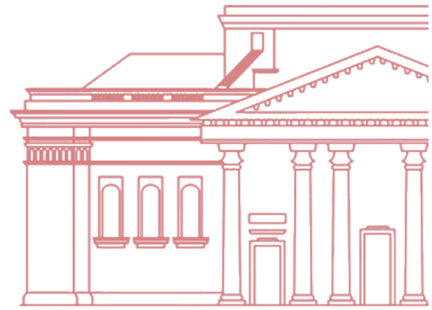
CENTRE DE RECHERCHES EN ÉCONOMIE ET DROIT
Paris Center for Law and Economics



CRED WORKING PAPER N^o 2019-10

Arbitration: Committee preferences and information acquisition

Malin Arve* and Claudine Desrieux†

*NHH Norwegian School of Economics. E-mail: malin.arve@nhh.no.
†CRED, University Paris 2. E-mail: claudine.desrieux@u-paris2.fr.

Abstract

We model arbitral committees whose task is to solve a conflict between two disputants. The correct decision depends on the state of the world that is imperfectly known. Committee members can make an effort to learn about the true state of the world. We compare committees made up neutral arbitrators (neutral committees) to committees including biased arbitrators (polarized committees). We show that polarized committees may be more efficient than neutral committees whose members' efforts are complements. Our results have implications for the procedural rules governing the appointment of arbitrators.

1 Introduction

Whether in international commercial contracts, foreign direct investments or labor management disputes, arbitration has become an often-used method of dispute resolution. Instead of going to courts, the conflict opposing two parties is submitted to an arbitral tribunal whose final decision is binding. Most of the time, arbitral tribunals are made up of three arbitrators, even if rules governing institutional arbitration simply require an odd number of arbitrators.[1,2] Arbitration allows experts to act as judges, ensures confidentiality about decisions, and has also been argued to be more flexible and faster than litigation (Blackaby, 2015). A key characteristic is also the arbitrators' appointment principle. Under a three-arbitrator panel, each party appoints one arbitrator and the third member, who serves as President, is decided by mutual agreement or by the appointed co-arbitrators. International conventions generally mention that all arbitrators must be independent and free of conflict of interest[3], but the temptation is high for any party to look for a supporter of one's situation rather than a neutral arbitrator. In this paper, our goal is to determine whether the presence of pro-appointer arbitrators impacts the efficiency of the dispute resolution and, if so, in what way. To address this issue, we compare the efficiency of three-arbitrator committees when they include pro-appointer arbitrators or only neutral arbitrators. We also generalize our analysis to any committee size, discuss the optimal size of such committees and argue that three-member committees are indeed optimal.

Statistics from the International Court of Arbitration of the International Chamber of

[1]Two types of arbitrations are usually distinguished: *institutional* arbitration and *ad hoc* arbitration. In the former case, an institution administers the arbitration process through a set of rules. Some common institutions are the London Court of Institutional Arbitration (LCIA), the International Chamber of Commerce (ICC), the Institutional Center for Settlement of Investment Disputes (ICSID). In the latter case (*ad hoc* arbitration), there is no institution administering the procedure and parties have to determine all aspects of the arbitration themselves. A study (Queen Mary University, 2008) summarizing data from 82 questionnaires and 47 interviews states that 86% of awards in international arbitrations that were rendered over the last ten years were under the rules of an arbitral institution, while 14% were under ad hoc arbitrations.

[2]If parties disagree on the number of arbitrators, the default rule is generally three arbitrators. As an illustration, Article 37 of the ICSID convention states that "The Tribunal shall consist of a sole arbitrator or any uneven number of arbitrators appointed as the parties shall agree (...) Where the parties do not agree upon the number of arbitrators and the method of their appointment, the Tribunal shall consist of three arbitrators, one arbitrator appointed by each party and the third, who shall be the president of the Tribunal, appointed by agreement of the parties." Other institutions as LCIA or ICC require either one or three arbitrators.

[3]As an example, the article 14(1) of the ICSID (International Centre for Investment Dispute) Convention stipulates that all arbitrators must be "persons of high moral character and recognized competence in the fields of law, commerce, industry, finance, who may be relied upon to exercise independent judgment.

Commerce (ICC), one of the most popular arbitral institution, show that 930 arbitrators among the 1,301 arbitrators appointed in ICC arbitrations were selected by the parties (Brekoulakis, 2013). Only if parties fail to agree on the composition of the arbitral committee, the institution administering the arbitration procedure takes this right away and appoints the arbitrators (Blackaby, 2015).[4] Yet, the right of the parties to participate in the constitution of arbitral tribunals is considered by many legal scholars as "the very essence of arbitration" (Rau, 1997).[5] Moreover, having the right to choose the panel composition does not mean that biased arbitrators should be designated. Several recent examples illustrate this point: IMF Chief Christine Lagarde was recently accused of negligence in overseeing an arbitration case with an impartial arbitrator[6], and in the United Kingdom, the High Court has removed an arbitrator from a construction dispute in April 2016 (*Cofely Ltd v Bingham and Knowles Ltd*), because he may have been biased towards one of the parties involved. More broadly, arbitrators should have no significant financial or personal interest in one of the parties, or the outcome of the case.[7] Yet, as one practitioner puts it: "*in selecting his party appointed arbitrator, [the counsel's] choice will be guided not primarily by an interest in finding a strictly impartial or neutral individual, but by the hope of employing one with qualities which tend to give him and his client the greatest assurance that their viewpoint will be understood, appreciated and, ultimately will prevail (...) strictly neutral panels are not what the disputants seek*".[8]

[4]Blackaby (2015) (p.142) state that the arbitrators' appointment by institutions is "a sensible solution to the problem of constituting an arbitral tribunal (...) However, there may be difficulties when it comes to obtaining recognition and enforcement of an award made by a tribunal that has been established for the parties, rather than by the parties. The New York Convention, in Article V(1) (d), states that recognition and enforcement of an award may be refused on proof that the composition of the arbitral authority or the arbitral procedure was not in accordance with the agreement of the parties, or, failing such agreement, was not in accordance with the law of the country where the arbitration took place."

[5]An arbitration clause that would provide that 'if a dispute arises, one party will appoint all members of the tribunal' would most likely be an invalid arbitration clause. In its decision dated of 7 January 1991 (*Dutco v. BKMI and Siemens*), the French *Cour de Cassation* relies on the principle of equality of the parties in the appointment of arbitrators [which] is a matter of public policy."

[6]In this case, Bernard Tapie, a French tycoon, was awarded in 2008 more than 400 million euros to settle a dispute with the partly state-owned bank *Credit Lyonnais*. A scandal emerged as one of the arbitrator, a former senior French Judge, was said to have ties with Mr Tapie's lawyer. Mrs Lagarde was charged with negligence for allowing the arbitration and for declining to appeal the verdict. In December 2016, a special French court found Lagarde guilty of negligence but not for allowing the arbitration in the first place.

[7]See the *IBA (International Bar Association) Guidelines on Conflicts of Interest in International Arbitration* (October 2014) for lists of specific situations indicating whether they warrant disclosure or disqualification of an arbitrator.

[8]"Effective Selection of International Arbitrators in International Arbitration", James Wangelin, Mealey's International Arbitration Report, November 1999.

In our model, we assume that arbitrators can be either neutral or in favor of one party. Political scientists and legal scholars have presented justifications for both of these two assumptions: On the one hand, arbitrators are a close-knit community. Professional barriers to entry (notably the requirement of legal experience) and institutional codes of ethics regulate the conduct of individual arbitrators. On the other hand, because arbitrators compete for re-appointment, pro-appointer bias may develop hoping for future nominations. Some arbitrators may also have the mistaken belief that they have an obligation to the party that appointed them. To avoid - or at least limit - these situations, some legal scholars even suggest that an external authority could be in charge of arbitrators' appointment instead of the parties (Martinez, 2012; Brekoulakis, 2013). Beyond confirming that parties seem to have a preference for arbitrators that have previously favored their side (Bloom and Cavanagh, 1986) and that judges may favor whomever appointed them (Posner and de Figueiredo, 2005; Donaubauer et al, 2018), surprisingly little has been done in the economic literature to contribute to this question.[9] Our paper fills this gap by exploring how incentives to search for truth are influenced by the appointment of neutral or pro-appointer arbitrators.

We consider arbitration committees whose goal is to solve a dispute between two parties.[10] The correct decision depends on the realized state of the world that is imperfectly known to the committee members. However, the committee members receive a signal correlated with the true state of the world, and whose quality is increasing with a costly effort: a higher level of effort implies a higher correlation between the true state of the world and the signal.

We consider two types of committees, polarized and neutral committees. For a three-member committee, a polarized committee means that each party to the conflict appoints an arbitrator defending its own interest whatever the state of the world.[11] The third member of the committee is neutral and prefers the *correct* decision, i.e., wants to match the decision with the realized state of the world. In reality, this implies that he represents the *pivotal* member of the committee that in practice takes the final decision. On the opposite, a neutral three-member committee is made up of three members looking for a

[9] A notable exception is Ashenfelter (1987) that show how arbitrators are exchangeable in the decision-making process. Something that is partially confirmed in our more strategic setting.

[10] As mentioned above, some institutions allow for an odd number of arbitrators. We demonstrate in our model that three-arbitrator panels are more efficient. This is consistent with observed practices as most of arbitral committees gather three arbitrators.

[11] In an extension to our basic model (section 4.2), we relax this assumption to consider arbitrators with *mixed preferences*, i.e. caring for both their appointer's viewpoint and truth.

fair decision, i.e. they all want to match the decision with the true state of the world. We then explore the behavior of each member regarding the effort to learn about the true state of the world, when the efforts can be either complements or substitutes.
Our results show that all members exert efforts in neutral committees. In polarized committees, only one member (the neutral one) exerts effort and the two biased members do not exert any effort. When efforts are substitutes, neutral committees perform better in terms of matching the decision with the true state of the world. There is a positive externality between the members' efforts which enhances the incentives to efforts in neutral committees. This effect does not appear in polarized committee since only one member exerts effort. Yet, when efforts are complements, there is a negative externality (caused by free-riding) between the members' efforts. Polarized committees then perform better because they do not suffer from a free-riding effect as in neutral committees. This holds regardless of the committee size. This results is an important contribution to current discussions on the procedures governing arbitrators' appointment.

This paper is related to several strands of the economic literature. First, many papers have investigated collective decision making in committees using game theoretic settings.[12] Based on the seminal work of Condorcet (1785) showing that when voters are more likely than not to know the true state of the world, large electorates will choose the right decision under majority voting, the modern literature has investigated problems of optimal decision rule (Levy, 2007), strategic voting (Austen, 1996; Feddersen and Pesendorfer, 1996, 1999), incentives for costly information acquisition (Dewatripont and Tirole, 1999; Martinelli, 2006; Mukhopadhaya, 2003; Persico, 2004; Gershkov and Szentes, 2009), conflicting interests (Feddersen and Pesendorfer (1997); Gerardi (2000); Gerardi and Yariv (2008); Gruner and Kiel (2004); Li (2001)), jury's size (Feddersen and Pesendorfer, 1998; Cai, 2009), and communication (Doraszelski et al., 2003; Gerardi and Yariv, 2007; Schulte, 2012). We build on this literature, and especially on Feddersen and Pesendorfer (1998) and Schulte (2010), to model how committee members decide when information is imperfect. We also extend the literature on incentives for information acquisition to common signals and strategic interaction in the collective information gathering process. We thereby identify a new free-riding problem that is different from the ones identified in for instance Li (2001) and Mukhopadhaya (2003). Li (2001) focus on free-riding in private information gathering and how to design a rule that gives incentives to gather information. Mukhopadhaya (2003) studies a jury's incentives to pay attention

[12] See Gerling et al. (1997) for a survey.

to publicly provided information and juror's incentives to free-ride on others jurors' as well as the implications that this has on the optimal size of a jury.

Another part of the literature has been dedicated to the study of alternative dispute resolution. Some papers have compared arbitration and mediation (Goltsman et al., 2009; Horner et al., 2015). The comparison between the various types of arbitration (i.e. Final Offer Arbitration or conventional Arbitration) has also drawn some attention (Crawford, 1979; Farmer and Pecorino, 1998, 2003; Olszewski, 2011). While our focus is also on arbitration, we depart from this literature by exploring the specific issue of arbitrators' appointment. We consider arbitrator committees whose composition may diverge: the members can be either neutral, or some of them might be polarized.

The empirical literature gives us some evidence to justify the partiality of arbitrators. Puig and Strezhnev (2017) show that the nationality of the presiding member or its professional background may significantly impact the decision. Repeated appointments of arbitrators may also influence their behavior (Bloom and Cavanagh, 1986; Waibel and Wu, 2017; Van Harten, 2007). However, empirical evidence is mixed as other works show no significant correlations between those factors and the decisions made in arbitration cases (Frank, 2009; Kapeliuk, 2010; Schneiderman, 2010). This gives empirical support to both of our assumptions (neutral and biased arbitrators). Our theoretical model sheds new light on this literature by exploring the consequence of polarized and neutral committees on dispute resolution.

Our paper is organized as follows. Section 2 describes our model. Section 3 yields our main results. It established the committee members' incentives to make effort under polarized committees and neutral committees and compares these outcomes. Section 4 introduces heterogenous contributions of arbitrators, and explores mixed preferences of arbitrators who are allowed to care for both their appointer's viewpoint and truth. It also addresses the question of committee size. Section 5 concludes.

2 The model

A conflict between two parties arises and the parties have chosen to resolve the issue using arbitration. Thus, a collective decision $x \in \{a, b\}$ has to be made by majority voting without abstension in an arbitration committee consisting of three members. A decision $x = a$ represents a decision in favor of party A and $x = b$ in favor of party B.[13]

[13] For instance, the conflict could be about which disputant will pay for accidental damages or it could involve the allocation of a valuable resource in a commercial dispute.

There are two possible states of nature, $\omega \in \{A, B\}$. In state $\omega = A$, party A is correct and in state $\omega = B$, party B is correct. There is uncertainty about the realization of the state of the world. Ex ante both states are equally likely.

Timing. The timing of the game is as follows:

1. Nature chooses the state of the world.

2. Each committee member i decides how much effort e_i to spend on obtaining more information about the state of the world.

3. The committee gets a signal which is correlated with the efforts made by the members. This signal is observed by all members.

4. Committee members vote for their preferred decision. The majority rule is applied to determine the final decision and payoffs are realized.

Information technology. We assume that using the information technology is costly. The information technology is such that each committee member can make a costly effort $e_i \geq 0$ to learn about the state of the world. The cost of effort for committee member i is $c(e_i) = \frac{e_i^2}{2}$, i.e. this cost is increasing and convex ($c'(e_i) \geq 0$ and $c''(e_i) > 0$).

Thanks to the committee members' efforts, the committee receives a signal $\sigma \in \{\alpha, \beta\}$, which is correlated with the true state of the world:

$$prob\{\sigma = \alpha | \omega = A\} = prop\{\sigma = \beta | \omega = B\} = q(e_1, e_2, e_3), \frac{1}{2} < q(e_1, e_2, e_3) < 1.$$

This means that the quality of the signal σ depends on the efforts made by the committee members, but the signal is always imperfectly informative about the state of the world. We assume that more effort implies a better signal in the sense that there is a higher correlation between the true state of the world and the signal: $q_{e_i}(e) \geq 0$ where $e \equiv (e_1, e_2, e_3)$.

More precisely, we will consider that the probability function can be represented by a CES production function with homogenous weights on the inputs (individual efforts e_1, e_2 and e_3).

$$q(e_1, e_2, e_3) = q_0 + A(ae_1^r + ae_2^r + ae_3^r)^{\frac{1}{r}}$$

where $a = \frac{1}{3}$, $r \in]-\infty, 1]$, $A > 0$ and $q_0 = \frac{1}{2}$. The variable a represents the weight of committee member i's effort in the probability to get an informative signal (and is generalized to heterogenous weights in section 4.1), and r represents the degree of complementarity/substitutability of efforts. We have chosen to work with this general function as it includes a whole range of degrees of substitution and complementarity within the same function. In fact, the function can be split into two regions:

- $r \in (0, 1)$: efforts are substitutes;
- $r < 0$: efforts are complements.

The CES function is not well-defined at $r = 0$. However as $r \to 0$, the function approaches a Cobb-Douglas function with constant returns to scale. In Appendix B we show that the results obtained under $r > 0$ also hold in this limit case.

The signal produced by this information technology is observed by the entire committee. However, if each member receives private signals but these are hard information, our model should work in the same way. There will be full information revelation in equilibrium as long as the preferences of each member are known: if one member would refuse to reveal his own signal, the others would know that the information is unfavourable to his favorite decision. This is the standard unravelling argument going back to Milgrom (1981) and Grossman (1981).

Preferences and committee types. Throughout the analysis we assume a certain degree of homogeneity in preferences, which ensures that the desirability of decision $x = a$ weakly increases in the probability that the state is $\omega = A$ for each agent. This is formally stated in the following Assumption.

Assumption 1.

$$u_i(a, A) + u_i(b, B) - u_i(a, B) - u_i(b, A) \geq 0, \forall i \in \{1, 2, 3\}.$$

We consider two types of committee members; neutral and polarized. A neutral committee member would prefer to match the decision to the true state of the world whereas a polarized committee member prefers a given decision x regardless of the state w. In its most simple form this implies that a neutral committee member i's preferences are defined as follows:

$$u_i(a, A) = u_i(b, B) = 1, \; u_i(a, B) = u_i(b, A) = 0.$$

A polarized committee member i's preferences depend on the direction of his bias. If he prefers decision $x = A$, his preferences can be written as:

$$u_i(a, A) = u_i(a, B) = 1,\ u_i(b, A) = u_i(b, B) = 0.$$

Symmetrically, if he prefers $x = b$ then the preferences are described as follows:

$$u_i(b, A) = u_i(b, B) = 1,\ u_i(a, A) = u_i(a, B) = 0.$$

We define a neutral committee as one with only neutral members. Similarly a polarized committee is one in which committee member 1 prefers to match the state w and the decision x, i.e., he prefers the "correct" decision and is neutral. However, committee member 2 always prefers $x = a$ regardless of the probability that A is the true state. Likewise, committee member 3 always prefers $x = b$. Preferences are common knowledge and we do not allow for transfer schemes.

In this model, it is only the difference between the utility from the two possible decisions in state w that matters and normalizing preferences to $\{0, 1\}$ is without loss of generality for neutral committee members. However, one could of course argue that biased arbitrators also, to some degree, value the truth. In Section 4.2, we extend our model to allow for such *mixed* preferences and show that our result still holds.

Equilibrium. Our equilibrium concept is subgame-perfect Nash equilibrium and we focus the analysis on pure strategies.

In the next section we analyze the outcome of the decision-making stage given a signal outcome. Then we determine the incentives of each arbitrator to make efforts in the two committee types and we finally deduce the signal's quality (i.e. the value of $q(e_1, e_2, e_3)$) to compare the efficiency of each type of committee.

3 Main result

3.1 Decision stage

Let q denote the probability that the committee assigns to the state of the world $\omega = A$ given the information available to them. A committee member i prefers the implementation of a rather than b if and only if

$$q > \frac{u_i(b,B) - u_i(a,B)}{u_i(a,A) + u_i(b,B) - u_i(a,B) - u_i(b,A)}.$$

Notice that even though the committee members have access to the same information and have the same beliefs about the state of the world, their threshold for preferring action $x = a$ varies across their preferences. This threshold above which committee member i prefers decision $x = a$ is called the *threshold of doubt* in the literature (Feddersen and Pesendorfer, 1998; Schulte, 2010).

Given Assumption 1, a threshold below 0 means that $u_i(b,B) - u_i(a,B) < 0$. In other words, the committee member i always prefers decision a regardless of whether the true state of the world is A or B. Symmetrically, a threshold above 1 means that committee member i always prefers decision b regardless of the true state of world. It is only when the threshold is between 0 and 1 that agent i is willing to make his decision (a or b) conditional on the probability that the true state of the world is A.

In a neutral committee, all members have the same threshold of doubt and the committee always agrees on what the best decision is. Following a signal $\sigma = \alpha$ decision $x = a$ is made unanimously and following $\sigma = \beta$ decision $x = b$ is chosen. This follows straightforwardly from the literature and is summarized in the following lemma.

Lemma 1. *Following a signal $\sigma \in \{\alpha, \beta\}$, a neutral committee unanimously votes for $x = a$ when $\sigma = \alpha$ and $x = b$ when $\sigma = \beta$.*

In a polarized committee, member 2 has a threshold of doubt below 0 and will always vote for decision $x = a$. Symmetrically, member 3 has a threshold of doubt above 1 and will always vote for decision $x = b$. Therefore, in a polarized committee's vote for what decision to choose, committee member 1 is always pivotal and determines the final outcome x after having observed the signal σ and updated his beliefs about the state of the world. If $\sigma = \alpha$, the decision will be $x = a$ as we are above member 1's threshold of doubt and $x = b$ will be voted if $\sigma = \beta$.

Lemma 2. *In a polarized committee, member 2 (resp. 3) votes for $x = a$ (resp. $x = b$) regardless of the signal realization σ. The neutral member 1 is always pivotal and votes for $x = a$ when $\sigma = \alpha$ and $x = b$ when $\sigma = \beta$.*

3.2 Information acquisition under neutral committees

In a neutral committee, each committee member chooses effort to maximize his expected utility:

$$\max_{e_i} \frac{1}{2}\left[q(e)u_i(a,A) + (1-q(e))u_i(b,A) + (1-q(e))u_i(a,B) + q(e)u_i(b,B)\right] - c(e_i)$$
$$\Leftrightarrow \max_{e_i} q(e) - c(e_i).$$

The first-order condition can be written as:

$$A[ae_i^r + ae_j^r + ae_k^r]^{\frac{1-r}{r}} = \frac{e_i^{2-r}}{a}. \tag{1}$$

Because of homogeneity in a, all members are identical (in terms of preferences and first-order conditions) and therefore exert effort $e_1 = e_2 = e_3 = e^N$. That is, at the equilibrium all committee members exert the same level of effort. Inserting this into equation (1) yields:

$$A[a(e^N)^r + a(e^N)^r + a(e^N)^r]^{\frac{1-r}{r}} = \frac{(e^N)^{2-r}}{a} \tag{2}$$
$$\Leftrightarrow \quad e^N = aA = \frac{A}{3}. \tag{3}$$

We can then derive the probability to get the correct signal in a neutral committee:

$$\begin{aligned} q^N(e^N, e^N, e^N) = & \quad q_0 + A(a(e^N)^r + a(e^N)^r + a(e^N)^r)^{\frac{1}{r}} \\ = & \quad q_0 + aA^2 = q_0 + \frac{A^2}{3}. \end{aligned} \tag{4}$$

These results are summarized in the following lemma.

Lemma 3. *In a neutral committee, all committee members exert the same level of effort. This effort level is given by (3) which implies that the probability of obtaining a correct signal is (4).*

3.3 Information acquisition under polarized committees

As described in Lemma 2, committee members 2 and 3 vote for the same candidate decision regardless of the outcome of the signal. It is therefore straightforward to conclude that they have no incentive to put effort into improving the signal (since $q(.)$ does not influence their expected utility). Formally, this is because for $i = 2, 3$, their choice solves

$$\begin{aligned}
&\max_{e_i} \frac{1}{2}\left[q(e)u_i(a,A) + (1-q(e))u_i(b,A) + (1-q(e))u_i(a,B) + q(e)u_i(b,B)\right] - c(e_i) \\
\Leftrightarrow &\max_{e_i} \frac{1}{2} - c(e_i).
\end{aligned}$$

We therefore have $e_2 = e_3 = 0$. This holds regardless of what level of effort is chosen by the other committee members.[14]

Committee member 1 makes his choice in order to maximize his own expected utility from the decision taking into account $e_2 = e_3 = 0$. Formally,

$$\begin{aligned}
&\max_{e_i} \frac{1}{2}\left[q(e)u_i(a,A) + (1-q(e))u_i(b,A) + (1-q(e))u_i(a,B) + q(e)u_i(b,B)\right] - c(e_i) \\
\Leftrightarrow &\max_{e_i} q(e) - c(e_i).
\end{aligned}$$

Taking the first-order condition implies that, in a polarized committee, committee member 1 chooses an effort level e_1^P that equalizes his marginal benefit from an improved signal and the marginal cost of effort $\frac{\partial q(e_1,e_2,e_3)}{\partial e_1} = c'(e_1)$.

This first-order condition writes:

$$\begin{aligned}
&A[ae_1^r]^{\frac{1-r}{r}} = \frac{e_1^{2-r}}{a} \\
\Leftrightarrow \quad &e_1^P = Aa^{1/r} = A(\tfrac{1}{3})^{1/r}. \qquad (5)
\end{aligned}$$

Replacing e_1, e_2 and e_3 by their values, the probability to get the correct signal under a polarized committee when the neutral committee member exert effort is then:

$$\begin{aligned}
q^P(e_1^P, 0, 0) = &\quad q_0 + A(a(e_1^P)^r)^{1/r} \\
= &\quad q_0 + A^2 a^{\frac{2}{r}} = q_0 + \frac{A^2}{3^{2/r}}. \qquad (6)
\end{aligned}$$

These results are summarized in the following lemma.

Lemma 4. *In a polarized committee, only the neutral member 1 exerts effort. His effort*

[14]Recall that we consider here positive efforts $e_i \geq 0$. A more general setting would allow for negative efforts that could be here strategies to reduce the quality of the signal. Such a generalization would not change our result. Since the two states of the world are both equally likely ex ante, the expected utility from effort of a biased member ($\frac{1}{2}$) is independent of the level of effort e_i. The biased members have then no incentive to make any type of effort.

level is given by (5) which implies that the probability of obtaining a correct signal is given by (6).

3.4 Comparison

Let us first compare the individual effort made by a neutral member in each type of committee. From the previous analysis, we can see that the individual effort of the neutral member is:

- higher under a neutral committee (compared to a polarized one) whenever $r \in (0, 1)$,
- lower under a neutral committee (compared to a polarized one) whenever $r < 0$.

In the case when efforts are substitutes ($r \in (0, 1)$), if one introduces more input factors, these will be substitutes in the signal-generating process. This increases the individual incentives to exert effort. The neutral committee member (member 1) exerts more effort when his peers also exert effort. There is then a *positive externality* from having active members in the committe (i.e., members making strictly positive efforts). With only one input factor (the polarized members never provide any effort), this positive effect disappears. It is therefore preferable to be in the case with three *active* committee members (i.e., the neutral committee). However, if $r < 0$, the efforts of the committee members are complements and one member's effort reduces the incentives of the other members. There is then a *negative externality* from having active members in the committee as this generates *free-riding* and lower incentives to make efforts. In this case, it is therefore better to have only one member exert effort: polarized committees perform better than neutral ones.

Technically this can be seen by comparing the marginal benefit in the two cases. Marginal benefit of an active member in a neutral committee being higher than in a polarized committee (for given values of e) is equivalent to

$$a^{\frac{1}{r}} A[e_i^r + e_j^r + e_k^r]^{\frac{1-r}{r}} e_i^{r-1} \geq a^{\frac{1}{r}} A[e_i^r]^{\frac{1-r}{r}} e_i^{r-1}. \tag{7}$$

It is straighforward to show that this is equivalent to

$$\frac{1-r}{r} \ln\left(\frac{e_i^r + e_j^r + e_k^r}{e_i^r}\right) \geq 0. \tag{8}$$

Since the last factor is always positive, we can conclude that the condition holds only for $r > 0$ and that in this case it always holds.

Even though the number of committee members exerting a non-zero level of effort varies across the two types of committees, the result on individual effort carries over to signal precision (as measured by the probability of obtaining a correct signal). When efforts are substitutes ($r > 0$), neutral committees lead to a more precise signal as the individual incentives to exert effort of active members increase when the other committee members also exert effort. This leads to a relatively high level of the signal's quality. Under a polarized committee, only one neutral member exerts an effort and he does not benefit from the positive externalities coming from the other members' efforts. The quality of the signal is then lower under a polarized committee. This is no longer true when $r < 0$ (efforts are complements). Efforts become lower when there are other active members in the committee. The probability to get a correct signal is then higher in a polarized committee (where the effort of the neutral member does not suffer from any free-riding) than in a neutral committee. Even with three active members, the individual efforts are too low to compensate for the high effort of the neutral member of the polarized committee.

This is formalized in the next Proposition.

Proposition 1. *$q^P > q^N$ if and only if $r < 0$.*

The proof of Proposition 1 can be found in Appendix A.

Proposition 1 states that a polarized committee is more efficient than a neutral one when $r < 0$. On the opposite, a polarized committee underperforms when efforts are substitutes ($r > 0$). Appendix B shows that the result for $r > 0$ also holds at the limit.

Before going to the next section, one remark is in order. Proposition 1 only compares the precision of the signal obtained in the two regimes, but says nothing about the optimality of this signal. One could for instance argue that for $r > 0$, even if the precision of the committee's decision is higher so are the costs, and perhaps the level of q^N is in fact too high from a social perspective. The purpose of the next proposition is to calm such concerns and prove that the best-performing committee is actually performing at the socially optimal level. Here socially optimal is defined as the level that maximizes the precision of the signal net of costs.

Proposition 2. *The socially optimal levels of effort are*

- *For $r > 0$, symmetric effort $e^* = e^N$ is optimal.*
- *For $r < 0$, the optimal solution is to have only one member exert effort and this member's effort is $e_i^* = e_1^P$.*

The proof of this proposition can be found in Appendix A. It relies on the maximization of the signal's precision (given by the probability $q(e)$) minus the cost of efforts made by the arbitrators ($\sum_{i=1}^{3} c(e_i)$).[15] Let us note that this maximization program is equivalent to minimizing the total costs under each type of committee as made for instance in Emons and Fluet (2009). These total costs would be made up of (i) error costs that represent the societal cost or loss from an inaccurate decision made by the committee $(1 - q(e))$, and (ii) costs of efforts made by the committee members ($\sum_{i=1}^{3} c(e_i)$). Our results show that when $r > 0$, the optimum is given by the interior solution $e_1 = e_2 = e_3 = \frac{A}{n}$. When $r < 0$, the solution with only one member exerting a nonzero effort is optimal.

Going back to Proposition 1, one could easily argue that our model used to derived this proposition is oversimplified. However, this is done in order to convey the result in its most simple form. Our results readily extend to the case of heterogenous weights in the CES production function. We can also show that our result is robust to the introduction of *mixed preferences*. These extensions as well as the optimal size of the committee are topics in Section 4.

4 Robustness Checks

In this section, we explore some extensions of our previous theoretical model. First, we investigate what happens if committee members contribute differently to the collective effort ($a_1 \neq a_2 \neq a_3$). Second, we consider polarized committee members with mixed preferences, i.e., valuing both their appointer's viewpoint and the truth. Third, we explore the effects of the committee's size.

4.1 Heterogeneous contributions of committee members

In this subsection, we show that our results extend straightforwardly to the case of heterogenous weights in the information technology. Mathematically this means that we generalize $q(e_1, e_2, e_3)$ to

$$q(e_1, e_2, e_3) = q_0 + A(a_1 e_1^r + a_2 e_2^r + a_3 e_3^r)^{\frac{1}{r}}$$

[15] The benefit for the whole society is here considered as the precision of the signal. From a societal perspective, the search of the truth matters more than the utilities of the arbitrators.

with $\sum_{i=1}^{3} a_i = 1$. To prove the equivalent of Proposition 1 we determine the outcome (equilibrium effort levels and production precision) under the two types of committees and compare them.

Information acquisition under neutral committees. In this environment, each committee member chooses effort to maximize his expected utility:

$$\max_{e_i} q_0 + A(a_i e_i^r + a_j e_j^r + a_k e_k^r)^{\frac{1}{r}} - c(e_i).$$

The first-order condition can be written as:

$$A[a_i e_i^r + a_j e_j^r + a_k e_k^r]^{\frac{1-r}{r}} = \frac{e_i^{2-r}}{a_i}. \tag{9}$$

Since the left-hand side is the same for all committee members, we can conclude that $\frac{e_1^{2-r}}{a_1} = \frac{e_3^{2-r}}{a_3}$. Equation (9) can then be used to express each individual effort as a function of e_1 (the effort of committee member 1).

$$e_3 = (\frac{a_3}{a_1})^{\frac{1}{2-r}} e_1. \tag{10}$$

In the same way, we get

$$e_2 = (\frac{a_2}{a_1})^{\frac{1}{2-r}} e_1. \tag{11}$$

Contrary to Section 3.2, the efforts made by the members of a neutral committee are no longer equal. The intensity of effort now depends on its relative weight in the probability to obtain an informative signal. When $a_j < a_1$ ($j \in \{2;3\}$), then $e_j < e_1$. When one member's relative weight is higher than some other member, then he will exert more effort than this other member.
Inserting the expressions of e_2 and e_3 into equation (9) yields:

$$\begin{aligned} A\left[a_1 e_1^r + a_2(\frac{a_2}{a_1})^{\frac{r}{2-r}} e_1^r + a_3(\frac{a_3}{a_1})^{\frac{r}{2-r}} e_1^r\right]^{\frac{1-r}{r}} &= \frac{e_1^{2-r}}{a_1} \\ \Leftrightarrow \quad e_1^N = a_1 A\left[a_1 + (\frac{a_2^2}{a_1^r})^{\frac{1}{2-r}} + (\frac{a_3^2}{a_1^r})^{\frac{1}{2-r}}\right]^{\frac{1-r}{r}}&. \end{aligned} \tag{12}$$

We can then derive the probability to get the correct signal under a neutral committee:

$$\begin{aligned} q^N(e_1^N, e_2^N, e_3^N) = &\quad q_0 + A\left(a_1 e_1^r + a_2 e_2^r + a_3 e_3^r\right)^{\frac{1}{r}} \\ = &\quad q_0 + A\left(a_1 + (\frac{a_2^2}{a_1})^{\frac{1}{2-r}} + (\frac{a_3^2}{a_1})^{\frac{1}{2-r}}\right)^{\frac{1}{r}} e_1. \end{aligned}$$

Let us denote $X \equiv a_1 + (\frac{a_2^2}{a_1})^{\frac{1}{2-r}} + (\frac{a_3^2}{a_1})^{\frac{1}{2-r}}$. We can rewrite $e_1^N = a_1 A X^{\frac{1-r}{r}}$ and

$$q^N(e_1^N, e_2^N, e_3^N) = q_0 + a_1 A^2 X^{\frac{2-r}{r}}. \tag{13}$$

Information acquisition under polarized committees. It is straightforward to see that both committee members 2 and 3 have no incentive to put effort into improving the signal as $q(.)$ does not influence their expected utility ($e_2^P = e_3^P = 0$).

Committee member 1 will be crucial in determining what decision is taken and he chooses effort so as to maximize his own expected utility from the decision. Formally,

$$\max_{e_1} \frac{1}{2}\left[q(e)u_1(a,A) + (1-q(e))u_1(b,A) + (1-q(e))u_1(a,B) + q(e)u_1(b,B)\right] - c(e_1).$$

This first-order condition writes:

$$\begin{aligned} A[a_1 e_1^r]^{\frac{1-r}{r}} &= \frac{e_1^{2-r}}{a_1} \\ \Leftrightarrow e_1^P &= A a_1^{1/r}. \end{aligned} \tag{14}$$

Replacing e_1, e_2 and e_3 by their values, the probability to get the correct signal under a polarized committee is then:

$$\begin{aligned} q^P(e_1^P, 0, 0) = &\quad q_0 + A(a_1(a_1^{1/r}A)^r)^{\frac{1}{r}} \\ = &\quad q_0 + a_1 A^2 a_1^{\frac{2-r}{r}}. \end{aligned} \tag{15}$$

Comparison. Let us first compare the individual effort made by the neutral member in each type of committee.

We can show that $\forall(a_1, a_2, a_3)$, with $a_1 + a_2 + a_3 = 1$, $q^P > q^N \Leftrightarrow r < 0$:

$$\begin{aligned} q^P > q^N \Leftrightarrow \quad & a_1^{\frac{2-r}{r}} > [a_1 + (\frac{a_2^2}{a_1^r})^{\frac{1}{2-r}} + (\frac{a_3^2}{a_1^r})^{\frac{1}{2-r}}]^{\frac{2-r}{r}} \\ \Leftrightarrow \quad & \frac{2-r}{r} ln[a_1/(a_1 + (\frac{a_2^2}{a_1^r})^{\frac{1}{2-r}} + (\frac{a_3^2}{a_1^r})^{\frac{1}{2-r}})] > 0. \end{aligned}$$

Since $a_1 + (\frac{a_2^2}{a_1^r})^{\frac{1}{2-r}} + (\frac{a_3^2}{a_1^r})^{\frac{1}{2-r}} \leq a_1$, we have $q^P > q^N \Leftrightarrow r < 0$.

It is now straightforward to extend Proposition 1 to heterogenous weights.

Proposition 3. *With heterogenous contributions of arbitrators, $q^P > q^N$ if and only if $r < 0$.*

Proposition 3 generalizes Proposition 1: even with heterogeneous weights in the collective signal-generating function, the polarized committee is more efficient than the neutral one when efforts are complements ($r < 0$). In neutral committees, all members exert non-zero efforts (even if these efforts are of different intensity), while in polarized committees, only one member exerts effort. The relative performance of the committees crucially depends on efforts being complements or substitutes. When efforts are complements, there is a free-riding effect between the three active members of a neutral committee. This does not happen in a polarized committee: only the neutral member exerts effort, and does not suffer from free-riding since there is no effort from the other members of the committee. On the opposite, a polarized committee underperforms when efforts are substitutes since the only one member exerting effort does not benefit of the positive externality of the other members' efforts. In a neutral committee, the three members exert effort and each member's effort benefits from a positive externality of the other members' efforts. The precision of the signal is then higher in a neutral committee than in a polarized one when efforts are substitutes.

4.2 Committee members with mixed preferences

In Section 3, we use simplified utility functions: the arbitrators are either entirely satisfied or dissatisfied with a decision in a given state of the world, i.e., their utility is either 0 or 1. However, in polarized committees, arbitrators may have *mixed preferences*, i.e. value both (i) the appropriate decision in the corresponding state of the world (*truth*) even if it is not their appointer's viewpoint, and (ii) their appointer's viewpoint even if it is not the appropriate decision (*bias*). In other words, they may want their appointer's viewpoint to prevail but still get some satisfaction from the other party's victory if it corresponds to the correct state of the world. In this subsection, we propose to compare the performance of neutral committees and polarized ones, with biased members of polarized committees having these mixed preferences. As in Section 2, we assume homogeneity in a: the efforts have the same weight in obtaining the signal.

Utilities. We denote $\gamma_B \in (0,1)$ (where B stands for *biased*) the arbitrator's utility when the decision made by the committee is that of his appointer but in the "wrong" state of the world, and $\gamma_T \in (0,1)$ (where T stands for *truth*) the arbitrator's utility level when the correct decision is made by the committee but is unfavorable to his appointer. The utilities of the arbitrators are then as follows:

$$\begin{aligned}
&u_1(a,A) = u_1(b,B) = 1,\ \ u_1(a,B) = u_1(b,A) = 0,\\
&u_2(a,A) = 1, u_2(a,B) = \gamma_B,\ \ u_2(b,A) = 0, u_2(b,B) = \gamma_T,\\
&u_3(b,A) = \gamma_B, u_3(b,B) = 1,\ \ u_3(a,A) = \gamma_T, u_3(a,B) = 0.
\end{aligned}$$

where $u_1(.)$ is the utility of a neutral arbitrator, $u_2(.)$ is the utility of the arbitrator appointed by party A, and $u_3(.)$ is the utility of the arbitrator appointed by party B.

Since neutral committee members keep the same utility functions as in Section 2, the analysis is in this case the same as the one in Subsection 3.2, i.e., $e_i^N = \frac{A}{3}$ and $q^N(e_1^N, e_2^N, e_3^N) = q_0 + \frac{A^2}{3}$.

For the polarized committee, the changes in the utility functions imply that we need to check whether the biased committee members have an incentive to exert effort or not. Recall that a committee member only exerts effort if the threshold of doubt is between zero and one. Applying the mixed preferences, the threshold of doubt for:

- a biased committee member in favor of decision $x = a$ becomes

$$\frac{\gamma_T - \gamma_B}{1 + \gamma_T - \gamma_B},$$

- a biased committee member in favor of decision $x = b$ becomes

$$\frac{1}{1 + \gamma_T - \gamma_B}.$$

For the biased member in favor of $x = a$, whenever $\gamma_T \leq \gamma_B$, his threshold becomes negative: the biased committee members make no effort, so that $e_2 = e_3 = 0$. Their preference for truth (γ_T) is too weak compared to their bias in favor of his appointer (γ_B), so that supporting the cost of effort is not profitable for him. The cost of exerting effort is worth being paid only if $\gamma_T > \gamma_B$. In this case, the threshold of doubt of a biased committee member is between zero and one. His final decision then depends both on his bias (γ_B), his preference for truth (γ_T) and the precision of the signal (given by the probability q^P).
Similarly, for the biased member in favor of $x = b$, whenever $\gamma_T \leq \gamma_B$, his threshold becomes superior to one so that he does not exert any effort ($e_2 = e_3 = 0$), as his taste for the truth is too weak. Efforts are exerted only when $\gamma_T > \gamma_B$.
In what follows, we distinguish between these two cases that we call weak and strong preferences for the truth.

Definitions. We say that committee members have *weak preferences for the truth* when $\gamma_T \leq \gamma_B$. Committee members have *strong preferences for the truth* when $\gamma_T > \gamma_B$.

Equilibrium under weak preferences for the truth. Since only the neutral committee member exerts a nonzero effort, the probability to obtain a correct signal is the same as the one found in Subsection 3.3 (equation (6)):

$$q^P(e_1^P, 0, 0) = q_0 + \frac{A^2}{3^{2/r}}.$$

Equilibrium under strong preferences for the truth. In this case, all thresholds of doubts are between 0 and 1, and all arbitrators maximize their non-trivial utility functions. The neutral arbitrator (arbitrator 1) then maximizes:

$$\max_{e_1} q_0 + A(\frac{e_1^r}{3} + \frac{e_2^r}{3} + \frac{e_3^r}{3})^{\frac{1}{r}} - c(e_1).$$

The first-order condition becomes:

$$A[\frac{e_1^r}{3} + \frac{e_2^r}{3} + \frac{e_3^r}{3}]^{\frac{1-r}{r}} = 3e_1^{2-r}. \tag{16}$$

Each polarized arbitrator $j \in \{2; 3\}$ maximizes:

$$\max_{e_j} \frac{[1 - \gamma_B + \gamma_T]}{2} q^P(e_1, e_2, e_3) - c(e_j).$$

The first-order condition of a polarized arbitrator is then:

$$\frac{[1 - \gamma_B + \gamma_T]}{2} A[\frac{e_1^r}{3} + \frac{e_2^r}{3} + \frac{e_3^r}{3}]^{\frac{1-r}{r}} = 3e_j^{2-r}. \tag{17}$$

Combining (16) and (17), we can derive that:

$$e_j = e_1(\frac{1 + \gamma_T - \gamma_B}{2})^{\frac{1}{2-r}}. \tag{18}$$

The effort made by a biased committee member is then lower than the effort made by the neutral member in a polarized committee. Mathematically, this comes from $r \leq 1$ and $\frac{1+\gamma_T-\gamma_B}{2} \leq 1$. It is due to the fact that the arbitrator has a trade-off between increasing his effort to get utility from the truth and decreasing it because of his bias.
Replacing e_2 and e_3 by their values in equation (16), we get:

$$A[\frac{e_1^r}{3} + \frac{2}{3}(e_1((\frac{1 + \gamma_T - \gamma_B}{2})^{\frac{1}{2-r}})^r]^{\frac{1-r}{r}} = 3e_1^{2-r} \tag{19}$$

$$\Leftrightarrow e_1 = \frac{A}{3} Y^{\frac{1-r}{r}}. \tag{20}$$

with $Y = [\frac{1}{3} + (\frac{2}{3}) Z^{\frac{r}{2-r}}]$ and $Z = \frac{1-\gamma_B+\gamma_T}{2}$.

We can then deduce the probability to get the signal that is correlated to the truth state of the world:

$$q^P(e_1, e_2, e_3) = q_0 + \frac{A^2}{3} Y^{\frac{2-r}{r}} \text{ if } \gamma_T > \gamma_B. \tag{21}$$

To summarize our results under a polarized committee, we can write:

$$q^P(e_1, e_2, e_3) = \begin{cases} q_0 + \frac{A^2}{3^{2/r}} & \text{if } \gamma_T \leq \gamma_B \\ q_0 + \frac{A^2}{3} Y^{\frac{2-r}{r}} & \text{if } \gamma_T > \gamma_B. \end{cases}$$

Proposition 4. *When $\gamma_T \leq \gamma_B$ (weak preferences for the truth), $q^P > q^N$ if and only if $r < 0$. When $\gamma_T > \gamma_B$ (strong preferences for the truth), $q^N > q^P$ always holds.*

The proof of Proposition 4 is relegated to Appendix A.

Our results can be interpreted as follows: When the biased arbitrators have weak preferences for the truth, i.e., $\gamma_T \leq \gamma_B$, then, as in Section 3, neutral committees induce a more precise signal and perform better than polarized committees if and only if $r > 0$. Biased members of polarized committees do not make any effort because their preferences for truth are too weak. The situation is the same as the one described in Section 3.

The neutral committee performs better than the polarized committee when efforts are substitutes because efforts are reinforced by the others' efforts. Yet, when $r < 0$ (i.e. efforts are complements), polarized committees perform better because neutral committees suffer from free-riding.

When the biased arbitrators have strong preferences for the truth, i.e., $\gamma_T > \gamma_B$, then neutral committees perform better than polarized committees regardless of the value of r. The biased members of polarized committees exert positive efforts to look for truth, but these efforts are lower than neutral members' efforts because their preferences are not fully driven by the search for the truth. The utility from the truth is lower for these members compared to neutral members whose preferences are fully driven by the search for the truth. When $r > 0$ (efforts are substitutes), the positive effect induced by the peers' efforts is stronger in neutral committees. When $r < 0$ (efforts are complements), neutral committees suffer from free-riding, but polarized committees suffer both from free-riding and lower incentives to make efforts because of the partial consideration of truth. Neutral committees then still perform better than polarized ones, regardless of whether efforts are substitutes or complements.

A last remark can be made on Proposition 4. We consider here that the two biased committee members are "similarly" biased, i.e. the two members have the same utilities γ_T and γ_B. There is no reason that these biases in favor of the truth or of their appointer change according to the identity of the party that appoints them. However, we verify in Appendix C that Proposition 4 still holds for biased members with different preferences, i.e. $\gamma_{T2} \neq \gamma_{T3}$ and $\gamma_{B2} \neq \gamma_{B3}$.

4.3 Larger committees

Our main result suggests that neutral arbitration committees outperform polarized committees in terms of information acquisition and the precision of the signal about the state of the world if and only if efforts are substitutes. However, our result is obtained for three-arbitrator committees only. In this section, we prove that our result holds for any (odd-numbered) committee size and we also provide arguments suggesting that three is indeed the optimal committee size.

To extend our previous model to include n arbitrators, we assume that n can be any odd number greater or equal to three.

With n arbitrators, the probability of obtaining a correct signal becomes

$$q(e_1, \ldots, e_n) = q_0 + A(\sum_{i=1}^{n} a_n e_i^r)^{\frac{1}{r}}, \tag{22}$$

where $a_n = \frac{1}{n}$. For simplicity we assume that all arbitrators have equal weight in the signal production function.

Neutral committees. In a neutral committee, each committee member maximizes

$$\max_{e_i} q(e_1, \ldots, e_n) - c(e_i). \tag{23}$$

It is straightforward to show that in equilibrium all members exert the same level of effort which is given by

$$e_n^N = a_n A, \tag{24}$$

where the superscript N indicates neutral committees and the subscript n indicates the number of committee members. Since $a_n = \frac{1}{n}$, then the effort made by each member is decreasing with the committee size. Each individual's effort has a lower weight as the committee size increases. The marginal benefit of the effort is then lower, so that the intensity of the effort decreases.

This yields a correct signal with probability

$$q_n^N = q_0 + a_n A^2 = q_0 + \frac{A^2}{n}. \tag{25}$$

Observe that this probability is decreasing in n. This is a consequence of the marginal benefit of the individual effort being lower the larger the committee.

Furthermore, the function $q(.)$ has constant returns to scale since $\sum_{i=1}^{n} a_i = \sum_{i=1}^{n} \frac{1}{n} = 1$. This implies that $q(\frac{1}{n}e_1, ..., \frac{1}{n}e_n) = \frac{1}{n}q(e_1, ..., e_n)$. Maximizing the probability to get a correct signal then implies to have $\frac{1}{n}$ as high as possible, i.e., $n = 3$.

Polarized committees. In a polarized committee with only three members, it was immediate that one was in favor of A while another was in favor of B. Denote the (even) number m the number of polarized committee members whereof $\frac{m}{2}$ members are in favor of each of the two decisions (A and B). In a larger committee it is not clear whether all members (but one) are polarized ($m = n - 1$), only two ($m = 2$) are polarized or if the number should be somewhere in-between ($m \in \{4, \ldots, n-3\}$).

In practice, different arbitral institutions provide slightly different rules to organize arbitrations (see footnote 2). Most of arbitral institutions recommend three-arbitrator panels.[16] Institutions that simply mention that parties have to agree on an odd number of arbitrators and on a method of appointing arbitrators suggest that each party appoints exactly the same number of arbitrators.[17] For instance, if there are 5 arbitrators, one party appoints two arbitrators, the other party chooses two arbitrators and they appoint the fifth arbitrator on a common agreement. These rules suggest that all but one arbitrator might be polarized ($m = n - 1$).

However, to be as general as possible and in order to be able to say something about the optimality of this rule, we allow for an arbitrary number $m \in \{2, 4, \ldots, n-1\}$ of polarized arbitrators. This, of course, includes the case described above ($m = n - 1$).

In a polarized committee with m polarized members, this implies that these m members' effort is equal to zero $e_m = 0$. Only $n - m$ arbitrators exert effort and it can easily be checked that their efforts (which maximize their individual utility) are given by

$$e_n^P = (n-m)^{\frac{1-r}{r}} a_n^{\frac{1}{r}} A = \frac{A(n-m)^{\frac{1-r}{r}}}{n^{\frac{1}{r}}}. \tag{26}$$

The level of effort of a neutral arbitrator in a polarized committee depends both on the total size of the committee and the number of biased arbitrators. For a given number m of biased arbitrators, when $r < 0$ (efforts are complements), $\frac{\partial e_n^P}{\partial n} < 0$.[18] The effort

[16]For three-arbitrator panels, the appointing rules state that each party nominates one arbitrator and the third is chosen by mutual agreement, as described in Section 3. For example, see the rules of the ICSID: https://icsid.worldbank.org/en/Pages/process/Number-of-Arbitrators-and-Method-of-their-Appointment-(Additional-Facility-Arbitration).aspx)

[17] http://konrad-partners.com/knowledge-base/arbitration-guide/the-arbitration-tribunal.htm

[18] $\frac{\partial e_n^P}{\partial n} = \frac{A}{rn^{1/r}}(n-m)^{\frac{1-r}{r}}[\frac{1-r}{n-m} - \frac{1}{n}]$.

of a committee member reduces the effort of the other members, so that an increase of the committee size (and the relative share of neutral members in the committee) leads to more free-riding and lower incentives to exert effort.

When $r > 0$ (efforts are substitutes), efforts reinforce each other. This increases the incentives to exert effort. However, the weight of each arbitrator ($\frac{1}{n}$) also decreases as n increases. This creates an opposite effect: the marginal benefit of the effort is decreasing which reduces the incentives to exert effort. We find that $\frac{\partial e_n^P}{\partial n} > 0$ if $r < \frac{m}{n}$ and $\frac{\partial e_n^P}{\partial n} < 0$ otherwise. There is then a threshold on n: for n small enough, any increase in n increases the individual effort (*spillover effect*), but when n is too high so that $r > \frac{m}{n}$, then the individual efforts are decreasing (*relative weight effect)*.

Regarding the variations of m (i.e., the number of biased members) for a given number of committee members n, we find that $\frac{\partial e_n^P}{\partial m} > 0$ if $r < 0$ and $\frac{\partial e_n^P}{\partial m} < 0$ if $r > 0$. An increase in m implies that the relative number of neutral committee members is decreasing in the committee. When efforts are substitutes, this has a negative impact of incentives because efforts of the neutral members reinforce each other. When efforts are complements, this has a positive impact because free-riding is reduced.

This translates into a probability of obtaining the correct signal that inherits this property of the underlying effort and is such that

$$q_n^P = q_0 + \frac{(n-m)^{\frac{2}{r}}}{n-m} a_n^{\frac{2}{r}} A^2 = q_0 + \frac{A^2 (n-m)^{\frac{2}{r}}}{(n-m) n^{\frac{2}{r}}}. \tag{27}$$

Comparison. We are now ready to state our generalized version of Proposition 1.

Proposition 5. *For any committee size n, $q_n^N > q_n^P$ if and only if $r > 0$.*

The proposition shows that our finding where neutral committees are only preferred whenever efforts are substitutes holds for any committee size and composition. The proof can be found in Appendix A.

Optimal committee size. When efforts are substitutes, neutral committees outperform polarized committees. Coupled with the fact that the efficiency of a neutral committee (as measured by q_n^N) is decreasing in committee size. This suggests that when $r > 0$, the smaller the committee the better. In fact this implies that for neutral committees the optimal committee size is 3. This result justifies our initial assumption of $n = 3$.

For $r < 0$, the result is a bit more nuanced. As summarized in the next lemma, q_n^P is decreasing in committee size n, but increasing in the number of polarized members.

Lemma 5. *For $r < 0$,*

$$\frac{\partial q_n^P}{\partial n} < 0, \tag{28}$$

$$\frac{\partial q_n^P}{\partial m} > 0. \tag{29}$$

This means that for $r < 0$, increasing the general committee size is inefficient as it increases free-riding within the committee among the neutral members of the committee. However, if (for a given committee size) the number of polarized committee members increases (i.e., the relative number of neutral members in the committee decreases), efficiency goes up as this decreases the free-riding problem. Overall, this lemma suggests that the result might depend on whether polarized or neutral members are introduced or removed.

This can also be seen from the two polar cases, $m = 2$, which we will call *weakly polarized* (WP) and $m = n - 1$, *very polarized* (VP). The associated probabilities of obtaining a signal that matches the underlying state are

$$q_n^{WP} = q_0 + A^2 \frac{(n-2)^{\frac{2}{r}}}{n^{\frac{2}{r}}(n-2)}, \tag{30}$$

$$q_n^{VP} = q_0 + a_n^{\frac{2}{r}} A^2 = q_0 + \frac{A^2}{n^{\frac{2}{r}}}. \tag{31}$$

For weakly polarized committees, whenever $r < 0$, q_n^{WP} is decreasing in committee size so that the same argument as for neutral committees remains valid. However, for very polarized committees the opposite hold: q_n^{VP} is increasing in n.

This implies that for $r < 0$, it is optimal for very polarized committees to be very large. Notice however that this result relies on an artifact of the model which says that when the committee size increases, the weight of each member in the production of the signal precision (assumed to be symmetric) decreases and this makes the marginal benefit from effort of the one neutral member increase. However, if adding new polarized members to the committee does not change the weight of the neutral arbitrator in the signal-generating function, then the equilibrium value of the probability of a correct signal does not change. In this situation, the incentives of the neutral member making efforts are not changed as the costs and benefits derived from his effort are the same. This effort is the only one determining the precision of the signal so that the quality of the signal remains the same whatever the number of biased members.

Up to now, we have investigated the impacts of the committee size for the most efficient committee, i.e. the neutral committee when $r > 0$ and the polarized committee when $r < 0$. However, our results can be generalized to the less efficient committee in each case. When $r < 0$, the precision of the signal is still decreasing in the size of the committee, as $q_n^N = q_0 + \frac{A^2}{n}$. When $r > 0$, adding biased members do not change the quality of the signal as long as the weight of the neutral members are unchanged. Adding neutral members does not increase the quality of the signal provided the relative weight of the biased members in the committee does not change.

By generalization of these arguments (which is formally done in Appendix A), we obtain the following proposition.

Proposition 6. *Consider a committee of size n, if adding new members of some type (polarized or neutral) does not change the weight of the other type in $q(e)$ but uniformly reduces the weight within the type of the new members, then*

- *Increasing committee size never increases $q(e)$.*
- *Decreasing committee size never decreases $q(e)$.*

Together these two results imply that the optimal committee size is $n = 3$.

Proposition 6 is established abstracting away from any cost of remunerating the arbitrators and any coordination cost inside the committee. Adding these costs would just reinforce our results as this would make any increase of the committee's size costly.

5 Conclusion

We investigate the incentives to exert effort within arbitral committees. Such committees are common dispute resolution mechanisms outside of the court system. Focusing on three-member arbitral committees, we have compared the incentives to exert effort to learn the truth of two types of panels, i.e. neutral committees (made up of neutral members) and polarized committees (made up of two biased members and one neutral member). We allow for different types of efforts that can be either substitutes or complements. Our results show that polarized committees perform better than neutral committees when efforts are complements. In this situation, efforts have a negative impact on the other members' efforts, which leads to free-riding. In neutral committees, all members make efforts to look for truth, so that this type of committee strongly suffers from free-riding. On the opposite, in polarized committees, only one member makes effort, so that there is no free-riding and the performance of this committee is then higher. Our results are robust to different assumptions, such as heterogeneous weights among committee members, mixed preferences of polarized members and the number of arbitrators in the committees.[19] We also demonstrate that under some conditions three-member committees are more efficient than committees of any other size.

Our findings have strong implications for the appointment rules of arbitral committees. These appointment rules are quite debated. As an illustration, in October 2016, Belgium refused to sign a key trade agreement between E.U. and Canada, which had been in the pipeline for seven years. One reason of Belgium's opposition was the introduction of arbitration (as an alternative to the court system) for settling disputes between foreign investors and governments. It was feared that the appointment rules of arbitrators could contradict the right to an independent and impartial judiciary. A compromise was found with the signature of the trade agreement with the exception of the arbitration clause and Belgium gets the right to ask the European Court of Justice to determine whether a system of investor-state tribunals were compatible with EU law. In parallel, alternative appointment rules for arbitrators are explored.

Our results shed new light on the problem of appointment rules in arbitral committees. Some conflicts call for multi-dimensional investigations. For instance, in conflicts regarding contracts involving engineers, firms and funders, several types of investigations need to be done (investigations about the appropriate regulation to apply, the technical problem, the contractual design, the financial vehicle...). For these conflicts, the efforts to search for the truth are likely to be substitutes. Arbitrators investigate different dimensions of the project to get a more complete view of the conflict. Each effort allows to better understand a part of the conflict and may help the others to better investigate on their own dimension. There is then positive externalities between efforts. Our model states that neutral committees should perform better in this situation. Biased members of polarized committees do not make any effort and such positive externalities cannot be realized. On the opposite, some other conflicts call for general investigation in a precise field of law.

[19]Although we limit the analysis to arbitral committees with an odd number of members, this is a common rule in arbitration (see footnote 2) as it avoids ties in the decision-making process.

For instance, a conflict on labor law needs deep investigation in this field of law. Efforts of arbitrators are likely to be complements and to suffer from free-riding: each arbitrator anticipates the others' efforts to learn more about the conflict and could decide to save on his or her own effort. To avoid such a situation, our model recommends polarized committees so that free-riding behavior can be avoided.

Going back to our model, the scope of our results could be larger than arbitral committees. For instance, in some countries, juries made up of several judges hear judicial cases. Judges are sometimes appointed by public officials who choose a representative of their political or societal preferences. The appointment of judges in the U.S. Supreme Court is quite representative of such a system. In some other cases, judges standing in juries are civil servants who are not appointed by politicians nor elected by citizens. Judges in the French *Cour de Cassation* (i.e. the highest Court in the French judiciary) are a good example of such a system.

Our analysis could be extended along several lines. First, a repeated games framework could show how committees' members efforts impact their probability to be nominated again in the future. Second, different types of efforts could be included. We focus here on efforts to learn the truth, but we could also assume other types of efforts, such as efforts to make one's own viewpoint prevail (whether this viewpoint is true or not). All these extensions represent avenues for future research on arbitration committees, but are beyond the scope of the current paper.

A Proofs

Proof of Proposition 1. Let us show that $q^N > q^P$ as given by (6) and (4) if and only if $r > 0$.

$$\begin{aligned} q^N > q^P \quad & \Leftrightarrow \frac{A^2}{3} > \frac{A^2}{3^{2/r}} \Leftrightarrow \frac{2}{r} > 1 \\ & \Leftrightarrow \begin{cases} 2 > r & \text{if } r > 0, \\ 2 < r & \text{if } r < 0. \end{cases} \end{aligned}$$

The first condition is always verified as $r \in]-\infty, 1]$. This implies that $q^N > q^P$ whenever $r > 0$. □

Proof of Proposition 2. The optimal levels of effort solve

$$\max_e q(e) - c(e_1) - c(e_2) - c(e_3).$$

It is straighforward to check that the fully interior solution to this problem is $e_1 = e_2 = e_3 = aA = e^N$.

There could also be two types of corner solutions: one with one member exert nonzero effort and the other one with two member exerting nonzero effort.

The first case corresponds to $e_i = a^{\frac{1}{r}} A = e_1^P$ and $e_j = e_k = 0$ while the latter corresponds to $e_i = 0$ and $e_j = e_k = 2^{\frac{1-r}{r}} a^{\frac{2}{r}} A$.

From the comparison of the value of the objective function in the three cases, it is immediate that for $r > 0$ the symmetric interior solution is optimal while for $r < 0$ the solution with only one member exerting a nonzero effort is optimal. □

Proof of Proposition 4. For $\gamma_T \leq \gamma_B$, we are back to the basic model. The proof is the same as for Proposition 1 and is therefore omitted.

For $\gamma_T > \gamma_B$, $q^P \leq q^N$ if and only if

$$Y[\frac{1}{3} + \frac{2Z^{\frac{r}{2-r}}}{3}]^{\frac{1}{r}} \leq 1 \tag{A.1}$$

$$\Leftrightarrow \left(\frac{1}{3} + \frac{2}{3} Z^{\frac{r}{2-r}}\right)^{\frac{2-r}{r}} \leq 1. \tag{A.2}$$

When $r < 0$ the exponent $\frac{2-r}{r}$ is negative and we need to show that the base $\frac{1}{3} + \frac{2}{3} Z^{\frac{r}{2-r}}$ is greater than one. When $r > 0$ it is the opposite. Since $\frac{2-r}{r}$ is greater than one, we need to show that $\frac{1}{3}+\frac{2}{3}Z^{\frac{r}{2-r}} \leq 1$.

Notice that by definition $Z<1$. Thus for $r<0$ we have $Z^{\frac{r}{2-r}} \geq 1$ and for $r>0$ we have $Z^{\frac{r}{2-r}} \leq 1$. This gives us the two inequalities we need and we can conclude that $q^P \leq q^N$ if and only if $r>0$.

$\square$

Proof of Proposition 5. $q_n^N > q_n^P$ is equivalent to

$$q_0 + \frac{A^2}{n} > q_0 + \frac{A^2(n-m)^{\frac{2}{r}}}{(n-m)n^{\frac{2}{r}}} \iff \frac{n^{\frac{2}{r}}}{n} > \frac{(n-m)^{\frac{2}{r}}}{(n-m)}. \tag{A.3}$$

Define $K(x) \equiv \frac{x^{\frac{2}{r}}}{x} = x^{\frac{2-r}{r}}$. Since $n > n-m$, $q_n^N > q_n^P$ is equivalent to $K' > 0$.

It is immediate that

$$K'(x) = \frac{2-r}{r} x^{\frac{2-2r}{r}}. \tag{A.4}$$

This is positive if and only if $r > 0$. $\square$

Proof of Proposition 6. Suppose the initial committee is of size n and that two members are added or removed. Note that you cannot add or remove just one member as that breaks the symmetry between between A and B.

Consider first a neutral committee. In this scenario, only neutral members can be added and the exercise boils down to comparing a committee of size n with $a_n = \frac{1}{n}$ and a committee of size $n-2$ with $a_{n-2} = \frac{1}{n-2}$.[20] With $n-2$ members, individual effort is $\frac{A}{n-2}$ and $q_{n-2}^N = \frac{A^2}{n-2}$. It is immediate that a smaller committee is more efficient ($q_{n-2}^N > q_n^N$).

Let us now turn to polarized committees. Assume first that two polarized members are added. Since these members never exert effort and only diminish the weight on zero-effort arbitrators (but do not change the neutral committee members' weights), output does not change compared to the situation without these additional members. The same argument applies when removing two polarized members.

Finally, we show that adding two neutral members is detrimental and removing two such members is beneficial. If you add two new neutral members, this changes the share of each member in the production function from $a_n = \frac{1}{n}$ to $\tilde{a}^N = \frac{(n-m)}{n}\frac{1}{(n-m+2)}$ (total share of the $n-m$ initial members divided by the number of members when the two new

[20] In theory, we could add or remove just one neutral member, but to keep arguments as similar as possible throughout the proof we chose to add or remove 2. This choice does not change our result.

ones have been added). It is straightforward to show that the new probability of signal matching state is

$$q^{P+2} = q_0 + \frac{A^2(n-m+2)^{\frac{2}{r}}}{(n-m+2)} \frac{(n-m)^{\frac{2}{r}}}{n^{\frac{2}{r}}(n-m+2)^{\frac{2}{r}}}, \tag{A.5}$$

$$q^{P+2} = q_0 + \frac{A^2(n-m)^{\frac{2}{r}}}{(n-m+2)n^{\frac{2}{r}}}. \tag{A.6}$$

$q_n^P > q^{P+2}$ can be written as

$$\frac{(n-m)^{\frac{2}{r}}}{(n-m)n^{\frac{2}{r}}} > \frac{(n-m)^{\frac{2}{r}}}{(n-m+2)n^{\frac{2}{r}}} \tag{A.7}$$

$$\Leftrightarrow (n-m+2) > n-m. \tag{A.8}$$

The latter is always true.

A symmetric argument applies when removing two neutral members. It changes the share of each member in the production function from $a_n = \frac{1}{n}$ to $\tilde{a}^N = \frac{(n-m)}{n} \frac{1}{(n-m-2)}$ and it is straightforward to show that the new probability of signal matching state is

$$q^{P-2} = q_0 + \frac{A^2(n-m)^{\frac{2}{r}}}{(n-m-2)n^{\frac{2}{r}}}. \tag{A.9}$$

$q_n^P > q^{P-2}$ can be written as

$$\frac{(n-m)^{\frac{2}{r}}}{(n-m)n^{\frac{2}{r}}} > \frac{(n-m)^{\frac{2}{r}}}{(n-m-2)n^{\frac{2}{r}}} \tag{A.10}$$

$$\Leftrightarrow (n-m-2) > n-m. \tag{A.11}$$

The latter is never true. □

B Cobb-Douglas

As $r \to 0$, the CES function approaches Cobb-Douglas function with constant returns to scale, i.e.,

$$q(e) = q_0 + Ae_1^a e_2^a e_3^a, \tag{B.1}$$

with $q = \frac{1}{3}$.

In a polarized committee, member 2 and 3 never exert any effort because their decision in the voting stage is not influenced by the signal.

The neutral committee member's program can be written as

$$\max_{e_1} q_0 + A e_1^{1/3} e_2^{1/3} e_3^{1/3} - c(e_1). \tag{B.2}$$

This first-order condition writes:

$$\frac{A}{3} e_1^{1/3-1} e_2^{1/3} e_3^{1/3} = e_1. \tag{B.3}$$

Since $e_2 = e_3 = 0$, we can conclude from the first-order condition that $e_1 = 0$ and thus $q^P = q_0$.

In a neutral committee, each committee member i chooses effort to maximize his expected utility and the first-order condition is the same as above (in the neutral member's program above) and can be rearranged as

$$\frac{A}{3} e_i^{1/3} e_j^{1/3} e_k^{1/3} = e_i^2. \tag{B.4}$$

Since the left-hand side is the same in all three first-order conditions, we can conclude that the right-hand side are also equal and thus $e_1 = e_2 = e_3$. Using this in the first-order condition and rearranging yield

$$e^N = \frac{A}{3}. \tag{B.5}$$

This implies that $q^N = q_0 + \frac{A^2}{3} > q^P$ and we have thus shown that the CES result for $r > 0$ also holds at the limit.

C Mixed preferences with different biases

Let us assume that the two biased arbitrators have different biased preferences so that:

$$u_1(a,A) = u_1(b,B) = 1,\ u_1(a,B) = u_1(b,A) = 0,$$
$$u_2(a,A) = 1, u_2(a,B) = \gamma_{B2},\ u_2(b,A) = 0, u_2(b,B) = \gamma_{T2},$$
$$u_3(b,A) = \gamma_{B3}, u_3(b,B) = 1,\ u_3(a,A) = \gamma_{T3}, u_3(a,B) = 0.$$

1. First case: the two polarized members have weak preferences for truth This means that $\gamma_{T2} - \gamma_{B2} < 0$ and $\gamma_{T3} - \gamma_{B3} < 0$, so that $e_2 = e_3 = 0$. The equilibrium is the *weak preferences equilibrium* described in Section 4.2.

2. Second case: The two biased arbitrators have strong preferences for the truth, but with different intensity.

The neutral arbitrator (arbitrator 1) maximizes:

$$\max_{e_1} q_0 + A(\frac{e_1^r}{3} + \frac{e_2^r}{3} + \frac{e_3^r}{3})^{\frac{1}{r}} - c(e_1).$$

Each polarized arbitrator $j \in \{2;3\}$ maximizes:

$$\max_{e_j} \frac{[1 - \gamma_{Bj} + \gamma_{Tj}]}{2} q^P(e_1, e_2, e_3) - c(e_j).$$

Resolving similarly to the demonstration made in Section 3, we get $e_1 = \frac{A}{3}\tilde{Y}^{\frac{1-r}{r}}$, with $\tilde{Y} = [\frac{1}{3} + (\frac{1}{3})\tilde{Z}_2^{\frac{r}{2-r}} + (\frac{1}{3})\tilde{Z}_3^{\frac{r}{2-r}}]$ and $\tilde{Z}_j = \frac{1-\gamma_{Bj}+\gamma_{Tj}}{2}$.

We can then deduce the probability to get the informative signal:

$$q^P(e_1, e_2, e_3) = q_0 + \frac{A^2}{3}\tilde{Y}^{\frac{2-r}{r}}. \tag{B.6}$$

Proposition 4 is still valid: when biased members have strong preferences for the truth (with different intensity), neutral committees perform better. Because the preferences of biased members are partly driven by the search of truth, they have some incentives to make efforts, but their incentives are still lower than that of neutral members, whether efforts are complements or substitutes.

3. Third case: one biased arbitrator has strong preferences for the truth and the other has weak preferences

We assume that arbitrator 1 is neutral, arbitrator 2 has strong incentives for the truth, and arbitrator 3 has weak preferences for the truth.[21] This directly implies that $e_3 = 0$.

The neutral member in the committee maximizes:

$$\max_{e_1} q_0 + A(\frac{e_1^r}{3} + \frac{e_2^r}{3})^{\frac{1}{r}} - c(e_1).$$

The polarized arbitrator 2 maximizes:

$$\max_{e_2} \frac{[1 - \gamma_{B2} + \gamma_{T2}]}{2} q^P(e_1, e_2) - c(e_2).$$

Resolving as in Section 3, we get $e_1 = \frac{A}{3}\hat{Y}^{\frac{1-r}{r}}$ where $\hat{Y} = [\frac{1}{3} + \frac{1}{3}\hat{Z}^{r/2-r}]$ and $\hat{Z} = \frac{1-\gamma_{B2}+\gamma_{T2}}{2}$. This leads to a probability to get the correct signal under a polarized committee:

$$q^P(e_1, e_2, 0) = q_0 + \frac{A^2}{3}\hat{Y}^{\frac{2-r}{r}}. \tag{B.7}$$

As previously, Proposition 4 still holds. The polarized committee has two members making positive efforts. Their incentives are lower compared to the neutral committee so that this polarized committe performs less efficiently.

[21] The case where arbitrator 3 has weak preferences for the truth and arbitrator 3 has strong preferences for the truth yields the same final result and is therefore omitted.

References

Ashenfelter, O. (1987), "Arbitrator Behavior". *American Economic Review*, 77(2), 342-346.

Austen-Smith, D. and Banks, J.S. (1996), "Information Aggregation, Rationality, and the Condorcet Jury Theorem". *American Political Science Review*, 90, 34-45.

Blackaby N., Partasides C., Redfern A., and Hunter M. (2015), "Chapter 1: An Overview of International Arbitration". *Journal of International Dispute Settlement*, in *Redfern and Hunter on International Arbitration*, 6^{th} Edition, Kluwer Law International, Oxford University Press, 1-70.

Bloom, D.E. and Cavanagh, C.L. (1986), "An Analysis of the Selection of Arbitrators". *American Economic Review*, 76(3), 408-422.

Brekoulakis, S. (2013), "Systemic Bias and the Institution of International Arbitration: A New Approach to Arbitral Decision-Making". *Journal of International Dispute Settlement*, 4(3), 553-585.

Cai, H. (2009), "Optimal Committee Design with Heterogeneous Preferences". *The Rand Journal of Economics*, 40(1), 173-189.

Crawford, V. (1979), "On Compulsory-Arbitration Schemes". *Journal of Political Economy*, 87(1), 131-159.

de Condorcet, N. (1785), "Essai sur l'Application de l'Analyse à la Probabilité de Décisions Rendues à la Pluralité des Voix". *L'imprimerie royal*, Paris.

Dewatripont, M. and Tirole, J. (1999), "Advocates". *Journal of Political Economy*, 107, 1-39.

Donaubauer, J., Neumayer, E., and Nunnenkamp, P. (2018), "Winning or Losing in Investor-to-State Dispute Resolution: The Role of Arbitrator Bias and Experience". *Review of International Economics*, 26(4), 892-916.

Doraszelski, U., Gerardi, D., and Squintani, F (2003), "Communication and Voting with Double-Sided Information". *Contributions to Theoretical Economics*, 3(1), Article 6.

Emons, W. and Fluet, C. (2009) "Accuracy versus Falsification Costs: The Optimal Amount of Evidence Under Different Procedures". *Journal of Law, Economics and Organization*, 25(1), 134-156.

Farmer, A. and Pecorino, P. (2003), "Bargaining with Informative Offers: An Analysis of Final-Offer Arbitration". *Journal of Legal Studies*, 27, 415-32.

Farmer, A. and Pecorino, P. (2003), "Bargaining with Voluntary Transmission of Private Information: Does the Use of Final Offer Arbitration Impede Settlement?". *Journal of Law, Economics and Organization*, 19(1), 64-82.

Feddersen, T. and Pesendorfer, W. (1996), "The Swing Voter's Curse". *American Economic Review*, 86, 408-424.

Feddersen, T. and Pesendorfer, W. (1997), "Voting Behavior and Information Aggregation in Elections with Private Information". *Econometrica*, 65, 1029-1058.

Feddersen, T. and Pesendorfer, W. (1998), "Convicting the Innocent: The Inferiority of Unanimous Jury Verdicts under Strategic Voting". *American Political Science Review*, 92(1), 23-35.

Feddersen, T. and Pesendorfer, W. (1999), "Abstention in Elections with Asymmetric Information and Diverse Preferences". *American Political Science Review*, 93, 381-398.

Frank, S.D. (2009), "Development and Outcomes of Investment Treaty Arbitration". *Harvard International Law Journal*, 50(2).

Frank, S.D. (2011), "The ICSID Effect? Considering Potential Variations in Arbitration Awards". *Virginia International Law Journal*, 51(4).

Gerardi, Dino (2000), "Jury Verdicts and Preference Diversity". *American Political Science Review*, 94, 395-406.

Gerardi, D. and Yariv, L. (2007), "Deliberative Voting". *Journal of Economic Theory*, 134, 317-338.

Gerardi, D. and Yariv, L. (2008), "Information Acquisition in Committees". *Games and Economic Behavior*, 62, 436-459.

Gerling, K.n, Gruner, H.P., Kiel, A. and Schulte, E. (2005), "Information Acquisition and Decision Making in Committees: A Survey". *European Journal of Political Economy*, 21, 563-597.

Gershkov, A. and Szentes, B. (2009), "Optimal Voting Schemes with Costly Information Acquisition". *Journal of Economic Theory*, 144(1), 36-68.

Goltsman, M., Horner, J. and Pavlova, G. (2009), "Mediation, Arbitration and Negotiation". *Journal of Economic Theory*, 144(4), 1397-1420.

Grossman, S. J. (1981), "The Informational Role of Warranties and Private Disclosure about Product Quality". *Journal of Law and Economics*, 24(3), 461-483.

Gruner, H.P. and Kiel, A. (2004), "Collective Decisions with Interdependent Valuations". *European Economic Review*, 48(5), 1147-1168.

Horner, J., Morelli, M., and Squintani, F. (2015), "Mediation and Peace". *Review of Economics Studies*, 82(4), pp. 1483-1501.

Kapeliuk, D. (2010), "The Repeat Appointment Factor: Exploring Decision Patterns of Elite Investment Arbitrators". *Cornell Law Review*, 96(47), 47-90.

Levy, G. (2007), "Decision Making in Committees: Transparency, Reputation, and Voting Rules". *American Economic Review*, 97(1), 150-168.

Li, H. (2001), "A Theory of Conservatism". *Journal of Political Economy*, 109(3), 617-636.

Li, H. and Rosen, S. and Suen, W. (2001), "Conflicts and Common Interests in Committees". *American Economic Review*, 91(5), 1478-1497.

Martinelli, C. (2006), "Would Rational Voters Acquire Information?". *Journal of Economic Theory*, 129(1), 225-251.

Martinez, L. (2012), "The ICDR's Arbitrator Appointment Process - The Institutional Role and Available Options". *ABA Section of International Law*, 1(1), 20-24.

Milgrom, P. (1981), "Good News and Bad News: Representation Theorem and Applications". *Bell Journal of Economics*, 12(2), 380-391.

MUKHOPADHAYA K. (2003), "Jury Size and the Free-Rider Problem". *Journal of Law, Economics and Organization*, 19(1), 24-44.

OLSZEWSKI, W. (2003), "A Welfare Analysis of Arbitration". *American Economic Journal: Microeconomics*, 3(1), 174-213.

PERSICO, N. (2004), "Committee Design with Endogenous Information". *Review of Economic Studies*, 71(1), 165-191.

POSNER, E.A. AND DE FIGUEIREDO, M.F.P. (2005), "Is the International Court of Justice Biased?". *The Journal of Legal Studies*, 34(2), 599-630.

PUIG, S. AND STREZHNEV, A. (2017), "Affiliation Bias in Arbitration: An Experimental Approach". *The Journal of Legal Studies*, 46(2), 371-398.

QUEEN MARY UNIVERSITY (2008), "International Arbitration: Corporate Attitudes and Practices (2008)". *Queen Mary School of International Arbitration & PWC*, 1-28.

RAU, A.S. (1997), "Integrity in Private Judging". 38 *South Texas Law Review*, 485, 514-521.

SCHNEIDERMAN, D. (2010), "Judicial Politics and International Investment Arbitration: Seeking an Explanation or Conflicting Outcomes". *Northwestern Journal of International Law and Business*, 30(2), 383-496.

SCHULTE, E. (2010), "Information Aggregation and Preference Heterogeneity in Committees". *Theory and Decision*, 69(1), 97-118.

SCHULTE, E. (2012), "Communication in Committees: Who Should Listen?". *Public Choice*, 150(1-2), 97-117.

VAN HARTEN, G. (2007), *"Investment Treaty Arbitration and Public Law"*, Oxford University Press.

WAIBEL, M. AND WU, Y. (2017), "Are Arbitrators Political? Evidence from International Investment Arbitration". *Working Paper*.