review, 100, 209–217.
- Bardhi, Arjada and Nina Bobkova (2023), "Local Evidence and Diversity in Minipublics." *Journal* of *Political Economy*, 131, 2451–2508.
- Börgers, Tilman (2004), "Costly Voting." American Economic Review, 94, 57–66.
- Chemmanur, Thomas J. and Viktar Fedaseyeu (2018), "A Theory of Corporate Boards and Forced CEO Turnover." Management Science, 64, 4798–4817.
- Chen, Jie, Woon Sau Leung, Wei Song, and Marc Goergen (2019), "Why Female Board Representation Matters: The Role of Female Directors in Reducing Male CEO Overconfidence." *Journal* of Empirical Finance, 53, 70–90.
- Condorcet, Marquis de. (1785), "Essai sur l'application de l'analyse a la probabilite des decisions rendues a la pluralite des voix." In *Classics of Social Choice. (transl.)*, 91–112, University of Michigan Press (1995), Ann Arbor.
- Feddersen, Tim and Wolfgang Pesendorfer (1998), "Convicting the Innocent: The Inferiority of Unanimous Jury Verdicts." American Political Science Review, 92, 23–35.
- Feddersen, Timothy and Wolfgang Pesendorfer (1997), "Voting Behavior and Information Aggregation in Elections with Private Information." *Econometrica*, 65, 1029–1058.
- Grüner, Hans Peter and Alexandra Kiel (2004), "Collective Decisions with Interdependent Valuations." European Economic Review, 48, 1147–1168.
- Hofstede, Geert (1991), Cultures and Organizations: Software of the Mind. McGraw-Hill UK, London.
- Kim, Daehyun and Laura T. Starks (2016), "Gender Diversity on Corporate Boards: Do Women Contribute Unique Skills?" American Economic Review, 106, 267–71.
- Li, Hao, Sherwin Rosen, and Wing Suen (2001), "Conflicts and Common Interests in Committees." American Economic Review, 91, 1478–1497.
- Li, Hao and Wing Suen (2009), "Decision-Making in Committees." *Canadian Journal of Economics*, 42, 359–392.

- Malenko, Andrey, Ramana Nanda, Matthew Rhodes-Kropf, and Savitar Sundaresan (2023), "Catching Outliers: Committee Voting and the Limits of Consensus when Financing Innovation." HBS working paper.
- Meyer, Margaret and Bruno Strulovici (2015), "Beyond Correlation: Measuring Interdependence Through Complementarities." Working paper, University of Oxford.
- Moldovanu, Benny and Xianwen Shi (2013), "Specialization and Partisanship in Committee Search." *Theoretical Economics*, 8, 751–774.
- Name-Correa, Alvaro J. and Huseyin Yildirim (2019), "Social Pressure, Transparency, and Voting in Committees." *Journal of Economic Theory*, 184, 104943.
- Name-Correa, Alvaro J. and Huseyin Yildirim (2021), "Biased Experts, Majority Rule, and the Optimal Composition of Committee." *Games and Economic Behavior*, 127, 1–27.
- Rosar, Frank (2015), "Continuous Decisions by a Committee: Median versus Average Mechanisms." Journal of Economic Theory, 159, 15–65.
- Triandis, Harry C. (2001), "Individualism-Collectivism and Personality." Journal of Personality, 69, 907–924.
- Yildirim, Huseyin (2012), "Time-Consistent Majority Rules and Heterogeneous Preferences in Group Decision-Making." Working paper, Duke University.