

Specialization and partisanship in committee search

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A committee decides by unanimity whether to accept the current alternative or to continue costly search. Each alternative is described by a vector of distinct attributes and each committee member can privately assess the quality of one attribute (her “specialty”). Preferences are heterogeneous and interdependent: each specialist values all attributes, but puts a higher weight on her specialty (partisanship). We study how acceptance standards and members’ welfare vary with the amount of conflict within the committee. We also compare decisions made by committees that consist of specialized experts to decisions made by committees of generalists who can each assess all information available. The acceptance standard decreases (increases) in the degree of conflict when information is public (private). In both cases, welfare decreases in the level of conflict. Finally, we identify situations where specialized committee decisions yield Pareto improvements over specialized, one-person decisions and over committee decisions made by generalists.

KEYWORDS. Committee search, asymmetric information, interdependent values, specialization, partisanship.

JEL CLASSIFICATION. D82, D83, C72.

1. INTRODUCTION

In this paper we study how committees of “biased specialists”—each possessing private information about some partial aspect of the problem at hand—choose one out of several multifaceted alternatives that appear over time.

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Most complex decisions in modern public or private organizations are nowadays taken by committees rather than by single individuals.¹ Another ubiquitous feature of modern industrialized societies is the compartmentalization of knowledge.² Just to give an example, medical specialization only started around 1830 in the great Paris hospitals, while the past half century has seen a tremendous increase in the number of medical specialties, along with the near disappearance of the general practitioner.³

The possession of private information creates incentives for strategic manipulation within committees. This aspect would be less significant if the experts/specialists would weigh all relevant aspects in the same way. But it is often the case that specialization also leads to a form of “bias” or “partisanship”—the view that one’s own information/specialty is more important than others. For example, Hardy (1940, p. 66) advises that “[i]t is one of the first duties of a professor, for example, in any subject, to exaggerate a little both the importance of his subject and his own importance in it.” (Surely all learned readers of this article can offer some empirical evidence to the effect that Hardy’s advice is widely followed.)

Differences in the weighting of various attributes may be intrinsic or psychological, or due to the fact that the decision makers are accountable to different constituencies and are better informed about the effects of the decision on their own constituency. One important example of the second type is offered by the monetary policy board of the European Central Bank. Grüner and Kiel (2004) argue that national central banks care about a policy that accommodates macroeconomic shocks in their own country, but, due to demand spillover effects, shocks in one country affect the desired policy in others. Moreover, national central bankers presumably have private information about their own national macroeconomic conditions (e.g., Greece before and during the banking crisis).⁴

If it is strong enough, the degree of partisanship within a committee implies that each member will insist on a particularly high standard in his own specialty, leaving

¹Examples where committees decide over alternatives appearing over time are hiring decisions for high-profile jobs that require multiple skills, e.g., for a CEO, public administrator, or university professor; investment decisions within a firm or a partnership of venture capitalists; funding decisions for (possibly interdisciplinary) research made by ad hoc expert committees assembled within science agencies.

²In earlier times, some individuals knew “everything.” Examples are Leonardo da Vinci (painter, sculptor, architect, musician, mathematician, engineer, inventor, anatomist, geologist, cartographer, and botanist), Isaac Newton (physicist, mathematician, astronomer, natural philosopher, alchemist, master of the mint, and theologian), or Benjamin Franklin (author, printer, political theorist, postmaster, scientist, inventor, statesman, and diplomat).

³For a history of specialization in medical science, see Weisz (2006). A lively debate takes place in the medical literature about the merits of specialists versus generalists. For example, Lowe et al. (2000) study admission decisions for cardiac patients performed by doctors with different trainings. The decision problem is multidimensional since many of these patients suffer from *comorbidity*—the presence of several other serious conditions.

⁴Another example is offered by international environmental policy. States are interested in achieving less pollution, and presumably possess private information about the national amount of emissions, the cost of reducing emissions, or the economic consequences of a reduction. But the environmental situation in one country is co-determined by the emissions in neighboring countries and, hence, policy needs to be coordinated (e.g., the Kyoto or Copenhagen conferences).

little room for trade-offs among the various aspects of each alternative. Such behavior leads to delay in reaching decisions.⁵

So as to study the interaction among specialization, private information, and partisanship in a dynamic framework where delay is meaningful, we study a model where a stream of alternatives is presented to a committee that has to decide whether to accept the current alternative, or to continue costly search (which can be seen as preserving a given status quo). This is a multiperson generalization of a classical one-person optimal stopping or search problem.⁶ Each alternative is described by several distinct attributes. Each committee member is able to privately assess the quality of one attribute only (her “specialty”), but has only statistical knowledge about the distribution of other relevant attributes. Thus, the game our agents play is one with *asymmetric* information. Members’ preferences are *interdependent*: the utility of each member is given by a convex combination of his own private signal and the private signals of other members.⁷ We assume that committee members care most about the attribute about which they are also privately informed, but other cases can be treated also. We focus here on unanimity decisions, but, at least in principle, similar analyses for committees that employ other decision rules (e.g., voting by majority) can be performed using the same tools.

Our main results study how acceptance standards and members’ welfare vary with the amount of partisanship (or conflict), and compare the multiperson committee decision under specialization to committees without specialization, where all members are generalists and have access to all the available information (thus there is complete information).⁸

It is important to point out that with extreme divergence of opinions, which corresponds here to the private values case (i.e., when each committee member puts all the weight on the attribute that corresponds to her own specialty), it makes no difference whether the committee members have private information. The reason is that acceptance by a member (who votes based on information about her own specialty) conveys no additional information that directly affects another member’s utility. Important recent papers that study the private values case are [Albrecht et al. \(2010\)](#) and [Compte and Jehiel \(2010a\)](#) (see the literature review below).

⁵Here is, for example, what [Farrell and Saloner \(1988\)](#) write in their influential study of standard setting committees: “More than a hundred thousand people meet regularly in committees with the goal of reaching agreement on product and interface compatibility standards. ... But these committees too are imperfect coordinators. Often, by the time a committee is convened, participants have vested interests in incompatible positions, and the committee must resolve this conflict. Since the ‘consensus principle’ which is generally accepted in voluntary standard setting, requires committees to seek a stronger consensus than a simple majority vote (though not necessarily unanimity), there may be a battle of wills in committee, while users wait.”

⁶See [Chow et al. \(1971\)](#) for a classical exposition.

⁷Thus, abstracting from informational issues, we follow the approach of the so-called *multi-attribute utility theory*, a standard tool in decision analysis. The additive form—where the utility of an alternative is the weighted sum of the conditional utilities of the alternative’s attributes, with weights adding up to 1—is the simplest, yet most widely used form (see [Keeney and Raiffa 1976](#) for a classical exposition).

⁸Several important tools in our comparative statics results revolve around the concept of *mean residual life* of a random variable, which is borrowed from *reliability* theory (see [Shaked and Shanthikumar 2007](#), Chapter 2). Another important set of concepts and tools is borrowed from (stochastic) *majorization* theory (see the classical treatise by [Marshall and Olkin 1979](#)).

The situation dramatically changes when a member values attributes other than her specialty, i.e., when there is less conflict and when values are interdependent. Then, under complete information (generalist decision makers), a committee member accepts candidates whose weighted combination of all observed attributes is above an optimal cutoff, which equals the continuation value obtained by continuing search. Under asymmetric information, behavior can be conditioned only on the single observed attribute (the respective specialty), and member A , say, imprecisely infers from an acceptance by another member B that the attribute monitored by B —which now directly matters for A —is of relatively high quality. The continuation value is now a function of the acceptance cutoff in A 's specialty and the inferred expected attributes in the other dimensions.

A consequence of this difference is that increased conflict leads to a more lenient acceptance rule under complete information, but to a more stringent rule under asymmetric information! In particular, there are balanced, but not exceptional, candidates who are accepted by the specialized committee, but rejected by the nonspecialized one. On the other hand, the specialized committee rejects candidates who are excellent in just one dimension and who would be accepted by the generalist committee.

Although acceptance standards move in opposite directions, members' welfare in both settings behave similarly. Roughly speaking, welfare in committees increases with the covariance of the members' random utilities, where an increase in covariance can stem either from an increase in the variance of the underlying attributes (an effect that is beneficial already in one-person decisions) or from a decrease in the degree of conflict within the committee.⁹

A generalist "dictator" cannot gain by forming a committee where power has to be shared with others (unless the search costs can be passed to others). In contrast, when search costs are not too high, a specialist dictator prefers to share power and invite other specialists to the committee rather than make a partially uninformed decision by himself. Moreover, the invited specialist is better off to join the committee rather than stay out and bear the consequences of the dictator's decision. This Pareto improvement holds provided that there is a minimal congruence of interests among potential members and is achieved in spite of a necessarily longer search duration in the committee problem.

The paper is organized as follows. In the next subsection, we review the related literature. In [Section 2](#), we present the committee decision model. In [Section 3](#), we prove equilibrium existence and uniqueness. In [Section 4](#), we study how acceptance standards and members' welfare vary with the amount of conflict within the committee, and compare the results to the benchmark, the complete information setting. We also analyze the effects of changes in the distribution of attributes. In [Section 5](#), we compare the performance of committees of specialists with that of a partially informed dictator. [Section 6](#) concludes. The [Appendix](#) contains the technical proofs omitted from the main text.

⁹Another interesting comparison is the one between specialist dictatorships and specialist committees: a "paradox of committees" may occur whereby some candidates get rejected by all specialists acting on their own, yet unanimously get approved by a committee formed by these same specialists.

1.1 *Related literature*

Decision making in committees is the subject of much scholarly work. A large majority of the existing papers study static cases where the committee makes a decision just once. We refer the reader to the survey by [Li and Suen \(2009\)](#) for a discussion of some of the main topics addressed, and focus below on papers that incorporate committee decisions within a formal search model.¹⁰

A small literature, originating during the mid 1970's–1980's in statistics/operations research, analyzes multiperson stopping games: each alternative is characterized by a set of attributes and each committee member cares about only one attribute. This basic framework with two players, where stopping requires unanimous consent, was first analyzed by [Sakaguchi \(1973\)](#). [Kurano et al. \(1980\)](#) and [Yasuda et al. \(1982\)](#) establish equilibrium existence for environments with more than two players and with more flexible voting rules, e.g., majority. [Ferguson \(2005\)](#) points out that the voting games analyzed by these authors typically have many nontrivial stationary equilibria and he offers conditions on the distribution of the alternatives' attributes that ensure the existence of a unique stationary equilibrium for the case of unanimous consent.

There is a more recent interest in collective search games in economics, where various versions of the model studied here are analyzed in private values, complete information frameworks. [Wilson \(2001\)](#) and [Compte and Jehiel \(2010a\)](#) take a bargaining perspective: they study environments where proposals are presented randomly and sequentially to a set of bargainers who can accept or not. These authors relate the bargaining outcome when players are very patient to the Nash bargaining solution. [Compte and Jehiel](#) also analyze who has more (if any) effect on the decision, how search duration is affected by the majority rule, and the impact of dimensionality on the size of the acceptance set. Most of their results are derived for very patient agents. [Albrecht et al. \(2010\)](#) consider general patient agents and derive the existence of a unique symmetric and stationary equilibrium for symmetric settings; for general majority rules, they compare committee decision making with single person search problems, and study how the committee size and voting rules affect the search outcome. These authors and [Compte and Jehiel \(2010b\)](#) compare majority rules with unanimity and show that unanimity is optimal for sufficiently patient agents. [Alpern and Gal \(2009\)](#) and [Alpern et al. \(2010\)](#) consider augmented voting games where the committee members can also veto candidates, but have a restricted number of vetoes.

[Lizzeri and Yariv \(2010\)](#) consider a committee that decides every period whether to continue deliberation (costly information gathering) or to stop and make a final decision by voting. These authors show that voting rules may be irrelevant, while delibera-

¹⁰Several static models allow for interdependent values. [Grüner and Kiel \(2004\)](#) consider a voting model with a one-dimensional set of alternatives. [Caillaud and Tirole \(2007\)](#) define a measure of *internal congruence* for committees. As our notion of degree of partisanship, this is related to measures of positive dependence among random variables. [Yildirim \(2012\)](#) analyzes a model where there is no commitment about the committee's voting procedure and he focuses on time consistent majority rules.

tion rules are critical for the determination of the duration and accuracy of final decisions.¹¹ This theoretical finding is consistent with the experimental results documented in Goeree and Yariv (2011). Strulovici (2010) studies a model of collective experimentation by voting and shows that collective decision making often leads to a socially insufficient level of experimentation.

Although various aspects of aggregation of private information comprise a significant topic in the static literature on decision making in committees (see, for example, Gilligan and Krehbiel 1989 and Li et al. 2001), we note again that all papers mentioned above (that discuss dynamic settings) conduct a complete information analysis. The combination of dynamic search, private information, multidimensional alternatives, and interdependent values is the distinctive feature of the present paper.

Damiano et al. (2009) study the role of delay for information aggregation in a dynamic model of committee decision where committee members possess private information and have conflicting preferences. In their model, members repeatedly vote on a decision—which is taken only once—until an agreement is reached.

2. THE MODEL

We present the model in a specific and familiar setting of a recruiting committee. As mentioned in the [Introduction](#), our analysis applies more broadly to other committee decision frameworks.

A hiring committee is in charge of filling an open position. Candidates are evaluated one at a time. In each period t , the current candidate is evaluated on the basis of n attributes X_{it} , $i = 1, \dots, n$, where X_{it} 's are nonnegative random variables. These n attributes are drawn independently of each other, and each attribute X_i is independently drawn across periods from commonly known distributions F_i . All distributions $\{F_i, i = 1, \dots, n\}$ have finite second moments and continuous densities, with a common support $[0, \bar{\theta}]$, where $\bar{\theta} \leq +\infty$.¹²

The committee consists of n members. Member i is specialized in evaluating attribute X_i and privately observes the realization of this random variable.

The committee members view the value of a candidate in possibly different ways: each member is biased toward hiring a candidate who is strong in his own respective field of specialization. This is captured here by assuming that, net of search costs, the payoff for member i from hiring a candidate $(x_1, \dots, x_n)$ is given by

$$\alpha x_i + (1 - \alpha) \frac{1}{n-1} \sum_{j \neq i} x_j,$$

with $\alpha \in [1/n, 1]$. If $\alpha = 1/n$, this becomes a setting of common interests, and if $\alpha = 1$, this is a private values setting. For all $\alpha > 1/n$, member i puts relatively more weight on

¹¹In a similar environment, Chan and Suen (2011) show that simple majority rule may lead to hasty decisions if voters are heterogeneous in more than one dimension.

¹²The assumption of common support is just for convenience of notation.

attribute x_i than on other attributes x_j with $j \neq i$. Higher values of α represent here a higher degree of conflict within the committee, that is, more partisanship (with extreme conflict at $\alpha = 1$).

After each evaluation, members simultaneously cast votes of “yes” or “no.”¹³ Acceptance is by unanimity, that is, a candidate is hired and search stops if all members vote “yes”; otherwise search continues. In the latter case, each member incurs a cost c and the process repeats itself.¹⁴ Once rejected, a candidate cannot be recalled. In the sequel, we always focus on equilibria where search ends in finite time, so as to avoid the trivial equilibria where one agent never votes “yes.”

3. EQUILIBRIUM CHARACTERIZATION

We focus on stationary equilibria that employ cutoff strategies. Each member casts her vote based only on her own information. Specifically, i votes “yes” for candidate $(x_1, x_2, \dots, x_n)$ if and only if $x_i \geq x_i^*$, where x_i^* denotes the cutoff used by member i .

Let v_i denote the continuation value member i derives by following her optimal strategy, given the equilibrium strategy x_j^* of all other members $j \neq i$. The Bellman equation for i is given by

$$\begin{aligned} v_i &= -c + \max_{x_i^*} \left\{ E \left[\alpha X_i + (1 - \alpha) \frac{1}{n-1} \sum_{j \neq i} X_j \mid X_k \geq x_k^*, \forall k \right] \Pr\{X_k \geq x_k^*, \forall k\} \right. \\ &\quad \left. + [1 - \Pr\{X_k \geq x_k^*, \forall k\}] v_i \right\} \\ &= -c + \max_{x_i^*} \left\{ \alpha E[X_i \mid X_i \geq x_i^*] + \frac{1 - \alpha}{n-1} \sum_{j \neq i} E[X_j \mid X_j \geq x_j^*] \right\} \prod_k [1 - F_k(x_k^*)] \\ &\quad + \left\{ 1 - \prod_k [1 - F_k(x_k^*)] \right\} v_i. \end{aligned} \tag{1}$$

The second equality follows because X_i 's are independent. The first-order condition is

$$v_i = \alpha x_i^* + (1 - \alpha) \frac{1}{n-1} \sum_{j \neq i} E[X_j \mid X_j \geq x_j^*]. \tag{2}$$

Intuitively, conditional on being pivotal (i.e., $X_j \geq x_j^*$ for all $j \neq i$), member i is indifferent between accepting the marginal candidate with $X_i = x_i^*$ and continuing costly search. Therefore, the continuation value v_i must be equal to the expected payoff from hiring the marginal candidate, which is $\alpha x_i^* + (1 - \alpha)(1/(n-1)) \sum_{j \neq i} E[X_j \mid X_j \geq x_j^*]$. In contrast to the more familiar complete information setting where the stopping cutoff equals the continuation utility, here the equilibrium cutoff and the equilibrium utility

¹³Under the unanimity rule studied here, simultaneity does not matter.

¹⁴These can be thought of as time costs, evaluation costs, etc.

do not coincide: the cutoff x_j^* of opponent j affects not only the probability of acceptance, but also the expected worth of the marginal candidate.

We can rewrite the Bellman equation (1) as

$$v_i = \alpha E[X_i | X_i \geq x_i^*] + (1 - \alpha) \frac{1}{n-1} \sum_{j \neq i} E[X_j | X_j \geq x_j^*] - \frac{c}{\prod_k [1 - F_k(x_k^*)]}. \quad (3)$$

That is, the expected payoff for member i is equal to the expected value of the chosen alternative minus the expected search costs. Using the first-order condition (2), we obtain from (3) the following equilibrium conditions that characterize the stationary equilibrium cutoffs x_i^* :

$$\frac{c}{\prod_k [1 - F_k(x_k^*)]} = \alpha E[X_i - x_i^* | X_i \geq x_i^*], \quad i = 1, \dots, n. \quad (4)$$

Before discussing equilibrium existence and uniqueness, we need to introduce several definitions.

DEFINITION 1. (i) The mean residual life (MRL) of a random variable $X \in [0, \bar{\theta}]$ is defined as

$$m(x) = \begin{cases} E[X - x | X \geq x] & \text{if } x < \bar{\theta} \\ 0 & \text{if } x = \bar{\theta}. \end{cases}$$

- (ii) A random variable X satisfies the (strict) decreasing mean residual life (DMRL) property if $m(x)$ is (strictly) decreasing in x .
- (iii) A random variable X satisfies the increasing failure rate (IFR) property if the failure rate $\lambda(x) = f(x)/[1 - F(x)]$ is increasing in x .

If we let X denote the lifetime of a component, then $m(x)$ measures the expected remaining life of a component that has survived until time x .¹⁵ The IFR assumption is commonly made in the economics literature. DMRL is a weaker property and it is implied by IFR. We are now ready to state the first main result of this section.

PROPOSITION 1. *Suppose that each of the random variables X_i , $i = 1, \dots, n$, satisfies the strict DMRL property. Then the voting game among specialists has a unique cutoff equilibrium.*

The proof in the [Appendix](#) utilizes the observation that the equilibrium conditions (4) in our asymmetric information setting with interdependent values can be translated into analogous equilibrium conditions in the complete information setting with private

¹⁵The MRL function is related to the hazard rate (or failure rate) $\lambda(x) = f(x)/[1 - F(x)]$, which measures the instantaneous failure probability conditional on survival up to time x . The relation between the two is $m(x) = \int_x^{\bar{\theta}} \exp\{-\int_x^t \lambda(u) du\} dt$ for $x < \bar{\theta}$. Both measures are conditional concepts (and uniquely determine the underlying distribution), but they are conceptually different: the hazard rate $\lambda(x)$ takes into account only the instantaneous present, while the mean residual life $m(x)$ takes into account the complete future (see [Guess and Proschan 1988](#)). The exponential distribution is the only distribution that has a constant mean residual life and a constant hazard rate.

values. Therefore, it is sufficient to establish equilibrium existence and uniqueness in the latter environment. In this environment, general equilibrium existence is established by [Yasuda et al. \(1982\)](#), while [Ferguson \(2005\)](#) shows that the strict DMRL property is sufficient to guarantee equilibrium uniqueness. The assumption of *strict* DMRL is critical for the uniqueness result. If this assumption fails, then multiple equilibria are possible (see [Ferguson 2005](#) for examples).

4. SPECIALIZATION AND CONFLICT

We now investigate how the interaction between the degree of conflict and specialization affects committee decision making in ex ante symmetric settings. We use as a benchmark the setting with complete information (no specialization). In this setting, each member's payoff is the same as in the asymmetric information setting, but member i observes the *entire* vector of a candidate's attributes $(x_1, \dots, x_n)$. Let

$$Z_i = \alpha X_i + (1 - \alpha) \frac{1}{n-1} \sum_{j \neq i} X_j$$

denote the (stochastic) value of a candidate for member i . In a stationary cutoff equilibrium, member i votes “yes” if and only if $Z_i \geq z_i^*$, where z_i^* is the candidate's overall “score.” It is important to note that the equilibrium cutoff $z_i^* = z^*$ coincides here with member i 's equilibrium expected utility.

PROPOSITION 2. *Suppose that $F_i = F$, $i = 1, 2, \dots, n$. In the complete information setting, there exists a unique symmetric equilibrium where the common equilibrium cutoff z^* (and thus expected utility) is strictly decreasing in α . In contrast, in the asymmetric information setting, there exists a unique symmetric equilibrium where the common equilibrium cutoff x^* is strictly increasing in α , but expected utility is strictly decreasing in α .¹⁶*

Note that, in both settings, the DMRL condition is not needed for the symmetric equilibrium to be unique among symmetric equilibria. If F satisfies the strict DMRL property, then, in both settings, the symmetric equilibrium is unique among all (possibly asymmetric) equilibria.¹⁷

To gain some intuition for the above result, it is instructive to consider here the case of $n = 2$ (where $\alpha \in [\frac{1}{2}, 1]$) and to rewrite the equilibrium condition (4) for the asymmetric information case as

$$\alpha E \left[\left(\frac{1}{2} X_1 + \frac{1}{2} X_2 - x^* \right) \cdot \mathbf{1}_{\{X_1 \geq x^*, X_2 \geq x^*\}} \right] = c.$$

¹⁶Although preferences vary as α changes, the message of the welfare comparative statics is clear-cut compared with that for a single-agent decision maker. In our earlier working paper ([Moldovanu and Shi 2011](#)), we show that a higher α increases the expected utility of a partially or fully informed dictator. Thus, although the dictator shares the same preferences as one of our committee members, the welfare in single-agent decision making and in collective decision making goes in opposite directions as α increases. See also footnote 18 below.

¹⁷The strict DMRL property is invoked for uniqueness of symmetric equilibria in the symmetric, private values case by [Albrecht et al. \(2010\)](#). The reason is that these authors considered more general majority voting rules.

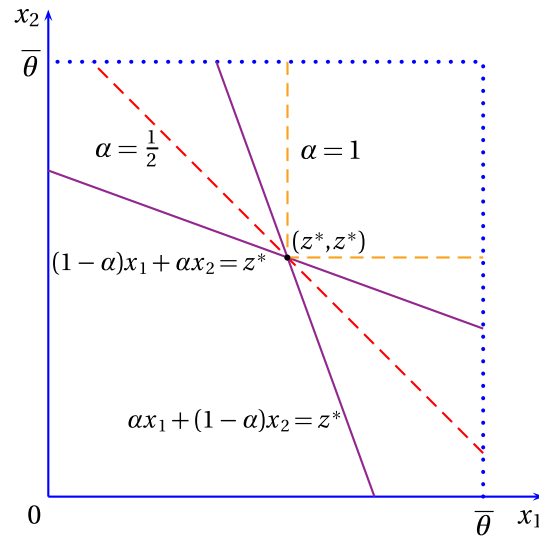


FIGURE 1. A higher degree of conflict leads to a smaller acceptance region.

The equilibrium condition for the complete information case (see (5) in the proof of Proposition 2) is

$$E\left[\left(\frac{1}{2}X_1 + \frac{1}{2}X_2 - z^*\right) \cdot \mathbf{1}_{\{\alpha X_1 + (1-\alpha)X_2 \geq z^*, (1-\alpha)X_1 + \alpha X_2 \geq z^*\}}\right] = \tilde{c},$$

where $\tilde{c}$ denotes the search cost incurred by a generalist who evaluates *both* attributes. Raising the degree of conflict among specialists (while fixing the acceptance cutoff) raises the “stakes” controlled by each member without affecting the acceptance area. Thus, committee members respond by raising the cutoff. In contrast, raising the degree of conflict among generalists (while fixing the acceptance cutoff) has no effect on the controlled stake, but decreases the acceptance area. For a fixed acceptance score z^* , the acceptance area under unanimity is given by

$$\{(x_1, x_2) : \alpha x_1 + (1-\alpha)x_2 \geq z^*, (1-\alpha)x_1 + \alpha x_2 \geq z^*\}.$$

When α (the degree of conflict within the committee) increases, the acceptance region shrinks, as shown in Figure 1. As a result, a successful search takes more periods, which means that both members have to incur higher expected search costs. To counter this effect, both members lower their acceptance standard and settle on less desirable candidates, striking a balance between candidate quality and search costs.

Although the equilibrium acceptance cutoffs go in the opposite direction in the two information settings, the members’ welfare goes in the same direction. In the setting with complete information, an increase in α has two opposite effects on welfare: on the one hand, an increase in α increases the variability of the future candidates’ stochastic value to members, which is known to be beneficial for a one-person decision maker

(dictator);¹⁸ on the other hand, an increase in α shrinks the acceptance region. The benefit of an increased variance is inconsequential for member 1 if member 2 ultimately says “no” to the better candidates for which 1 waited. Conditional on observing a high value, member 1 needs 2 to also have a high expected value: only then does search stop. Note that the covariance of the members’ random utilities,

$$\text{Cov}[\alpha X_1 + (1 - \alpha)X_2, (1 - \alpha)X_1 + \alpha X_2] = 2\alpha(1 - \alpha)\text{Var}(X),$$

is increasing in the variance of the underlying attributes, but is *decreasing* in the degree of conflict α on $[\frac{1}{2}, 1]$. Thus, our result shows that the consensus effect is dominant in committees.¹⁹

Now let us consider the setting with asymmetric information. As we pointed out earlier, with asymmetric information, the continuation payoffs are different from equilibrium cutoffs, and this observation is key to understanding why members’ utilities decrease although the equilibrium cutoff increases in α . Member 1’s payoff is given by $v_1 = \alpha x^* + (1 - \alpha)E[X_2|X_2 \geq x^*]$. Note that $E[X_2|X_2 \geq x^*] \geq x^*$. Therefore, an increase in α has two effects on v_1 : a higher α leads to a higher cutoff and thus to an increase of both terms in v_1 , while a higher α also shifts weight from the larger term $E[X_2|X_2 \geq x^*]$ to the smaller term x^* and thus lowers v_1 . It turns out that the second effect dominates and, thus, v_1 is decreasing in α .

As an application, consider funding of research projects based on research proposals. In many countries, these decisions are (sequentially) taken by panels of experts coming from various disciplines. Our result that the acceptance cutoff in specialist committees decreases when α —the weight on one’s own discipline—decreases, offers some explanation for the perception among some scientists that the increased fixation on interdisciplinary research (ever so popular among politicians and science administrators) may sometimes lead to lower scientific standards in some of these panels.

4.1 Who gets accepted?

We now compare the decisions of specialist and generalist committees. The comparison certainly depends on the ratio of respective search costs. As a benchmark, assume first that a generalist enjoys a very strong return to scope in knowledge, so that the search cost $\tilde{c}$ incurred by a generalist to evaluate *both* attributes is equal to the search cost c incurred by each specialist to evaluate the *single* attribute in her specialty.

¹⁸The proof of this result (for details, see our earlier working paper [Moldovanu and Shi 2011](#)) relies on a majorization theorem due to [Marshall and Proschan \(1965\)](#) that shows that an increase in α leads to a second-order stochastic decrease of the random utility Z_i and, hence, to a higher variance.

¹⁹This observation suggests a deeper mathematical connection: when conflict decreases, the members’ random utilities become *more associated*, where “more association” is a well known measure of positive dependence among random variables, due to [Schriever \(1987\)](#). He proves the following example: Consider random variables (X_1, X_2) and let H_α be the joint distribution function of the linear transform $T_\alpha(X_1, X_2) = (\alpha X_1 + (1 - \alpha)X_2, (1 - \alpha)X_1 + \alpha X_2)$, where $\alpha \in [\frac{1}{2}, 1]$. Then $\alpha \geq \alpha'$ implies $H_\alpha \preceq_{\text{assoc}} H_{\alpha'}$. As an application of their stochastic supermodular order, [Meyer and Strulovici \(2012\)](#) show that this observation holds more generally.

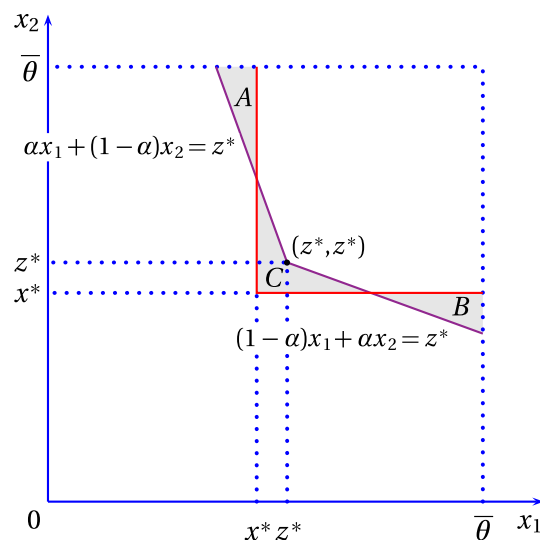


FIGURE 2. Acceptance regions of specialist committees and generalist committees.

When $\alpha = 1$ the two respective equilibrium conditions coincide (since private information is inconsequential) and, therefore, we have $z^* = x^*$. As shown in [Proposition 2](#), the acceptance standards move in opposite directions when we lower the degrees of conflict. Note also that the score of a candidate with attributes $(x^*, x^*, \dots, x^*)$ is equal to x^* . These observations immediately imply the following corollary.

COROLLARY 1. *Suppose that $F_i = F$, $i = 1, 2, \dots, n$. For any degree of conflict α , the equilibrium acceptance score z^* under complete information (no specialization) is higher than the equilibrium acceptance cutoff x^* under asymmetric information (specialization).*

For illustration, consider again a setting with two members. It is intuitive that a specialized committee rejects candidates who are excellent in just one dimension (candidates in areas *A* and *B* in [Figure 2](#)) and would be accepted by generalists. But we also obtain that there are *always* balanced candidates with attributes above and close to (x^*, x^*) (candidates in area *C*) who are accepted by the specialized committee while being rejected by the generalist one. [Figure 2](#) illustrates the acceptance areas in these two cases.

In reality, a generalist who is able to assess several dimensions of a complex problem may have less precise information about each of them than a specialist. Alternatively, to obtain the same quality of information as several specialists (one for each dimension), the cost incurred by a generalist for assessing an additional dimension may be higher than the cost incurred by a specialist who assesses only that particular dimension. In such cases, a specialized committee becomes more advantageous: for example, suppose that F_1 and F_2 are both uniform on the interval $[0, 1]$, and suppose that $\tilde{c}/c = 2$ (i.e., a generalist faces a cost function that is linear in the number of assessed dimensions;

convexity is needed in general). Then one can easily verify that the specialist committee dominates the generalist committee in terms of members' welfare.²⁰

4.2 Comparative statics within and across specialized committees

In this section, we investigate how the equilibrium of specialized committees varies when we change the distribution of the candidate's attributes. We first recall several well known stochastic orders.

DEFINITION 2. (i) Let m and l denote the mean residual life function of random variables X and Y , respectively. Then X is said to be smaller than Y in the mean residual life order, denoted by $X \leq_{\text{MRL}} Y$, if $m(t) \leq l(t)$ for all $t \in [0, \bar{\theta}]$.

(ii) Let r and q denote the hazard rate function of random variables X and Y , respectively. Then X is said to be smaller than Y in the hazard rate order, denoted by $X \leq_{\text{HR}} Y$, if $r(t) \geq q(t)$ for all $t \in [0, \bar{\theta}]$.

Our first result shows that, within a given committee, a member who observes a stochastically higher attribute in the MRL sense has a higher equilibrium acceptance standard and is better off. The MRL order is independent of the usual stochastic order (denoted by $\leq_{\text{ST}}$). The hazard rate order $\leq_{\text{HR}}$ implies both $\leq_{\text{MRL}}$ and $\leq_{\text{ST}}$. Note that if $\tilde{X} \leq_{\text{MRL}} X$ and $E\tilde{X} = EX$, then $\tilde{X}$ second-order stochastically dominates X and, hence, $\tilde{X}$ has a lower variance than X (see Shaked and Shanthikumar 2007).

PROPOSITION 3. Suppose that all random variables X_k , $k = 1, \dots, n$, satisfy the strict DMRL condition. If $X_j \leq_{\text{MRL}} X_i$, then in the unique equilibrium it holds that $x_j^* \leq x_i^*$ and $v_j \leq v_i$.²¹

Our second result looks across committees, and shows that members' acceptance standards and utilities go up given a stochastic improvement in the privately observed attributes. Here we need the improvement to be in the sense of the stronger hazard rate order.

PROPOSITION 4. Consider a committee C_1 , where attributes are governed by random variables $X_i = X$, $i = 1, \dots, n$, and another committee C_2 , where attributes are governed by random variables $\tilde{X}_i = \tilde{X}$, $i = 1, \dots, n$. Suppose that X and $\tilde{X}$ satisfy the strict DMRL condition, and that $\tilde{X} \leq_{\text{HR}} X$. Then the acceptance cutoff and the members' utilities in the respective unique equilibrium are higher in committee C_1 than in C_2 .

²⁰We refer interested readers to our earlier working paper (Moldovanu and Shi 2011) for a detailed welfare comparison between these two types of committees.

²¹Thomas Watson, the founder of IBM, is said to have advised, "[i]f you want to be more successful, increase your failure rate." Our result shows that increasing mean residual life is sufficient, at least in committee interactions.

5. EMERGENCE OF COMMITTEES

In this section, we briefly discuss the incentives of a specialist “dictator” (who is informed only about one dimension of the problem) to involve in the decision making process a specialist on a different dimension: there is a trade-off between sharing power and gaining valuable information. We focus on the case where $n = 2$ (members A and B) and where the distributions of the two attributes are symmetric: $F_1 = F_2 = F$.

5.1 Dictatorship versus committee

Whenever there are conflicts of interests, a generalist dictator who is completely informed about the problem at hand (say member A) obviously stands to lose if he invites member B to form a committee and share control over the decision. Thus, whenever decision power is asymmetrically distributed, a lack of specialization suggests that most decisions will be made by the authority person who is in power. But we show below that when the search cost is sufficiently small, a potential dictator A , who is informed only about one dimension of the problem at hand, stands to gain by forming a committee with another member B , who is informed about another dimension. Moreover, informed members who were excluded from decision making also gain by affecting the decision within a committee, even when the extra search cost is taken into account. These results hold even for large degrees of conflict between A and B , in spite of the fact that the expected search duration in a committee is higher than under dictatorship. In other words, a late informed decision is better than an early uninformed one. Thus, the modern trend to more specialization offers a natural explanation for the observed increase in the number of decisions by committees and for the often bemoaned increased delay in reaching those decisions.

The proposition below compares a decision under specialized dictatorship (of member A) to a decision under specialized unanimity, where A invites B to join the committee.²²

PROPOSITION 5. *Suppose F satisfies the strict DMRL condition and has a bounded support. Consider the transition from specialized dictatorship to specialized unanimity.*

- (i) *The acceptance standard goes down, while the expected search duration goes up.*
- (ii) *As long as the search cost c is sufficiently small, both members gain by forming a committee.*

An implication of the first part of the above result is a *paradox of committees*: a candidate can be hired by the committee that consists of members A and B , although he would have been rejected by both A and B separately acting as dictators. This finding in our *asymmetric* information setting is related to that in Albrecht et al. (2010), who show

²²Under dictatorship, we assume that B free rides on A 's decision without paying any search cost. Our conclusion about the value of forming specialized committees gains extra support if B also incurs some extra cost (of waiting, say) while being outside the committee.

that committees are less picky than individual decision makers in the *complete* information setting, but our underlying mechanism, however, is different from theirs. In their setting, committee members are less picky because of a “loss of control” effect: each member cannot directly control the stopping decision, so the value of search and, thus, the equilibrium cutoff goes down. In our setting, the loss of control effect is still present, but there is another force: when a specialist (who is not completely biased) learns that the candidate was deemed to be suitable by a specialist in another discipline, he updates upward the candidate’s expected value in the other discipline, which further lowers the cutoff in his own discipline—a *winner’s blessing* effect.

When the degree of conflict is small (α close to $\frac{1}{2}$), the gains are more evenly divided, whereas member B stands to gain more when the degree of conflict is relatively high (α close to 1). This is intuitive since a dictator who is informed about the only dimension that is of interest to him (i.e., private values) has obviously nothing to gain by forming a committee, while with private values, member B gains control of the dimension that is of interest to him by joining the committee, whereas he had no control before.

5.2 Committee management

In settings with both complete or asymmetric information where members have the same bias α and the same search cost, we have shown that members’ utilities decrease in the degree of conflict. If members are heterogeneous in bias and search cost, it is not necessarily true that a dictator is always better off by inviting a more moderate member because a member with more extreme preferences is more motivated to maintain a high acceptance standard despite a high search cost. This can sometimes be beneficial through the higher quality of the taken decision. Here is an example under specialization.

EXAMPLE 1. Suppose that the dictator A with preference $\alpha x_A + (1 - \alpha)x_B$, $\alpha \geq \frac{1}{2}$, invites member B with preference $(1 - \beta)x_A + \beta x_B$, $\beta \geq \frac{1}{2}$, to join the committee. Suppose F is uniform on $[0, 1]$ and that $c_B = 8c_A = 8c$. The equilibrium cutoffs x_A^* and x_B^* are given by $x_A^* = 1 - (1/(2\alpha))\sqrt[3]{2\alpha\beta c}$ and $x_B^* = 1 - (4/\beta)\sqrt[3]{2\alpha\beta c}$. Member A ’s payoff is $v_A = 1 - (\frac{1}{2} + 2(1 - \alpha)/\beta)\sqrt[3]{2\alpha\beta c}$, which is strictly increasing in β , as long as $8(1 - \alpha) > \beta$. Note that $\beta \geq \frac{1}{2}$ and that member B is more extreme when β is higher. Therefore, as long as the dictator’s preference is not too extreme, he is better off by inviting a more extreme member B . $\diamond$

Similarly, it is not always better to invite agents with low search cost to join the committee. Suppose that member A has the option to choose his committee colleague among several candidates. Suppose also that all candidates to join him have the same preference with $\alpha = \beta$, but have a different search cost c_B . Should A choose a colleague with a high or a low search cost? A general rule is that the cost has to be moderate. If it is too high (low), then member B may set a too low (high) standard.²³

²³A precise answer is distribution-specific. For example, in the exponential distribution case, it is never optimal for A to choose anyone with a higher cost than himself, because then B will become the dictator.

Finally note that a more flexible communication structure within a committee allows both an increase in the dictator's payoff and, sometimes, a Pareto improvement over unanimity. Suppose that dictator A can consult with member B before making a decision, without giving B veto power.²⁴ For simplicity, assume that member B can send either a "yes" or a "no" message to member A and let y_B denote member B 's cutoff for sending the message "yes." Member A then uses two cutoffs: x_A^1 when member B says "yes" and x_A^0 when member B says "no." Member A can implement the outcome of unanimity by setting $x_A^1 = x^*$ (his equilibrium cutoff under unanimity) and $x_A^0 = \bar{\theta}$ (the upper bound of the attribute's support), because the best response for member B is then to set $x_B = x^*$, his own equilibrium cutoff under unanimity. Therefore, by optimizing the two cutoffs x_A^1 and x_A^0 , A can do even better and, depending on the parameters, even member B can be made better off.

6. CONCLUDING REMARKS

We have studied a relatively rich model for the analysis of committee search conducted by generalists or by specialized, privately informed members with heterogeneous preferences defined on a multidimensional alternative space. The model generates implications that could, in principle, be tested in the field or in the laboratory. For instance, the model predicts that as the degree of conflict within committees increases, the acceptance standards move in opposite directions for generalist and specialist committees, but the members' welfare in both settings decreases.

We see several avenues for future research: (i) consider committees where some members are specialized, while some are generalists; (ii) consider different aggregation rules, e.g., decisions by a qualified majority; (iii) endogenize the choice of information acquisition/specialization; (iv) consider a model where the specialization bias is also private information.

APPENDIX

PROOF OF PROPOSITION 1. The *asymmetric* information equilibrium condition

$$\frac{c}{\prod_k [1 - F_k(x_k^*)]} = \alpha E[X_i - x_i^* | X_i \geq x_i^*]$$

can be rewritten as

$$\frac{c/\alpha}{\prod_k [1 - F_k(x_k^*)]} = E[X_i - x_i^* | X_i \geq x_i^*].$$

Then the set of equilibrium conditions coincides with that in the *complete* information setting where the only payoff relevant attribute information for member i is X_i (i.e., private values, $\alpha = 1$) and where the search cost is given by $\kappa = c/\alpha$. Therefore, it is enough

It is also not useful for A to choose a member B with a cost lower than himself, because then the choice of B does not matter. Thus, if it is optimal for a dictator to form a committee, he should choose someone with the same search cost as his own.

²⁴This seems to be the modus operandi of most scientific journals: experts are consulted but the decision is taken by an editor.

to establish the existence and uniqueness of the solution for the system of n equations that determine the optimal cutoffs in the complete information case with private values. This is shown in [Ferguson \(2005\)](#). For completeness and to explain the role of DMRL, we reproduce the simple proof below.

Let us define

$$\bar{\rho} \equiv \frac{\alpha}{c} \max_i E[X_i]$$

and

$$\underline{\rho} = \min_i \lim_{x_i \rightarrow \bar{\theta}} \frac{\alpha}{c} E[X_i - x_i | X_i \geq x_i].$$

Note that all threshold equilibria must satisfy the n equilibrium conditions (4). If $\bar{\rho} \leq 1$, then by the DMRL assumption, we must have $x_i^* \leq 0$ for all i . This means that we have a corner solution where the committee accepts any candidate: this is indeed an equilibrium and essentially unique. From now on, we assume $\bar{\rho} > 1$. The n equilibrium conditions imply that for all i and j ,

$$E[X_i - x_i^* | X_i \geq x_i^*] = E[X_j - x_j^* | X_j \geq x_j^*].$$

Since each F_i has strict DMRL, we can find, for each $\xi \in (\underline{\rho}, \bar{\rho})$, a unique vector $(x_1^*(\xi), \dots, x_n^*(\xi))$ (some entries could be negative) such that, for all i and j ,

$$E[X_i - x_i^*(\xi) | X_i \geq x_i^*(\xi)] = E[X_j - x_j^*(\xi) | X_j \geq x_j^*(\xi)] = \xi.$$

As ξ increases, $x_i^*(\xi)$ decreases strictly and continuously, until one or several of them reach the upper bound $\bar{\theta}$. At the same time, when ξ increases and $x_i^*(\xi)$ decreases, the function

$$\frac{1}{P(\xi)} \equiv \frac{1}{\prod_k [1 - F_k(x_k^*)]}$$

decreases strictly and continuously. Note that when $\xi = \underline{\rho}$,

$$\frac{1}{P(\underline{\rho})} = \frac{1}{(1 - F(\bar{\theta}))(1 - G(\bar{\theta}))} \rightarrow +\infty > \underline{\rho},$$

and when $\xi = \bar{\rho}$,

$$\frac{1}{P(\bar{\rho})} = 1 < \bar{\rho}.$$

Therefore, there exists a unique value $\xi_0 \in (\underline{\rho}, \bar{\rho})$ such that $\xi_0 = 1/P(\xi_0)$. Since each ξ corresponds to an essentially unique vector $(x_1^*(\xi), \dots, x_n^*(\xi))$, a cutoff equilibrium exists and is unique. $\square$

PROOF OF PROPOSITION 2. (i) *Complete information.*

Let v_i denote the continuation value of member i when she follows her optimal strategy given the equilibrium strategy of other members. Then we have

$$v_i = -c + \max_{z'} \{E[Z_i | Z_i \geq z', Z_j \geq z^* \text{ for all } j \neq i] \Pr(Z_i \geq z', Z_j \geq z^* \text{ for all } j \neq i) \\ + [1 - \Pr(Z_i \geq z', Z_j \geq z^* \text{ for all } j \neq i)]v\}.$$

In equilibrium, it must hold that $v_i = z^*$. By substituting z^* for v_i , we obtain the equilibrium condition

$$c = E[Z_i - z^* | Z_k \geq z^* \text{ for all } k] \Pr(Z_k \geq z^* \text{ for all } k).$$

It is clear that the right hand side is strictly decreasing in z^* . Therefore, there exists a unique z^* that satisfies the above equilibrium condition.

We now show that the equilibrium score z^* (and thus each member's expected utility) must be decreasing in α . To see this, note that in the symmetric setting, $X_i = X$ are independent and identically distributed. Hence, we obtain

$$\begin{aligned} & E[Z_i - z^* | Z_k \geq z^* \text{ for all } k] \Pr(Z_k \geq z^* \text{ for all } k) \\ &= E \left[\left(\alpha X_i + (1 - \alpha) \frac{1}{n-1} \sum_{j \neq i} X_j - z^* \right) \cdot \mathbf{1}_{\{\alpha X_k + ((1-\alpha)/(n-1)) \sum_{j \neq k} X_j \geq z^*, \forall k\}} \right] \\ &= \frac{1}{n} E \left[\left(\alpha \sum_i X_i + \frac{1-\alpha}{n-1} \sum_i \left\{ \sum_j X_j - X_i \right\} - n z^* \right) \right. \\ &\quad \left. \cdot \mathbf{1}_{\{\alpha X_k + ((1-\alpha)/(n-1)) \sum_{j \neq k} X_j \geq z^*, \forall k\}} \right] \\ &= \frac{1}{n} E \left[\left(\alpha \sum_i X_i + (1 - \alpha) \sum_j X_j - n z^* \right) \cdot \mathbf{1}_{\{\alpha X_k + ((1-\alpha)/(n-1)) \sum_{j \neq k} X_j \geq z^*, \forall k\}} \right] \\ &= \frac{1}{n} E \left[\left(\sum_i X_i - n z^* \right) \cdot \mathbf{1}_{\{\alpha X_k + ((1-\alpha)/(n-1)) \sum_{j \neq k} X_j \geq z^*, \forall k\}} \right]. \end{aligned}$$

Thus, the equilibrium condition can be rewritten as

$$E \left[\left(\frac{1}{n} \sum_i X_i - z^* \right) \cdot \mathbf{1}_{\{\alpha X_k + (1-\alpha)(1/(n-1)) \sum_{j \neq k} X_j \geq z^*, \forall k\}} \right] = c. \quad (5)$$

Observe that expectation is Schur-concave in

$$\left(\alpha, (1 - \alpha) \frac{1}{n-1}, (1 - \alpha) \frac{1}{n-1}, \dots, (1 - \alpha) \frac{1}{n-1} \right),$$

because the indicator function is Schur-concave, and because the function $(1/n) \sum_i X_i - z^*$ does not depend on α and is positive whenever the indicator function is not equal to

zero. Thus, the left hand side decreases with α . Since it also decreases with z^* , we obtain that the equilibrium score z^* decreases in α .

(ii) *Asymmetric information.*

Recall that with $F_i = F$, the equilibrium condition becomes

$$c = \alpha[1 - F(x^*)]^n E[X_i - x^* | X_i \geq x^*],$$

which is increasing in α but decreasing in x^* . Therefore, there exists a unique x^* that satisfies the equilibrium condition, and the equilibrium cutoff x^* is increasing in α .

It remains to show that members' expected utilities are decreasing in α . It follows from (3) that the utility for member i is given by

$$v_i = E[X_i | X_i \geq x^*] - \frac{c}{[1 - F(x^*)]^n} = \frac{[1 - F(x^*)]^{n-1} \int_{x^*}^{\bar{\theta}} sf(s) ds - c}{[1 - F(x^*)]^n}.$$

Therefore, v_i can be written as $v_i(x^*)$, a function of x^* only. Since x^* strictly increases in α , to show that v_i is strictly decreasing in α , it is sufficient to show that $v_i(x^*)$ is strictly decreasing in x^* . Note that

$$\begin{aligned} v'_i(x^*) &= \frac{nf(x^*)}{[1 - F(x^*)]^{n+1}} \left\{ [1 - F(x^*)]^{n-1} \int_{x^*}^{\bar{\theta}} sf(s) ds - c \right\} \\ &\quad + \frac{1}{[1 - F(x^*)]^n} \left\{ -(n-1)[1 - F(x^*)]^{n-2} f(x^*) \int_{x^*}^{\bar{\theta}} sf(s) ds \right. \\ &\quad \left. - [1 - F(x^*)]^{n-1} x^* f(x^*) \right\} \\ &= \frac{f(x^*)}{1 - F(x^*)} \left\{ \frac{\int_{x^*}^{\bar{\theta}} sf(s) ds}{1 - F(x^*)} - x^* - \frac{nc}{[1 - F(x^*)]^n} \right\} \\ &= \frac{f(x^*)}{1 - F(x^*)} \left\{ E[X - x^* | X \geq x^*] - \frac{nc}{[1 - F(x^*)]^n} \right\} \\ &= \frac{f(x^*)}{1 - F(x^*)} \{ E[X - x^* | X \geq x^*] - n\alpha E[X - x^* | X \geq x^*] \} \\ &= \frac{f(x^*)}{1 - F(x^*)} (1 - n\alpha) E[X - x^* | X \geq x^*] < 0 \end{aligned}$$

for all $\alpha > 1/n$. Therefore, members' utilities are strictly decreasing in α . $\square$

PROOF OF PROPOSITION 3. Recall that the equilibrium condition is given by (2):

$$\frac{c}{\prod_k [1 - F_k(x_k^*)]} = \alpha E[X_i - x_i^* | X_i \geq x_i].$$

We know that for all $j \neq i$,

$$\frac{c}{\prod_k [1 - F_k(x_k^*)]} = \alpha E[X_i - x_i^* | X_i \geq x_i] = \alpha E[X_j - x_j^* | X_j \geq x_j].$$

By $X_j \leq_{\text{MRL}} X_i$, we obtain that

$$\forall x, \quad E[X_j - x | X_j \geq x] \leq E[X_i - x | X_i \geq x].$$

Together with DMRL, this implies $x_j^* \leq x_i^*$. From

$$\begin{aligned} v_i &= \alpha x_i^* + (1 - \alpha) \frac{1}{n-1} \sum_{j \neq i} E[X_j | X_j \geq x_j^*] \\ &= \alpha x_i^* + (1 - \alpha) \frac{1}{n-1} \left(\sum_k E[X_k | X_k \geq x_k^*] - E[X_i | X_i \geq x_i^*] \right), \end{aligned}$$

we obtain

$$v_i - v_j = \alpha(x_i^* - x_j^*) + (1 - \alpha) \frac{1}{n-1} \{E[X_j | X_j \geq x_j^*] - E[X_i | X_i \geq x_i^*]\}.$$

We also know from (3) that

$$v_i = \alpha E[X_i | X_i \geq x_i^*] + (1 - \alpha) \frac{1}{n-1} \sum_{j \neq i} E[X_j | X_j \geq x_j^*] - \frac{c}{\prod_j [1 - F_j(x_j^*)]}$$

so that

$$v_i - v_j = \left[\alpha - (1 - \alpha) \frac{1}{n-1} \right] \{E[X_i | X_i \geq x_i^*] - E[X_j | X_j \geq x_j^*]\}.$$

From the two representations of $(v_i - v_j)$ above and from $x_j^* \leq x_i^*$ we obtain

$$E[X_i | X_i \geq x_i^*] - E[X_j | X_j \geq x_j^*] = x_i^* - x_j^* \geq 0.$$

Because $\alpha \geq 1/n$, we obtain

$$v_i - v_j = \left[\alpha - (1 - \alpha) \frac{1}{n-1} \right] (E[X_i | X_i \geq x_i^*] - E[X_j | X_j \geq x_j^*]) \geq 0$$

as desired. □

PROOF OF PROPOSITION 4. Recall that $\tilde{X} \leq_{\text{HR}} X$ implies both $\tilde{X} \leq_{\text{MRL}} X$ and $\tilde{X} \leq_{\text{ST}} X$. Let F ($\tilde{F}$) denote the distribution of X ($\tilde{X}$). We first show that $x^* \geq \tilde{x}^*$. Suppose the opposite is true. Then from the equilibrium conditions we have

$$\begin{aligned} \frac{c}{[1 - F(x^*)]^n} &= \alpha E[X - x^* | X \geq x^*] \\ &\geq \alpha E[X - \tilde{x}^* | X \geq \tilde{x}^*] \\ &\geq \alpha E[\tilde{X} - \tilde{x}^* | \tilde{X} \geq \tilde{x}^*] \\ &= \frac{c}{[1 - \tilde{F}(\tilde{x}^*)]^n}. \end{aligned}$$

The two inequalities follow from the DMRL assumption on X and from the assumption $\tilde{X} \leq_{\text{MRL}} X$, respectively. Therefore, we must have $F(x^*) \geq \tilde{F}(\tilde{x}^*)$. Since $\tilde{X} \leq_{\text{ST}} X$, we also have $F(x^*) \geq \tilde{F}(\tilde{x}^*) \geq F(\tilde{x}^*)$, which implies that $x^* \geq \tilde{x}^*$, a contradiction.

In equilibrium we also have

$$\begin{aligned} v_i &= \alpha x^* + (1 - \alpha) \frac{1}{n-1} \sum_{j \neq i} E[X_j | X_j \geq x^*] \\ &\geq \alpha \tilde{x}^* + (1 - \alpha) \frac{1}{n-1} \sum_{j \neq i} E[X_j | X_j \geq \tilde{x}^*] \\ &\geq \alpha \tilde{x}^* + (1 - \alpha) \frac{1}{n-1} \sum_{j \neq i} E[\tilde{X}_j | \tilde{X}_j \geq \tilde{x}^*] \\ &= \tilde{v}_i. \end{aligned}$$

The first inequality follows because v_i is increasing in x^* , while the second inequality follows by recalling that $\tilde{X} \leq_{\text{HR}} X$ implies $[\tilde{X} | \tilde{X} \geq \tilde{x}^*] \leq_{\text{ST}} [X | X \geq \tilde{x}^*]$. $\square$

PROOF OF PROPOSITION 5. Let x_D denote the cutoff employed by the specialist dictator A . This cutoff is determined by the Bellman equation

$$v_A^D = -c_A + \max_{x_D} \{E[\alpha X_A + (1 - \alpha)X_B | X_A \geq x_D] \Pr(X_A \geq x_D) + [1 - \Pr(X_A \geq x_D)]v_D\}.$$

The first-order condition for x_D implies that

$$v_A^D = \alpha x_D + (1 - \alpha)E[X],$$

where x_D is determined by the equilibrium condition

$$\alpha E[X - x_D | X \geq x_D][1 - F(x_D)] = c.$$

It is easy to see that the acceptance cutoff x_D is unique. Member B 's payoff under dictatorship is given by

$$v_B = \alpha E[X] + (1 - \alpha)E[X | X \geq x_D].$$

The above expression assumes that member B can free ride on A 's decision without paying any search cost. Our conclusion about the value of forming committees under specialization gains extra support if B also incurs some extra cost (of waiting, say) while being outside the committee.

If A invites member B to join a committee that employs the unanimity rule, then their payoffs in this symmetric setting are given by

$$v_A^U = v_B^U = \alpha x^* + (1 - \alpha)E[X | X \geq x^*],$$

where the cutoff x^* is determined by

$$\alpha E[X - x^* | X \geq x^*][1 - F(x^*)]^2 = c.$$

The fact that $x_D > x^*$ follows immediately from the respective equilibrium conditions, the DMRL property, and the fact that $1/(1 - F(x)) \leq 1/(1 - F(x))^2$. Concerning search duration, we have

$$\frac{1}{1 - F(x_D)} = \frac{\alpha}{c} E[X - x_D | X \geq x_D] < \frac{\alpha}{c} E[X - x^* | X \geq x^*] = \frac{1}{[1 - F(x^*)]^2},$$

where the inequality follows from our DMRL assumption and $x_D > x^*$.

For the second part, observe that the difference $(x_D - x^*)$ tends to zero as c goes to zero, since both tend to the upper boundary of the attributes' support. As c tends to zero, the dictator's expected gain from forming a committee is

$$\begin{aligned} \lim_{c \rightarrow 0} (v_A^U - v_A^D) &= \lim_{c \rightarrow 0} [(1 - \alpha)(E[X | X \geq x^*] - E[X]) - \alpha(x_D - x^*)] \\ &= (1 - \alpha) \lim_{c \rightarrow 0} (E[X | X \geq x^*] - E[X]) = (1 - \alpha)(\bar{\theta} - E[X]) > 0. \end{aligned}$$

Similarly, member B 's expected gain from joining the committee is

$$\begin{aligned} \lim_{c \rightarrow 0} (v_B - v_B^D) &= \lim_{c \rightarrow 0} (\alpha x^* + (1 - \alpha)E[X | X \geq x^*] - \alpha E[X] - (1 - \alpha)E[X | X \geq x_D]) \\ &= \lim_{c \rightarrow 0} (\alpha(x^* - E[X]) + (1 - \alpha)(E[X | X \geq x^*] - E[X | X \geq x_D])) \\ &= \alpha(\bar{\theta} - E[X]) > 0. \end{aligned}$$

Therefore, as $c \rightarrow 0$, both members gain from forming a committee. It is clear by the above expressions, and by continuity, that both benefits are positive for any sufficiently small c . $\square$

REFERENCES

- Albrecht, James, Axel Anderson, and Susan Vroman (2010), "Search by committee." *Journal of Economic Theory*, 145, 1386–1407. [753, 755, 759, 764]
- Alpern, Steve and Shmuel Gal (2009), "Analysis and design of selection committees: A game theoretic secretary problem." *International Journal of Game Theory*, 38, 377–394. [755]
- Alpern, Steve, Shmuel Gal, and Eilon Solan (2010), "A sequential selection game with vetoes." *Games and Economic Behavior*, 68, 1–14. [755]
- Caillaud, Bernard and Jean Tirole (2007), "Consensus building: How to persuade a group." *American Economic Review*, 97, 1877–1900. [755]
- Chan, Jimmy and Wing Suen (2011), "Does simple majority rule produce hasty decisions?" Unpublished paper. [756]
- Chow, Y. S., Herbert Robbins, and David Siegmund (1971), *Great Expectations: The Theory of Optimal Stopping*. Houghton-Mifflin, Boston. [753]

Compte, Olinier and Philippe Jehiel (2010a), “Bargaining and majority rules: A collective search perspective.” *Journal of Political Economy*, 118, 189–221. [753, 755]

Compte, Olinier and Philippe Jehiel (2010b), “On the optimal majority rule.” Unpublished paper. [755]

Damiano, Ettore, Hao Li, and Wing Suen (2009), “Delay in strategic information aggregation.” Unpublished paper. [756]

Farrell, Joseph and Garth Saloner (1988), “Coordination through committees and markets.” *RAND Journal of Economics*, 19, 235–252. [753]

Ferguson, Thomas S. (2005), “Selection by committee.” In *Advances in Dynamic Games* (Andrzej S. Nowak and Krzysztof Szajowski, eds.), 203–209, Birkhäuser, Basel. [755, 759, 767]

Gilligan, Thomas W. and Keith Krehbiel (1989), “Asymmetric information and legislative rules with a heterogeneous committee.” *American Journal of Political Science*, 33, 459–490. [756]

Goeree, Jacob K. and Leeat Yariv (2011), “An experimental study of collective deliberation.” *Econometrica*, 79, 893–921. [756]

Grüner, Hans Peter and Alexandra Kiel (2004), “Collective decisions with interdependent valuations.” *European Economic Review*, 48, 1147–1168. [752, 755]

Guess, Frank and Frank Proschan (1988), “Mean residual life: Theory and applications.” In *Handbook of Statistics*, Vol. 7 (P. R. Krishnaiah and C. R. Rao, eds.), 215–224, North-Holland, New York. [758]

Hardy, G. H. (1940), *A Mathematician's Apology*. Cambridge University Press, Cambridge. [752]

Keeney, Ralph L. and Howard Raiffa (1976), *Decisions With Multiple Objectives*. Wiley, New York. [753]

Kurano, Masami, Masami Yasuda, and Junichi Nakagami (1980), “Multi-variate stopping problem with a majority rule.” *Journal of the Operations Research Society of Japan*, 23, 205–223. [755]

Li, Hao, Sherwin Rosen, and Wing Suen (2001), “Conflicts and common interests in committees.” *American Economic Review*, 91, 1478–1497. [756]

Li, Hao and Wing Suen (2009), “Decision-making in committees.” *Canadian Journal of Economics*, 42, 359–392. [755]

Lizzeri, Alessandro and Leeat Yariv (2010), “Sequential deliberation.” Unpublished paper. [755]

Lowe, Julia, Paula Candlish, David Henry, John Wlodarczyk, and Peter Fletcher (2000), “Specialist or generalist care? A study of the impact of selective admitting policy for patients with cardiac failure.” *International Journal for Quality in Health Care*, 12, 339–345. [752]

Marshall, Albert W. and Ingram Olkin (1979), *Inequalities*. Academic Press, New York. [753]

Marshall, Albert W. and Frank Proschan (1965), “An inequality for convex functions involving majorization.” *Journal of Mathematical Analysis and Applications*, 12, 87–90. [761]

Meyer, Margaret and Bruno Strulovici (2012), “The stochastic supermodular ordering.” Unpublished paper. [761]

Moldovanu, Benny and Xianwen Shi (2011), “Search committees.” Unpublished paper. [759, 761, 763]

Sakaguchi, Minoru (1973), “Optimal stopping in sampling from a bivariate distribution.” *Journal of the Operations Research Society of Japan*, 16, 186–200. [755]

Schriever, B. F. (1987), “An ordering for positive dependence.” *Annals of Statistics*, 15, 1208–1214. [761]

Shaked, Moshe and J. George Shanthikumar (2007), *Stochastic Orders*. Springer, New York. [753, 763]

Strulovici, Bruno (2010), “Learning while voting: Determinants of collective experimentation.” *Econometrica*, 78, 933–971. [756]

Weisz, George (2006), *Divide and Conquer: A Comparative History of Medical Specialization*. Oxford University Press, New York. [752]

Wilson, Charles A. (2001), “Mediation and the Nash bargaining solution.” *Review of Economic Design*, 6, 353–370. [755]

Yasuda, Masami, Junichi Nakagami, and Masami Kurano (1982), “Multi-variate stopping problems with a monotone rule.” *Journal of the Operations Research Society of Japan*, 25, 334–350. [755, 759]

Yildirim, Huseyin (2012), “Time consistent majority rules with interdependent valuations.” Unpublished paper. [755]