Information Aggregation in Political Decision Making

How Differences in Information Processing and Institutional Constraints Affect Information Aggregation

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Summary

Information about the impact of policies is indispensable for political decision making. In politics, exchange of information in committees or the knowledge of experts from stakeholders are ways to aggregate enough evidence to make an informed decision. Research in economics and political science shows that truthful information transmission in committees or from a better informed sender to a decision maker is not always rational due to differences in preferences. However, individuals also differ in the way they process information and face institutional constraints when making decisions.

In this dissertation I analyze how differences in information processing between individuals affect information aggregation and decision making in groups. Across two articles, I show that individuals strategically deviate from full information sharing behavior as a reaction to different cognitive biases of others. In a third article I examine the effect of institutional constraints on strategies of stakeholders in the consultation procedure of the European Commission.

In chapter 2, I use a formal model to show how differences in posterior beliefs caused by correlation neglect affect information aggregation and decision making in deliberative committees. Correlation neglect is a cognitive bias that describes individuals' inability to correctly process correlation between different signals. If all committee members use the same process to update their beliefs, full information sharing will be possible for similar preferences. Committees with only individuals who neglect correlation may perform better than committees with only perfectly rational individuals if committee members' preferences are extreme. In committees with both types full information sharing behavior only describes an equilibrium strategy under very specific conditions. If there exists a majority of one type of

committee members, the space for equilibria with full information sharing behavior increases.

In chapter 3, I show how differences in belief updating caused by confirmation bias affect individuals' information sharing strategies and information aggregation in committees. Existence of a full information sharing equilibrium in groups depends not only on the similarity of individuals' preferences, but also on similarity of their belief updating functions. Strategic actors react to large differences in belief updating by hiding information. The predictions are tested in an online experiment where participants interact with automated players whose belief updating is affected by confirmation bias. Participants are informed about the automated players' behavior and can adjust their information provision strategy. The results show evidence for strategic hiding and sharing of signals depending on automated players' information processing.

Chapter 4 covers the effect of institutional constraints on information transmission in the consultation process of the European Commission. When drafting policies, the European Commission heavily relies on information it receives as feedback to its published policy initiatives and consultations. I describe information transmission to the European Commission in a model of information transmission with a receiver who is constrained in the ability to observe information and can decide to additionally constrain its own agenda a priori. I demonstrate that stakeholders will decide to provide more informative submissions if the Directorate General decides not to constrain the agenda. Using a novel data set of stakeholders' feedback to roadmap documents of new initiatives by the European Commission, I measure informativeness as the logged number of words per topic. The analysis provides evidence that the informativeness of stakeholders' feedback is associated with the decision to constrain the policy's agenda.

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1

Introduction

"We can't do evidence based policy without evidence" is one of the mantras of Nobel prize winner Richard Thaler (Thaler, 2012). Thaler uses this mantra to describe the need for expert knowledge and further research for policy making. The need for evidence can also be observed in the organization of information exchange in politics: There are 712 registered expert groups that advise the European Commission and its Directorate Generals (DG). Each parliament has committees on each topic of legislature and almost countless interest groups provide information of all sorts to politicians and bureaucrats responsible for policy making. Information is not only needed for policy making, but also determines the content of policy. Therefore, strategic information transmission is an integral part of politics, inside committees, parliaments, and between decision makers and interest groups.

Information and advice from experts are the basis for most policies. This has become apparent in the Corona pandemic when virologists all over the world explained to the public and health officials how the virus spreads, changes, and what we can do to reduce infections. US-President Joe Biden even said about the Omicron-variant that his government was "going to fight this variant with science [...]" (Gay, 02.12.2021). In politics, information from several sources is usually discussed in long meetings in order to reach a final decision. Sometimes, as with the "Ministerpräsidentenkonferenz" in Germany, the public follows these sessions attentively, sometimes, as with most legislative committees, committees work constantly in the background always following the goal of making decisions or at least to come up with some declaration. For political scientists it is important to understand how these committees arrive at decisions which is closely connected to the question: How is information aggregated inside committees?

The supposed advantage of committee decision making is that a committee can efficiently aggregate information and is collectively more likely to come to a correct decision than an individual alone. Condorcet (1976) famously states that voting in groups more likely leads to the correct decision than individual decision making if all committee members vote the way they would decide individually. Strategic voting, meaning maximizing the own utility in voting taking into account others' decisions, however can be an obstacle to efficient information aggregation and, therefore, for efficient decision making in committees. Strategic considerations of individuals for the case of being the pivotal voter can induce hiding or lying about private information (Austen-Smith and Banks, 1996). Voting rules directly affect information aggregation with the unanimity rule leading to a higher rate of errors (Feddersen and Pesendorfer, 1998). Introducing deliberation prior to committee decision making can lead to efficient information aggregation in deliberation under all voting rules (Coughlan, 2000; Schulte, 2010). However, the unanimity rule remains susceptible to strategic considerations due to individuals' veto power (Gerardi and Yariv, 2007).

Strategic information provision is not only an obstacle for information aggregation in committees but also for sender-receiver situations, where one better informed sender transmits signals to a decision maker whose decision affects the payoff of both sender and receiver. In their seminal paper Crawford and Sobel (1982) show that in equilibrium informative signals in sender-receiver situations can be described as partitions of a distribution. The sender sends the partition that includes the true value. With more than one dimension, full revelation of information is possible if there is more than one sender (Battaglini, 2002).

Sender-receiver situations are a typical characterization of informational lobbying where interest groups try to influence individual politicians or decision making bodies by providing information about the probable effect of policies. Interest groups use their expertise to provide policymakers with policy relevant information. The policymakers are fully aware of the interest groups' policy preferences when evaluating the information. Diverging interest of policymakers and interest groups can be overcome by introducing costs for lobbying which makes information credible (Potters and van Winden, 1992; Lohmann, 1995).

The main obstacle for efficient information aggregation or transmission in the scenarios above is diverging interest between either individuals or sender and receiver. However, cognitive biases can also affect information aggregation. There are differences in the amount of information that is aggregated in electorates with and without correlation neglect, a cognitive bias where individuals do not correctly take into account the correlation between two signals (Levy and Razin, 2015*a*). Cognitive biases like correlation neglect affect individuals' information updating such that it diverges from the often assumed Bayesian updating. There is evidence that correlation neglect leads to overconfidence in the own opinion (Ortoleva and Snowberg, 2015; Spiwoks and Bizer, 2018). Other cognitive biases like confirmation bias, the tendency to believe that ambiguous evidence supports the own belief, can lead to polarization (Fryer, Harms and Jackson, 2019).

The first thesis of this dissertation is that differences in information updating between individuals in a committee can be a major obstacle for information aggregation. That means that even if there is no diverging interest between individuals, differences in information updating can lead to different posterior beliefs based on the same evidence and therefore to different decisions. These possible differences in posterior beliefs can induce strategic information provision in deliberation of committees. While for individual decision making it is important how information is updated by one individual, for group decisions and deliberation it is also important how others update information compared to individuals in the same group. As information aggregation is a central part for the quality of committee decision making, understanding the effect of differences in information updating between individuals on information aggregation in deliberation is as central as the effect of diverging interest.

The second part of this thesis focuses on information transmission in lobbying. The European Commission actively tries to aggregate information and different interests using consultations of stakeholders when drafting policies. The *Better Regulation Guidelines* are designed to ensure that in the cycle of drafting, evaluating, and reforming policies the interests of all stakeholders are taken into account and as much information as possible is used (European Commission, 2017). Analyses of the consultation regime show that indeed interests of different stakeholders are included in the different consultation mechanisms of the European Commission (Rasmussen and Gross, 2015). However, we know that for decision makers there are different obstacles like resource constraints that can affect the information transmission strategies of stakeholders (Dellis and Oak, 2019).

The second thesis of this dissertation is that information transmission in the consultation regime of the European Commission is affected by different constraints in the consultation process. Organizations can constrain the own agenda to induce competition between interest groups and improve information transmission (Dellis and Oak, 2019). For the European Commission it is important to understand how their own choices in the consultation procedure and external constraints affect the information transmission of stakeholders.

This dissertation analyzes strategic information transmission in two different scenarios. First, it focuses on deliberation in committees when members differ in their information updating from another. For two cognitive biases, correlation neglect and confirmation bias, I show how differences in information updating based on these biases affect information aggregation in deliberative committees and complement the literature on the effect of cognitive biases on decision making and information aggregation in groups. In chapter 2, I provide a novel formal model of decision making in committees under the presence of correlation neglect for some committee members. Chapter 3 presents a model where committee members might suffer from confirmation bias and presents experimental evidence on strategic information provision in deliberation. Chapter 4 focuses on the second scenario, obstacles for information transmission in stakeholder consultations of the European Commission. I present a formal model of the strategic decision on the informativeness of stakeholders' statements about possible policy consequences and show how different (self-imposed) constraints of the European Commission affect their decisions. I create a novel data set of stakeholders' feedback documents to policy initiatives of the European Commission and provide evidence how constraints affect the informativeness of these feedback documents.

1.1 Information Aggregation and Transmission

This dissertation is about individuals' or groups' decisions to share or hide verifiable information strategically. I analyze this problem in two different situations: (1) deliberation in committees and (2) information transmission from better informed senders to a decision maker. A common theme in both situations is that strategic actors might have incentives to hide or lie about private information. Whenever it is, in expectation, beneficial for a rational individual to not disclose private information, the individual will not disclose the information.

A rational individual deviates from truthfully sharing all information whenever there might be conflict if information is shared, and no conflict if information is not shared. Conflict between two individuals here describes a situation where given their own thresholds of doubt and posterior beliefs the two individuals prefer different outcomes. Figure 1.1 is a stylized representation of the formation of such a conflict for (a) differences in individuals' thresholds of doubt and (b) differences in individuals' information processing. Consider situation (a), let $Pr(B)_0^{1,2}$ be the common prior belief of person 1 and person 2 about the benefits of some policy B for the group. As both rectangles in (a) are above the common prior belief $Pr(B)_0^{1,2}$, in the beginning both are against the implementation of the policy. If they receive a piece

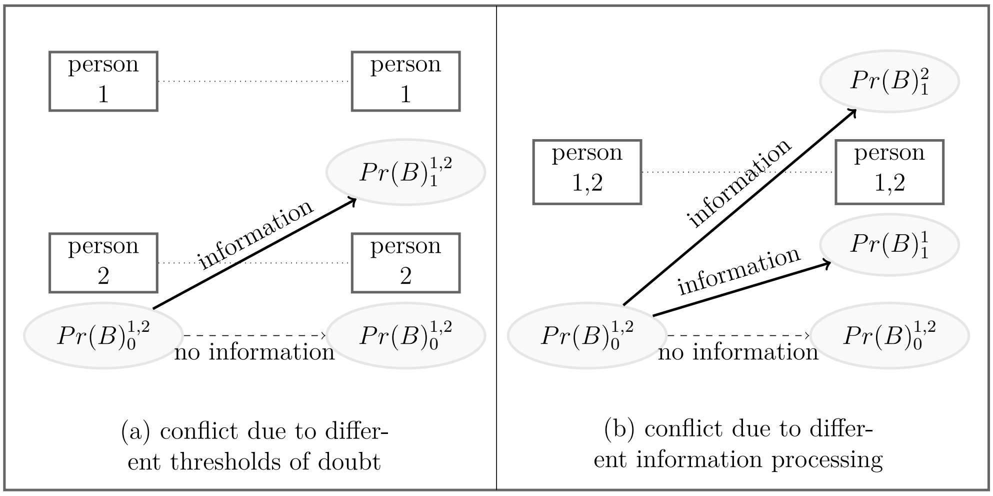


Figure 1.1: Stylized representation of conflict in decision making. Rectangles represent thresholds of doubt, ellipses prior (0) and posterior (1) beliefs, and individuals are in favor of a decision if the posterior belief is above their thresholds of doubt.

of information both update their belief to some common posterior belief $Pr(B)_1^{1,2}$. Now, person 1 is still not convinced that the policy is beneficial for the group while person 2 is convinced by the information presented as they have different individual thresholds of doubt. Next, consider situation (b). Here, persons 1 and 2 have identical thresholds of doubt and a common prior belief $Pr(B)_0^{1,2}$. Again, in the beginning both are convinced that the policy is not beneficial for the group. Here, information is processed differently by the two individuals, leading to a situation where person 2 is convinced that the policy is beneficial for the group while person 1 is still convinced that the policy is not beneficial for the group, although they have a common threshold of doubt.

The result of conflict between the individuals described in the two scenarios in figure 1.1 is the same. In both situations person 1 might avoid conflict by not presenting the piece of information to person 2. However, the way that conflict came about differs.

Research on strategic information provision and committee decision making mainly concentrated on the first problem of different thresholds of doubt. The problem of conflict due to differences in information processing however is underdeveloped with respect to strategic information provision and committee decision making. The focus of this strand of research is more concerned with individuals' decision making. Only a few researchers examine how differences in information processing affect information aggregation in elections or can be exploited from information providers. However, both, differences in individual thresholds of doubt and information processing, are important to understand whether and how information can be efficiently transmitted or aggregated.

1.1.1 Information Aggregation: Different Thresholds of Doubt

Many political decisions are the result of committees' constant deliberation. Following Francis (1982), the US committee system is "perhaps the only satisfactory vehicle by which a collective choice body can process a great volume of demand for legislation and, at the same time, satisfy the need for expertise, specialization, and legislative control over programs"(p.822). A main reason why group decision making in committees is seen as superior to individual decision making is the Condorcet Jury Theorem (Condorcet, 1976). The Jury Theorem can be summarized as follows: There is a committee of n members who make a binary decision (A or B). Suppose that one alternative is better for all n committee members but there is uncertainty which alternative it is. Each committee member votes with a common probability of $p > \frac{1}{2}$ for the better alternative. The Jury Theorem states that in such a situation the decision of the committee has a higher probability to be the better alternative than p (and approaches 1 as n goes to infinity)(Berg, 1993). The theorem makes use of the implicit assumption that any member of a committee would always vote exactly the same way as if the individual would decide on the subject when being a single decision maker. However, it might be rational for committee members to vote differently in a committee than they would decide individually.

Assume again a committee that has to make a binary decision. All committee members have the same prior belief $Pr(B)_0$ about B being the better alternative. Each committee member i receives a private signal $\sigma_i \in \{\alpha, \beta\}$. Let probabilities be such that $Pr(\alpha|A) = Pr(\beta|B) > \frac{1}{2}$. If committee members all voted *informatively*, following the private signal they receive, the Condorcet Jury Theorem would apply. Austen-Smith and Banks (1996) argue that *informative* voting in this context is not necessarily *rational*, in the sense that such behavior might not describe a Nash equilibrium. The authors make the following example (Austen-Smith and Banks, 1996, p.34ff): Assume a three members committee which uses simple majority rule to make a decision. Further, assume the prior belief $Pr(B)_0$ that B is the better alternative is so weak that all three signals need to be β for an individual to be convinced. Next, assume that all committee members $j \neq i$ vote informatively. Then i can find itself in three situations:

(a) All signals of the other committee members $j \neq i$ show α, then the decision is A and i's vote does not matter.

(b) All signals of the other committee members $j \neq i$ show β, then the decision is B and i's vote does not matter.

(c) One signal of the other committee members is α and the other is β. Then the decision depends on i's vote.

A rational committee member i conditions its vote choice on the third case of being pivotal, being the voter who is decisive for the committee decision. So, only situation (c) is of interest and in this case there is always at least one signal showing α. Therefore, it is rational for committee member i to always vote for decision A regardless of the own signal σ_i. Accordingly *informative* voting is not always *rational*.

Following the conclusion of Austen-Smith and Banks (1996), a main interest of researchers was to understand the effect of different majority voting rules on rational voting. In committees, rational members always condition their action in each stage on the situation when their action is pivotal for the committee decision. The unanimity rule was of particular interest for researchers as it supposedly reduces the probability for falsely accepting a proposal at the cost of increasing the probability of falsely rejecting that proposal. Accordingly, the unanimity rule is assumed to be a good mechanism for trials by jury to minimize the probability to convict an innocent defendant at the cost of acquitting a guilty defendant. However, formal theorists show that in the basic model described above the unanimity rule can lead to a higher probability of convicting an innocent defendant than other majority rules if committee members vote strategically (Feddersen and Pesendorfer, 1998). Coughlan (2000) shows that including mistrials or communication in the basic model makes complete revelation of information in voting an equilibrium strategy under certain conditions. For nonstrategic voting the unanimity rule leads to a maximization of the expected utility. Under the communication model, the sequence of committee decision making is as follows:

1. Nature decides the state of the world $\omega \in \{A, B\}$ and each committee member receives a private signal $\sigma_i \in \{\alpha, \beta\}$ which is correlated with the true state of

the world.

2. Committee members take a nonbinding straw vote and update their beliefs.

3. Committee members take a binding vote following some majority voting rule and payoffs are realized.

Coughlan (2000) proofs that if and only if a closeness condition of individuals' thresholds of doubt is fulfilled informative voting in the straw vote stage is always a Nash equilibrium strategy. The closeness condition requires that all committee members make the same voting decision given a realization of multiple noisy signals. If the closeness condition is fulfilled, it is possible that all information is aggregated in committees. However, several researchers show that the unanimity rule is different from other majority voting rules considering the set of possible equilibria (Gerardi and Yariv, 2007) and the probability to make the correct decision (Duggan and Martinelli, 2001). Further, any equilibrium in which all information is disclosed in a communication stage that exists under unanimity also exists under any other majority voting rule (Austen-Smith and Feddersen, 2006). Experiments provide evidence for strategic voting in committee decision making and show that individuals tend to reveal their private information in a straw vote (Guarnaschelli, McKelvey and Palfrey, 2000). Experimental research shows further that deliberation in committees overall improves decision making and reduces differences caused by different majority voting rules (Goeree and Yariv, 2011).

Enhancements of the model of a deliberative committee include reputational concerns of committee members (Visser and Swank, 2007), introducing uncertainty about individuals thresholds of doubt (Doraszelski, Gerardi and Squintani, 2003), or making signals verifiable (Schulte, 2010). In the model with verifiable information, the model of a deliberative committee is changed such that there are three different possible realizations of an individual's private signal $\sigma_i \in \{\alpha, \beta, \varnothing\}$, where $\sigma_i = \varnothing$ means that a committee member received an uninformative signal. As the signal is verifiable, individuals cannot lie and say their signal was α when it was in fact β. However, they can hide a signal by saying a signal was $\sigma_i = \varnothing$, meaning empty or uninformative, when it was in fact α or β, meaning informative about the state of the world. Schulte (2010) shows that under these circumstances there exists an equilibrium where all individuals informatively share their private signals in deliberation if thresholds of doubt are similar enough.

For the two chapters on committee decision making, the model of a deliberative committee with verifiable information will be the baseline model. However, compared to previous authors, the model additionally incorporates diversity in committee members' information processing.

1.1.2 Information Aggregation: Cognitive Biases

One common assumption in models of committee decision making and information aggregation in committees is that all individuals update their beliefs in the same way, usually following Bayes rule. However, it is known that individuals do not update beliefs in a Bayesian way (Lord, Ross and Lepper, 1979). Formal theorists analyzed how biases in information updating affect and change posterior beliefs compared to rational posterior beliefs using Bayesian updating. Persuasion bias describes a bias that is based on humans' problems to account for repetition of signals exchanged in networks (DeMarzo, Vayanos and Zwiebel, 2003). Persuasion bias can reduce a multidimensional set of issues to one dimension. Further, information of actors with prominent positions in a network, more outgoing and incoming connections, receives more weight in information updating (Brandts, Giritligil and Weber, 2015; Corazzini et al., 2012; DeMarzo, Vayanos and Zwiebel, 2003).

A related bias is correlation neglect, which describes individuals inability or ignorance of correlation between different signals. Experimental research suggests that many individuals systematically neglect correlation between signals whenever the environment is complex (Enke and Zimmermann, 2017; Eyster and Weizsäcker, 2011; Kallir and Sonsino, 2009). Correlation neglect creates overconfidence in one's own beliefs, meaning that individuals overestimate the amount of information they received (Levy and Razin, 2015*a*; Ortoleva and Snowberg, 2015). Experimental evidence supports the conclusion that correlation neglect leads to overconfidence in one's own beliefs (Budescu and Yu, 2007; Spiwoks and Bizer, 2018). In group decisions, correlation neglect can be modeled as a neglect of sources of information. Let a private signal be denoted by $\sigma_{ij} \in \{\alpha, \beta, \varnothing\}$ where i denotes the individual and j the source. Signals shared in deliberation from the same source j are identical and have the same realization. Perfectly rational individuals would count the two signals as just one signal in their information updating while individuals with correlation neglect double count the signal and become overconfident in their belief as they overestimate the evidence.

The effect of individuals' correlation neglect and the resulting overconfidence in one's own beliefs can lead to extreme views in groups (Glaeser and Sunstein, 2009). However, others show that electorates with correlation neglect are more likely to decide for the correct decision as they base their vote decision more on evidence and less on prior beliefs (Levy and Razin, 2015*a*). While correlation neglect leads to more polarized voters, it does not necessarily create more polarized policies (Levy and Razin, 2015*b*). Correlation neglect can also reduce the efficiency of information such that even in the limit of receiving infinitely many signals individuals do not perfectly learn the true state of the world (Denter, Dumav and Ginzburg, 2021). Individuals who neglect correlation also create an incentive for senders of signals, like newspapers, to fully manipulate receivers by creating a large number of correlated signals (Levy, Moreno de Barreda and Razin, 2021). Correlation neglect overall induces overconfidence in one's own beliefs as individuals more strongly follow correlated evidence that is presented to them, creating possibilities of manipulation but also for evidence based group decisions.

Confirmation bias is another cognitive bias that is known to create overconfidence in one's own beliefs. Rabin and Schrag (1999) show that confirmation bias, individuals' tendency to interpret ambiguous evidence as confirming the own predisposition, causes overconfidence in the own belief, meaning that individuals believe more strongly than appropriate in their preferred hypothesis. As ambiguous evidence is interpreted as supportive of the own predisposition, it can lead to diverging opinions (Andreoni and Mylovanov, 2012) and polarization (Fryer, Harms and Jackson, 2019). There are different ways how confirmation bias is implemented in formal theory. One option is that there is some positive probability that individuals misread evidence for state A as evidence for state B (Rabin and Schrag, 1999) others introduce ambiguous signals that can be interpreted either way (Fryer, Harms and Jackson, 2019). A third variant is that signals for different states of the world are weighted differently by individuals. Eil and Rao (2011) provide experimental evidence for this kind of bias where individuals put more weight on positive signals about their self image while putting less weight on negative signals. Electorates with confirmation bias decrease incentives for pandering and can increase voter welfare (Lockwood, 2017).

Cognitive biases affect individual decision making, group decision making, and actions by others who observe the biased information processing. Senders of signals can make use of biases for persuasion (Levy, Moreno de Barreda and Razin, 2021). However, it remains unclear how deliberation in groups is affected by cognitive biases and whether efficient information aggregation is harmed.

1.1.3 Informational Lobbying and Institutional Constraints

On the one hand information sharing inside of committees is important for informed decision making, on the other hand it is important to receive information from better informed experts from outside. In their seminal paper Crawford and Sobel (1982) show that whenever preferences of sender and receiver differ it is never an equilibrium strategy for a sender to send a fully informative signal. They show that the best that can be achieved in this classic cheap talk model, meaning that sending a signal is free and payoffs only depend on the receiver's final decision, is a signal that informs the receiver about the partition of the full distribution in which the true state of the world lies in. Constraining the space of possible signals that can be sent to the receiver makes it possible to find equilibria where informative signals are transmitted.

In political science informational lobbying can be modeled as a classic example of such a cheap talk situation. Lobbyists as such are better informed about the true state of the world than politicians who are the decision makers. However, lobbyists have known interest in the policy which might differ from the politician's interest. Information provided by lobby groups might therefore not be credible. Literature on informational lobbying provides mechanisms and evidence when and how information can be used as a persuasive tool by stakeholders. The problem that decision makers face is that they want information from stakeholders, however, they do not want to be manipulated by them. Ainsworth (1993) proposes two ways how lobbying can be controlled such that stakeholders provide the relevant information but cannot manipulate decision maker: (1) costs for lobbying and (2) verifying information about all or at least about certain lobby groups.

Several authors show that persuasive information transmission by interest groups is possible if information is costly (Austen-Smith and Wright, 1992; Lohmann, 1995; Potters and van Winden, 1992). Costs can create constraints on interest groups such that they only transmit information if they have “good" information for the decision maker (Potters and van Winden, 1992). Costs can be modeled as costs for acquiring information (Austen-Smith and Wright, 1992) or for receiving access to politicians (Lohmann, 1995).

Milgrom and Roberts (1986) use an approach where information can be freely verified and show that competition among stakeholders is only beneficial for a decision maker if the decision maker is well informed and sceptical about information from stakeholders. Rasmusen (1993) presents a model where interest groups provide evidence and the decision maker can verify the information when paying a cost. There exists an equilibrium with lobbying if both the lobby group and the decision maker follow a mixed strategy where they sometimes lobby although information is non-beneficial for the decision maker and the decision maker sometimes verifies the information. Dahm and Porteiro (2008) argue that buying verifiable information is a risky attempt to persuade the decision maker as the information may make the decision maker more convinced to decide against the interest group's preferences. Therefore, the decision whether to buy verifiable information or not depends on the interest group's risk preferences.

If there is more than one interest group involved, the other groups' actions affect a group's strategy. For example, if there are multiple interest groups with the same interest who form a lobby coalition, there will exist a free rider problem (Lohmann, 1995). While free riding might be a problem for lobby coalitions, lobby groups also have to consider when to lobby the decision maker. Austen-Smith (1993) shows that lobbying at the agenda stage is always influential while lobbying at the vote stage is not. Other authors show that an interest group might also deviate from information provision and use a strategy of political pressure if the interest group's reputation is low (Sloof and van Winden, 2000).

Recent findings concentrate on the effect of different constraints that lobby groups and politicians face. A resource constrained decision maker is more likely to acquire information because of anticipated subsidies from lobby groups (Ellis and Groll, 2020). Constraining the access of interest groups to the decision maker can lead to overlobbying, meaning lobbying by interest groups who have information that is not supportive of the interest group's policy (Dellis and Oak, 2019). However, the decision maker can reduce overlobbying by additionally deciding to constrain the agenda, meaning the number of issues that can be reformed (Dellis and Oak, 2019).

1.1.4 Institutional Constraints of Informational Lobbying in the European Commission

The European Commission is the sole proposer of policy in the European Union (EU) and therefore one of the main targets for interest groups in the EU. The European Commission is limited in its resources, especially the staff (Crombez, 2002; Klüver, 2013). It is in need of information and has established a system of expert groups and consultation procedures to guarantee sufficient information supply for informed policy making.

Bouwen (2002) shows how information is used as an exchange good buying access to EU institutions. The idea that access goods are an important driver of lobbying in the EU has been used by several authors and there is empirical evidence that supports this claim (Bouwen, 2004*b*; Eising, 2007; Chalmers, 2013; Klüver, 2013). Information can also be used to put pressure on political actors in the policy-making process (de Bruycker, 2016).

The European Commission established a system of expert groups, consultations, and feedback mechanisms to ensure all relevant information is taken into account in the policy drafting process (European Commission, 2017). The rules in this system balance the representation of all important stakeholders in the information aggregation process (Bunea, 2017; Persson, 2007; Quittkat, 2011; Rasmussen and Carroll, 2014). At the one hand increased participation of interest groups in the European Commission's different consultation formats leads to policies closer to the interest groups' preferred positions (Belloc, 2015), on the other hand it also strengthens the European Commission's positions in subsequent bargaining with other European actors (Bunea and Thomson, 2015).

The European Commission with its different rules and constraints for informational lobbying is a special case and the strategic considerations of stakeholders can barely be explained by existing models of informational lobbying. The European Commission is constrained in resources and heavily in need for information. Access to the first feedback mechanisms on any major policy initiative is free, considering the obligatory public consultations for each initiative, where everybody can participate (European Commission, 2017). However, additional time constraints and agenda constraints might also affect strategic information provision of stakeholders. Chapter 4 of this dissertation focuses on exactly these mechanisms and improves our understanding of strategic information provision in feedback to policy initiatives in the European Union.

1.2 Outline

This dissertation consists of five chapters. Chapters 2-4 are standalone articles that are meant to be published in academic journals. Chapter 2 is purely theoretic, while chapters 3 and 4 include an empirical application of theoretical models.

Chapter 2: In this chapter I develop a formal model of decision making in a deliberative committee with verifiable information and committee members who neglect correlation between signals. I use the model to compare the performance of committees where all committee members are rational and committees with only committee members who neglect correlation between signals. Further I derive conditions for which it is possible that all information available is aggregated in deliberation.

Chapter 3: The formal model presented in this chapter is strongly connected to the model in chapter 2 with the difference that confirmation bias affects the information processing of some committee members instead of correlation neglect. I derive best response strategies for rational individuals in these committees under the assumption that all others follow a fully revealing strategy. The predictions of the formal model are tested in an online experiment where participants interact with automated committee members who have confirmation bias. The observed behavior supports the predictions of the formal model.

Chapter 4: This chapter moves from information transmission in deliberative committees to information transmission in informational lobbying. I develop a model that describes information transmission in stakeholder feedback mechanisms in EU policy drafting. The model shows under which circumstances stakeholders provide more or less informative feedback statements to policy initiatives. I test the predictions using novel data on stakeholder feedback to policy initiatives. The evidence suggests that stakeholders react to constraints in the consultation process when providing information. The announcement of public consultations increases the informativeness of stakeholders' feedback.

Chapter 5: The concluding chapter 5 provides an overview of the key findings of this dissertation and how they develop our understanding of strategic information provision in committees and lobbying. Further, I discuss opportunities for future research on strategic information transmission that build on the findings of this dissertation.

1.3 Contributions

The dissertation makes several contributions to the study of strategic information transmission. While most contributions are theoretical advancements, I also provide new data on the EU consultation procedure and a measurement of informativeness of a text.

1.3.1 Theory

The dissertation has two main theoretical contributions: to the best of my knowledge (1) it provides the first formal model of committee decision making in a deliberative committee with cognitive biases and (2) it provides a model of the consultation procedure in the European Union.

It departs from the conventional theories by including different belief updating functions into one committee. Research on group decision making usually compares how groups with cognitive biases perform compared to perfectly rational groups. The theories described in this dissertation go one step further by describing how cognitive biases affect information aggregation in mixed groups. Group members react on both differences in thresholds of doubt and differences in information aggregation between group members.

For a long time models of committee decision making only considered differences in thresholds of doubt to affect strategic information transmission in deliberation. However, we know that individuals also differ in their individual information processing. Knowing that somebody else processes information differently can create situations in which individuals strategically deviate from informative strategies and hide or lie about private signals. Full information aggregation in deliberation strongly depends on similarity of individuals' thresholds of doubt and information processing. These results have implication for the efficiency of all group decision making bodies and need more empirical investigation.

Further, chapter 4 presents a formal model as a micro foundation for the consultation process of the European Commission. Research on lobbying in the European Union often considers the complete bargaining process between different European institutions and how interest groups can affect policy at different stages reducing information to an exchange good for access at later stages. While this perspective is reasonable it neglects the persuasive potential of information in the policy drafting of the European Commission that is apparent in the different consultation phases of policy initiatives. The model explains how informativeness of signals provided by interest groups depends on circumstances of the policy initiatives like time frames and decisions made by the European Commission for the process of the initiative. The model can be used to explain rationals for the European Commission's decisions on the consultation procedure for policy initiatives. It shows how informativeness of consultations can be maximized and when information transmission is expected to break down.

1.3.2 Method

This dissertation makes one methodological contribution by proposing a new measurement for informativeness of text. Measuring informativeness of text is difficult as it depends on at least two dimensions: (1) the number of features of a text and (2) the relevance of these features for topics.

Features of a text can be represented by the number of content-related words of a text. However, a text is not necessarily more informative just because it explains something in lengthy words that are all related to the overall topic. To reduce the measurements bias of noisy word counts, I combine the word count with a measurement for the relevance to a topic.

A corpus of texts about one broad topic can be divided in multiple subtopics. The distribution of one text across these subtopics can be used as a measurement for the conciseness of a text. The more a text is focused on one subtopic the more informative it can be considered about this subtopic compared to a text of equal length that puts less weight on this subtopic.

I use unsupervised topic modeling (Blei, Ng and Jordan, 2003) to estimate the share of subtopics that a text mainly covers. I calculate the number of words that the text uses for each of its main topics. The measurement therefore combines both the features of a text and their relevance to a topic and can be considered a useful measurement for the informativeness of texts in one corpus.

The measurement can be used in all contexts of persuasive information whenever more information should be more effective than less information. The context can be any sender receiver situation like consultations, expert advice, or even committee deliberation. The measurement helps to make informativeness of text measurable and useful for quantitative research.

1.3.3 Policy Relevance

The findings of this dissertation are relevant for anybody in politics or business who decides on composition of committees. As efficient information aggregation is important for committee decision making, knowing circumstances that favor informative signal transmission in deliberation is important. Information aggregation is most efficient if all committee members process information in the same way. Biases in themselves are not problematic for information aggregation and possibly even beneficial for committee decision making as long as all committee members' biases do not diverge too much. When creating expert groups it might therefore be of interest to understand how similar the individual experts process information which can be learned by looking at individuals' previous decisions. Individuals who make the same decisions based on identical evidence are likely to aggregate information efficiently in deliberation.

While theoretical results can give guidelines for the efficient composition of committees, the experimental evidence shows that these guidelines are also empirically relevant. Individuals can understand how others process information based on observations of previous decisions. Cognitive ability can be considered one of the main factors for understanding others' information processing. In expert committees where individuals generally have high cognitive skills it is very likely that individuals know how others might react on a piece of information if they share it in deliberation. Further, individuals who realize that others might process information differently might manipulate information in deliberation and reduce the efficiency of information aggregation. Problems of large differences in information aggregation therefore can be considered to be a likely thread for efficient information aggregation.

The second relevant result for policy considers the consultation process of the European Commission. The European Commission can affect the informativeness of feedback submissions to policy initiatives by stakeholders. Announcing public consultations, which can be considered an unconstrained agenda, increases the informativeness of feedback received to the very first publication of a policy initiative. Accordingly the evidence on which the final policy is based can be expected more complete and detailed. However, in this case the European Commission can also expect overlobbying. The European Commission has to weigh benefits of more information and possibly a larger agenda against a smaller agenda with less undesired and unimportant information.

2

Correlation Neglect and Information Aggregation in Deliberative Committees

2.1 Introduction

In politics, committees are "perhaps the only satisfactory vehicle by which a collective choice body can process a great volume of demand for legislation and, at the same time, satisfy the need for expertise, specialization, and legislative control over programs"(Francis, 1982). Therefore, efficient information aggregation is indispensable for committees' decision making. Literature in political science and economics mainly blames differences in preferences as an obstacle for efficient information aggregation and consent decision making (Coughlan, 2000; Schulte, 2010). However, individuals also differ in information processing which can lead to different conclusions based on the same information (Lord, Ross and Lepper, 1979; Plous, 1991; Kahan et al., 2007; Fryer, Harms and Jackson, 2019). As differences in information processing can harm efficient information aggregation in committees, it is important to understand how perceived differences in information aggregation affect behavior of committee members and outcomes of committee decision making.

Committees accumulate a large amount of information from all possible sources. Committee members talk to several interest groups or talk with experts to receive the information necessary to arrive at an informed decision. Information is also shared among committee members before making a decision. When deliberating in committees, it is important to understand how information is connected with another. Assuming all signals to be independent can be problematic in reality. The number of experts is limited and multiple committee members have spoken to the same experts. In deliberation, agents might repeat the same piece of information, putting more weight on a single signal than appropriate. Correlation neglect is a cognitive bias that describes the inability of individuals to account for correlation between signals. If some agents neglect the correlation between repeated signals, a strategic actor may withhold information to manipulate the posterior belief of these agents.

I investigate the effect of differences in correlation neglect between individual committee members on decision making in a deliberative committee. To illustrate the main findings of the model, imagine a three-member committee that has to decide between introducing a new policy or keeping the status quo. Assume that preferences and prior beliefs are such that all committee members want to implement the policy if they see more evidence that suggests the policy to be beneficial.

There are two types of committee members, those who neglect correlation between information and those who only consider independent signals for belief updating. All committee members receive information in form of a binary signal. The information is verifiable and can be shared with other committee members in deliberation prior to voting. Assume that two of these three members receive identical information from the same expert and all committee members know that the information has the same source. Their signal indicates that a new policy should be introduced. The signal is shared twice in deliberation. Committee members who completely disregard the fact that this information is identical, call them *naive*, will count the information as two pieces of independent evidence in favor of a new policy. Committee members who account for the perfect correlation of these signals, *sophisticated* individuals, count this as only one signal in direction of a new policy. Neglecting the correlation between these signals leads to an overestimation of the information contained in the signals. Assume that the third signal that is shared in the committee is independent from the two identical signals and indicates that the status quo should be retained. *Naive* individuals in this case see more signals suggesting to vote for the introduction of a new policy than for retaining the status quo. They are convinced that a new policy should be implemented. *Sophisticated* committee members understand that the evidence is the same for introducing a new policy and retaining the status quo. They prefer to keep the status quo given these signals. In homogeneous groups all committee members end up with the same posterior belief and sharing all information cannot lead to conflicting posterior beliefs. In heterogeneous groups, posterior beliefs differ between members of different types, raising incentives to provide information strategically. For example, a strategic *sophisticated* individual who received one of the identical pieces of information would strategically hide the signal to change *naive* committee members voting decision and the outcome. Hiding information reduces the amount of information that is aggregated in deliberation and potentially might lead to worse outcomes.

I use a formal model to analyze situations like the one above. My analysis suggests that in committees with only one type sharing all information is an equilibrium for *naive* and *sophisticated* individuals. Further, there always exist preferences such that committees with only *naive* committee members are more likely to make the correct decision than committees with only *sophisticated* committee members. Full information sharing is possible in committees with both types of individuals only under very specific conditions. As long as there is a (qualified) majority of individuals of one type in the committee, the space for full information sharing equilibria is larger than without (qualified) majorities of one type.

2.2 Related Literature

Most research on committees in politics is connected to legislative committees in the US. The committee system of the US two-chamber system is an essential part of legislative politics in the US. Scholars are interested in the distributive effects of committees on resources (Bendor, 1988; Niskanen, 1971), others concentrate on the expert function that committees have in the legislative process of the congress (Gilligan and Krehbiel, 1987, 1989; Sabatier and Whiteman, 1985). Further research is concerned with the optimal size of committees (Francis, 1982), motivations for legislators to participate in committees (Hall, 1987), composition of committees (Krehbiel, 1990), biased opinions of committees (Krehbiel, 1990; Parker et al., 2004), or the power that committees have in the legislative process (Shepsle and Weingast, 1987; Krehbiel and Rivers, 1988; Snyder, 1992; Lupia and McCubbins, 1994).

Based on the Condorcet jury theorem, committees are expected to be more likely to make the correct decision than individuals (Condorcet, 1976). However, this result depends on the assumption that committee members vote sincerely and not strategically (Austen-Smith and Banks, 1996). But in committees, sincere voting is often not rational. This has implications for the efficiency of different majority voting rules, making the unanimous voting rule a particularly inefficient rule (Feddersen and Pesendorfer, 1998). While for all voting rules the probability to make mistakes goes to zero, the probability is bounded strictly above zero for the unanimity rule (Duggan and Martinelli, 2001).

Coughlan (2000) shows that honest information sharing prior to voting is possible under all majority voting rules if committee members' preferences are close enough. Further full information sharing is possible even if preferences of committee members are heterogeneous given that shared private information is verifiable (Schulte, 2010). If committee members have conflicting preferences, it might be beneficial to restrict communication (Schulte, 2012). The decision rule applied in a committee leads to strong predictions about the possibility to share information truthfully. Full information sharing is less likely under unanimity than under any other majority voting rule (Austen-Smith and Feddersen, 2006). But unanimity can be efficient if signals are perfectly informative (Meirowitz, 2002). Gerardi and Yariv (2007) model deliberation in a committee and show that a wide range of non-unanimous voting rules lead to the same equilibria if pre-vote deliberation is allowed. Further research on committees shows that secretive voting procedures induce better decisions than voting procedures in which a principal can observe the voting behavior of committee members (Levy, 2007). Empirical evidence from laboratory experiments show that people tend to share their information truthfully and that deliberation improves decision making generally (Guarnaschelli, McKelvey and Palfrey, 2000; Goeree and Yariv, 2011). So far, the focus of strategic behavior in committee decision making was on differences in interest and voting rules. The effect of individuals' differences in information processing on committee decision making remains unclear.

Scholars long came to realize that information in committees is not processed in a Bayesian way. Authors suggested different alternatives how committees or other networks can exchange information and reach consensus (DeGroot, 1974; DeMarzo, Vayanos and Zwiebel, 2003). Prominent positions in network can lead to a systematic bias which can also be found in experimental applications of the model (DeMarzo, Vayanos and Zwiebel, 2003; Brandts, Giritligil and Weber, 2015). Cognitive biases describe systematic deviations from rational behavior or information processing. Examples are people who interpret ambiguous information as supportive for their beliefs (*confirmation bias*), imitate others' behavior (*naive herding*), or ignore or do not understand the underlying correlation structure of multiple signals (*correlation neglect*). Individuals who suffer from cognitive biases are very likely to be overconfident about their final beliefs (Rabin and Schrag, 1999; Ortoleva and Snowberg, 2015; Eyster and Rabin, 2010; Levy and Razin, 2015*a*,*b*). Electorates that neglect correlation are likely to make better decisions, because they base their decision more on information than on their personal bias (Levy and Razin, 2015*a*). But correlation neglect also offers the opportunity of persuasion of voters and gives power to those providing information, like the media (Levy, Moreno de Barreda and Razin, 2021). Empirical evidence supports the finding that humans have problems to understand the underlying correlation structure of information (Enke and Zimmermann, 2017; Eyster and Weizsäcker, 2011; Spiwoks and Bizer, 2018). The effect of cognitive biases on beliefs, behavior, and decision making of individuals was the focus for most research on biased information processing. As many political decisions are made in groups, it is important to investigate how biased information belief updating affects interactions and decision making in committees.

I narrow this gap by investigating the effect of cognitive biases on decision making in groups. To the best of my knowledge, this is the first study on the effect of heterogeneity in information processing on group decision making and information aggregation. I show how differences in information processing affect the interaction between committee members. While cognitive biases change decision making in groups, they have no effect on individuals behavior inside the groups as long as the group is homogeneous in the updating behavior of individuals. Heterogeneity in information processing, however, affects the behavior of committee members. My findings connect the literature on decision making in committees to the literature on biased information processing. The results improve our knowledge about the effect of differences in information processing on decision making in deliberative committees.

2.3 The Model

The model follows the general committee decision making framework used by previous authors (Feddersen and Pesendorfer, 1998; Coughlan, 2000; Schulte, 2010). There is a committee that consists of n members. The committee has to make a policy decision $o \in \{a, b\}$, where a denotes the outcome to keep the status quo and

b to propose a reform policy. Committee members have the common goal to match the state of the world $\omega \in \{A, B\}$. The prior probabilities for the two states of the world are given by $Pr(B) = r$ and $Pr(A) = 1 - r$ for every committee member $i \in N$ where $N = \{1, 2, ..., n\}$ denotes the set of all committee members. Matching the state with the policy yields a utility of $u_i(a, A) = u_i(b, B) = 0$. The utilities of making the wrong decisions are given by $u_i(b, A) = -d_i$ and $u_i(a, B) = -(1 - d_i)$, where $d_i \in (0, 1)$ can be interpreted as the personal threshold of doubt of individual i.

Every member i receives one private signal $\sigma_{ij} \in \{\alpha, \beta, \varnothing\}$ where $j \in Z = \{0, 1, 2, ..., z\}$ indicates the source that a signal is from. Committee members cannot choose the source from which they receive their signal. Signals from the same source are perfectly correlated and show the same value.[1] $\sigma_{i0} = \varnothing$ denotes an uninformative signal and $Pr(\varnothing|A) = Pr(\varnothing|B) = q$. All uninformative signals come from the source $j = 0$. With $1 - q$ the signal $\sigma_{ij} \neq \varnothing$. All sources $j \neq 0$ contain informative signals, α or β. $Pr(j = 1) = Pr(j = 2) = ... = Pr(j = z) = \frac{1-q}{z}$ and $Pr(\sigma_{ij} = \alpha|A) = Pr(\sigma_{ij} = \beta|B) = (1 - q)p$ with $p \in (0.5, 1)$.

Before voting on the final decision, committee members share their signals in a deliberation stage. The profile of shared signals is denoted by s. Informative signals shared in deliberation are verifiable, but committee members can hide signals by changing informative signals $\sigma_{ij} = \{\alpha, \beta\}$ in uninformative signals $\sigma_{i0} = \varnothing$ if they want to.

After deliberation, committee members form their posterior belief about the

[1] Signals from different sources follow a binomial distribution $B(m, p)$, the signal profile shared in deliberation follows a joint distribution that can be described using the representation by Bahadur (1961).

probability $Pr(B|k(s))$ where $k(s)$ is the difference between the number of informative signals α and β in the signal profile $s = \{\sigma_{ij}\}_{i=1}^{n}$ following Bayes' rule:

$$Pr(B|k(s)) = \frac{r \cdot p^{k(s)}}{r \cdot p^{k(s)} + (1-r) \cdot (1-p)^{k(s)}} \ .$$

There are two types of committee members: *sophisticated* members of type R who only care about independent signals from different sources, and *naive* members of type C who double count information that is shared more than once in deliberation. Let s_α be the number of all shared signals that revealed α-signals and s_β be the number of β signals. Then

$$k_C(s) = s_\beta - s_\alpha$$

for all committee members of type C. Further, let s'_α and s'_β be the number of all sources in s that revealed α and β. Then

$$k_R(s) = s'_\beta - s'_\alpha$$

for all *sophisticated* committee members.[2]

After updating their beliefs, members cast their final vote $v_i \in \{0,1\}$ to make the decision o. The final decision is made by some majority rule that is defined by a number of votes m. If the number of votes for reform $\sum_{i=1}^{n} v_i \geq m$, the decision is

[2]Let $\mathcal{A}(s)$ be the profile of shared signals that revealed α-signals, $\mathcal{A}(s) = \{i \in N : \sigma_{ij} = \alpha\}$ and $\mathcal{A}^{'}(s) = \{j \in Z : \sigma_{ij} = \alpha\}$. Define $\mathcal{B}(s)$ and $\mathcal{B}^{'}(s)$ analogously. Let

$$1_{\mathcal{A}}(i) := \left\{ \begin{array}{ll} 1 & \text{if } i \in \mathcal{A} \\ 0 & \text{if } i \notin \mathcal{A} \end{array} \right\}$$

be the indicator function for the set $\mathcal{A}(s)$. Let $1_{\mathcal{B}}(i)$, $1_{\mathcal{A}'}(i)$, and $1_{\mathcal{B}'}(i)$ be defined in the same way for the set $\mathcal{B}(s)$, $\mathcal{A}^{'}(s)$, and $\mathcal{B}^{'}(s)$. Then $s_\alpha = \sum_{i=1}^{n} 1_{\mathcal{A}}(i)$ and $s_\beta = \sum_{i=1}^{n} 1_{\mathcal{B}}(i)$. Further $s'_\alpha = \sum_{j=1}^{z} 1_{\mathcal{A}'}(j)$,and $s'_\beta = \sum_{j=1}^{z} 1_{\mathcal{B}'}(j)$.

to reform, b. Otherwise the committee's decision is to stay with the status quo, a.

Members seek to maximize their utility $u_i(o, \omega)$, where o is the outcome and ω is the state of the world. Given their utility functions, a member i will prefer reform to the status quo whenever she believes that the probability that change is needed $Pr(B|k(s))$ is larger (or equal) than her personal threshold of doubt d_i.[3]

2.4 Decisions in Committees with One Type

Previous models of committee decision making do not differentiate between possibly different types of information processing. The differentiation between two types of committee members can lead to two different beliefs about the state of world based on the same profile of shared signals s. The reason is that *naive* committee members neglect the information about the source of a shared signal σ_{ij} completely and double count every signal that is shared more than one time, while *sophisticated* committee members count signals from one independent source j only once and ignore the double sharing.

The bias in posterior beliefs is given by

$$D(s) = \frac{r \cdot p^{k_C(s)+k_R(s)} + (1-r) \cdot p^{k_C(s)} \cdot (1-p)^{k_R(s)}}{r \cdot p^{k_C(s)+k_R(s)} + (1-r) \cdot p^{k_R(s)} \cdot (1-p)^{k_C(s)}},$$

and $Pr(B|k_C(s)) = Pr(B|k_R(s)) \cdot D(s)$.

This means that only if the number of double counted signals that indicate B is the same as double counted signals indicating A, posterior beliefs of *naive* committee members are unbiased.

[3] I assume that in case of indifference, $Pr(B|k(s)) = d_i$, individual i will vote $v_i = 1$.

Proposition 1. In a deliberative committee the posterior belief of *naive* and *sophisticated* committee members is the same if and only if

$$k_C(s) = k_R(s).$$

Proof. The beliefs of *naive* committee members is unbiased if and only if $D(s) = 1$.

$$\begin{aligned}
D(s) =& 1 \\
r \cdot p^{k_C(s)+k_R(s)} + (1-r) \cdot p^{k_C(s)} \cdot (1-p)^{k_R(s)} =& r \cdot p^{k_C(s)+k_R(s)} + (1-r) \cdot p^{k_R(s)} \cdot (1-p)^{k_C(s)} \\
\left(\frac{p}{1-p}\right)^{k_C(s)} =& \left(\frac{p}{1-p}\right)^{k_R(s)} \\
k_C(s) =& k_R(s)
\end{aligned}$$

□

So, the only possibility for an unbiased belief of the *naive* committee members is the situation in which the difference between signals indicating B and signals indicating A is the same in all shared signals and in all shared sources. In all other cases the final belief of *naive* and *sophisticated* players differ from another and possibly lead to different decisions in the final vote, although they have the same individual threshold of doubt d_i. Given these differences in posterior beliefs and possibly voting decisions, it is important to understand whether committees with only *naive* or *sophisticated* committee members are more likely to make correct decisions. For the rest of this section I refer to committees with only *naive* members as *naive* committees and to those with only *sophisticated* members as *sophisticated* committees. I will compare *naive* and *sophisticated* committees for a situation where all available information is shared in deliberation. So, first I describe conditions for which full information sharing describes an equilibrium strategy for all members in a committee with only one type.

Full information sharing describes a strategy in which committee members reveal all signals they received in deliberation and, after updating their beliefs, they vote according to their preferences. This means for $Pr(B|k(s)) < d_i$ an individual i votes for a and for $Pr(B|k(s)) \geq d_i$ an individual i votes for b. To find equilibria when full information sharing behavior is a useful strategy, I introduce the *minimal consent committee* (MCC).

Definition 1. A **minimal consent committee** is a committee of n members in which for a voting rule m

$$\exists k^* \text{ s.t. } Pr(B|k^* - 1) < d_i \leq Pr(B|k^*)$$

is true for every committee member $i \in N$.

The *MCC* describes a situation in which full information sharing behavior is possible if the committee has only one type of committee members (Coughlan, 2000; Schulte, 2010). To see that full information sharing is part of an equilibrium if we have a MCC, consider a situation in which a voter is pivotal. A voter i in a MCC is pivotal whenever, given all other committee members play a full information sharing strategy, she received at least one signal $\sigma_{ij} = \beta$ and the difference between signals for both states of the world without i's signal (or source) is $k(s_{-i}) = k^* - 1$. Then whenever i shares her signal (source) the final belief of all committee members will be $Pr(B|k^*)$ and the decision b. Hence, voter i prefers information sharing if and only if $Pr(B|k^*-1) < d_i \leq Pr(B|k^*)$.

After establishing that in MCCs with one type of committee members all committee members fully reveal their private information, we can check whether fully *naive* or *sophisticated* committees are more likely to make a correct decision.

In a MCC of the same type, all information is shared in deliberation. So, the maximum of available information is aggregated. Further, all committee members make the same voting decision, so the voting rule m is not important for the outcome. Given some threshold k^* that defines the MCC, the probability to make a correct decision for any committee with only one type can be expressed by

$$Pr(o=\omega|k^*,n,z) = \sum_{s_n=0}^{n} Pr(s_n|n,z) \cdot \sum_{s_z=min\{s_n,1\}}^{min\{s_n,z\}} Pr(s_z|s_n,z) \cdot Pr(o=\omega|k^*,s_z)$$

where s_n is the number of informative signals received by all committee members and s_z is the number of independent sources available in s_n informative signals. In the expression above, we must differentiate between the two types of committees in the probability for a correct decision $Pr(o=\omega|k^*,s_z)$.

For a MCC with only *sophisticated* committee members

$$\begin{aligned} Pr(o=\omega|k^*,s_z)_R = & \sum_{s'_\alpha=0}^{\frac{1}{2}(s_z-k^*)} \binom{s_z}{s'_\alpha} p^{s_z-s'_\alpha}(1-p)^{s'_\alpha} r + \\ & \sum_{s'_\alpha>\frac{1}{2}(s_z-k^*)}^{s_z} \binom{s_z}{s'_\alpha} p^{s'_\alpha}(1-p)^{s_z-s'_\alpha}(1-r) \end{aligned}$$

where s'_α is the number of sources in s that show α. As *sophisticated* committee members do not double count signals that are shared twice by different committee members, the outcome depends only on the independent sources that are shared.

In a MCC with only *naive* committee members the probability to make the correct decision is based on the total number of informative signals received and the number of independent signals:

$$\begin{aligned} Pr\left(o=\omega|k^*,s_n,s_z\right)_C = &\sum_{s'_\alpha=0}^{s_z} Pr\left(s_\alpha \leq \frac{s_n-k^*}{2}\right)\binom{s_z}{s'_\alpha}p^{s_z-s'_\alpha}(1-p)^{s'_\alpha}r+ \\ &\sum_{s'_\alpha=0}^{s_z} Pr\left(s_\alpha > \frac{s_n-k^*}{2}\right)\binom{s_z}{s'_\alpha}p^{s'_\alpha}(1-p)^{s_z-s'_\alpha}(1-r) \end{aligned}$$

with

$$\begin{aligned} &Pr\left(s_\alpha \leq \frac{s_n-k^*}{2}\right) = \\ &\sum_{s_\alpha=s'_\alpha}^{\frac{1}{2}(s_n-k^*)}\binom{s_n-s_z}{s_\alpha-s'_\alpha}\left(\frac{s'_\alpha}{s_z}\right)^{s_\alpha-s'_\alpha}\left(\frac{s_z-s'_\alpha}{s_z}\right)^{s_n-s_z-s_\alpha+s'_\alpha} \end{aligned}$$

and

$$\begin{aligned} &Pr\left(s_\alpha > \frac{s_n-k^*}{2}\right) = \\ &\sum_{s_\alpha>\frac{1}{2}(s_n-k^*)}^{s_n-k^*}\binom{s_n-s_z}{s_\alpha-s'_\alpha}\left(\frac{s'_\alpha}{s_z}\right)^{s_\alpha-s'_\alpha}\left(\frac{s_z-s'_\alpha}{s_z}\right)^{s_n-s_z-s_\alpha+s'_\alpha} \end{aligned}$$

Previous authors who compare *naive* and *sophisticated* electorates find that *naive* electorates aggregate the same or more information than rational electorates. For certain voter distributions *naive* electorates have a higher vote share for the optimal policy than *sophisticated* electorates (Levy and Razin, 2015*a*). In the committee model described here, information aggregation is part of the deliberation stage and in a MCC of one type the same amount of information is aggregated in both committees, as always all signals are disclosed truthfully. However, there is a

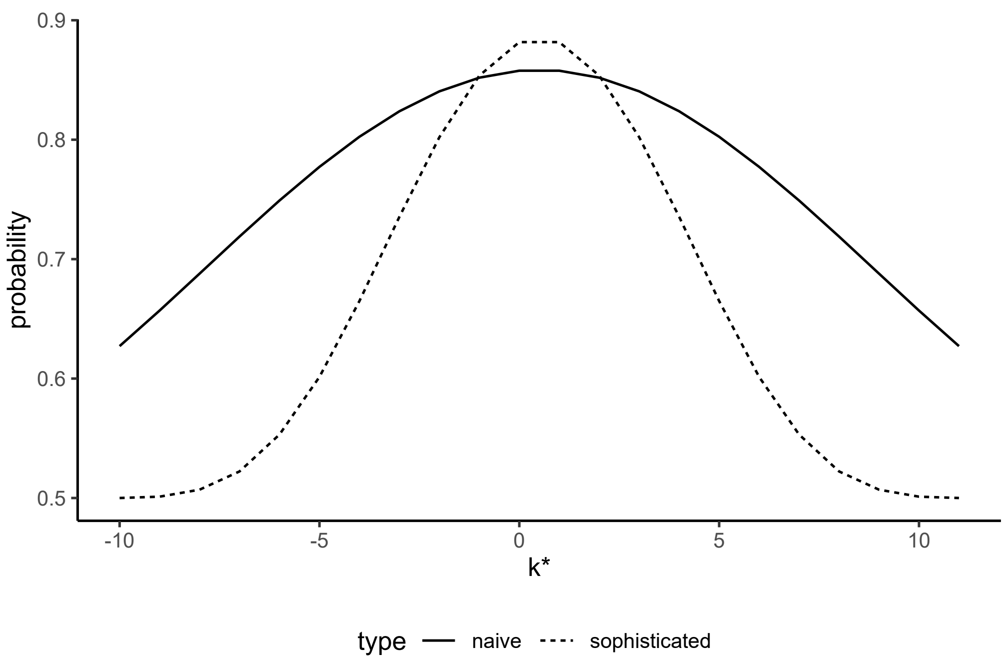


Figure 2.1: Probability to make the correct decision for committees with one type MCCs with increasing k^*. Other values are set at $n = 20$, $z = 10$, $q = 0.2$, $p = 0.7$, $r = 0.5$

difference between *naive* and *sophisticated* committees in their probability to make the correct decision depending on the critical value k^*.

Figure 2.1 shows a plot for a committee with changing critical values k^* from -10 to 10, given parameters for q, p, r, n and z. While for both types, the probability to make the correct decision is increasing with weaker preferences — a k^* closer to 0 — the curve of *sophisticated* committees is steeper.

Figure 2.1 gives us some intuition for the effect of different k^* on the probability for the two types of committees to make the correct decision. While it might seem reasonable to believe that committees with only *sophisticated* committee members are more likely to make a correct decision, figure 2.1 shows that for some "extreme" k^* *naive* committees are more likely to make the correct decision. The reason for this observation is that *naive* committee members always base their decision on more signals than *sophisticated* committee members. So, there is always a higher probability that *naive* committee members of a MCC with strong preferences is convinced of the opposite decision based on correlated signals than for *sophisticated* committee members who only count the available sources. The result that *naive* committee members base their voting decision more on information than *sophisticated* committee members is comparable with the finding by Levy and Razin (2015*a*) that *naive* electorates aggregate more information in elections than *sophisticated* electorates.

Proposition 2. For $z < n$, there always exists some k^* for which *naive* committees are more likely to make the correct decision than *sophisticated* committees.

To understand the reasoning behind proposition 2, assume $r \leq 0.5$ and $k^* = -n$. Then for both *sophisticated* and *naive* committees the probability to make a correct decision is the prior probability r which is the lower bound in this case. Next, assume some $k^{*'} = -n + 1$ and $n - 1 \geq z$. Then for the *sophisticated* committees $Pr(o = \omega|k^{*'}, n, z)_R = r$ as they cannot be convinced by the evidence. However, for the *naive* committee

$$Pr(o = \omega|k^{*'}, n, z)_C > Pr(o = \omega|k^*, n, z)_C$$

So, $Pr(o = \omega|k^{*'}, n, z)_C > Pr(o = \omega|k^{*'}, n, z)_R$.
The same reasoning can be used to show that for $r \geq 0.5$, $k^* = n$ and $k^{*'} = n - 1$, $Pr(o = \omega|k^{*'}, n, z)_C > Pr(o = \omega|k^{*'}, n, z)_R$.
The full proof can be found in the appendix A.2.

Proposition 2 suggests that for extreme values of k^* *naive* committees are more likely to make the correct decision. However, figure 2.1 suggests that for some moderate value of k^* *sophisticated* committees are more likely to make the correct decision, which is not necessarily true (e.g. for $z \leq 2$). Looking at proposition 2 we can at least say that there is always some k^* for which both *naive* and *sophisticated* MCCs are a priori equally likely to make the correct decision.

Figure 2.2 shows the probabilities to make correct decisions for some extreme cases to get an impression of the different effects k^* can have on the probability to make the correct decision for *naive* and *sophisticated* MCCs. From the top graph, we can see how the prior belief r acts as a lower bound for the *sophisticated* committee if $z = |k^*|$. In the middle graph we can see that this is also true for the *naive* committee if $n = |k^*|$. So the boundary is reached at more extreme k^* for *naive* committees than for *sophisticated* committees if $n > z$. The bottom graph gives an insight how a higher q decreases the difference in the probability to make the correct decision for *naive* and *sophisticated* committees. An increase in q makes informative signals overall less likely and therefore decreases the probability of double counting of signals. We could say the bottom graph describes a situation with scarcity of any information.

2.5 Information Aggregation in Committees with Both Types

Full information sharing is possible in a committee with only one type of individuals if the committee is a MCC (see also Schulte 2010). Committees that have both types of committee members bear the additional problem that not all individuals

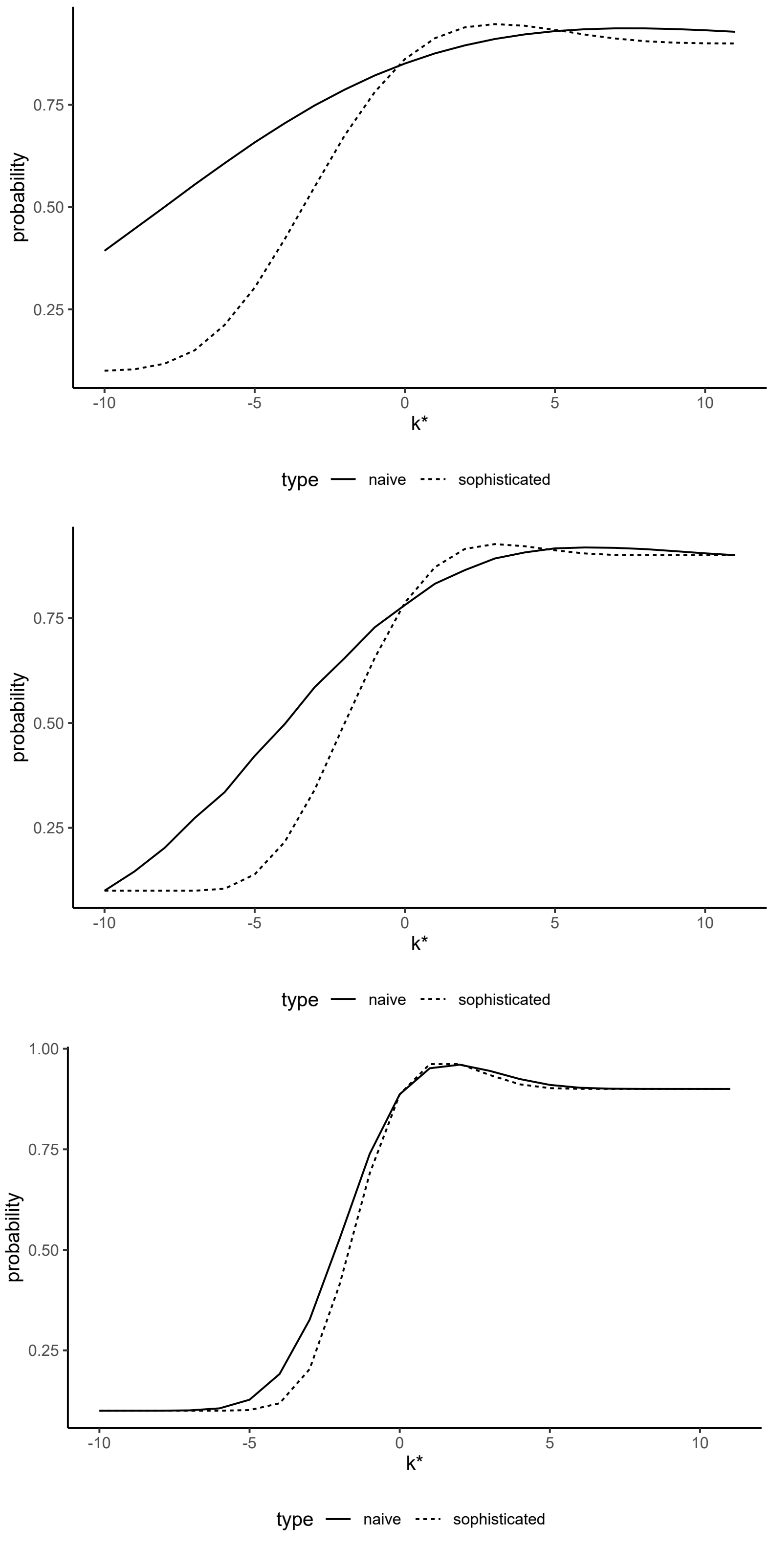


Figure 2.2: Probability for committees with one type MCCs with increasing k^*.
values top: $n = 20$, $z = 10$, $q = 0.1$, $p = 0.7$, $r = 0.1$
values middle: $n = 10$, $z = 7$, $q = 0.1$, $p = 0.7$, $r = 0.1$
values bottom: $n = 10$, $z = 7$, $q = 0.7$, $p = 0.7$, $r = 0.1$

necessarily end up with the same posterior belief about the state of the world.

Remember the example in the beginning where two committee members received the identical signal that indicated to introduce a new policy while the third member received a different signal that suggested to keep the status quo. Now, assume that one of the members who received the signal that indicated to introduce a new policy is *sophisticated*, while the other two members are *naive*. Further, assume that the decision is made using simple majority. If all committee members truthfully share their signals, then in posterior, the *sophisticated* individual would have preferred to hide the signal. So, a priori the *sophisticated* committee member would assume situations where the own signal might be pivotal for the voting decision of the other *naive* committee members and decide whether to share or not share the signal based on the probability that in either case the *sophisticated* committee member would make the same voting decision given the evidence as the *naive* committee members. So, the decision whether to share evidence or not depends not only on the preferences and the critical k^* as in the case of a committee with only one type, but also on the expectation of the evidence in deliberation s.

Corollary 1. In a committee with *naive* and *sophisticated* committee members, the assumption of a minimal consent committee is not a sufficient condition for full information sharing to be a perfect Bayesian equilibrium.

Corollary 1 is a direct effect of the problem that we have two different beliefs in a committee unless $D = 1$. The possible or probable existence of two beliefs affects the information sharing of rational actors. An individual committee member assesses the situations in which it might be pivotal. Under the assumption of being pivotal, committee members know whether their expected belief will be larger or smaller than that of the other type. Based on their expectation about their belief in the situation of being pivotal, a rational committee member decides on sharing or hiding information. This already suggests that generally situations exist in which full information sharing is still possible. When both types of committee members expect that sharing information is beneficial, both types can commit to full sharing. In the following I apply the three committee member example to the model and show that there exist parameters that suggest that sharing or hiding information is beneficial.

To see that for a *sophisticated* committee member it cannot always be an equilibrium strategy to share all signals consider the case of a three member MCC with two *naive* and one *sophisticated* committee member. Assume there exist two independent sources and $k^* = 0$. The *sophisticated* committee member received a signal $\sigma_{ij} = \alpha$. If both *naive* players share all information and the voting rule is $m = 2$, the *sophisticated* committee member is pivotal in two cases, either if the other two committee members did not receive any signals at all or one received a signal α and the other β. The *sophisticated* committee member wants to share the signal if it is the only signal and hide it if both of the others received a signal. So, the *sophisticated* committee member shares the signal if

$$q^2 \geq (1-q)^2 \binom{2}{1} p(1-p)$$

where q^2 is the probability that no other committee member received any information and $(1-q)^2\binom{2}{1}p(1-p)$ the probability that one member received the same α-signal as the *sophisticated* committee member and the other received a different β-signal.

We can see that there are situations in which the committee member would want

to share $\sigma_{ij} = \alpha$ (e.g. $q = 0.3$, $p = 0.9$) and in which it would be beneficial to hide the signal (e.g. $q = 0.1$, $p = 0.7$).
Next, assume the *sophisticated* player received the signal $\sigma_{ij} = \beta$. Then the *sophisticated* player is pivotal for one case, namely when only one other player received a signal from the other source that is α. In this case the *sophisticated* player would always want to share the signal.

Next, consider the same situation ($n = 3, z = 2, k^* = 0$) but this time with two *sophisticated* and one *naive* committee member. If both *sophisticated* committee members share all information, the *naive* committee member is pivotal when receiving a signal $\sigma_{ij} = \alpha$ only if none of the other players received a signal. So, the *naive* player would always want to share the α-signal. However, when receiving a β-signal, the *naive* committee member is pivotal when either only one of the other players received a signal that was α or both of the other players received a signal that was α. The *naive* player wants to share the β-signal for the first situation but not the second, so only if

$$q(1-q)((1-p)r + p(1-r)) \geq \frac{1}{4}(1-q)^2((1-p)^2r + p^2(1-r))$$

where $q(1-q)((1-p)r+p(1-r))$ is the probability that only one committee member received the other signal and it was α and $\frac{1}{4}(1-q)^2((1-p)^2r + p^2(1-r))$ is the probability that both received the same signal that was α.

Again, we find situations in which the *naive* player would want to share the signal (e.g. $q = 0.3$, $p = 0.9$, $r = 0.5$) and situations in which the *naive* player prefers hiding (e.g. $q = 0.1$, $p = 0.7$, $r = 0.5$). So in the particular case of three committee members in a MCC, we can find conditions for which full information sharing describes equilibrium strategies independent of the type but also conditions for which this is not possible.

The example above shows that there are situations where for both types of committee members full information sharing is possible. The examples work with the assumption that there is a majority of one type that does not need any votes from the other type for the final decision. However, looking at the example we can easily see that there exist situations in which full information sharing describes an equilibrium strategy even under the unanimity rule ($m = 3$).

Proposition 3. In a MCC with both types of committee members, there always exists an equilibrium where both types share all available information if

1. $Pr(k_C(s) \geq k^*|k_R(s) = k^*) \geq Pr(k_C(s) \leq k^* - 1|k_R(s) = k^*)$ and
2. $Pr(k_C(s) \leq k^* - 1|k_R(s) = k^* - 1) \geq Pr(k_C(s) \geq k^*|k_R(s) = k^* - 1)$ and
3. $Pr(k_R(s) \geq k^*|k_C(s) = k^*) \geq Pr(k_R(s) \leq k^* - 1|k_C(s) = k^*)$ and
4. $Pr(k_R(s) \leq k^* - 1|k_C(s) = k^* - 1) \geq Pr(k_R(s) \geq k^*|k_C(s) = k^* - 1)$

for all $i \in N$.

A proof for proposition 3 can be found in the appendix A.3. However, the proposition shows that only under special conditions full information sharing in a MCC can be an equilibrium. We can see that if there is a (qualified) majority of one type, meaning that $n_C \geq m$ or $n_R \geq m$, less conditions apply increasing the space for possible full information equilibria.

Corollary 2. In a MCC with either $n_C \geq m$ or $n_R \geq m$ the space for possible full information equilibria is weakly larger.

The corollary 2 is a direct consequence of the proof of proposition 3. Assume the case with $n_C \geq m$. Then the pivotal committee member in the voting stage is always of the *naive* type. Therefore, for any *naive* committee member full information sharing is an equilibrium strategy in a MCC given that all committee members share all information. For the minority of *sophisticated* committee members, full information sharing is only an equilibrium strategy if

- $Pr(k_R(s) \geq k^*|k_C(s) = k^*) \geq Pr(k_R(s) < k^*|k_C(s) = k^*)$ and
- $Pr(k_R(s) < k^* - 1|k_C(s) = k^* - 1) \geq Pr(k_R(s) \geq k^* - 1|k_C(s) = k^* - 1)$

Assuming a (qualified) majority of *sophisticated* committee members, $n_R \geq m$, it is always an equilibrium strategy to share all information for *sophisticated* committee members. For the minority of *naive* committe members, full information sharing is an equilibrium strategy if

1. $Pr(k_C(s) \geq k^*|k_R(s) = k^*) \geq Pr(k_C(s) < k^*|k_R(s) = k^*)$ and
2. $Pr(k_C(s) < k^* - 1|k_R(s) = k^* - 1) \geq Pr(k_C(s) \geq k^* - 1|k_R(s) = k^* - 1)$

Therefore, a (qualified) majority reduces the number of conditions that need to be fulfilled for a full information equilibrium to be possible, increasing the space for possible full information equilibria.

The result of corollary 2 shows that information sharing becomes more difficult in committees with unclear majorities. In a MCC with only one type of committee members full information sharing is always an equilibrium, independent of the majority voting rule m. In mixed committees the number of conditions that need to be fulfilled for full information sharing to be an equilibrium depends on both the heterogeneity and the voting rule m. For $n_C = n_R$, there exists no majority voting rule m that could lead to a majority of one type that determines the committee decision. The simple majority rule is the voting rule that allows for most heterogeneity in committees without the need to fulfill all conditions mentioned in proposition 3 for a full information sharing equilibrium.

In the next section I discuss how the findings on committees with members with and without correlation neglect connect to the existing literature on the effect of correlation neglect for information aggregation and decision making. Further, I give insights to which degree the findings can be extended to other possible differences in belief updating between individuals.

2.6 Discussion

Research on decision making in committees was mainly determined to explain how information aggregation and effective decision making is possible when preferences of individuals differ. This is the first theoretical model that analyzes how differences in information processing make information aggregation in deliberation even more difficult. Proposition 1 shows that heterogeneity in belief updating can lead to different posterior beliefs of individuals based on the same information. This can lead to conflict even for extremely similar preferences. Accordingly, it is important to take into account differences in information processing between individuals in research on group decision making. The main contribution of this article is to show that differences in information processing, in this case due to correlation neglect, require more conditions for possible full sharing equilibria in deliberative committees beyond similarity in individuals' thresholds of doubt.

Concerning the question whether *naive* or *sophisticated* committees are more likely to make the correct decision, proposition 2 suggests that for some extreme preferences naive committees perform better. Previous authors concluded that *naive* electorates aggregate at least as much information in elections as *sophisticated* electorates (Levy and Razin, 2015*a*). My analysis supports this finding by showing that *naive* committees with extreme preferences are more likely to make the correct decision than *sophisticated* committees with extreme preferences. There is always some preference for which *naive* committees are more likely to make the correct decision than *sophisticated* committees.

Based on this finding we can conclude that the bias of correlation neglect itself is not problematic for both information aggregation and decision making if there is only one type of committee member. For mixed committees this is not true. Conditions that enable full information sharing in deliberation are already strict in committees with individuals of the same type and differing preferences (Coughlan, 2000; Schulte, 2010). Differences in information processing add the possibility that individuals have the same preferences but still come to different conclusions. Proposition 3 shows that full information sharing is still possible in mixed committees. However, there are more conditions that need to be met. This is true even when all committee members have the same preferences. Qualified majorities of one type potentially increase the space for full information sharing as stated in corollary 2. This suggests that more heterogeneity in belief updating in committees makes full information sharing more difficult as it reduces the probability for (qualified) majorities. Since the problem is the existence of two different beliefs, we should expect similar problems for all situations where the same information leads to different beliefs. Further research is needed to understand the effect of other cognitive biases in pure and mixed committees on the quality of decision making. Differences in information processing could also affect decisions and information aggregation in principal agent relationships or other situations that include information exchange.

However, the results described above are based on the assumption of individuals knowing that they are of one type and another individual is of another type. While it is unreasonable to assume that individuals know how others process information and whether they differ in their information processing, it is probable that people have beliefs about the information processing. For rational individuals, believing that others process information differently may be enough to change the own information provision strategy and hide information in deliberation. Empirical findings on the "third-person effect" suggests that individuals tend to believe that information in mass media has a stronger effect on others than themselves (Albert, 1991; Perloff, 1993). The believe that information affects others differently than oneself may be enough to trigger the strategic hiding behavior described by the model above and may decrease the amount of information that can be aggregated in a deliberative committee.

Our understanding of the effects of differences in information processing on individuals' behavior and information provision strategies is still limited. This paper provides some first insights on the effect correlation neglect on decision making and information aggregation. As other authors have shown before, cognitive biases do not necessarily lead to worse outcomes. However, differences in belief updating in committees potentially hinder information aggregation in deliberation. This finding is not exclusive for the cognitive bias of correlation neglect and must be explored more thoroughly for other differences in belief updating.

3

Strategic Reactions to Confirmation Bias in Committees: An Experimental Study of Strategic Information Sharing

3.1 Introduction

Scholars from different disciplines examined why individuals process information differently (Druckman and McGrath, 2019; Flynn, Nyhan and Reifler, 2017; Gilens, 2001) and how different information processing affects individuals' beliefs and decisions (Swire-Thompson et al., 2020; Taber and Lodge, 2006; Fryer, Harms and Jackson, 2019). However, little is known about individuals' reactions to differences in information processing. Knowing that the information at hand changes others' beliefs in a different way than one's own might make someone think twice before sharing information.

Strategic provision of information is mainly discussed in the context of diverging preferences (Crawford and Sobel, 1982; Coughlan, 2000; Schulte, 2010). However, more recent findings suggest that not only diverging preferences lead to different decisions, but also differences in information processing (Levy and Razin, 2015*a*; Glaeser and Sunstein, 2009; Fryer, Harms and Jackson, 2019; Taber and Lodge, 2006). I argue that knowing others' cognitive bias makes strategic actors refrain from fully and truthfully sharing all information available.

I present a model of committee decision making where agents differ in information processing. Differences in information processing are assumed to be caused by confirmation bias. Individuals with confirmation bias put more weight on signals that support their preferred state of the world. The model's predictions suggest that strategic actors react to differences between their own and other agents' belief updating by changing their information sharing strategy. Large differences in the updating function restrain the exchange of information between committee members in deliberation. The predictions are tested in an online experiment. Participants decide in a committee with automated players about the color of an urn, which is either blue or red with equal probability. All committee members receive two private independent signals that can be informative or not. Informative signals show one of the two possible colors of the urn. The probability that it is the correct color is higher than 50%. An uninformative signal means that the participant receives no signal. Subsequently, participants decide which of the informative signals they want to share with the automated players in the deliberation stage. The outcome is decided using simple majority voting. While in the control setting automated players decide for the color with the higher probability of being correct based on the shared signals, in the treatment condition automated players undervalue red signals. The biased information processing of automated players can be observed by participants, so they can react accordingly in information sharing and voting.

The results show that most participants realize that automated players undervalue red signals. Evidence for strategic hiding of blue signals in the treatment group supports the model's predictions. Further, there is no evidence of strategic hiding of red signals in the treatment group, nor of any strategic hiding in the control group. To the best of my knowledge, this is the first experiment testing strategic reactions of individuals to others' cognitive biases. The results are an important contribution to our understanding of strategic information provision in committees when individuals are aware that others process information differently from themselves.

3.2 Related Literature

Literature on cognitive biases suggests that some individuals aggregate information not only in a non-Bayesian way, but have systematic biases in information processing (Agnew et al., 2018; Fryer, Harms and Jackson, 2019; Enke and Zimmermann, 2017). Confirmation bias, which describes individuals' tendency to interpret ambiguous signals as (more) supportive of their preferred hypothesis or state of the world, can lead to polarization and overconfidence in their own beliefs (Rabin and Schrag, 1999; Fryer, Harms and Jackson, 2019). In political science and psychology, the phenomenon of motivated reasoning is mainly used to describe the tendency of individuals to use information to reach a preferred conclusion (Stone and Wood, 2018).

Confirmation bias and motivated reasoning are closely related concepts (Stone and Wood, 2018; Kahan, 2015). Reasons for preferring information that supports one's own opinion are a positive self-conception (Dunning, 2003) or the intent to keep information coherent to support one's own decisions (Russo et al., 2008). Information that contradicts one's own opinion is often perceived as less credible (Druckman and McGrath, 2019; Kraft, Lodge and Taber, 2015) or is found to change beliefs but not the interpretation of information (Gaines et al., 2007; Parker-Stephen, 2013; Swire-Thompson et al., 2020). Like confirmation bias, motivated reasoning leads to overconfidence in one's own belief and polarization (Taber and Lodge, 2006; Parker-Stephen, 2013). While the effects on one's own belief and reasons for confirmation bias or motivated reasoning are well-studied, strategic (re)actions to others who process information differently remain unclear. Can altering or hiding information be strategic decisions to counteract the effects of differences in information processing?

Strategic information transmission generally applies to a better-informed sender and less informed receiver who has to make a decision that determines both players' payoff. In this setting, transmitted signals can be partially informative if preferences are similar (Crawford and Sobel, 1982). Information or signals can also be sent strategically in group decision making. In committees, individuals are often privately and imperfectly informed about the true state of the world. Condorcet (1976) prominently states that majority voting aggregates information efficiently, given that all individuals follow the signal they received. Strategic actors do not necessarily vote according to their private signals (Austen-Smith and Banks, 1996; Feddersen and Pesendorfer, 1998). They condition their voting decision on the event of being pivotal and, therefore, might vote against the signal they received. Experimental evidence supports the expectation of strategic voting (Guarnaschelli, McKelvey and

Palfrey, 2000; Goeree and Yariv, 2011). When committee members can communicate about their signals prior to voting, sincere information sharing and voting are possible if preferences are similar (Coughlan, 2000). Schulte (2010) shows that similar conditions apply in a committee situation with verifiable information. In this setting, individuals cannot lie about their private signals but have the option of hiding it. If preferences are closely aligned, full information sharing is possible. Divergence in preferences is the main obstacle for information provision studied in the current literature on information aggregation in both sender-receiver and committee settings. However, when differences in information updating are apparent, people can come to different conclusions despite having the same preferences, prior beliefs, and information. When differences in information updating make the information provision of individuals pivotal, strategic actors alter their behavior from truthfully sharing the private signal they received. I provide some first insights on (re)actions to differences in information processing with a model of committee decision making where individuals differ in their belief updating due to confirmation bias. To the best of my knowledge I provide the first experimental evidence for strategic reactions of individuals to biased information processing of others.

3.3 An Approach to Committee Decision Making With Confirmation Bias

Consider a set $N = \{1, 2, ..., n\}$ of n players who act as a committee to make a decision on a policy by some majority voting rule. First, nature chooses the state of the world $\omega = \{A, B\}$ with $Pr(\omega = B) = r \in (0, 1)$ and $Pr(\omega = A) = 1 - r$.

The policy outcome is determined following some majority voting rule $m \in (\frac{n}{2}, n]$, so whenever at least m members vote for b, the outcome is b; otherwise the outcome is a. A committee member i derives utility $u_i(a, A) = u_i(b, B) = 0$, $u_i(b, A) = -d_i$ and $u_i(a, B) = -(1 - d_i)$, with $d_i \in (0, 1)$. d_i is called the individual threshold of doubt, as committee members with a posterior belief $Pr(B) \geq d_i$ prefer to vote for b while those with a posterior belief $Pr(B) < d_i$ vote for a. Therefore, a smaller d_i indicates a preference for decision b. All committee members thus have the common goal to match the state of the world.

Prior to voting, every member i receives two private, independent signals about the state of the world $\sigma_i, \sigma_i' \in S^i = \{\alpha, \beta, \varnothing\}$. Here, $\varnothing$ indicates an uninformative signal and $Pr(\sigma_i = \varnothing) = q$. Whenever a signal is informative it shows the true state of the world with a probability of $p \in (0.5, 1)$, so that $Pr(\sigma_i = \alpha|A) = Pr(\sigma_i = \beta|B) = (1-q)p$ and $Pr(\sigma_i = \beta|A) = Pr(\sigma_i = \alpha|B) = (1-q)(1-p)$.

Committee members can share their signals in a deliberation stage. Every committee member i with σ_i can share either σ_i or $\varnothing$. That is, committee members cannot lie about the informative signal, but can hide it by sending an uninformative signal. Let $S = S^1 \times S^1 \times S^2 \times S^2 \times ... \times S^n \times S^n$ denote the signal space for $2n$ signals. Shared signals are represented by a signal profile $s = (\sigma_1, \sigma_1', \sigma_2, \sigma_2', ...\sigma_n, \sigma_n') \in S$.

After deliberation, the committee members' posterior belief about the probability that $\omega = B$ is given by Bayesian updating using the parameter $k_i(s)$:

$$Pr(B|k_i(s)) = \frac{r \cdot p^{k_i(s)}}{r \cdot p^{k_i(s)} + (1-r) \cdot (1-p)^{k_i(s)}} \ .$$

The difference $k_i(s)$ defining the posterior belief $Pr(B|k_i(s))$ for an individual

$i \in N$ is given by:

$$k_i(s) = k_\beta(s) - c_i \cdot k_\alpha(s)$$

Here, $k_\alpha(s)$ denotes the number of α-signals in the signal profile s and accordingly $k_\beta(s)$ the number of β-signals.

Let $c_i \geq 0$ be a bias parameter that describes how individuals "weight" α-signals. I study situation where the bias parameter c_i describes confirmation bias. So, if there are two individuals i and j with $d_j > d_i$, meaning that individuals i has a predisposition for b compared to j, then $c_j \geq c_i$, meaning that j "weights" α-signals stronger than i.

Definition 2. If there exists a ranking for the tuples $(c_1, c_2, ..., c_n)$ and $(d_1, d_2, ..., d_n)$ such that $d_1 \leq d_2 \leq ... \leq d_n$ and $c_1 \leq c_2 \leq ... \leq c_n$, the bias parameter c_i describes *confirmation bias*.

I assume for the following that definition 2 is always fulfilled, so I study situations where individuals have confirmation bias. We say a committee member with $c_i < 1$ undervalues and with $c_i > 1$ overvalues α-signals. An individual with $c_i = 1$ has no effective bias.[1]

After deliberation, committee members cast their final vote $v_i \in \{0, 1\}$ to decide about the outcome $\{a, b\}$ following a majority rule m. For $\sum_{i=1}^{n} v_i \geq m$, the outcome is b, otherwise it is a. Given their utility function, a committee member i votes for

[1]The definition of confirmation bias diverges technically from definitions of other authors like Rabin and Schrag (1999) or Fryer, Harms and Jackson (2019). The effect of my implementation is that individuals who face ambiguous evidence like two β-signals and two α-signals interpret the evidence in direction of their own predisposition. Further, my definition has the advantage that it can easily be implemented in an experimental setting and be understood by participants.

b, so $v_i = 1$, whenever $Pr(B|k_i(s)) \geq d_i$ and for a, so $v_i = 0$, otherwise.

In this setting, strategic actors base their decision in both voting and deliberation on the event of being pivotal. An agent i is pivotal in voting whenever her vote changes the outcome from a to b and in deliberation when sharing or hiding some signal σ_i or σ_i' changes the vote by the pivotal voter m.

The general setting has several equilibria. From the perspective of effective information aggregation, symmetric equilibria with a full information sharing strategy are of interest. Full information sharing describes a strategy where all committee members reveal all signals they received and then vote to maximize their expected utility. Previous results on committee decision making established that full information sharing behavior can be a perfect Bayesian equilibrium when either their own information can never change the outcome or a closeness condition is fulfilled (Coughlan, 2000; Schulte, 2010).

The full information sharing equilibrium in this model is related to the ones found for authors who studied the effect of diverging preferences on information aggregation (Coughlan, 2000; Schulte, 2010). There are three cases in which full information sharing can be an equilibrium strategy. The first two cases are extreme situations where information cannot change the committee decision at all due to the distribution of thresholds of doubts of committee members. These cases are of less interest as information has no effect on the final decision. The third case is characterized by a closeness condition comparable to that of previous authors (Coughlan, 2000; Schulte, 2010).

The closeness condition demands that the individual thresholds of doubt d_i have to be between two values $Pr(B|k^{'})$ and $Pr(B|k^{''})$ for all committee members

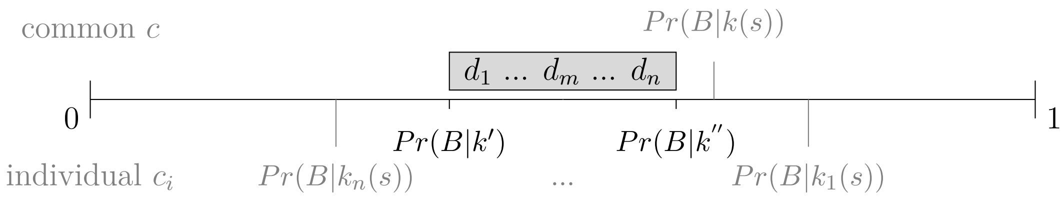


Figure 3.1: The effect of heterogeneous bias parameters c_i on posterior beliefs and the existence of full information sharing equilibria

as depicted in figure 3.1. The values of $k^{'}$ and $k^{''}$ are such that hiding one signal α or β changes the decision of all committee members if their "weighting" of α-signals is close enough. If all committee members had the same bias parameter c, they would all end up with the same posterior belief $Pr(B|k(s))$ as depicted in the upper part of figure 3.1 and make the same voting decision. However, the problem with individual and heterogeneous bias parameters c_i is that all committee members have potentially different posterior beliefs $Pr(B|k_i(s))$. Hence, even if thresholds of reasonable doubt fulfill the closeness condition, biases might lead to posterior beliefs as depicted in the lower part of figure 3.1, where committee member 1 and n still make different voting decisions.

Proposition 4. Let committee members be ordered such that $d_1 \leq d_2 \leq ... \leq d_n$. Full information sharing behavior describes a perfect Bayesian equilibrium for a given voting rule m if and only if one of the following three conditions is true:

1. $d_m \leq Pr(B|k_m(s))$ with $k_m(s) = -c_m 2n$; or
2. $Pr(B|k_m(s)) < d_m$ with $k_m(s) = 2n$; or
3. (a) $\exists k^{'}$ and $\exists k^{''} \in \{1-c_n(2n-1), 1-c_n(2n-2), ..., 2n\}$ such that $Pr(B|k^{'}) \leq d_i \leq Pr(B|k^{''})$ for all $i \in N$.

   (b) The borders $k^{'}$ and $k^{''}$ exist if there exists a Δ such that $Pr((c_n - c_1)k_\alpha(s) < \Delta) \geq Pr((c_n - c_1)k_\alpha(s) \geq \Delta)$ and $k^{''} - k^{'} < min\{1, c_m\} - \Delta$.

A proof of proposition 4 can be found in appendix B.1. Proposition 4 defines the three cases for which full information sharing behavior describes a perfect Bayesian equilibrium. Compared to previous findings, in this model the third case, the closeness condition, depends on the difference between the individual bias parameters of the most extreme committee members $c_n - c_1$ and the signal profile s. The dependence on condition 3.(b) makes the decision to share or hide signals more complex and dependent on the a priori unknown signal profile. Still, committee members can maximize their expected utility by conditioning their decisions on the probability that condition (3.b) is violated.

In the situation described, the full sharing equilibrium is interesting as it shows when information can be efficiently aggregated. Nevertheless, the results of proposition 4 show that in many situations full information sharing is not a best response strategy. In the following section I will show how the best response of an individual i depends on their belief about the bias c_m of the pivotal committee member m.

I demonstrate that not the actual bias c_m but only the relative difference to the individual's own bias parameter c_i is important for deciding whether to share or hide information.

3.4 Best-Response Strategies

In committee situations of incomplete information, best-response strategies have to be determined given beliefs about the state of the world and strategies chosen by the other players. For the following, I assume that a committee member i believes that all committee members $j \neq i$ truthfully reveal all signals they received. Based on this belief, committee member i chooses a strategy to maximize her utility given her private signals σ_i and σ_i'.

To further understand the effect of differences in biases on information aggregation, I analyze how the expected utility of sharing all information depends on the bias of other players c_j and one's own bias c_i. As in all situations of group decision making, strategic actions are dependent on the event of being pivotal. Given the ordering from definition 2, the committee member m is the pivotal voter because m is the last voter needed for a majority. Considering the deliberation stage, sharing or hiding signals changes the expected utility of a committee member i if the shared private signals change the decision of the pivotal or decisive committee member m. The expected utility for any strategy under the belief of a certain value for c_m can be described by:

$$EU_i^{c_m}(strategy|\sigma_i, \sigma_i') = \sum_{s \in S}(Pr(s|\sigma_i, \sigma_i') \cdot Pr(a|s) \cdot Pr(B|k_i(s)) \cdot u_i(a, B) +$$
$$Pr(s|\sigma_i, \sigma_i') \cdot Pr(b|s) \cdot Pr(A|k_i(s)) \cdot u_i(b, A))$$

The term above can be rewritten as:

$$EU_i^{c_m}(strategy|\sigma_i, \sigma_i') = \sum_{s \in S}(Pr(s|\sigma_i, \sigma_i') \cdot Pr(a|s) \cdot (d_i - Pr(B|k_i(s)))) -$$
$$d_i \cdot \sum_{s \in S}(Pr(s|\sigma_i, \sigma_i') \cdot (1 - Pr(B|k_i(s)))) \tag{E1}$$

While the second term of E1 is always negative and independent from other committee members, the first term depends on $Pr(a|s)$. $Pr(a|s)$ is either 1 or 0 depending on the decision by the decisive committee member m with a bias c_m and a threshold of reasonable doubt d_m. Whenever $Pr(B|k_i(s)) < d_i$ and $Pr(a|s) = 1$ the whole first term of E1 is ≥ 0, meaning when the voting behavior of i and the decisive voter m is the same given s, it cannot decrease the expected utility of individual i. However, when i and m differ in their voting behavior, $Pr(B|k_i(s)) \geq d_i$ and $Pr(a|s) = 1$, the term is ≤ 0, decreasing the expected utility. Accordingly i prefers situations in which the decisive voter m and i make the same voting decision. Assuming a common threshold of reasonable doubt d, the relative difference between the biases c_i and c_m determines the best response strategy for i.

Figure 3.2 shows the expected utility for three different strategies for two different individual biases c_i. The best response strategy changes from full information sharing to hiding either α or β the larger the difference between c_i and c_m. In the

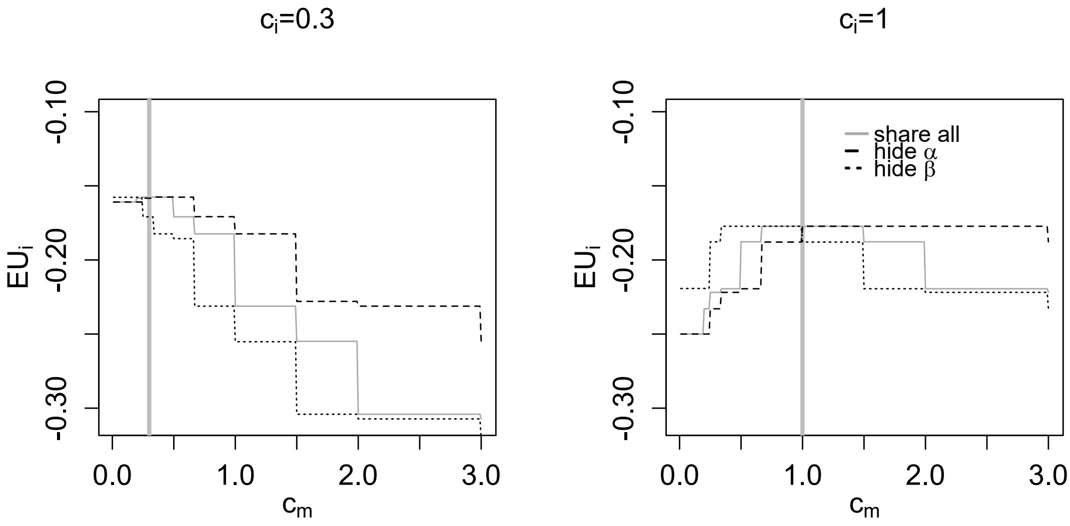


Figure 3.2: Expected utility of an agent i who received two signals $\sigma_i = \alpha$ and $\sigma_i' = \beta$ for $d_i = d_m = 0.5$, $r = 0.5$, $q = 0.1$, and $p = 0.6$ for different values of c_m. The two panels differ in the individual bias of i which is $c_i = 0.3$ and $c_i = 1$.

graph, we can see that the size of the bias c_i is not important for choosing a best response strategy but instead the relation to the decisive voter's bias c_m.

3.5 The Experimental Design

I tested the model's implications in an online experiment. Participants in the experiments received 1$ for attentive participation and an additional bonus that depended on luck and their own decisions in four different tasks: (1) a warm up game on probabilities, (2) the group decisions with the automated players, (3) their belief about the automated players information processing, and (4) their decision in a risk game.

In the warm up game, the participants were introduced to the problem that they had to decide on the most probable color of an urn. They saw random draws of colors out of five different urns and given these signals they received had to decide which color was more likely to be the color of the urn. If they could name the most probable color for all five example signal realizations they received a bonus.

In the main game, participants had to make a committee decision with two automated players about the color of an urn using simple majority rule. First, nature randomly chose either a blue or a red urn with equal probability. The color of the urn was unknown to all committee members. In a red (blue) urn there were 60% red (blue) and 40% blue (red) signals. Each committee member received two independent and private signals. Signals were either informative and showed "red" or "blue" or they were uninformative. Uninformative signals were not shown to the participants. In deliberation, committee members decided whether to hide — change a signal from informative to uninformative — or share an informative signal. Committee members could not change the value of a signal (from red to blue) or make up a non-existing signal (from $\varnothing$ to red or blue). The other committee members, the automated players, could not verify whether a committee member hid a signal or had just received less than the possible amount of informative signals. Thus, only if a player presented two signals, could the other committee members infer that they shared all signals they received. After seeing the signals that were shared in deliberation, players voted for either red or blue. The committee decision was made by simple majority voting, so it was the color that received at least two votes. Participants received a bonus when the committee decision matched the color of the urn. Otherwise participants received nothing.

The experiment is based on a game played in previous experiments of decision making in committees (Guarnaschelli, McKelvey and Palfrey, 2000; Goeree and Yariv, 2011) with the difference that participants did not interact with other participants, but with automated players. Participants knew that they interacted with automated players and not with humans. Since the experiment is supposed to estimate the effect of facing other committee members who process information differently, it is important to let participants know how information is processed by others. When playing with randomly assigned participants it is impossible to know how they process information or how this is perceived by others. Automated players' information processing can be communicated to the participants.

Automated players had a predefined strategy that was unknown to participants. However, in the instructions the participants observed five voting decisions that the automated players made. In the warm up exercise, participants saw the exact same signals and had to estimate the most likely color for these urns. Accordingly they could infer whether automated players' decisions followed Bayesian updating or were biased. The presented decisions differed from treatment to control group and can be seen in table 3.1.

Table 3.1: Decisions of the automated players in different treatment conditions

Signals	Control	Treatment
2 blue, 4 red	red	blue
3 blue, 2 red	blue	blue
0 blue, 1 red	red	red
1 blue, 3 red	red	blue
4 blue, 2 red	blue	blue

The treatment group decisions were designed such that it is clear that automated players decide for blue although there is more evidence of red (see urns 1 and 4 in table 3.1), but if there is unambiguous evidence like in urn 3 they are convinced that the urn is red. Accordingly, the treatment condition allows participants to identify information processing to be biased and leading to the irrational voting decisions of automated players.

The information about the automated players given to the participants corresponds well to situations where individuals observe the behavior of others and can infer whether the information updating of the others is similar to their own. Since there is no randomness in automated players' behavior, the participants can even predict likely behavior for the automated players in new situations.

3.5.1 Theoretical Expectations

Given these instructions, we can say that the experiment corresponds to the model as follows: The urn can either be *blue* (B) or *red* (A), and both states of the world are equally likely ($r = 0.5$). Signals are uninformative with a probability of $q = 0.1$. Informative signals display the true color of the urn with a probability of $p = 0.6$ and the other color with a probability of $1-p = 0.4$. As participants and automated players decide for the color that has a higher probability of being the true state of the world given their updating function, we can say that everybody has the same threshold of reasonable doubt $d = 0.5$.

The bias parameters differ between different treatment groups. The *control* group has a parameter of $c_{control} = 1$. In the *treatment* group, the number of red signals is multiplied by $c_{low} = 0.3$.[2] Participants who are fully rational would have a bias parameter of $c_i = 1$, so they simply vote for the color with the higher probability

[2]As noted, the precise updating of the automated players and the bias parameters are unknown to the participants. To reduce the necessity of precise mathematical calculations on side of the participants I decided for a more intuitive scenario, where individuals observe behavior but cannot observe the exact information updating function.

just like the automated players in the control condition.Automated players in the *treatment* condition undervalue red signals.

Now, consider figure 3.3. It shows the expected utilities of an individual with $c_i = 1$ for five possible pure strategies (*share all signals, hide one α-signal, hide one β-signal, hide two α-signals, hide two β-signals*) and all five possible private signals for a changing c_m given a set of parameters that match those in the experiment. The signal sharing is a utility maximizing strategy for biases close to one's own bias but its expected utility is decreasing for increasing differences between bias parameters. Contrarily, the hiding strategies are dominant when the difference between one's own bias and the bias of the decisive voter is increasing. From the graphs I derive the following hypotheses of the model for the experiment:

> *Participants in the control group ($c_m = 1$) and the treatment ($c_m = 0.3$) group share the same ratio of α-signals they received.*
>
> *Participants in the treatment group ($c_m = 0.3$), who have received at least one β-signal, hide more β-signals than participants in the control group ($c_m = 1$).*

3.6 Data and Results

The experiment was conducted from 26 December 2021 until 4 January 2022 and implemented using nodegame (Balietti, 2017). Participants are from the pool of workers located in the USA on Amazon's Mechanical Turk.

The sequence of the experiment was as follows: First, participants read the instructions of the warm up exercise where they have to decide on the most probable

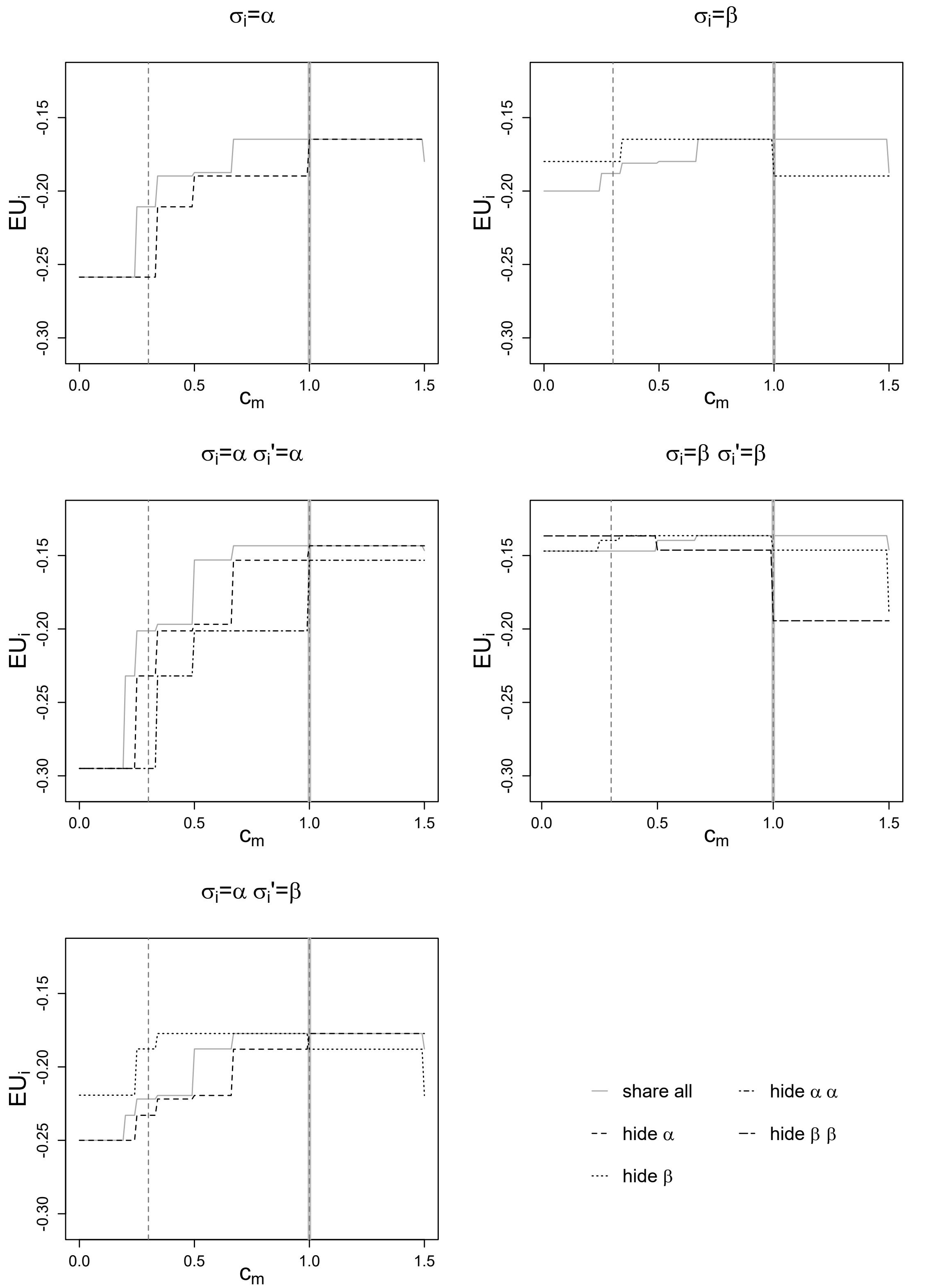


Figure 3.3: Expected utility of an agent with $c_i = 1$ for $d_i = d_m = 0.5$, $r = 0.5$, $q = 0.1$, and $p = 0.6$ for different values of c_m. The dotted lines are at values $c_m = 0.3$ and $c_m = 1$. Panels differ in the private signals that i received.

color of five different urns. They receive feedback about their performance and their payoff for the warm up exercise. Next, the participants read the instructions of the described committee game. Participants were only allowed to play the game if they were able to correctly answer three questions regarding the instructions. Participants were incentivized to read the instructions carefully with a bonus payment that was reduced for any failed attempt to answer the quiz correctly. Participants who failed five times were automatically excluded from the pool of participants to exclude participants who clearly did not read or understand the instructions.[3] Then they played six rounds of the committee game. Two of these six rounds were selected at random and the bonus was added to their payment. After the game, participants were asked about their belief about automated players' valuation of red signals in comparison to blue signals.[4] The participants were paid if their belief matched the condition they where assigned to. Then they answered an incentivized risk task, the "bomb" risk elicitation task (Crosetto and Filippin, 2013). It is a simple instrument to estimate risk aversion and risk seeking behavior while being unaffected by loss aversion.[5] In the end participants answered questions of the cognitive reflection test (CRT) (Frederick, 2005), answered eight matrices comparable to Raven's progressive matrices (Raven, 1941; Matzen et al., 2010), and questions on gender, age and education. Based on the questions assessing cognitive ability I created three

[3]All answers to the questions were stated in the instructions, so attentive reading was enough to answer them correctly. Participants were excluded after failing five times to exclude people who were unwilling to read the instructions thoroughly and simply want to be done with the HIT (Human Intelligence Task) as fast as possible. The instructions of the experiment can be found in the appendix B.2.1.

[4]The participants where asked whether automated players consider red signals (1) more important, (2) less important, or (3) equally important as blue signals.

[5]In the "bomb" risk elicitation task participants have to decide how many boxes out of 100 they want to open. In one box there is a bomb. The possible bonus which would be added to the final payoff linearly increases with the number of boxes opened. However, opening the box that includes the bomb leaves the player with nothing.

measurements of cognitive ability: (1) the sum of questions answered correctly in the CRT (from 1 to 5), (2) a latent variable calculated using item response theory based on the answers to the Raven-like matrices (Chalmers, 2012), and (3) another latent variable calculated based on the answers of both the CRT and the Raven-like matrices.[6]

The main data set consists of 912 game rounds played by 152 participants, 69 in the treatment and 83 in the control group. There is no statistically significant difference between treatment and control group in age, gender, education, or any cognitive ability measurement.[7] However, using a Wilcoxon-Ranksum test for the number of attempts needed to pass the quiz, I find a statistically significant difference between treatment and control group ($p = 0.000$) with a mean of 2.16 attempts in the treatment group compared to 1.27 attempts in the control group.[8] It suggests that instructions were more difficult to understand in the treatment group. We might expect worse understanding of players behavior in the treatment groups and failure of manipulation of their beliefs about automated players' information processing based on these differences. Given that groups are sufficiently comparable, statistically significant differences in participants' behavior between groups can be attributed to treatment effects. The formal model indicates that whenever people are aware that others process information differently, it might affect the information provision behavior by strategic actors. While participants should be aware of deviations from rational information processing by automated players from reading

[6]The experiment and analysis were preregistered as "Confirmation bias in committee deliberation". The preregistration is available on https://aspredicted.org/BLY_GRP.

[7]I used a Wilcoxon-Ranksum test for age ($p = .584$), CRT-scores($p = 0.683$), a latent dimension calculated using the Raven like matrices($p = 0.706$), and a latent dimension calculated for the combination of Raven-like matrices and CRT answers ($p = 0.896$). I used a χ^2-test for gender(0.073) and education ($p = 0.591$).

[8]Table B.1 in the appendix B.2 shows descriptive statistics of these variables.

the instructions, the belief elicitation can be used as a measurement of how well participants understood the updating behavior of automated players.

Table 3.2: Participants' beliefs about automated players' valuation of red and blue signals by experimental group

	value blue higher	equal	value red higher	total
Control	21.69%	62.65%	15.66%	100%
	(18)	(52)	(13)	(83)
Treatment	81.16%	11.59%	7.24%	100%
	(56)	(8)	(5)	(69)
Total	48.68%	39.47%	11.84%	100%
	(74)	(60)	(18)	(152)
Note:			$\chi^2 = 54.509$, $p = 0.00$	

Table 3.2 shows how the stated beliefs about automated players' valuation of red and blue signals in comparison with another. In the control group 62.65% of the participants believed that automated players valued both signals equally. In the treatment only 11.56% believed in an equal valuation of both signals, while a striking 81.16% of the participants in the treatment group realized that the automated players they faced valued blue signals higher than red signals. The result shows that the higher number of quiz attempts in treatment did not affected individuals' understanding of automated players' information processing negatively. A χ^2-test confirms that there is a statistically significant association between experimental group and the belief about automated players' valuation of blue and red signals. There is clear evidence that participants were able to understand how automated players valuated red and blue signals suggesting that the conditions are fulfilled for participants to follow the strategies suggested by the formal model.

Table 3.3 shows a logistic regression for all participants on the variable *correct*

Table 3.3: Logistic regression of correct belief

	Dependent variable:		
	correct belief		
	(1)	(2)	(3)
treatment	1.722^{**}	1.783^{**}	1.768^{**}
	(0.552)	(0.559)	(0.560)
college	-0.505	-0.447	-0.479
	(0.516)	(0.520)	(0.518)
male	0.482	0.520	0.466
	(0.432)	(0.429)	(0.432)
age	0.0001	0.002	-0.0003
	(0.020)	(0.019)	(0.019)
risk	-0.022^{*}	-0.023^{*}	-0.022^{*}
	(0.009)	(0.009)	(0.009)
CRT	0.207		
	(0.126)		
Raven scores		0.482^{*}	
		(0.243)	
cognitive scores			0.378^{*}
			(0.185)
quiz attempts	-0.661^{**}	-0.653^{**}	-0.649^{**}
	(0.234)	(0.238)	(0.239)
Constant	1.821	2.420^{*}	2.476^{*}
	(1.113)	(1.043)	(1.037)
Observations	152	152	152
Log Likelihood	-74.756	-74.072	-73.960
Akaike Inf. Crit.	165.512	164.145	163.919

Note: SE in brackets *p<0.05; **p<0.01; ***p<0.001

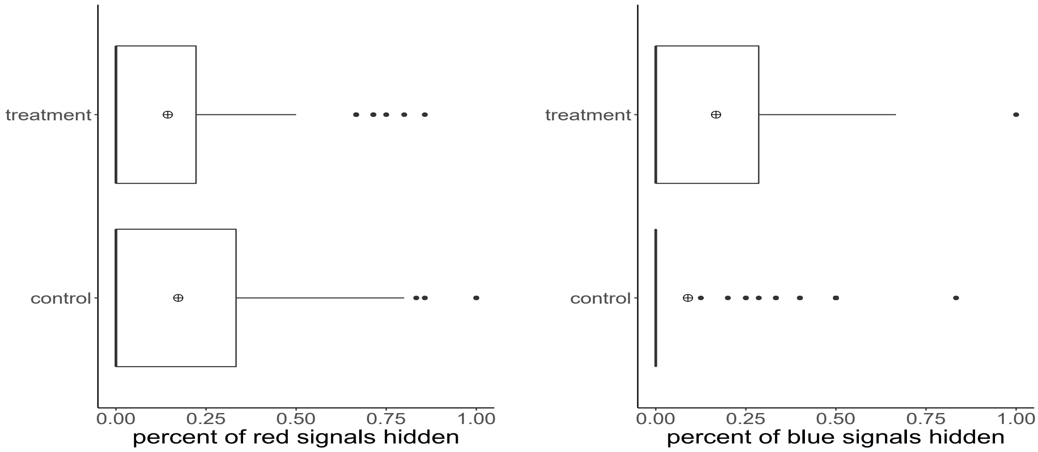


Figure 3.4: Percent of blue and red signals hidden in treatment and control group.

belief which describes whether the stated belief about automated players' valuation of red and blue signals matched the treatment group they were assigned to. Being assigned to the treatment group and higher cognitive abilities increased the probability for individuals to state a correct belief about automated players' behavior. However, especially many quiz attempts needed to pass the quiz about instructions reduced the probability to state the correct belief. So, neither treatment nor a low number of quiz attempts decreased the probability to state the correct belief about automated players' information processing. For a male participant with college degree in the treatment group with mean age, risk preference and cognitive abilities who needed five attempts to solve the quiz model (3) predicts a 50.3% chance to state the correct belief while the comparable person who needed just one attempt to solve the quiz the model predicts a 93.1% chance of stating the correct belief. The results suggest that attentive reading — all answers to the quiz were explicitly stated in the introduction — was enough for participants to understand automated players' behavior.

Given the beliefs stated in treatment and control groups, we would expect perfectly rational individuals to hide no red signals at all in both groups. In the control group perfectly rational individuals should also hide none of the blue signals they received. However, in the treatment group participants should hide all blue signals they received. Figure 3.4 shows a boxplot of the share of red and blue signals that individuals hid in deliberation. For red signals the share of hidden signals is similarly distributed in both groups with slightly more hiding in the control group. For blue signals, we can see that there are more individuals in the treatment group who hid a large share of the blue signals they received, while in the control group none of the individuals below the 75%-quantile hid any blue signals. A Wilcoxon-Ranksum test shows that there is a a significant difference between the means of hidden blue signals ($p = 0.015$) but not for red signals ($p = 0.761$).

I use several logistic regressions to test how treatment assignment and beliefs about automated players' behavior affect participants' decision to hide either blue signals or red signals. Table 3.4 shows the result for six regression models. Model (1) shows how the assignment to a treatment group and different control variables can be associated with the decision to hide at least one red signal whenever a participant received a red signal. There is no significant effect of treatment on the decision to hide red signals. Only cognitive ability measured by the CRT significantly reduced the probability for participants to hide red signals. The results support the claim that in both control and treatment group individuals share red signals or at least there is no difference in the decision to hide red signals between treatment groups. Model (2) shows the results of a logistic regression of participants beliefs about automated players' valuation of red and blue signals on their decision to hide red signals. The results of the formal analysis suggest that individuals who belief that

Table 3.4: Logistic regression of decision to hide a signal with cluster standard errors

	Dependent variable:					
	hide red signal			hide blue signal		
	(1)	(2)	(3)	(4)	(5)	(6)
treatment group	−0.311		−0.720	1.056***		−1.084
	(0.318)		(0.580)	(0.319)		(0.670)
overvalue red		0.394			0.934	
		(0.606)			(0.572)	
overvalue blue		0.432			1.591***	
		(0.385)			(0.426)	
correct belief			−0.874			−1.182*
			(0.488)			(0.597)
college	0.418	0.269	0.330	−0.630	−0.635	−0.637
	(0.451)	(0.441)	(0.451)	(0.439)	(0.422)	(0.426)
male	0.048	−0.032	0.157	−0.238	0.061	0.016
	(0.312)	(0.349)	(0.333)	(0.318)	(0.334)	(0.334)
age	0.022	0.026	0.026	0.015	0.022	0.029**
	(0.013)	(0.015)	(0.015)	(0.018)	(0.018)	(0.018)
risk	0.010	0.010	0.008	0.002	0.002	0.003
	(0.006)	(0.006)	(0.006)	(0.006)	(0.007)	(0.006)
CRT	−0.307***	−0.298**	−0.288**	−0.344***	−0.347***	−0.370***
	(0.090)	(0.094)	(0.090)	(0.088)	(0.094)	(0.089)
treatment group × correct belief			0.797			2.975***
			(0.775)			(0.862)
Constant	−2.037**	−2.482**	−1.680*	−1.297	−2.231*	−1.350
	(0.758)	(0.863)	(0.775)	(0.704)	(0.896)	(0.766)
Observations	659	659	659	630	630	630
Clusters	152	152	152	152	152	152
Log Likelihood	-285.874	-285.192	-281.606	-233.192	-226.397	-222.176
Akaike Inf. Crit.	585.747	586.385	581.212	480.384	468.793	462.351

Note: SE in brackets *p<0.05; **p<0.01; ***p<0.001

automated players overvalue red signals should be more likely to hide red signals. However, we find no evidence that beliefs affect participants decision to hide red signals. Model (3) additionally tests whether there is a difference between individuals who correctly understood the information updating of automated players and those who did not. For the hiding of red signals, there is no effect of having stated the correct beliefs neither in treatment nor in control.

Model (4) in table 3.4 tests the effect of being assigned to the treatment condition on participants' decision to hide a blue signal. Being in treatment, meaning that the automated players in the own group suffered from confirmation bias towards blue signals, significantly increased the probability to hide blue signals. This is strong evidence that, as predicted by the previous formal analysis, participants in treatment are more likely to hide blue signals than individuals in the control group. In model (5) I test how participants' beliefs affect hiding of blue signals. Here, we see that overvaluation of blue signals significantly increased the probability to hide blue signals while the belief to overvalue red signals has no statistically significant effect. This is additional evidence that individuals who belief that others overvalue information for a certain state of the world, e.g. due to confirmation bias, tend to strategically hide information for this state of the world. Again we see that cognitive ability overall decreased the probability to hide blue signals. Model (6) shows that the effect of treatment on the hiding of blue signals is mediated by understanding how automated players processed information. First, participants in the control group who stated the correct beliefs about automated players information updating were less likely to hide blue signals. There is also a strong interaction effect between treatment and having the correct belief, meaning that individuals in the treatment group who correctly understood automated players valuation of red and blue signals were more likely to hide signals than participants in the control group and participants in the treatment group who did not understand automated players behavior. The results presented in table 3.4 show that treatment had the expected effect on individuals' hiding strategy. While participants in treatment where more likely to hide blue signals, there was no effect of treatment on the decision to hide red signals. However, there is no clear evidence that this effect is completely determined by beliefs. If only beliefs mattered, we would expect to find a statistically significant effect of the belief that red signals are overvalued on the decision to hide red signals in model (2) which is not the case. There is a significant effect of the belief that blue signals are overvalued on the decision to hide blue signals. I interpret this finding such that if beliefs are backed by experience or observations, individuals strategically adapt their information sharing behavior to beliefs.

3.7 Discussion

Research on cognitive biases and motivated reasoning shows that people process information differently and why they do so. However, there is still substantive research missing that sheds light on individuals' reaction when realizing that others use information differently. I show that a known confirmation bias affects individuals' information sharing behavior and makes full information sharing in committees almost impossible.

I test the predictions of the model for strategic information sharing in an online experiment in which participants make decisions with automated players. Automated players in the treatment group undervalue red signals compared to rational behavior. The exact effect of a bias is unknown to participants. However, they observe prior decisions of automated players, which enables them to estimate automated players' information processing.

There is strong evidence for strategic hiding of information. However, participants do not hide to the extent predicted by theory. Rational individuals in the treatment group should hide all blue signals that they received. While they do hide statistically significant more blue signals than participants in the control group, they do not hide all signals. Hiding in the treatment group depends on participants understanding of automated players' information processing. This finding supports the conclusion of the formal analysis that understanding that others process information differently can reduce the amount of information that is aggregated in deliberation.

The formal analysis is concerned with the question on committee decision making when there are differences in information processing between committee members. As a committee is usually a group of elites who make a decision, the sample of the experiment is unlikely to reflect the population of interest. However, political or economic elites are expected to be of high cognitive ability and highly rational decision makers. As cognitive ability is a strong predictor for the correct guess about automated players' information processing, we can expect that elites are aware of others' information processing. Accordingly, it can be expected that the effects of differences between information processing on information processing would be stronger in a sample of elite participants.

Cognitive biases affect the way that individuals process information and can also affect group decisions, lead to overconfidence of individuals, or polarization (Levy and Razin, 2015*a*,*c*; Ortoleva and Snowberg, 2015; Fryer, Harms and Jackson, 2019; Parker-Stephen, 2013). The evidence presented in this paper suggests that differences in cognitive biases can also lead to strategic behavior that reduces the amount of information aggregated in deliberation. The experimental results show that participants tend to share information. Biased information processing is not leading to a complete breakdown of information aggregation in deliberation. However, the better people understand how information is processed, the more likely they are to hide information strategically.

The findings increase our knowledge about the effect of cognitive biases on information aggregation and decision making in groups. In a world where a tremendous amount of information is shared regularly among many people, it is important to understand why some information is hidden. Expected reactions of others might be one reason to strategically hide information and, therefore, decrease the amount of information aggregated in deliberation.

4

Ask, And You Shall Receive: Strategic Information Transmission under Better Regulation Guidelines of the European Commission

4.1 Introduction

Talk and information can be effective tools of persuasion. Research in political science and economics shows how information can be used strategically to convince an audience of a certain position (e.g. Crawford and Sobel, 1982; Austen-Smith and Riker, 1990; Austen-Smith, 1992; Schnakenberg, 2017). Informational lobbying describes the attempt of interest groups to persuade a decision maker of a position using information. The decision on using information to influence a decision maker often depends on the particular circumstances, such as the time capacities of a political decision maker (Dellis and Oak, 2019). In the context of policy making in the European Union (EU), it remains unclear how limiting the agenda by excluding some stakeholders from consultations affects stakeholders' information strategies in the consultation process.

In the EU a lot of information is transmitted in the so-called Better Regulation process of policy initiatives. The European Commission introduced the Better Regulation Guidelines in 2017 to guarantee a complete and transparent transfer of information from stakeholders to the responsible Directorate General (DG) in the process of policy making (European Commission, 2017). Research shows that already the previously established consultations led to more equal access of stakeholders to the policy process (Bunea, 2017; Persson, 2007; Rasmussen and Carroll, 2014).

As access for all stakeholders is more or less granted under the Better Regulation Guidelines, informational lobbying is less about exchange of information for access but about persuasive information provision. Strategic information provision should be a vehicle of persuasion for stakeholders in this process. Based on unstructured interviews with stakeholders and staff of the European Commission, I adapt a model of information provision under an agenda constraint (Dellis and Oak, 2019) such that it can describe feedback mechanisms under the Better Regulation Guidelines of the European Commission. The model predicts that a shorter time frame and an unconstrained agenda lead to more informative signals. To test these hypotheses, I estimate the informativeness of the stakeholders' feedback to policy initiatives of the European Commission. Informativeness is measured by the the quotient of a contribution's detail (number of content related words) and focus on single policy aspects of interest (number of main topics discussed in the submission). The measurement is the average number of words per topic covered in the document. The results of a multilevel regression analysis suggest that the DG can affect informativeness of stakeholders' contributions by using public consultations, which is comparable to not constraining the agenda of a policy a priori. The effect of a public consultation announcement is robust to several specifications of the informativeness measurement. The results provide evidence for the effect of the Commission's decision on interest groups' information provision.

4.2 Strategic Information Provision and Informational Lobbying

Information provision is one of the main tools for lobbyists to influence policy decisions (Koehler, 2019). Generally, policy makers are assumed to be in need of expert information but are limited in resources like staff or money. Interest groups provide policy makers with information to change policy according to their preferences. Since lobbyists have a known interest, credible information provision is hindered because lobby groups are assumed to lie or hide information strategically for their gains. This problem can be described by situations of so-called cheap talk (Crawford and Sobel, 1982). If information transmission is free of costs, final payoffs only depend on the decision makers decision, and the interests of sender and receiver differ, signals from lobbyists are considered not credible or informative. Game theorists developed several models to explain when credible information provision is supported in an equilibrium. Partially informative signals are credible whenever the preferences of the expert and the decision maker are not too distant or signal transmission is costly for the expert (Crawford and Sobel, 1982; Potters and van Winden, 1992). Others show that a policy maker always gives access to those lobbyists who have the same interest, while lobbyists with an opposite interest only get access when paying some contribution (Lohmann, 1995).

Lobbyists can also supply verifiable information which bears the risk of providing policy makers with information that is contrary to the interest groups' preferences. The decision whether to acquire costly verifiable information privately or publicly depends on interest groups' risk preferences (Dahm and Porteiro, 2008).

Acquiring public information is comparable to games of Bayesian persuasion. While in other sender-receiver scenarios a sender has private information and based on this information sends a (single-valued) signal to the receiver, in games of Bayesian persuasion senders and receiver have the same prior information but senders can "influence the outcome by specifying the allocation of information" (Kamenica, 2019, p.250). Here, limited capacities of receivers can create competition and therefore improve the information available to the receiver (Boleslavsky and Cotton, 2018).

In sender-receiver scenarios with a privately informed sender and verifiable information, agenda constraints can affect the senders' information strategy. Dellis and Oak (2019) show that an agenda constraint can help to reduce stakeholders' tendency to provide information if the stakeholder's proposal is not beneficial for the policy maker. As the mere act of costly lobbying is seen as evidence for the interest groups' cause, limiting the agenda a priori reduces the incentive to provide information that suggests not to implement a policy (Dellis and Oak, 2019). For a resource restricted policy maker, informational lobbing can induce a policy maker to not acquire costly private information and instead rely on the interest groups' information for decision making (Cotton and Déllis, 2016).

With respect to lobbying of EU institutions, it is often argued that interest groups trade goods in order to receive access to the legislative process of the EU (Bouwen, 2004*a*; Klüver, 2013). One of these goods is information. Empirical evidence supports the theoretical claim that information can be used to gain access to EU institutions (Bouwen, 2002). A formal model shows that the target of informational lobbying in the EU changes during the policy process from allies in early stages to opposed policy makers in later stages (Crombez, 2002). There is evidence that in the European Parliament the recipients of informational lobbying are usually highly influential committee members (Marshall, 2010). Further, different kinds of information are provided strategically to disparate recipients. Empirical research shows that politicians are mainly supplied with political information, while bureaucrats receive technical information (de Bruycker, 2016).

Research shows that information directly affects policy drafting in the EU already in early stages of policy making (Klüver, 2013). Characteristics of interest groups, such as resources, professionalisation, and decentralisation of interest groups, affect the amount of information that an interest group provides (Klüver, 2012). However, characteristics of interest groups should not determine the access of different groups to the policy making process in the EU. Therefore, the EU decided to standardize the information transmission from stakeholders to the European Commission to increase the transparency in the policy process and interactions with stakeholders.

4.2.1 EU Better Regulations Guidelines

In 2001 the European Commission published a “White Paper on European Governance”. In the paper, the European Commission argues that a consultation procedure should be implemented where interest groups can provide information to the European Commission to increase transparency and improve interest inclusion in policy making (European Commission, 2001). The procedure is supposed to give all relevant actors access to the EU policy process. Evidence suggests that public consultations help to give all stakeholders the opportunity to participate. Still, industry groups remain better represented in the consultation process than NGOs or other public interest groups (Quittkat, 2011; Persson, 2007; Rasmussen and Carroll, 2014; Bunea, 2017). However, different forms of consultation, like public consultations compared to expert groups, lead to varying degrees of diversity in participating stakeholders (Fraussen, Albareda and Braun, 2020). The responsible DG also chooses different consultation forms to better match the characteristic of an initiative (van Ballaert, 2017). Consultations increase the probability for an initiative to be enacted (Bunea and Thomson, 2015) as well as the time a policy proposal needs to be implemented (Rasmussen and Toshkov, 2013). For interest groups, resource endowment and organizational structures are crucial for effective informational lobbying during consultations (Klüver, 2012). However, the European Commission decided to standardize the policy making procedure even further.

The EU Better Regulation Guidelines were introduced in 2017 to improve EU policy making. The procedure was designed to cover the whole policy cycle, from policy preparation to implementation to evaluation. In principle, the process is meant to be a circle in which evaluation of an implemented policy is followed again by preparation of improvements and adjustments. The EU divides the procedure in two parts: Impact Assessment and Monitoring & Evaluation. I concentrate on the Impact Assessment part and primarily on the preparation part of this procedure. The process starts in step 1 with an impact assessment or roadmap document for the initiative[1], where the problem, legal basis, objectives, and policy options to tackle the problem are considered. Stakeholders can give feedback to this first publication of the initiative. Since the DG proposes the form of consultations used for the initiative and the time frame which are major constraints of the policy making process, I concentrate my analysis on the decisions made in the document and feedback of step 1. After the first publication of a roadmap in step 1, step 2 of the policy making process are consultations with stakeholders. Usually, a twelve week public consultation should be part of the consultation strategy. However, sometimes the responsible DG can justify in the roadmap document that a public consultation is not needed in the consultation step, can be replaced by a closed consultation, or they can add additional closed consultations like workshops or expert committees.[2] Omitting public consultations can be compared to constraining the agenda of a policy as issues of stakeholders who are not invited to the closed consultations are excluded. After receiving feedback on the impact assessment and consultations an impact assessment report should be written and published in step 3. The report explains

[1]Throughout this paper I only use the term roadmap but always also mean impact assessment, as both documents are fairly similar.

[2]For more information when different consultation procedures and combinations of open and closed consultation forms are used, see Fraussen, Albareda and Braun (2020).

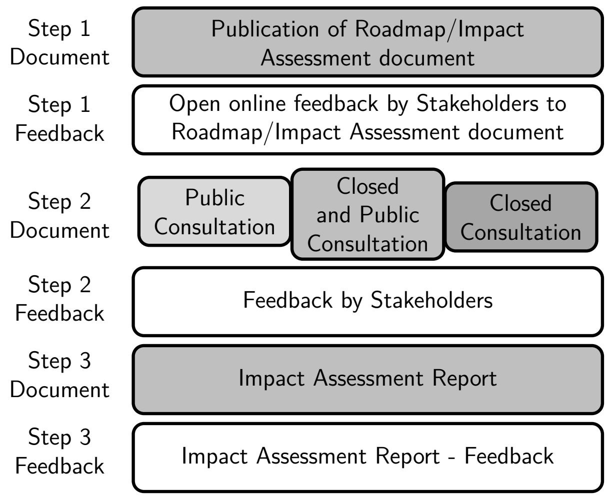


Figure 4.1: Procedure of Impact Assessment

which measures are used and why, taking into account the feedback received by stakeholders in different stages. The subsequent policy proposals should be backed by the impact assessment report. Figure 4.1 displays the process described above graphically.

The consultations and the impact assessment of a policy is standardized for the European Commission to maximize exchange with stakeholders and increase transparency of policy making. Before writing an impact assessment report, the DG receives information in two stages in which everybody can participate: (1) feedback to roadmaps and (2) public consultation. The first stage is always available to all stakeholders. The latter might be complemented or replaced by closed consultations like expert groups or workshops. This means that consultations are not always available for all interest groups (European Commission, 2017).

Furthermore, the type of feedback differs for roadmaps and consultations. For roadmaps, feedback is unstructured and interest groups can answer using an essay format. In public consultations, feedback is often asked for in a questionnaire, so interest groups are limited in the answers they can give.

In their feedback to roadmaps and in consultations, stakeholders present their opinion and back it with evidence. Feedback ranges from short and general statements on the policy to long detailed submissions on specific parts of the intended legislation. Stakeholders try to show how the policy might impact their industry or the interest they represent and convince the DG to include their needs in the policy proposal.

While the consultation stage of informational lobbying in the EU is the focus of most research on informational lobbying of the European Commission, I concentrate on the roadmap document and stakeholders feedback to this document. This stage is the center of the following model on informational lobbying in the consultation procedure of the European Commission and the empirical investigation.

The first feedback under the Better Regulation Guidelines is to a large degree about the inclusion of different issues in a policy proposal. Therefore, I argue that this situation is better understood as a situation where lobby groups propose issues of a policy and try to convince the policy maker to include their demands while not necessarily denying the demands of other interest groups instead of a one-dimensional conflict with two lobby groups or lobby coalitions on opposite sides. Dellis and Oak (2019) model a situation where two lobby groups try to convince a policy maker to put a policy on the agenda by giving policy relevant information. In the following paragraph I describe how the consultation process and its influence were presented to me in interviews with stakeholders and staff of DGs. Following these statements, I adapt the model by Dellis and Oak (2019) such that it fits the European Commission's Better Regulation Guidelines.

4.3 Modeling the European Commission's Better Regulation Guidelines

To better understand motives and behavior of actors involved and inform a model that can describe the first stage of consultation under the Better Regulation Guidelines of the European Commission, I conducted five unstructured interviews to get insights from staff of the European Commission in different DGs and stakeholders on their experience with consultations.[3] For both sides, the consultation procedure is seen as very helpful in the policy process.

For the staff of DGs, the information they receive from stakeholders is sometimes more and sometimes less important for drafting a policy proposal. When the DG believes to be already well informed about the topic, consultations are not considered a perfect instrument. However, there are often initiatives that are supposed to simplify regulations and improve the situation of stakeholders themselves. In these situations, feedback from stakeholders is extremely valuable to get stakeholders' private information about the probable policy impact.

A problem that bureaucrats in the European Commission encounter are short time frames. Sometimes time frames for policy proposals are chosen such that the development from a roadmap via a consultation to the finished policy proposal is barely the twelve weeks that are required for the consultation period alone. Time pressure to create a finished policy proposal is always high. However, short time frames make it almost impossible to react to feedback received by stakeholders.

[3] I conducted interviews with staff from two DGs, received one additional answer via e-mail, and interviewed three different stakeholders. Transcripts of interviews can be made available on request.

Overall, all interview partners from the European Commission emphasized that there is a well-established procedure and that they have limited scope to deviate from the procedures declared in the Better Regulation Guidelines.

All interviewed stakeholders called the consultation procedure one of their most important vehicles to influence European policy. Firstly, it is at the very beginning of the policy process, when larger adjustments to the policy are easier. Further, it is very important to signal that the policy is of interest to a stakeholder to become part of the development of the proposal. Both of these points make it extremely valuable for all stakeholders to say at least something about a policy in the consultation procedure.

When drafting feedback to consultations or roadmaps, stakeholders suggested that the provision of information is the most important tool to influence policy proposals. Associations as representatives and agents of their members are always well informed about upcoming policy initiatives of the European Commission. While associations make their members aware of upcoming initiatives and often provide a general position of the association for their members, they also ask them to add their own viewpoints and support the association's position with more private information.

Although stakeholders generally described the consultation procedure as very helpful, they also criticized it in several ways. One problem was seen in the use of questionnaires during the consultation phase. Questionnaires give stakeholders limited scope to express their own opinions and are often lengthy and annoying to fill out. Further, the Commission can use tendentious questions to get the feedback and support they intend to receive from stakeholders. When drafting environmental regulations, for example, the Commission can set low regulations that can easily be accepted by the producing sector and then ask whether the low regulations are too high. While the industrial sector supports these regulations, environmental associations also have to agree, even though they actually support stricter rules. Stakeholders often prefer the less regulated feedback in form of essays that they can give to roadmaps compared to the questionnaires.

Stakeholders also criticize that they are not always sure how their feedback is perceived and included in the policy proposals. The Commission always creates a report about stakeholders' feedback in the consultation process, however for stakeholders it sometimes remains unclear whether it affects the final policy or is just ignored. Stakeholders also recognize that sometimes policy proposals are drafted before the consultation stage is completed, meaning that their feedback cannot be included in the policy proposals. Constraints of the European Commission can therefore be considered to affect the feedback choices of stakeholders.

The formal model of Dellis and Oak (2019) shows how politicians can increase benefits from informational lobbying by restricting their own agenda. They find that an unrestricted agenda can lead to overlobbying. Overlobbying describes situations when stakeholders lobby although their private information suggests not to implement their preferred policy or include their issue of preference. However, to match the information received by the interview partners, their model has to be changed in several ways:

- instead of a binary decision to lobby or not (or a mixed strategy of the two), stakeholders decide on the continuous informativeness or effort they put in feedback submissions

- instead of a perfect signal if a stakeholder lobbies, stakeholders are uncertain about the effect of their own contribution

- instead of a fixed cost for lobbying, stakeholders pay increasing costs for more informative contributions

- instead of a general threshold of doubt at $\frac{1}{2}$, the threshold differs from policy to policy (depending on the time constraints a DG faces)

- instead of an access constraint, the DG grants access to everyone but faces a verification constraint of information due to a lack of staff (the effect of the constraint is the same)

- further, there are also topics the DG is already convinced of to be beneficial, so even without informative feedback a policy issue might be implemented

I adapt the model by Dellis and Oak (2019) such that the issues above are solved and the model can be used to analyze policy making under the Better Regulation Guidelines in the European Union.

4.3.1 A Formal Model of Informational Lobbying

To model the scenario of the roadmap stage of the Better Regulation Guidelines of the European Commission, I use the most basic case of two stakeholders $i \in \{1, 2\}$ who are senders and the Directorate General DG who is the receiver of signals. The DG wants to initiate a new policy proposal. The DG asks the stakeholders about feedback on the initiative. Each stakeholder gives feedback on one issue of the initiative. So, the initiative can be described by a policy agenda $p =$

(p_1, p_2), where $p_i \in \{0,1\}$ is the reform on the issue of stakeholder i. Adopting the reform according to stakeholder i's preferences on issue i means that $p_i = 1$ and ignoring stakeholder i's issue is denoted by $p_i = 0$. Before asking for feedback, the *DG* decides whether to constrain its agenda or not. Constraining the agenda means that $p \in \{(1,0),(0,1),(0,0)\}$, while not constraining means that $p \in \{(1,1),(1,0),(0,1),(0,0)\}$. The state of the world $\omega_i \in \{0,1\}$ denotes whether the issue i should be reformed, where $\omega_i = 1$ means that reform is necessary and $\omega_i = 0$ means that the issue should not be reformed. For each issue, the *DG* has a prior belief $Pr(\omega_i = 1) = \pi_i \in (0,1)$ about the need to reform. The *DG*'s utility depends on the correct choice of reform or not on both issues:

$$U(p,\omega) = u_1(p_1,\omega_1) + u_2(p_2,\omega_2)$$

with

$$u_i = \begin{cases} 1-\theta & \text{if issue } p_i = 1 \text{ and } \omega_i = 1 \\ -\theta & \text{if issue } p_i = 1 \text{ and } \omega_i = 0 \\ 0 & \text{if issue } p_i = 0. \end{cases}$$

Here, $\theta \in (0,1)$ is the *DG*'s trade-off between Type I error (0 instead of $1-\theta$), not implementing a beneficial policy, and Type II error ($-\theta$ instead of 0), implementing a non-beneficial policy. We can say that costs for making Type I error are $1-\theta$ and for making Type II error are θ. So a high θ suggests that the *DG* is reluctant to include an issue unless there is overwhelming evidence that the issue should be included. A small θ can be connected with a *DG* that prefers to include all issues with some evidence that the issue is important. A short time frame makes it difficult to include a new issue in a policy proposal and can therefore be connected with a large θ.

Stakeholders have private information about issue i that they can try to disclose to the *DG* in their feedback or not. A stakeholder can decide on the informativeness of the signal, through the parameter $\lambda_i \in [0,1]$. The informativeness gives the probability that private information is revealed to the *DG*. Revelation is denoted by $l_i \in \{0,1\}$ with $l_i = 1$ means ω_i can be learned and $l_i = 0$ means that no information is revealed. The informativeness of a submission λ_i can be interpreted as $Pr(l_i = 1) = \lambda_i$, with $\lambda_i = 0$ always indicates $l_i = 0$, $\lambda_i = 1$ leads to $l_i = 1$. The *DG* observes l_i but not λ_i. If $l_i = 1$ the *DG* can decide whether to verify the evidence or not based on its belief $\beta_i^{ver}(l_i) = Pr(\omega_i = 1|l_i)$ prior to verifying any ω_i. The verification decision $a_i = 1$ means that the state of the world ω_i is disclosed to *DG* forming the posterior belief $\beta_i(\omega_i)$. If $l_i = 1$ and $a_i = 0$, the *DG* knows that it could have learned ω_i, but it does not know ω_i. However, since the European Commission is generally understaffed (Klüver, 2013), I assume that the *DG* can verify at maximum one issue. So, the full verification decision can be denoted by $a = (a_1, a_2) \in \{(1,0),(0,1),(0,0)\}$.

Stakeholders receive utility $v_i(\lambda_i) = p_i - c(\lambda_i)$. Let the cost function for more informative submissions $c(\lambda_i)$ be a continuous, twice differentiable, and convex function with $c(0) = 0$, $\frac{dc}{d\lambda_i}(0) < 1$, and $\frac{dc}{d\lambda_i} > 0$ for $\lambda_i > 0$.[4] So each stakeholder tries to increase the probability of a policy being included while paying strictly increasing costs for more informative signals.

[4]The analysis is reduced to convex cost functions as they allow to predict equilibrium strategies with $\lambda_i \in (0,1)$. Other restrictions on the cost function are such that costs are never too high to make the only solution $\lambda_i = 0$.

The sequence of the game is as follows:

1. Nature decides on ω_i; π_i and $c(\lambda)$ become public knowledge, and ω_i is revealed to the stakeholders.
2. The *DG* decides whether to constrain the agenda or not.
3. Stakeholders decide on λ_i and nature decides on l_i.
4. l_i is revealed to the *DG* and the *DG* decides on a_i for $l_i = 1$.
5. The *DG* decides on $p = (p_1, p_2)$.

The equilibrium concept is the perfect Bayesian equilibrium. In the analysis I concentrate on the effects of θ and the *DG*'s constraining decision on the stakeholders' chosen level of informativeness λ_i.

4.3.2 Equilibrium Results and Predictions for Stakeholders' Information Strategies

The model above can nicely depict that not only the state of the world, costs, or control mechanisms can affect lobbyists information strategy, but also prior decisions like agenda constraints. This is visible in the different equilibria that can be derived for the model above.

A full analysis of possible equilibria including proofs of the propositions is in appendix C.2-C.5. Any stakeholders' information strategy consists of a tuple $(\lambda_i(0), \lambda_i(1))$. We can find multiple equilibria. In the following I present equilibria for the cases where either for both stakeholders $\pi_i \geq \theta$ or $\theta > \pi_i$:

(1) for $\pi_1 > \pi_2 \geq \theta$, there exists an equilibrium for which

- the DG does not constrain the agenda
- both interest groups choose $\lambda_i(\omega_i) = 0$
- beliefs are such that $\beta_1^{ver}(0) > \beta_2^{ver}(0) \geq \theta$
- $p = (1, 1)$

(2) for $\theta > \pi_1 > \pi_2$, there exists an equilibrium for which

- the DG does not constrain the agenda
- both interest groups choose $\lambda_i(1)$ such that $\frac{dc(\lambda_i)}{d\lambda_i} = 1$ and $\lambda_i(0)$ such that $\frac{dc(\lambda_i)}{d\lambda_i} = \frac{1}{2}(\lambda_{-i}(1)\pi_{-i} + \lambda_{-i}(0)(1 - \pi_{-i}))$ and $\frac{\lambda_2(0)}{\lambda_1(0)} = \frac{1-\pi_1}{1-\pi_2}$
- beliefs are such that $\beta_1^{ver}(1) = \beta_2^{ver}(1) \geq \theta > \beta_1^{ver}(0) > \beta_2^{ver}(0)$
- $p_i = 0$ if either $l_i = 0$ or $l_i = 1$, $a_i = 1$, and $\omega_i = 0$
- $p_i = 1$ if either $l_i = 1$ and $a_i = 0$, or $l_i = 1$, $a_i = 1$, and $\omega_i = 1$

(3) for $\pi_1 > \pi_2 \geq \theta$, there exists an equilibrium for which

- the DG constrains the agenda
- both stakeholders choose $\lambda_i(0) = 0$
  - stakeholder 1 chooses $\lambda_1(1)$ such that $\frac{dc(\lambda_1)}{d\lambda_1} = \frac{1}{2}\lambda_2(1)\pi_2$
  - stakeholder 2 chooses $\lambda_2(1)$ such that $\frac{dc(\lambda_2)}{d\lambda_2} = 1 - \frac{1}{2}\lambda_1(1)\pi_1$
- beliefs are such that for both $\beta_1^{ver}(1) = \beta_2^{ver}(1) > \beta_1^{ver}(0) \geq \theta > \beta_2^{ver}(0)$
- $p = (1, 0)$ for $l_1 = l_2 = 0$
- $p_i = 0$, $p_{-i} = 1$ for $l_i = l_{-i} = 1$, $a_i = 1$, $a_{-i} = 0$, $\omega_i = 0$

- $p_i = 1$, $p_{-i} = 0$ for $l_i = l_{-i} = 1$, $a_i = 1$, $a_{-i} = 0$, $\omega_i = 1$

(4) for $\theta > \pi_1 > \pi_2$, there exists an equilibrium for which

- the DG constrains the agenda
- both stakeholders choose $\lambda_i(0)$ such that $\frac{dc(\lambda_i)}{d\lambda_i} = \frac{1}{2}\lambda_{-i}(0)(1-\pi_{-i})$ and $\lambda_i(1)$ such that $\frac{dc(\lambda_i)}{d\lambda_i} = 1 - \frac{1}{2}\lambda_{-i}(1)\pi_{-i}$
- beliefs are such that for both $\beta_1^{ver}(1) = \beta_2^{ver}(1) \geq \theta > \beta_1^{ver}(0) > \beta_2^{ver}(0)$
- $p_i = 0$ for $l_i = 0$
- $p_i = 0$, $p_{-i} = 1$ for $l_i = l_{-i} = 1$, $a_i = 1$, $a_{-i} = 0$, $\omega_i = 0$
- $p_i = 1$, $p_{-i} = 0$ for $l_i = l_{-i} = 1$, $a_i = 1$, $a_{-i} = 0$, $\omega_i = 1$

The existence of these equilibria is shown in appendix C.6. The equilibria above are of interest as they describe situations where (1) no information is transmitted, (2) we can observe the highest level of informativeness of signals for both states of the world, (3) the highest possible separation between the two states of the world is transmitted, and (4) the highest level of overlobbying for a constrained agenda can be observed.

We can consider equilibrium (1) to be the equilibrium with the lowest levels of informativeness and equilibrium (2) with the highest levels of informativeness. However, equilibrium (2) also shows the highest overlobbying, meaning that $\lambda_i(0) > 0$. Comparing equilibrium (1) and (3), we see that constraining the agenda can increase the chosen informativeness $\lambda_i(1)$ while not raising incentives for overlobbying. Equilibrium (4) shows that for a constrained agenda, the chosen level of informativeness decreases for both $\lambda_i(1)$ and $\lambda_i(0)$ compared to equilibrium (3).

That being said, we can look at more general effects that are independent of the DG's decision to constrain the agenda or not. A signal $l_i = 1$ can only be credible without observing ω_i if and only if $\lambda_i(0) \leq \lambda_i(1)\frac{\pi_i - \pi_i\theta}{1-\pi_i}$, following Bayes' rule. Therefore, we can say that the ratio $\frac{\lambda_i(1)}{\lambda_i(0)} \geq \frac{1-\pi_i}{\pi_i - \pi_i\theta}$ strictly increases in θ. So we can expect that a higher θ always induces a higher $\lambda_i(1)$ relative to $\lambda_i(0)$, increasing the separation in informativeness of signals.

To test empirically how well the model can predict information transmission of stakeholders in the European Commission's Better Regulation Guidelines, I will show how the results above apply to the situation that stakeholders face in the beginning of the policy process in the European Union. I concentrate on the very first stage of the Better Regulation process where the DG publishes a roadmap and stakeholders can give feedback to the roadmap document as this is also the focus of the empirical analysis. In later stages of the policy drafting process stakeholders have more options to express their opinion and share information. It is likely that these considerations affect the information transmission strategy of stakeholders. I focus on the early stage, however, as stakeholders confirmed a preference for being integrated in the policy drafting process as early as possible and the access to full statements in this stage of the process.

In the process, the staff of a DG creates a policy initiative. In the initiative, they announce the time frame of the policy initiative and the form of consultation they will follow. In both of these decisions the DG is limited. The time frame of a policy is usually determined by politicians and not bureaucrats. Rules allow disclaiming public consultations only with "good" reason. Generally bureaucrats can find these reasons if necessary. Therefore, I consider the DG to have more leverage in the decision to constrain the agenda than the time frame.

Time frames are usually externally given. They affect the planning of consultations in all forms. They limit the option to have multiple consultations. They limit the number of issues that can be included in a policy proposal as time is necessary for changing a policy proposal. Bureaucrats keep the time frame in mind when planning an initiative and also base their decision to limit the agenda on the time frame. In the theoretical model the parameter of θ is comparable to the time frame. The size of θ affects the DG's decision to limit the own agenda. Further, comparable to a short time frame a large θ can be connected with a reluctance to include additional issues in a policy proposal. Therefore, I argue to interpret a time frame as the externally given θ that affects mainly the DG's decision to limit the agenda. The equilibrium analysis shows that for the same situations a higher or lower θ can decide whether the DG wants to constrain the agenda or not for comparable situations. Then a short time frame would be connected to a high θ and a long time frame with a low θ. Given the effect of θ on stakeholders' information strategies, the first hypothesis is:

H1: A longer time frame reduces the informativeness of stakeholders' feedback to roadmaps.

Limiting the access of stakeholders to consultations during the process by not using public consultations excludes issues that are not discussed in consultation from entering the policy at all. This is clearly an agenda constraint as it prevents some stakeholders and their issues to be part of the consultation. These issues can still be covered in the feedback to the initial initiative. So, disclaiming public consultations is comparable to an agenda constraint in the theoretical model.

The effect of a constrained agenda on the informativeness of a signal is less clear, as the effect differs dependent on the relation between π_i and θ. However, given that we are looking at data where at least to some degree informative lobbying took place, we can expect that the case of $\pi_i \geq \theta$ with an unconstrained agenda and $\lambda_i(\omega_i) = 0$ is not observable in the data (or only in exceptional cases). So, for $\pi_i \geq \theta$ we should only observe informative lobbying when the agenda is constrained. Accordingly, we can concentrate on the situations when $\theta > \pi_i$ to predict the effect of a constrained agenda compared to an unconstrained agenda. Comparing equilibrium (2) with equilibrium (4), we know that $\lambda_i(1)$ is larger with an unconstrained agenda. We also know that $\lambda_i(0)$ is larger for the unconstrained agenda.

> *H2: For an unconstrained agenda the informativeness of stakeholders' feedback to roadmaps increases.*

We can expect more informative signals when the agenda is unconstrained. However, the empirical test cannot distinguish between overlobbying, meaning a $\lambda_i(0) > 0$, or information about potentially beneficial policies. Evidence supportive of hypothesis 2 might be driven by overlobbying.

I test the hypotheses using stakeholders' feedback to different policy initiatives. As the model is highly complex and can predict very different information strategies in equilibrium given different parameters and cost functions, the evidence can be used to evaluate some empirical implications of the model but not all.

4.4 Data and Operationalization

The cases used in this analysis are all roadmaps of directives and regulations on the "have-your-say" data base of the European Union[5] and the respective feedback submissions by registered stakeholders in English which were available in March 2021.[6] The data consists of 108 initiatives with 2698 submissions from registered organizations in English from February 2017 until January 2021.

Published roadmaps include information about the quarter of finishing the policy proposal and whether and when a public consultation will be conducted. Based on this information the dummy variable *no agenda constraint*, which indicates whether there will be a public consultation, was created. The distance between the publishing date of the roadmap document and the last day of the quarter when the policy proposal is supposed to be published is a measurement for the variable *time frame*.

4.4.1 Measuring the Informativeness of Submissions

Informativeness of text is determined by the number of features about a category it provides and the relevance of text to that category (Giora, 1988). Following this logic, I created a measurement that is based on the features of a submission — the number of content related words — and the relevance to the main topics of the text.

To find the main topics covered in a submission I used Latent Dirichelet Allocation (Blei, Ng and Jordan, 2003) (LDA).[7] Using a predefined number of topics,

[5]https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives

[6]Submissions from non registered organizations or private citizens were not taken into account in this analysis as the strategic considerations of stakeholders are not applicable to private citizens and to a lesser degree to organizations who are not listed in the transparency register of the European Union (3638 submissions). Further non-English submissions had to be dropped to guarantee an unbiased quantitative text analysis (437 submissions).

[7]Text pre-processing of the submissions included deleting stopwords using a stopwordlist for

LDA is an unsupervised method to determine a distribution of words over topics and a distribution of topics over documents. A critical aspect of topic models is to decide on the correct number of topics that are covered in a corpus. The number of topics in a corpus of submissions including the roadmap document itself is determined using the R-package ldatuning (Murzintcev and Chaney, 21.04.2020). The number of topics chosen is the number that maximized an additive combination of four measurements for the fit of the number of topics[8] (Arun et al., 2010; Cao et al., 2009; Deveaud, SanJuan and Bellot, 2014; Griffiths and Steyvers, 2004). To calculate the number of topics that a document is mainly about, I count the topics that cover a share less than three standard deviations from the topic with the highest share of the document. The measurement of informativeness is then given by the quotient of the logarithm of content related words in the document and the number of topics covered. Let m_i be the number of topics mainly covered in document i and l_i the number of content related words in document i. Then informativeness of a document, inf_i, is calculated as $inf_i = \frac{ln(l_i)}{m_i}$. Higher values indicate more informativeness and lower values less.

Previous measurements of information in a text only considered the length of a document (Klüver, 2013). While it might seem that longer statements are a sign of more information, I argue that using more words should be weighted by the number of topics that a text is about. The *informativeness* measurement is closer connected to the combination of (1) the number of features and (2) the relevance of theses features to the topics of interest.

English provided by the R-package quanteda (Benoit et al., 2018), removing punctuation, symbols, urls, separators, and hyphens, and stemming.

[8]If the minimum of a measurement was the optimum, the negative value of that measurement was used in the combination.

	The Polish Union of Cosmetics Industry *F16093 Jan 2019*	The Ordo Iuris Institute Institute for Legal Culture *F1453825 Jan 2021*
Initiative	Labelling fragrance allergens	Combating gender-based violence — protecting victims and punishing offenders
Number of topics in corpus	9	19
Number of topics in initiative	9	2
Number of content relevant words	242	4970
Measured informativeness	0.6099	4.2556
Text sample	• "[...] take into account its technical feasibility and its real impact on the safety of European Consumers." • "The Commission on the Inception Impact Assessment states that overall the frequency of contact allergy to fragrance ingredients in the general population in Europe is 1-3%." • "[...]most of the products on the market would require re-labelling to include information on additional fragrance ingredients[...]"	• "Article 82(2) and Article 83(1) TFEU cannot be legal basis for taking legislative action [...]" • "The biased and ideologised character of the gender-based violence perspective translates into its inefficiency in combating domestic violence and violence against women." • "[..] it should be emphasised that the Istanbul Convention is still controversial [...]"

Table 4.1: Examples of less and more informative feedback

To get an idea what is considered a more and less informative contribution, table 4.1 shows two feedback documents to different roadmaps. The feedback *F16093* by the Polish Union of Cosmetics Industries is considered relatively uninformative. This is because the feedback itself is short but still covers nine out of nine topics found in the corpus of feedback documents. The text samples shown in table 4.1 basically summarize the stakeholder's feedback on the initiative, which lacks detail about the real costs of re-labeling products. The feedback *F1453825* by The Ordo Iuris Institute for Legal Culture, on the other hand, can be considered more informative. It concentrates on two topics out of 19 found in the corpus of stakeholder feedback on the initiative about "Combating gender-based violence". The main focus of the feedback is on the legal basis of the initiative. The stakeholder provides a summary as a first feedback and additionally a 18-page long statement. Overall, the statement can be considered more informative due to its focus on two main aspects and the detail of its arguments. While for the feedback *F16093* the text samples give all the information that is contained, the text samples from *F1453825* can be considered headers of detailed descriptions of why they come to these conclusions.

The examples from table 4.1 can give a first impression how informativeness might differ between different stakeholders' feedback. As we would expect from theory, the informativeness of feedback from stakeholders to the same initiative is highly correlated. All interest groups strategically design their feedback to the initiative's characteristics. Therefore, it can be expected that feedback to the same initiative should be similar in its informativeness.

4.4.2 The Statistical Model

I use a multilevel linear model to test the derived hypothesis on the effect of a planned public consultation and the indicative planning on the informativeness of a submission. Variation on the level of initiatives is taken care of by a random intercept for initiatives. Further, *#-topics* controls for the number of topics found in the corpus of a initiative, a dummy controls for the type of legislation (*type=Proposal for a regulation*), and the logarithm of the budget stated in the EU's Transparency Register is used to control for individual stakeholders' capacities to invest in lobbying.[9] The equation for the main model can be described as:

$$\begin{aligned} inf_i =& \beta_0 + \beta_0 j + \beta_1 \cdot timeframe_j + \beta_2 \cdot NoAg.Constr._j + \beta_3 \cdot \# - topics + \\ & \beta_4 \cdot type_j + \beta_5 \cdot log(budget)_i + \varepsilon_{ij} \end{aligned}$$

where i indicates the individual submission of stakeholders and j the single initiative. I provide an additional model that controls for the DGs involved and the section that a stakeholder belongs to using dummy variables.

The next section shows the results of the statistical analysis and evaluates the hypotheses derived in the formal model. Further, I investigate in the effect of different numbers of topics for the measurement of informativeness and its effect on the results of the statistical analysis.

Table 4.2: Summary statistics

	agenda constraint	no agenda constraint
N submissions	16.82	27.84
	(36.24)	(29.91)
time frame***	286.07	409.42
	(118.17)	(223.10)
#-topics	16.04	18.16
	(6.41)	(5.39)
average length of submissions	830.09	952.17
	(552.67)	(633.11)
average Informativeness**	2.13	2.97
	(1.29)	(1.21)
N initiatives	28	80
N proposal for directive	9	33
N proposal for regulation	19	47

Note: SD in brackets t-test: $^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

4.5 Results

The theoretical considerations suggest that an agenda constraint affects the informativeness of stakeholders' feedback to roadmaps. Table 4.2 shows summary statistics for the 108 initiatives. There is a statistically significant difference in the mean of the time frame. Initiatives with a planned public consultation, without an agenda constraint, usually have a longer time frame than those without a consultation. The average informativeness of submissions is significantly higher for initiatives that wihtout an agenda constraint compared to initiatives with a constrained agenda, supporting hypothesis 2.

The results of the multilevel model main analysis can be found in table 4.3. The coefficients of the models in columns (1), (2), and (3) show that an unconstrained agenda is a statistically significant predictor of a submission's informativeness. As expected the coefficient of time frame is negative but it is not statistically significant. The formal model presented above suggests that generally a higher punishment for type II error, implementing a non-beneficial policy, increases the informativeness of signals. However, I cannot find evidence for that prediction.

The existence of an agenda constraint measured by a planned public consultation affects the informativeness of feedback. This finding supports the theoretical predictions for situations in which the *DG* needs to be convinced of an issue i and would not include the issue in the policy without seeing informative evidence, meaning $\theta > \pi_i$. As argued before I expect that in situations of informative lobbying stakeholders still need to convince the policymaker to implement their policy

[9] The information on budget is missing for 30 stakeholder observations, reducing the number of observations for the full model to 2668.

Table 4.3: Multilevel regression models of *informativeness*

	Dependent variable:		
	informativeness		
	(1)	(2)	(3)
(Intercept)	0.23	−0.51	1.14
	(0.29)	(0.40)	(0.73)
time frame	−0.0006	−0.0006	−0.0008
	(0.0004)	(0.0004)	(0.0005)
no agenda constraint	0.54**	0.55**	0.44*
	(0.19)	(0.19)	(0.22)
#-topics	0.14***	0.14***	0.13***
	(0.01)	(0.01)	(0.02)
type=Proposal for a regulation		−0.09	−0.28
		(0.15)	(0.18)
log(budget)		0.06**	0.07**
		(0.02)	(0.02)
DG included			Yes
Section included			Yes
Observations	2698	2668	2668
Groups: Initiative	108	108	108
Var: Initiative (Intercept)	0.36	0.37	0.33
Var: Residual	2.67	2.67	2.65
Log Likelihood	−5228.81	−5172.94	−5142.56
Akaike Inf. Crit.	10469.62	10361.88	10371.12

Note: SE in brackets $^{*}p<0.05$; $^{**}p<0.01$; $^{***}p<0.001$

preference. Accordingly, the results support the predictions of hypothesis 2. The size of the effect is almost unaffected by including additional control variables like the budget, dummies for the different DGs involved in the initiative, or the section that a stakeholder belongs to.

The expectation that more informative signals are more costly is also supported by the strong positive relationship between budget and informativeness of feedback documents. Stakeholders who provide more information also spend more money on activities that are related to the transparency register.

4.5.1 Robustness of Results to Different Specifications of Topic Models

The results supporting the predictions of the formal model should be treated with caution. While the measurement chosen for informativeness of interest groups' feedback is motivated theoretically, the way of creating it heavily depends on the specification of topic models. When calculating topic models, the researcher has to specify the number of topics contained in the corpus. I used an additive index of four measurements of model fit for topic models to decide on the number of topics in a corpus. However, for each of these four measurements of model fit, the suggested number of topics for a corpus diverges. To test how robust my results are to the specified number of topics, I created four additional measurements that use the number of topics that maximize the model fit based on the individual measurements by Arun et al. (2010), Cao et al. (2009), Griffiths and Steyvers (2004), and Deveaud, SanJuan and Bellot (2014) instead of a additive combination of the four.[10]

[10] Arun et al. (2010) minimize the Kullback-Leibler divergence of distributions across the topic-word matrix and the document-topic matrix. Cao et al. (2009) try to minimize correlation between

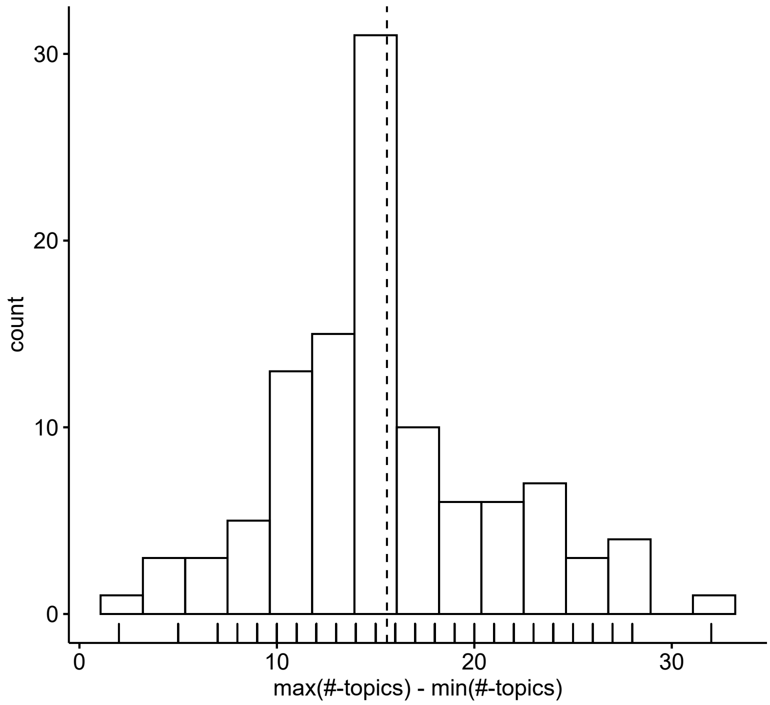


Figure 4.2: Histogram of difference for suggested topics of different measurements of fit

All four measurements of model fit are supposed to find the empirically "correct" number of topics in a corpus. Looking at the range of proposed numbers of topics between the four measurements, we find a maximum of 32 with the smallest suggested number at 13 and the highest at 45. The mean range for all initiatives is at 15.57 with a standard deviation of 5.69. A histogram of the difference between the maximum and minimum of proposed topics for each initiative can be seen in figure 4.2. The correlation between the number of topics suggested by the four different measurements is very high, always above 0.64. The correlation between the informativeness measurements using the suggested number of topics for the measurements by Cao et al. (2009), Arun et al. (2010), and Griffiths and Steyvers (2004) is always above 0.67. The informativeness measurement following Deveaud, SanJuan and Bellot (2014) is different from the other measurements with a correlation coefficient below 0.4 for all of the other three measurements.

The results for the multilevel models using these alternative measurements of informativeness can be seen in table 4.4. The measurement using the suggested number of topics by the model fit measurement developed by Griffiths and Steyvers (2004) produces results that are comparable to the ones of the model with the additive index. For the measurement using the number of topics suggested by the measurement of Cao et al. (2009), the effect of the a planned public consultation on the informativeness of submissions is apparent and time frame is negative and statistically significant. So one of the robustness models even supports H1. Further, all four models show the strong effect of budget on the informativeness of submissions.

topics and create a more stable topic model. Griffiths and Steyvers (2004) maximize the probability of a latent variable that indicates the topic from which a word was drawn given that word. Deveaud, SanJuan and Bellot (2014) maximize the information divergence between all topic pairs to achieve the most dissimilar topics. Generally all of these methods assume that the optimal number of topics is reached when topics given words are most dissimilar.

Table 4.4: Multilevel model with different specifications of the dependent variable *informativeness*

	Dependent variable:			
	informativeness			
	Cao	Griffith	Arun	Deveaud
(Intercept)	0.70	−0.51	−0.80*	1.58***
	(0.36)	(0.40)	(0.36)	(0.33)
time frame	−0.0008*	−0.0006	0.0000	−0.0001
	(0.0004)	(0.0004)	(0.0003)	(0.0004)
no agenda constraint	0.49*	0.55**	0.32	0.03
	(0.21)	(0.19)	(0.18)	(0.22)
#-topics	0.09***	0.14***	0.15***	−0.01
	(0.01)	(0.01)	(0.01)	(0.02)
type=Proposal for a regulation	−0.05	−0.09	−0.07	−0.15
	(0.17)	(0.15)	(0.14)	(0.19)
log(budget)	0.04*	0.06**	0.07***	0.06***
	(0.02)	(0.02)	(0.02)	(0.01)
Observations	2668	2668	2668	2667
Groups: Initiative	108	108	108	108
Var: Initiative (Intercept)	0.50	0.37	0.28	0.79
Var: Residual	2.53	2.67	2.54	1.21
Log Likelihood	−5112.70	−5172.94	−5099.49	−4181.34
Akaike Inf. Crit.	10241.40	10361.88	10214.97	8378.67
Note: SE in brackets		*p<0.05; **p<0.01; ***p<0.001		

4.5.2 Evidence for Overlobbying

Dellis and Oak (2019) use overlobbying to describe stakeholders' decision to use verifiable information to lobby for the inclusion of an issue although the information suggests not to include their issue. Hereby, stakeholders make use of the resource constraints of decision makers who cannot verify all information and therefore consider an informative signal to be evidence for the inclusion of an issue.

Overlobbying might also contribute to the empirical finding that feedback is more informative if the agenda is unconstrained. While I cannot differentiate between overlobbying and useful information using quantitative measures, I will provide some anecdotal insights what overlobbying might look like in feedback to initiative roadmaps.

Overlobbying is characterized by statements making false claims that cannot be supported by scientific research or hard facts. Signs of overlobbying in the current data can be found in the initiative "Strengthening the principle of equal pay between men and women through pay transparency". The initiative has several objectives like "[...] strengthening access to information on pay levels, improving understanding of some existing legal concepts and enhancing enforcement mechanisms on the EU legal provision [...]" (European Commission, 2020, p.2).

While there is feedback that provides empirical evidence like the feedback by the Confederation of Swedish Enterprises or by HOTREC, an association of hotels, bars, restaurants, and cafés in Europe, there is also a stakeholder claiming that a gender pay gap would not exist in their industry. The ZDH, the German Confederation of Skilled Crafts and Small Businesses, states that collective agreements amongst social partners in the sector would create a structure that "leaves no room for gender pay gaps"[11]. However, data suggests that women employed in crafts enterprises in Germany earn on average 7.26% less than men (gehalt.de, 04.03.2021). Therefore, their feedback might be considered overlobbying. Since the initiative is not constrained in its agenda, we would expect overlobbying to be a phenomenon that can be observed in the feedback to this initiative.

Summing up, there is empirical evidence that stakeholders increase the informativeness of their feedback to roadmaps of initiatives if the DG announces public consultations. However, there is no strong evidence that time frames affect the informativeness of stakeholders' submissions. The overall signal to welcome feedback by announcing a public consultation — not constraining the agenda — generally increases the informativeness of submissions. Overlobbying as defined by Dellis and Oak (2019) might also be a reason for an increase in informativeness for unconstrained agendas. The results suggest that the responsible DG can to some degree affect the informativeness of feedback by announcing public consultations.

4.6 Discussion

Stakeholders in the EU not only use information as an exchange good for access as often suggested (Bouwen, 2002, 2004*b*; Klüver, 2013), they also use information as a tool of persuasion. The analysis of feedback to roadmaps of policy initiatives of the European Commission suggest that stakeholders strategically react in their information behavior on decisions or constraints of the DG. The main takeaway follows the "ask, and you shall receive" logic: When the DG credibly shows that

[11] The full feedback can be found under https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12098-Gender-pay-gap-transparency-on-pay-for-men-and-women/details/F503428_en. Last accessed 11.03.2022.

they are interested in all stakeholders opinions by announcing a public consultation, they receive more informative feedback on their roadmaps. However, answers from unstructured interviews suggest that stakeholders still feel a lack of responsiveness to their opinions.

A possible reason of low responsiveness might be temporal constraints that lead to a higher fear of making type II errors, which means including an issue in the policy that should be excluded. European Commission staff and publication dates of initiative roadmaps, consultation periods, and policy proposals suggest that time frames are often very short, leaving limited capacities to thoroughly consider all issues. The formal model suggests that such a situation can be described by a hard-to-convince DG, meaning a DG with a large punishment for including policy issues that are not beneficial for the DG.

As often with evidence based on quantitative text analysis, the results depend to some degree on specifications of the used topic models, especially the number of topics assumed in a corpus. To reduce the effect of a specific measurement of model fit that are used to find the empirically optimal number of topics in a corpus, I chose a simple additive index of four different measurements (Arun et al., 2010; Cao et al., 2009; Deveaud, SanJuan and Bellot, 2014; Griffiths and Steyvers, 2004). The finding that stakeholders provide more informative feedback to initiatives that plan a public consultation is also robust to several values for the number of topics on a corpus.

The empirical analysis supports the prediction that an unconstrained agenda increases the informativeness of feedback documents. However, it is possible that this finding is based on overlobbying by stakeholders. The measurement of informativeness cannot differentiate between lobbying for an issue that is beneficial from viewpoint of the DG and an issue that is not beneficial. Accordingly, increased overlobbying might be a reason for more informative statements when public consultations are announced.

While this paper is a first step to understand strategic information provision in the context of the European Commission's consultation system, there are other questions that remain open. The most important question is probably how strongly does the Commission react to information when creating a policy proposal? Previous research suggests that at least the detail, measured in the length of the feedback, affects the final policy proposal in a one-dimensional space (Klüver, 2013). Feedback to roadmaps is just the very first option to affect policies in the drafting stage. There might also be an effect of stakeholders' feedback to roadmaps on the issues covered by the DG in the subsequent consultations. More research on the effect of feedback to initiative roadmaps is needed to get a better picture of the effect of Better Regulation Guidelines on final policy proposals. While several open questions still remain, it is evident that when a policy maker asks for information, stakeholders will provide.

5

Conclusion

This dissertation studies questions on information transmission in different scenarios. Chapters 2 and 3 concentrate on decision making in deliberative committees. In both chapters a formal model was described where some committee members process information in a biased way compared to Bayesian updating. In chapter 2, I show that a cognitive bias in itself, in this chapter correlation neglect, does not necessarily lead to worse group decisions or information aggregation than perfectly rational committees. However, a heterogeneous committee with members who are perfectly rational and some who neglect correlation decreases the space for possible full information sharing equilibria. In chapter 3, I demonstrate that also in a committee with individuals who have different levels of confirmation bias additional conditions are required to make full information sharing an equilibrium strategy. Further, I provide experimental evidence that participants understand when automated players process information in a biased way and react strategically in their information provision. To the best of my knowledge both studies were the first to analyze the effect of heterogeneity in information processing on decision making in deliberative committees. Chapter 4 is concerned with the European Commission's consultation procedure and strategic information transmission in consultations. I present a model that explains information provision strategies of stakeholders in the consultation procedure and empirical evidence for some of the model's predictions for the feedback on policy initiatives.

5.1 Implications for Research on Deliberative Committees

Research on deliberative committees was mainly concerned with the effect of differences in preferences or thresholds of doubt between committee members, how these differences might affect information aggregation in deliberation and decision making. I show that differences in information processing also affect information sharing in deliberation and reduces the space for full information sharing equilibria. The results suggest that for efficient information aggregation individuals' information processing should not differ too much.

This finding is somewhat contrary to theses and findings of deliberative democracy. Group polarization is found to be the consequence of deliberation among like minded (Sunstein, 2002) while exposure to opposite political opinions is connected with more tolerance and acceptance of opposite viewpoints (Mutz, 2002). However, the findings of this paper rather focus on the existence of deliberation given differences in information processing. The results only speak to the literature on deliberative democracy in the way that they describe necessary conditions for deliberation to take place. However, deliberative democracy is not restricted on group decision making in deliberative committees but is also concerned with deliberation in the whole society. In deliberative committees, (small) groups make a decision after an exchange of information creating incentives for strategic behavior when there is heterogeneity in information processing. It remains unclear whether the same strategic considerations may hinder deliberation among individuals in other situations like deliberation events for the sake of information exchange.

This dissertation only considers two cognitive biases, correlation neglect and confirmation bias. For both, I find that additional conditions must be met to make full information sharing in deliberation possible. While the conditions in themselves differ, they both follow the logic: The bias of individuals must be similar enough such that there is a low probability of conflict between individuals with different information processing. We can expect that for other cognitive biases findings are similar and full information sharing equilibria require additional conditions.

In both models I assume that individuals' information processing is common knowledge. In reality, it is unlikely that individuals know how others process information. However, they may have beliefs about others' information processing which may affect their decisions. The experiment in chapter 3 provides empirical evidence that beliefs about others' behavior can affect information transmission in deliberation. Beliefs are usually not deterministic but rather probabilistic. Incorporating beliefs about others' information processing instead of assuming others' information processing to be common knowledge may be a way to increase the space for possible full information sharing equilibria by relaxing some of the conditions stated in chapter 2 and 3. Previous findings show that uncertainty about individuals' thresholds of doubt increase the space for possible full sharing equilibria compared to situations where individuals' thresholds of doubt are common knowledge (Schulte, 2010). A similar mechanism might also work for differences in information processing between members of the same group.

The theoretical results of this dissertation also call for more empirical research on (strategic) reactions of individuals on others' biased information processing. To the best of my knowledge, the experiment in chapter 3 is the first to test empirically how beliefs about individuals' information processing affect information transmission in deliberation. The results support the theoretical predictions. However, more empirical research is necessary to better understand when individuals have beliefs that others process information differently. Another question of interest is how large differences have to be such that individuals adapt their information provision strategy. Further, other cognitive biases should be used in a comparable setting to understand whether they can also be identified by humans and whether their beliefs affect information transmission in deliberation.

5.2 Implications for Research on the European Commission's Consultations

The European Commission's consultations are a platform where stakeholders can use information to persuade decision makers of implementing their preferred policy. I provide a formal framework that shows how the responsible DG can affect the informativeness of signals provided by stakeholders. The model suggests that the informativeness of stakeholders' feedback increases if public consultations are included in the policy making process. A first empirical investigation using new data of feedback to roadmaps of policy initiatives provides evidence that stakeholders prepare more informative feedback if public consultations are announced.

The formal model is a first model of the European Commission's consultation process and gives insights how costs and other constraints affect decisions of DGs and stakeholders. The model is focused on the very first stage of the consultation procedure where stakeholders give feedback to roadmaps of policy intiatives. However, the Better Regulation Guidelines cover additional stages where interest groups can affect policy making, like the following public consultation, expert committees, workshops, or the feedback to the impact assessment report. Further, the process is meant to be an infinite loop of re-evaluation of policy. The different stages of informational lobbying in EU policy drafting might affect stakeholders' information transmission strategy in the different stages. The model presented in this dissertation can give insights how the DG's decisions about public consultations or the time frame might affect stakeholders' information strategy. However, another model that includes the subsequent stages might be useful to better understand participation of stakeholders in the feedback loop to roadmaps, the different consultation forms, or feedback to the impact assessment report.

While most research on the consultation procedures of the European Commission is focused on the different consultation forms in the consultation stage, stakeholders transmit information to DGs already prior to consultation in feedback to roadmaps and subsequently in feedback to impact assessment reports. There still lacks empirical evidence about the impact of these feedback stages on EU policy or a comparison of the informativeness of these different consultation stages for a DG's staff. Quantitative text analysis methods might be a way to assess the number of topics different stages bring up or how much information is transmitted.

Decisions and constraints of decision makers like the European Commission influence how (much) information is transmitted by stakeholders. Accordingly decision makers should take into account how stakeholders' information transmission strategy might be affected by (self-inflicted) constraints of the decision maker. The decision makers have the power to shape the rules of consultations and accordingly to some degree of informational lobbying. Research on informational lobbying and consultation procedures has the potential to improve the information flow from better informed stakeholders to decision makers to ensure that enough evidence is available for decision makers to make evidence based policy.

Appendix A

Chapter 2

A.1 Probabilities

For the calculation of proofs, several probabilities are important to know. The first one is given a number of committee members n and a probability for receiving an uninformative signal q, the probability to see s_n informative signals is given by:

$$Pr(s_n) = \binom{n}{s_n} q^{n-s_n}(1-q)^{s_n}$$

Given an number of informative signals s_n and a number of sources z, the probability to see s_z independent signals is given by:

$$Pr(s_z) = \left(\frac{1}{z}\right)^{s_n} \cdot \sum_{i=1}^{s_z} \left(\binom{z}{z-s_z+i-1} \cdot (s_z-i+1)^{s_n} \cdot \prod_{j=1}^{i-1} \left((-1)\frac{z-s_z+j}{j}) \right) \right)$$

where i and j are used as help variables and do not indicate a committee member as in the main text.

A.2 Proof of Proposition 2

Assume, $r \leq 0.5$ and $k^* = -n$ then, for a *naive* committee the probability to make the correct decision is given by

$$Pr(o = \omega|k^*, n, z) = \sum_{s_n=0}^{n} Pr(s_n|n, z) \cdot \sum_{s_z=min\{s_n,1\}}^{min\{s_n,z\}} Pr(s_z|s_n, z) \cdot Pr(o = \omega|k^*, s_z)_C$$

with

$$\begin{aligned} Pr\left(o = \omega|k^*, s_n, s_z\right)_C = &\sum_{s'_\alpha=0}^{s_z} Pr\left(s_\alpha \leq \frac{s_n - k^*}{2}\right) \binom{s_z}{s'_\alpha} p^{s_z - s'_\alpha}(1-p)^{s'_\alpha} r + \\ &\sum_{s'_\alpha=0}^{s_z} Pr\left(s_\alpha > \frac{s_n - k^*}{2}\right) \binom{s_z}{s'_\alpha} p^{s'_\alpha}(1-p)^{s_z - s'_\alpha}(1-r) \end{aligned}$$

For $k^* = -n$, $Pr(s_\alpha \leq \frac{s_n - k^*}{2}) = 1$ and $Pr(s_\alpha > \frac{s_n - k^*}{2}) = 0$ for all s'_α.

Then $Pr\left(o = \omega|k^*, s_n, s_z\right)_C = r$ for any s_z, leading to $Pr(o = \omega|k^*, n, z) = r$.

For a *sophisticated* committee member, the probability to make a correct decision is given by

$$Pr(o = \omega|k^*, n, z) = \sum_{s_n=0}^{n} Pr(s_n|n, z) \cdot \sum_{s_z=min\{s_n,1\}}^{min\{s_n,z\}} Pr(s_z|s_n, z) \cdot Pr(o = \omega|k^*, s_z)_R$$

with

$$\begin{aligned} Pr(o = \omega|k^*, s_z)_R = &\sum_{s'_\alpha=0}^{min(\frac{1}{2}(s_z - k^*), s_z)} \binom{s_z}{s'_\alpha} p^{s_z - s'_\alpha}(1-p)^{s'_\alpha} r + \\ &\sum_{s'_\alpha > \frac{1}{2}(s_z - k^*)}^{s_z} \binom{s_z}{s'_\alpha} p^{s'_\alpha}(1-p)^{s_z - s'_\alpha}(1-r) \end{aligned}$$

For $k^* = -n$ and $n > z$,

$$Pr(o = \omega | k^*, s_z)_R = \sum_{s'_\alpha=0}^{s_z} \binom{s_z}{s'_\alpha} p^{s_z - s'_\alpha}(1-p)^{s'_\alpha} r$$
$$= r$$

and therefore, $Pr(o = \omega | k^*, n, z) = r$ for *sophisticated* committees as well.

Next, assume $k'^* = -n + 1$. Since $n > z$, $n - 1 \geq z$. Therefore, the probability to make the correct decision stays r for *sophisticated* committees.

For *naive* committees, the difference in probabilities between decisions under k'^* and $k^* = k'^* - 1$ is given by

$$\sum_{s_n=0}^{n} Pr(s_n|n,z) \cdot \sum_{s_z=min\{s_n,1\}}^{min\{s_n,z\}} Pr(s_z|s_n,z) \cdot \left(Pr\left(o = \omega | k'^*, s_n, s_z\right)_C - Pr\left(o = \omega | k'^* - 1, s_n, s_z\right)_C \right)$$

The difference in the brackets can be written as

$$\begin{aligned}
&\sum_{s'_\alpha=0}^{s_z} Pr(s_\alpha \leq \frac{s_n - k'^*}{2}) \cdot \binom{s_z}{s'_\alpha} p^{s_z - s'_\alpha}(1-p)^{s'_\alpha} r \\
-&\sum_{s'_\alpha=0}^{s_z} Pr(s_\alpha \leq \frac{s_n - k'^* + 1}{2}) \cdot \binom{s_z}{s'_\alpha} p^{s_z - s'_\alpha}(1-p)^{s'_\alpha} r \\
+&\sum_{s'_\alpha=0}^{s_z} Pr(s_\alpha > \frac{s_n - k'^*}{2}) \cdot \binom{s_z}{s'_\alpha} p^{s_z - s'_\alpha}(1-p)^{s'_\alpha} (1-r) \\
-&\sum_{s'_\alpha=0}^{s_z} Pr(s_\alpha > \frac{s_n - k'^* + 1}{2}) \cdot \binom{s_z}{s'_\alpha} p^{s_z - s'_\alpha}(1-p)^{s'_\alpha} (1-r)
\end{aligned}$$

Then, for $k'^* = -n + 1$, we know that $Pr(s_\alpha \leq \frac{s_n - k'^* + 1}{2}) = 1$ and $Pr(s_\alpha > \frac{s_n - k'^* + 1}{2}) = 0$. Further, $Pr(s_\alpha > \frac{s_n - k'^*}{2}) = 0$ except for $s_n = n$. Then the difference is given by:

$$\sum_{s'_\alpha=0}^{s_z}\sum_{s_\alpha=s'_\alpha}^{\frac{1}{2}(2n-1)}\binom{n-s_z}{s_\alpha-s'_\alpha}\left(\frac{s'_\alpha}{s_z}\right)^{s_\alpha-s'_\alpha}\left(\frac{s_z-s'_\alpha}{s_z}\right)^{n-s_z-s_\alpha+s'_\alpha}\cdot\binom{s_z}{s'_\alpha}p^{s_z-s'_\alpha}(1-p)^{s'_\alpha}r$$
$$+\sum_{s'_\alpha=0}^{s_z}\sum_{s_\alpha>\frac{1}{2}(2n-1)}^{n}\binom{n-s_z}{s_\alpha-s'_\alpha}\left(\frac{s'_\alpha}{s_z}\right)^{s_\alpha-s'_\alpha}\left(\frac{s_z-s'_\alpha}{s_z}\right)^{s_n-s_z-s_\alpha+s'_\alpha}\cdot\binom{s_z}{s'_\alpha}p^{s_z-s'_\alpha}(1-p)^{s'_\alpha}(1-r)$$
$$-\sum_{s'_\alpha=0}^{s_z}\sum_{s_\alpha=s'_\alpha}^{n}\binom{n-s_z}{s_\alpha-s'_\alpha}\left(\frac{s'_\alpha}{s_z}\right)^{s_\alpha-s'_\alpha}\left(\frac{s_z-s'_\alpha}{s_z}\right)^{n-s_z-s_\alpha+s'_\alpha}\cdot\binom{s_z}{s'_\alpha}p^{s_z-s'_\alpha}(1-p)^{s'_\alpha}r$$

so there is a difference between the probabilities only for $s'_\alpha = s_z$ and $s_\alpha = n$

$$\binom{n-s_z}{n-s_z}\left(\frac{s_z}{s_z}\right)^{n-s_z}\left(\frac{0}{s_z}\right)^{n-s_z-n+s_z}\cdot\binom{s_z}{s_z}\left(p^{s_z}(1-p)^{s_z-s_z}(1-r)-p^{s_z-s_z}(1-p)^{s_z}r\right)$$
$$=p^{s_z}(1-r)-(1-p)^{s_z}r$$

For $r \leq 0.5$, $p^{s_z}(1-r)-(1-p)^{s_z}r > 0$ meaning that for *naive* committees $Pr(o=\omega|k'^*,n,z) > Pr(o=\omega|k^*,n,z) = r$.

We still have to show that for $r \geq 0.5$, we can find a similar situation to proof proposition 2. So, assume $r \geq 0.5$ and $k^* = n$. Then for both *sophisticated* and *naive* the probability to make the correct decision is $(1-r)$. The derivation of this result is equivalent to the case above.

Next assume some $k'^* = n-1$. Since $n > z$, $k'^* \geq z$ and for *sophisticated* committees $Pr(o=\omega|k'^*,n,z) = r$.

For *naive* committees, the difference between $Pr(o=\omega|k^*,n,z) - Pr(o=\omega|k'^*,n,z)$

is given by

$$\sum_{s_n=0}^{n} Pr(s_n|n,z)\cdot \sum_{s_z=min\{s_n,1\}}^{min\{s_n,z\}} Pr(s_z|s_n,z)\cdot \Bigg(Pr\left(o=\omega|k'^{*}+1,s_n,s_z\right)_C - Pr\left(o=\omega|k'^{*},s_n,s_z\right)_C \Bigg)$$

The difference in the brackets can be written as

$$\begin{aligned}
&\sum_{s'_\alpha=0}^{s_z} Pr(s_\alpha \leq \frac{s_n-k'^{*}-1}{2})\cdot \binom{s_z}{s'_\alpha} p^{s_z-s'_\alpha}(1-p)^{s'_\alpha} r \\
-&\sum_{s'_\alpha=0}^{s_z} Pr(s_\alpha \leq \frac{s_n-k'^{*}}{2})\cdot \binom{s_z}{s'_\alpha} p^{s_z-s'_\alpha}(1-p)^{s'_\alpha} r \\
+&\sum_{s'_\alpha=0}^{s_z} Pr(s_\alpha > \frac{s_n-k'^{*}-1}{2})\cdot \binom{s_z}{s'_\alpha} p^{s_z-s'_\alpha}(1-p)^{s'_\alpha}(1-r) \\
-&\sum_{s'_\alpha=0}^{s_z} Pr(s_\alpha > \frac{s_n-k'^{*}}{2})\cdot \binom{s_z}{s'_\alpha} p^{s_z-s'_\alpha}(1-p)^{s'_\alpha}(1-r)
\end{aligned}$$

Then, for $k'^{*}=n-1$, we know that $Pr(s_\alpha \leq \frac{s_n-k'^{*}-1}{2})=0$ and $Pr(s_\alpha > \frac{s_n-k'^{*}-1}{2})=1$. Further, $Pr(s_\alpha \leq \frac{s_n-k'^{*}}{2})=0$ except for $s_n=n$. Then the difference is given by:

$$\begin{aligned}
&\sum_{s'_\alpha=0}^{s_z}\sum_{s_\alpha=s'_\alpha}^{n} \binom{n-s_z}{s_\alpha-s'_\alpha}\left(\frac{s'_\alpha}{s_z}\right)^{s_\alpha-s'_\alpha}\left(\frac{s_z-s'_\alpha}{s_z}\right)^{s_n-s_z-s_\alpha+s'_\alpha}\cdot\binom{s_z}{s'_\alpha} p^{s_z-s'_\alpha}(1-p)^{s'_\alpha}(1-r) \\
-&\sum_{s'_\alpha=0}^{s_z}\sum_{s_\alpha=s'_\alpha}^{\frac{1}{2}} \binom{n-s_z}{s_\alpha-s'_\alpha}\left(\frac{s'_\alpha}{s_z}\right)^{s_\alpha-s'_\alpha}\left(\frac{s_z-s'_\alpha}{s_z}\right)^{n-s_z-s_\alpha+s'_\alpha}\cdot\binom{s_z}{s'_\alpha} p^{s_z-s'_\alpha}(1-p)^{s'_\alpha} r \\
-&\sum_{s'_\alpha=0}^{s_z}\sum_{s_\alpha=max(1,s'_\alpha)}^{n} \binom{n-s_z}{s_\alpha-s'_\alpha}\left(\frac{s'_\alpha}{s_z}\right)^{s_\alpha-s'_\alpha}\left(\frac{s_z-s'_\alpha}{s_z}\right)^{s_n-s_z-s_\alpha+s'_\alpha}\cdot\binom{s_z}{s'_\alpha} p^{s_z-s'_\alpha}(1-p)^{s'_\alpha}(1-r)
\end{aligned}$$

so there is a difference between the probabilities only for $s'_\alpha = 0$ and $s_\alpha = 0$

$$\begin{aligned}&\binom{n-s_z}{0}\left(\frac{0}{s_z}\right)^0\left(\frac{s_z}{s_z}\right)^{n-s_z}\cdot\binom{s_z}{0}\left(p^0(1-p)^{s_z}(1-r)-p^{s_z}(1-p)^0r\right)\\=&(1-p)^{s_z}(1-r)-p^{s_z}r\end{aligned}$$

For $r \geq 0.5$, $(1-p)^{s_z}(1-r)-p^{s_z}r < 0$ meaning that for *naive* committees $Pr(o = \omega|k'^*, n, z) > Pr(o = \omega|k^*, n, z) = r$.

So we can say that for $z < n$ there always exists some k^* for which *naive* committees are more likely to make the correct decision.

A.3 Proof of Proposition 3

Proof. To show that full information sharing can describe a perfect Bayesian equilibrium in a MCC, I start backwards with the voting decision.

Let $Pr(B|k(s))$ be the posterior belief for any committee member i, where $k(s)$ is either $k_C(s)$ or $k_R(s)$ depending on i's type. Each committee member conditions the own voting decision on being pivotal in the voting stage, meaning for $v_i = 1$ $o = b$ and for $v_i = 0$ $o = a$.

$$\begin{aligned}EU(v_i = 1) =& Pr(\omega = B)\cdot 0 + Pr(\omega = A)\cdot(-d_i)\\EU(v_i = 0) =& Pr(\omega = B)\cdot(-(1-d_i)) + Pr(\omega = A)\cdot 0\end{aligned}$$

Committee members choose to vote for reform if

$$
\begin{aligned}
EU(v_i = 1) \geq & EU(v_i = 0) \\
(1 - Pr(\omega = B)) \cdot (-d_i) \geq & Pr(\omega = B) \cdot (-(1 - d_i)) \\
d_i \leq & Pr(\omega = B)
\end{aligned}
$$

Given that all committee members truthfully share all information, beliefs are given by $Pr(B|k(s))$ with $k_C(s)$ for *naive* committee members and $k_R(s)$ for *sophisticated* committee members.

Whether the strategy of sharing all information is sequentially rational depends on the committee members beliefs in the event of being pivotal. A committee member who has a signal $\sigma_{ij} = \beta$ is pivotal if sharing the signal leads to a belief $Pr(B|k^*)$ for the pivotal committee member in the voting stage. If the pivotal committee member in the voting stage is of the same type, then

$$
\begin{aligned}
EU(s_i = \sigma_{ij}) = & (1 - Pr(B|k^*)) \cdot (-d_i) \\
EU(s_i = \sigma_{i0}) = & Pr(B|k^*) \cdot (-(1 - d_i))
\end{aligned}
$$

since $Pr(B|k^*) \geq d_i$, $EU(s_i = \sigma_{ij}) \geq EU(s_i = \sigma_{i0})$ and any committee member prefers sharing over hiding the signal.

A committee member who has a signal $\sigma_{ij} = \alpha$ is pivotal if sharing the signal leads to a belief $Pr(B|k^* - 1)$ for pivotal committee member in the voting stage. Then

$$
\begin{aligned}
EU(s_i = \sigma_{ij}) = & Pr(B|k^* - 1) \cdot (-(1 - d_i)) \\
EU(s_i = \sigma_{i0}) = & (1 - Pr(B|k^* - 1)) \cdot (-d_i)
\end{aligned}
$$

since $Pr(B|k^* - 1) < d_i$, $EU(s_i = \sigma_{ij}) \geq EU(s_i = \sigma_{i0})$ and committee members of the same type prefer sharing over hiding the signal.

Next, consider a situation where the pivotal committee member in the voting stage is of the other type. For a minority type the strategy depends on the expected probability $Pr(B|\sigma_{ij})$, d_i when being pivotal, and the agents' types. For any committee member of a different type than the pivotal committee member in the voting stage with a signal $\sigma_{ij} = \beta$, being pivotal means that

$$\begin{aligned} EU(s_i = \sigma_{ij}) =& (1 - Pr(B|k(s)) \cdot (-d_i) \\ EU(s_i = \sigma_{i0}) =& Pr(B|k(s)) \cdot (-(1 - d_i)) \end{aligned}$$

while for committee members of the same type $Pr(B|k(s)) = Pr(B|k^*)$ — independent of being *sophisticated* or *naive* — that is not true for committee member of another type than the pivotal committee members in the voting stage.

Assume, the type of the pivotal committee member in the voting stage is *sophisticated*, then for any *naive* committee member i with $\sigma_{ij} = \beta$

$$\begin{aligned} EU(s_i = \sigma_{ij}) =& (1 - Pr(B|k_C(s)) \cdot (-d_i) \\ EU(s_i = \sigma_{i0}) =& Pr(B|k_C(s)) \cdot (-(1 - d_i)) \end{aligned}$$

and the *naive* committee member wants to share the signal if and only if

$$\begin{aligned} EU(s_i = \sigma_{ij}) &\geq EU(s_i = \sigma_{i0}) \\ (1 - Pr(B|k_C(s)) \cdot (-d_i) &\geq Pr(B|k_C(s)) \cdot (-(1 - d_i)) \\ d_i &\leq Pr(B|k_C(s)) \end{aligned}$$

We know that in a situation where i with $\sigma_{ij} = \beta$ is pivotal in the deliberation stage, $k_R(s) = k^*$. Then i decides to share $\sigma_{ij} = \beta$ if

$$Pr(k_C(s) \geq k^* | k_r(s) = k^*) \geq Pr(k_C(s) \leq k^* - 1 | k_R(s) = k^*)$$

The condition above is fulfilled if

$$\sum_{s_n=1}^{n} Pr(s_n) \cdot \sum_{s_z=1}^{min(s_n,z)} Pr(s_z) \cdot Pr(s'_\alpha = \frac{1}{2}(s_z - k^*)) \cdot \left(\sum_{s_\alpha = s'_\alpha}^{\frac{1}{2}(s_n - s_z) + s'_\alpha} Pr(s_\alpha | s'\alpha = \frac{1}{2}(s_z - k^*)) - \sum_{s_\alpha > \frac{1}{2}(s_n - s_z) + s'_\alpha}^{(s_n - s_z) + s'_\alpha} Pr(s_\alpha | s'\alpha = \frac{1}{2}(s_z - k^*)) \right) \geq 0$$

which can be calculated as

$$\sum_{s_n=1}^{n} Pr(s_n) \cdot \sum_{s_z=1}^{min(s_n,z)} Pr(s_z) \cdot Pr(s'_\alpha = \frac{1}{2}(s_z - k^*)) \cdot \left[\sum_{t=0}^{\frac{1}{2}(s_n - s_z)} \left(\frac{\frac{1}{2}(s_z - k^*)}{s_z} \right)^t \left(\frac{\frac{1}{2}(s_z + k^*) - 1}{s_z} \right)^{\frac{1}{2}(s_n - s_z) - t} \binom{s_n - s_z}{t} - \sum_{t > \frac{1}{2}(s_n - s_z)}^{s_n - s_z} \left(\frac{\frac{1}{2}(s_z - k^*)}{s_z} \right)^t \left(\frac{\frac{1}{2}(s_z + k^*) - 1}{s_z} \right)^{\frac{1}{2}(s_n - s_z) - t} \binom{s_n - s_z}{t} \right] \geq 0$$

where $t \in \mathbb{N}$.

Next, consider a situation, where the pivotal committee member in the voting stage is *sophisticated*. Then a *naive* committee member i with $\sigma_{ij} = \alpha$ is pivotal in the deliberation stage if sharing leads to $k_R(s) = k^* - 1$ while hiding leads to $k_R(s) = k^*$.

The *naive* committee member wants to share the signal if

$$EU(s_i = \sigma_{ij}) \geq EU(s_i = \sigma_{i0})$$
$$Pr(B|k_C(s)) \cdot (-(1-d_i)) \geq (1 - Pr(B|k_C(s)) \cdot (-d_i)$$
$$Pr(B|k_C(s)) \leq d_i$$

We know that in a situation where i with $\sigma_{ij} = \alpha$ is pivotal in the deliberation stage, $k_R(s) = k^* - 1$. Then i decides to share $\sigma_{ij} = \alpha$ if

$$Pr(k_C(s) \leq k^* - 1 | k_r(s) = k^* - 1) \geq Pr(k_C(s) \geq k^* | k_R(s) = k^* - 1)$$

The condition above is fulfilled if

$$\sum_{s_n=1}^{n} Pr(s_n) \cdot \sum_{s_z=1}^{min(s_n,z)} Pr(s_z) \cdot Pr(s'_\alpha = \frac{1}{2}(s_z - k^* + 1)) \cdot$$
$$\left(\sum_{s_\alpha = s'_\alpha}^{\frac{1}{2}(s_n - s_z - 1) + s'_\alpha} Pr(s_\alpha | s'\alpha = \frac{1}{2}(s_z - k^* + 1)) - \sum_{s_\alpha \geq \frac{1}{2}(s_n - s_z) + s'_\alpha}^{(s_n - s_z) + s'_\alpha} Pr(s_\alpha | s'\alpha = \frac{1}{2}(s_z - k^* + 1)) \right) \leq 0$$

which can be calculated as

$$\sum_{s_n=1}^{n} Pr(s_n) \cdot \sum_{s_z=1}^{min(s_n,z)} Pr(s_z) \cdot Pr(s'_\alpha = \frac{1}{2}(s_z - k^*)) \cdot$$
$$\Bigg[\sum_{t=0}^{\frac{1}{2}(s_n - s_z - 1)} \left(\frac{\frac{1}{2}(s_z - k^* + 1) - 1}{s_z} \right)^t \left(\frac{\frac{1}{2}(s_z + k^* - 1)}{s_z} \right)^{\frac{1}{2}(s_n - s_z) - t} \binom{s_n - s_z}{t} -$$
$$\sum_{t \geq \frac{1}{2}(s_n - s_z - 1)}^{s_n - s_z} \left(\frac{\frac{1}{2}(s_z - k^* + 1) - 1}{s_z} \right)^t \left(\frac{\frac{1}{2}(s_z + k^* - 1)}{s_z} \right)^{\frac{1}{2}(s_n - s_z) - t} \binom{s_n - s_z}{t} \Bigg]$$
$$\leq 0$$

where $t \in \mathbb{N}$.

Next, assume the pivotal committee member in the voting stage is *naive*. Then any *sophisticated* committee member i who received $\sigma_{ij} = \beta$ is pivotal in the deliberation stage if sharing leads to $k_C(s) = k^*$ while hiding leads to $k_C(s) = k^* - 1$. So, the expected utility for sharing and hiding is given by

$$EU(s_i = \sigma_{ij}) = (1 - Pr(B|k_R(s)) \cdot (-d_i)$$
$$EU(s_i = \sigma_{i0}) = Pr(B|k_R(s)) \cdot (-(1 - d_i))$$

Further, we know that $s_\beta - s_\alpha = k^*$. Then, the question whether $EU(s_i = \sigma_{ij}) \geq EU(s_i = \sigma_{i0})$ depends on

$$Pr(k_R(s) \geq k^*|k_C(s) = k^*) \geq Pr(k_R \leq k^* - 1|k_C(s) = k^*)$$

which is given by

$$\sum_{s_n=1}^{n} Pr(s_n) \cdot \sum_{s_z=1}^{min(s_n,z)} Pr(s_z) \cdot \sum_{s'_\alpha=0}^{\frac{1}{2}(s_z-k^*)} \frac{Pr(s_\alpha = \frac{1}{2}(s_n - k^*)|s'_\alpha) \cdot Pr(s'_\alpha)}{Pr(s_\alpha = \frac{1}{2}(s_n - k^*))}$$
$$\geq \sum_{s_n=1}^{n} Pr(s_n) \cdot \sum_{s_z=1}^{min(s_n,z)} Pr(s_z) \cdot \sum_{s'_\alpha > \frac{1}{2}(s_z-k^*)}^{s_z-1} \frac{Pr(s_\alpha = \frac{1}{2}(s_n - k^*)|s'_\alpha) \cdot Pr(s'_\alpha)}{Pr(s_\alpha = \frac{1}{2}(s_n - k^*))}$$

where

$$\frac{Pr(s_\alpha = \frac{1}{2}(s_n - k^*)|s'_\alpha) \cdot Pr(s'_\alpha)}{Pr(s_\alpha = \frac{1}{2}(s_n - k^*))} =$$
$$\frac{\binom{s_z}{s'_\alpha}\left(\frac{s'_\alpha}{s_z}\right)^{\frac{1}{2}(s_n-k^*)-s'_\alpha}\left(\frac{s_z-s'_\alpha}{s_z}\right)^{\frac{1}{2}(s_n+k^*)-s_z+s'_\alpha}\left(rp^{s_z-s'_\alpha}(1-p)^{s'_\alpha} + (1-r)p^{s'_\alpha}(1-p)^{s_z-s'_\alpha}\right)}{Pr(s_\alpha = \frac{1}{2}(s_n - k^*))}$$

Next, assume the pivotal committee member in the voting stage is *naive*. Then any *sophisticated* committee member i who received $\sigma_{ij} = \alpha$ is pivotal in the deliberation stage if sharing leads to $k_C(s) = k^* - 1$ while hiding leads to $k_C(s) = k^*$. So, the *sophisticated* committee member i wants to share the signals if

$$\begin{aligned} EU(s_i = \sigma_{ij}) &\geq EU(s_i = \sigma_{i0}) \\ Pr(B|k_R(s)) \cdot (-(1-d_i)) &\geq (1 - Pr(B|k_R(s)) \cdot (-d_i) \\ Pr(B|k_R(s)) &\geq d_i \end{aligned}$$

We know that in a situation where i with $\sigma_{ij} = \alpha$ is pivotal in the deliberation stage, $k_C(s) = k^* - 1$. Then i decides to share $\sigma_{ij} = \alpha$ if

$$Pr(k_R(s) \leq k^* - 1 | k_C(s) = k^* - 1) \geq Pr(k_R(s) \geq k^* | k_C(s) = k^* - 1)$$

The condition above is fulfilled for

$$\begin{aligned} &\sum_{s_n=1}^{n} Pr(s_n) \cdot \sum_{s_z=1}^{min(s_n,z)} Pr(s_z) \cdot \sum_{s'_\alpha = \frac{1}{2}(s_z - k^* + 1)}^{s_z} \frac{Pr(s_\alpha = \frac{1}{2}(s_n - k^* + 1)|s'_\alpha) \cdot Pr(s'_\alpha)}{Pr(s_\alpha = \frac{1}{2}(s_n - k^* + 1))} \\ &\geq \sum_{s_n=1}^{n} Pr(s_n) \cdot \sum_{s_z=1}^{min(s_n,z)} Pr(s_z) \cdot \sum_{s'_\alpha=1}^{\frac{1}{2}(s_z - k^* + 1)} \frac{Pr(s_\alpha = \frac{1}{2}(s_n - k^* + 1)|s'_\alpha) \cdot Pr(s'_\alpha)}{Pr(s_\alpha = \frac{1}{2}(s_n - k^* + 1))} \end{aligned}$$

$\square$

Appendix B

Chapter 3

B.1 Proof of Proposition 4

Let committee members be numbered such that $d_1 \leq d_2 \leq ... \leq d_n$. Full information sharing behavior describes a perfect Bayesian equilibrium for a given voting rule m if and only if one of the following conditions is true:

1. $d_m \leq Pr(B|k_m(s))$ with $k_m(s) = -c_m 2n$; or
2. $Pr(B|k_m(s)) < d_m$ with $k_m(s) = 2n$; or
3. (a) $\exists k^{'}$ and $\exists k^{''} \in \{1-c_n(2n-1), 1-c_n(2n-2), ..., 2n\}$ such that $Pr(B|k^{'}) \leq d_i \leq Pr(B|k^{''})$ for all $i \in N$.
   (b) The borders $k^{'}$ and $k^{''}$ exist if there exists a Δ such that $Pr((c_n - c_1)k_\alpha(s) < \Delta) \geq Pr((c_n - c_1)k_\alpha(s) \geq \Delta)$ and $k^{''} - k^{'} < min\{1, c_m\} - \Delta$.

Proof. The full information sharing strategy has two steps: First, share all informative signals and second, vote according to one's own posterior belief. I start with the voting stage and first show that strategic actors, given the belief that all committee members share all available informative signals and vote sincerely, vote for b only when $Pr(B|k_i(s)) > d_i$, for a when $Pr(B|k_i(s)) < d_i$ and are indifferent for $Pr(B|k_i(s)) = d_i$. I consider the situation for a pivotal voter m. Whenever m votes for b the decision is b and whenever she votes a it is a. The expected utility for voting for b is then given by:

$$\begin{aligned} EU(b|k_m(s)) &= Pr(B|k_m(s)) \cdot u(b, B) + (1 - Pr(B|k_m(s))) \cdot u(b, A) \\ &= Pr(B|k_m(s)) \cdot 0 + (1 - Pr(B|k_m(s))) \cdot (-d_m) \\ &= Pr(B|k_m(s))d_m - d_m \end{aligned}$$

and voting for a:

$$\begin{aligned} EU(a|k_m(s)) &= Pr(B|k_m(s)) \cdot u(a, \omega = B) + (1 - Pr(B|k_m(s))) \cdot u(a, A) \\ &= Pr(B|k_m(s)) \cdot (d_m - 1) + (1 - Pr(B|k_m(s))) \cdot 0 \\ &= Pr(B|k_m(s))d_m - Pr(B|k_m(s)) \end{aligned}$$

So, m votes for b whenever:

$$\begin{gathered} EU(b|k_m(s)) > EU(a|k_m(s)) \\ Pr(b|k_m(s))d_m - d_m > \Pr(b|k_m(s))d_m - Pr(b|k_m(s)) \\ d_m < \Pr(b|k_m(s)) \end{gathered}$$

and accordingly votes for a when $d_m > \Pr(b|k_m(s))$ and is indifferent for $d_m = \Pr(b|k_m(s))$.

The described voting behavior is part of an equilibrium when all committee members share all informative signals they received. This is only equilibrium behavior whenever conditions (1.), (2.), or (3.a) and (3.b) are fulfilled.

Case 1:

$d_m \leq Pr(B|k_m(s))$ with $k_m(s) = -c_m 2n$. This means that even if there are as many possible informative signals as possible and all signals suggest to vote for a the pivotal voter m still prefers voting for b. Since hiding signals has no effect in this case, no committee member has an incentive to hide any signals, making full information sharing an equilibrium strategy.

Case 2:

$Pr(B|k_m(s)) < d_m$ with $k_m(s) = 2n$. This means that even if there are as many possible informative signals as possible and all signals suggest to vote for b the pivotal voter m still prefers voting for a. Since hiding signals has no effect in this case, no committee member has an incentive to hide any signals, making full information sharing an equilibrium strategy.

Case 3:

$\exists k^{'}$ and $\exists k^{''} \in \{1 - c_n(2n-1), 1 - c_n(2n-2), ..., 2n\}$ such that $Pr(B|k^{'}) \leq d_i \leq Pr(B|k^{''})$ for all $i \in N$. The borders $k^{'}$ and $k^{''}$ exist if there exists a Δ such that $Pr((c_n - c_1)k_\alpha(s) < \Delta) \geq Pr((c_n - c_1)k_\alpha(s) \geq \Delta)$ and $k^{''} - k^{'} < min\{1, c_m\} - \Delta$. Intuitively, this is a closeness condition that there exist two differences between signals, $k^{'}$ is the difference of information for which nobody would vote for b and $k^{''}$ is the difference for which everybody would vote for a. The condition further connects the two thresholds such that whenever β-signal is hidden and all informative signals would lead to a $k^{''} \leq k_i(s) \forall i \in N$, the new emerging evidence is $k_i(s) - 1 \leq k^{'} \forall i \in N$ leading to a decision a. Whenever an α-signal is hidden and all informative signals would lead to a $k_i(s) \leq k^{'} \forall i \in N$ then the new emerging evidence is $k^{''} \leq k_i(s) + c_1 \forall i \in N$ leading to a decision b.

Consequently, some committee member i is pivotal in deliberation whenever she received at least one signal $\sigma_i = \beta$ and the available signals lead to a $k^{''} \leq k_i(s)$. Hiding the signal leads to a difference in evidence of $(k^{''} - 1) \leq (k_i(s) - 1) \leq k^{'}$. Therefore, sharing all informative signals lead to the decision b and hiding the signal $\sigma_i = \beta$ leads to the decision a. Expected utility for sharing $\sigma_i = \beta$ is given by:

$$
\begin{aligned}
EU(show|k_i(s)) &= Pr(B|k_i(s)) \cdot u(b, B) + (1 - Pr(B|k_i(s))) \cdot u(b, A) \\
&= (1 - Pr(B|k_i(s))) \cdot (-d_i) \\
&= Pr(B|k_i(s))d_i - d_i \\
&\geq Pr(B|k^{''})d_i - d_i
\end{aligned}
$$

And for hiding:

$$
\begin{aligned}
EU(hide|k_i(s)) &= Pr(B|k_i(s)) \cdot u(a, B) + (1 - Pr(B|k_i(s))) \cdot u(a, A) \\
&= Pr(B|k_i(s)) \cdot (d_i - 1) \\
&= Pr(B|k_i(s))d_i - Pr(B|k_i(s)) \\
&\leq Pr(B|k^{''})d_i - Pr(B|k^{''})
\end{aligned}
$$

$$d_i \leq Pr(B|k^{''})$$
$$\Rightarrow d_i - Pr(B|k^{''})d_i \leq Pr(B|k^{''}) - Pr(B|k^{''})d_i$$
$$Pr(B|k^{''})d_i - d_i \geq Pr(B|k^{''})d_i - Pr(B|k^{''})$$
$$Pr(B|k_i(s))d_i - d_i \geq Pr(B|k^{''})d_i - d_i \geq Pr(B|k^{''})d_i - Pr(B|k^{''}) \geq Pr(B|k_i(s))d_i - Pr(B|k_i(s))$$
$$EU(show|k_i(s)) \geq EU(hide|k_i(s))$$

Now, assume some committee member i is pivotal in deliberation whenever she received at least one signal $\sigma_i = \alpha$ and the available signals lead to a $k_i(s) \leq k^{'}$. Hiding the signal leads to a difference in evidence of $k^{''} \leq k_i(s) + c_i \leq k^{'} + c_1$. Therefore, sharing all informative signals lead to the decision a and hiding the signal $\sigma_i = \alpha$ leads to the decision b. Expected utility for sharing $\sigma = \alpha$ is given by:

$$\begin{aligned}
EU(show|k_i(s)) &= Pr(B|k_i(s)) \cdot u(a,B) + (1 - Pr(B|k_i(s))) \cdot u(a,A) \\
&= Pr(B|k_i(s)) \cdot (d_i - 1) \\
&= Pr(B|k_i(s))d_i - Pr(B|k_i(s)) \\
&\geq Pr(B|k^{'})d_i - Pr(B|k^{'})
\end{aligned}$$

And for hiding:

$$\begin{aligned}
EU(hide|k_i(s)) &= Pr(B|k_i(s)) \cdot u(b,B) + (1 - Pr(B|k_i(s))) \cdot u(b,A) \\
&= (1 - Pr(B|k_i(s))) \cdot (-d_i) \\
&= Pr(B|k_i(s))d_i - d_i \\
&\leq Pr(B|k^{'})d_i - d_i
\end{aligned}$$

$$d_i \geq Pr(B|k_1^{'})$$

$$\Rightarrow d_i - Pr(B|k^{'})d_i \geq Pr(B|k^{'}) - Pr(B|k^{'})d_i$$

$$Pr(B|k^{'})d_i - d_i \leq Pr(B|k^{'})d_i - Pr(B|k^{'})$$

$$Pr(B|k_i(s))d_i - d_i \leq Pr(B|k^{'})d_i - d_i \leq Pr(B|k^{'})d_i - Pr(B|k^{'}) \leq Pr(B|k_i(s))d_i - Pr(B|k_i(s))$$

$$EU(hide|k_i(s)) \leq EU(show|k_i(s))$$

For the existence of a $k^{'}$ and a $k^{''}$ such that $Pr(B|k^{'}) \leq d_i \leq Pr(B|k^{''})$ for all $i \in N$, there must be a Δ such that $Pr((c_n - c_1)k_\alpha(s) < \Delta) \geq Pr((c_n - c_1)k_\alpha(s) \geq \Delta)$ and $k^{''} - k^{'} < min\{1, c_m\} - \Delta$. To see that this is necessary, assume committee member n has a signal $\sigma_n = \beta$ and is pivotal, meaning $Pr(B|k_i(s)) \geq d_i$ for all $i \leq m$. The largest $k_i(s)$ is given by $k_1(s)$. For $k^{'}$ and $k^{''}$ to be the described borders, it must be that $k_1(s) - 1 < k^{'}$ and $k^{''} \leq k_1(s)$. Further, it must be that $k^{''} \leq k_n(s)$ and $k_1(s) - k_n(s) = (c_n - c_1)k_\alpha(s)$.

$$\rightarrow max(k_1(s) - k^{'}) < 1$$

$$\rightarrow min(k_1(s) - k^{''}) = (c_n - c_1)k_\alpha(s)$$

$$\rightarrow k^{''} - k^{'} < 1 - (c_n - c_1)k_\alpha(s)$$

Since $(c_n - c_1)k_\alpha(s)$ is a priori unknown, it must be that $k^{''} - k^{'} < 1 - \Delta$ such that $Pr((c_n - c_1)k_\alpha(s) < \Delta) \geq Pr((c_n - c_1)k_\alpha(s) \geq \Delta)$ for $k^{'}$ and $k^{''}$ to exist.

Next, assume 1 has a signal $\sigma_1 = \alpha$ and is pivotal, meaning $Pr(B|k_i(s)) < d_i$ for all $i \geq m$. The smallest $k_i(s)$ is given by $k_n(s)$. For $k^{'}$ and $k^{''}$ to be the described borders, it must be that $k_n(s) < k^{'}$ and $k^{''} \leq k_n(s) + c_n$. Further, it must be that

$k_1(s) < k^{'}$ and $k_1(s) - k_n(s) = (c_n - c_1)k_\alpha(s)$.

$$\rightarrow max(k^{''} - k_n(s)) = c_n$$
$$\rightarrow min(k^{'} - k_n(s)) > (c_n - c_1)k_\alpha(s)$$
$$\rightarrow k^{''} - k^{'} < c_n - (c_n - c_1)k_\alpha(s)$$

Since $(c_n - c_1)k_\alpha(s)$ is a priori unknown, it must be that $k^{''} - k^{'} < c_n - \Delta$ such that $Pr((c_n - c_1)k_\alpha(s) < \Delta) \geq Pr((c_n - c_1)k_\alpha(s) \geq \Delta)$ for $k^{'}$ and $k^{''}$ to exist.

For the existence of $k^{'}$ and $k^{''}$ the stricter of the conditions $k^{''} - k^{'} < 1 - \Delta$ or $k^{''} - k^{'} < c_n - \Delta$ must be fulfilled. Accordingly, $k^{'}$ and $k^{''}$ must be such that $k'' - k^{'} < min(1, c_n) - \Delta$ with $Pr((c_n - c_1)k_\alpha(s) < \Delta) \geq Pr((c_n - c_1)k_\alpha(s) \geq \Delta)$.

When none of the three cases is fulfilled then $\exists\ k^{'}$ and some $k^{''} \in \{1 - c_1(2n - 1), ..., 2n\}$ such that $Pr(B|k^{'}) \leq d_m \leq Pr(B|k^{''})$. And $d_1 < Pr(B|k^{'})$ or $d_n > Pr(B|k^{''})$ or both.

Suppose $d_1 < Pr(B|k^{'})$ and consider the situation when committee member 1 received at least one signal $\sigma_1 = \alpha$ and is pivotal. Then sharing leads to a believe $Pr(B|k_i(s)) \leq Pr(B|k^{'})$ for all committee members i and the decision will be a, while hiding leads to $Pr(B|k_i(s) + c_i) \geq Pr(B|k^{''})$ and the decision will be b. Since $d_1 < Pr(B|k^{'})$, committee member 1 prefers the decision b and has an incentive to deviate and hides one signal $\sigma_1 = \alpha$.

Now, suppose $d_n > \Pr(B|k^{''})$ and consider the situation when committee member n has at least one signal $\sigma_n = \beta$ and is pivotal. Then sharing leads to a believe

$Pr(B|k_m(s)) \geq Pr(B|k^{''})$ for the pivotal committee member m and the decision will be b, while hiding leads to $Pr(B|k_m(s)-1) \leq \Pr(B|k^{'})$ and the decision will be a. Since $\Pr(B|k^{''}) < d_n$, committee member n prefers the decision a and has an incentive to deviate and hides one signal $\sigma_n = \beta$.

Thus, if all conditions (1), (2), and (3) are violated, then full information sharing is not describing a perfect Bayesian equilibrium in deliberation.

□

B.2 Further Details on the Experiment

Ethical Concerns: This study was not presented to an ethics board. Since the study **does not involve physical or psychological risk, strong emotions, traumatizing experiences, manipulation, underage participants, deception, or other ethical concerns** the author did not seek the approval of an ethics board. The study did not make any connections to political processes or created a connection between the exercises and reality. Before starting the experiment all participants were presented with a text that informed them about their rights and how their data will be used. They also received contacts where to turn to in case they have any issues with the study. Participants explicitly agreed to these statements by continuing to the experiment. Therefore, all participants where informed how their data was used and agreed to the usage. The author has no concerns about the ethical standards of this study.

Table B.1: Descriptive statistics of main data

	control				treatment			
	Obs.	mean	SD	min; max	Obs.	mean	SD	min; max
male	83	0.49	0.5	0; 1	69	0.65	0.48	0 ; 1
age	83	39.05	11.22	20; 69	69	37.88	9.73	24; 68
college	83	0.72	0.45	0; 1	69	0.81	0.39	0; 1
risk	83	47.02	22.14	8; 100	69	44.8	23.47	10; 100
CRT	83	3.6	1.73	0; 5	69	3.75	1.58	0; 5
Raven score	83	0.11	0.9	-2.11; 1.8	69	0.02	0.88	-2.11; 1.8
cognitive score	83	0.15	1.11	-2.48; 2.27	69	0.11	1.1	-2.48; 2.27
Learning result	83	0.83	0.38	0; 1	69	0.81	0.39	0; 1
quiz attempts	83	1.27	0.73	1; 5	69	2.16	1.23	1; 5
bonus	83	3.03	1.2	0.05; 5.00	69	3.03	1.05	0.07; 5.25

Table B.2: Logistic regression of decision to hide a signal with cluster standard errors

	Dependent variable:					
	hide red signal			hide blue signal		
	(1)	(2)	(3)	(4)	(5)	(6)
treatment group	−0.318		−0.732	0.914**		−1.150
	(0.325)		(0.559)	(0.326)		(0.736)
overvalue red		0.098			0.927	
		(0.631)			(0.597)	
overvalue blue		0.374			1.490***	
		(0.380)			(0.423)	
correct belief			−0.801			−1.199*
			(0.486)			(0.563)
college	0.290	0.159	0.236	−0.670	−0.658	−0.664
	(0.439)	(0.427)	(0.433)	(0.407)	(0.385)	(0.389)
male	−0.078	−0.194	0.035	−0.410	−0.152	−0.180
	(0.300)	(0.341)	(0.320)	(0.314)	(0.334)	(0.329)
age	0.021	0.023	0.024	0.009	0.012	0.019
	(0.013)	(0.014)	(0.014)	(0.018)	(0.017)	(0.017)
risk	0.011	0.012	0.010	0.006	0.006	0.007
	(0.006)	(0.006)	(0.006)	(0.007)	(0.008)	(0.007)
Raven scores	−0.574***	−0.570***	−0.516***	−0.305	−0.298	−0.347
	(0.155)	(0.165)	(0.155)	(0.197)	(0.196)	(0.197)
treatment group × correct belief			0.775			2.884**
			(0.750)			(0.894)
Constant	−2.961***	−3.283***	−2.589***	−2.173**	−2.976***	−2.150**
	(0.788)	(0.862)	(0.781)	(0.740)	(0.894)	(0.806)
Observations	659	659	659	630	630	630
Clusters	152	152	152	152	152	152
Log Likelihood	-285.449	-285.151	-281.969	-242.664	-235.376	-231.587
Akaike Inf. Crit.	584.899	586.301	581.938	499.328	486.752	481.175

Note: SE in brackets *p<0.05; **p<0.01; ***p<0.001

Table B.3: Logistic regression of decision to hide a signal with cluster standard errors

	Dependent variable:					
	hide red signal			hide blue signal		
	(1)	(2)	(3)	(4)	(5)	(6)
treatment group	−0.332		−0.757	0.974**		−1.135
	(0.322)		(0.562)	(0.318)		(0.701)
overvalue red		0.112			0.830	
		(0.635)			(0.595)	
overvalue blue		0.375			1.511***	
		(0.381)			(0.426)	
correct belief			−0.781			−1.127
			(0.488)			(0.577)
college	0.314	0.172	0.254	−0.705	−0.684	−0.702
	(0.444)	(0.433)	(0.442)	(0.421)	(0.403)	(0.407)
male	0.021	−0.103	0.127	−0.339	−0.066	−0.097
	(0.302)	(0.342)	(0.322)	(0.311)	(0.331)	(0.328)
age	0.024	0.026	0.027	0.013	0.017	0.025
	(0.013)	(0.014)	(0.014)	(0.018)	(0.017)	(0.018)
risk	0.009	0.010	0.007	0.003	0.004	0.005
	(0.006)	(0.006)	(0.006)	(0.007)	(0.007)	(0.007)
cognitive scores	−0.518***	−0.514***	−0.478***	−0.406**	−0.396**	−0.440**
	(0.119)	(0.132)	(0.118)	(0.153)	(0.153)	(0.145)
treatment group × correct belief			0.785			2.928**
			(0.762)			(0.894)
Constant	−3.027***	−3.348***	−2.670***	−2.267**	−3.095***	−2.393**
	(0.750)	(0.844)	(0.771)	(0.700)	(0.885)	(0.796)
Observations	659	659	659	630	630	630
Clusters	152	152	152	152	152	152
Log Likelihood	-281.552	-281.351	-278.303	-237.840	-230.976	-226.673
Akaike Inf. Crit.	577.105	578.703	574.606	489.680	477.952	471.345

Note: SE in brackets *p<0.05; **p<0.01; ***p<0.001

B.2.1 Instructions and Game Displays

Warm Up Task

Stage 2 / 14 Done

Instructions for the first task

Please read these instructions carefully!

In this task, you have to guess the color of an urn. The urn can be blue or red. Both colors are equally likely.
In each urn there are 100 balls. In the blue urn there are **60** blue balls and **40** red balls. While in the red urn there are **60** red balls and **40** blue balls.
To help you guess the correct color of the urn, one ball is randomly drawn out of the urn, the color shown to you and then ball is returned to the urn. This procedure is possibly repeated several times. Your hint might then look for example as follows:
blue, blue, red
In this task you have to guess which color the urn probably has.
You are paid when all your different guesses match the most likely color of the different urns.
During the game we use an Experimental Currency (ECU). 10 ECU are equal to $0.25. If you guess the color of all urns correctly, you receive 30 ECU.
You receive information about your performance and bonus payment in the end of the game.
If you understand the instructions press the 'Done' button to proceed to the first task.

Stage 3 / 14 Done

Which colors have the different urns?

For each urn it is equally likely that the urn is either red or blue.

Below you see **the color of balls** drawn out of the different urns you are facing.

In the blue urn there are **60** blue balls and **40** red balls. In the red urn there are **60** red balls and **40** blue balls. Please, guess the most likely color of each urn!

	Balls	Guess
Urn 1	blue, red, red, red, blue, red	○ **red** ○ **blue**
Urn 2	blue, blue, red, red, blue	○ **red** ○ **blue**
Urn 3	red	○ **red** ○ **blue**
Urn 4	red, red, blue, red	○ **red** ○ **blue**
Urn 5	blue, red, red, blue, blue, blue	○ **red** ○ **blue**

Please, choose which urns you believe to be **red** or **blue**.

Hit submit to submit your guesses.

Submit

Instructions and Quiz for Control Group

Stage 4 / 14 Show Player Behavior Done

Instructions for the second task

Please read these instructions carefully!

There will be a quiz when klicking 'Done'. Only if you can answer all questions in the quiz correctly, you can proceed to the game. If you fail five times, your HIT will be rejected. Make sure you understand all of the instructions.

In this task, you have to guess the color of an urn together with two automated players in a group.

Just like in the previous task, the urn can be blue or red. Both colors are equally likely. As before, you and the automated players are shown random balls that were drawn successively out of an urn. Each ball is either red or blue. In the blue urn there are **60** blue balls and **40** red balls. In the red urn there are **60** red balls and **40** blue balls. This time, the game consists of two steps:

In the beginning, every player is shown between **0 and 2 balls**. No other player knows how many or which balls you saw.
In the first part of the game you have to decide whether you want to **share the color of the balls with the automated players or hide it from them**. If you **share** a ball, the automated players take its color into account when making their vote choice in the second step. If you **hide** a ball, the automated players cannot take its color into account when making their vote choice.

The exact probability of seeing 0, 1, or 2 balls is shown in the table below.

Number of balls	Probability
0	1%
1	18%
2	81%

The automated players always share all of the balls they see.

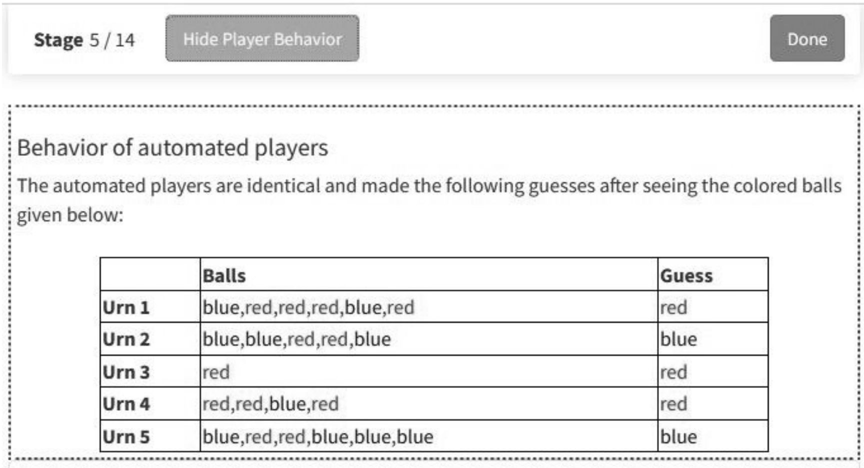
After your decision to share or hide your ball(s), you will **see all shared balls** (both, from you and the automated players) and you have to **make a vote choice** on the probable color of the urn.

The automated players will see all balls that were shared as well and base their vote decision on the different colors of these balls.
You have information about the players previous guesses for the six urns you have faced in the previous game:

	Balls	Guess
Urn 1	blue, red, red, red, blue, red	red
Urn 2	blue, blue, red, red, blue	blue
Urn 3	red	red
Urn 4	red, red, blue, red	red
Urn 5	blue, red, red, blue, blue, blue	blue

During the game you can use the yellow button above to re-read the information about the automated players' behavior.

In the end all the votes for 'blue' and 'red' are counted and the **color with more votes is the group decision**.
The task is **repeated six times**. Only two randomly chosen rounds of these six are paid in US$ in the end.
If the **group decision** and the **true color** of the urn **match**, the possible payoff for the round is **30 ECU** (Experimental Currency).
Remember, 10 ECU are equal to $0.25.
After the task you can earn **more money by completing additional tasks**.
If you understand the instructions press the 'Done' button to proceed to a quiz about the instructions.
Only if you can answer all questions in the quiz correctly, you can proceed to the task.



Behavior of automated players

The automated players are identical and made the following guesses after seeing the colored balls given below:

	Balls	Guess
Urn 1	blue,red,red,red,blue,red	red
Urn 2	blue,blue,red,red,blue	blue
Urn 3	red	red
Urn 4	red,red,blue,red	red
Urn 5	blue,red,red,blue,blue,blue	blue

Stage 5 / 14 Show Player Behavior Done

Here we test your understanding of the instructions.

If you answer all questions correctly, you will earn 20 ECU and the game starts.

A failed attempt to answer the questions correctly reduces the payoff by 5 ECU.

If you fail 5 times, your HIT will not be approved!

Press the "Show Player Behavior" button to get help.

What do you have to decide on in your group?

The color preferred by most people.
The color of an urn.
The color of a box.
The most beautiful color.
I don't know.

What can you do with the balls that you are shown in the first stage?

Either share the true colors of the balls or lie about them.
Nothing.
I don't know.
I can decide which players receives which of the balls, while I can provide any ball only to a single automated player.
Either share the balls with the automated players or hide them.

The automated players saw the following balls blue,blue,red,red,blue. What was their voting decision?

The decision is random.
blue
red

Instructions and Quiz for Treatment Group

Stage 4 / 14 Show Player Behavior Done

Instructions for the second task

Please read these instructions carefully!

There will be a quiz when klicking 'Done'. Only if you can answer all questions in the quiz correctly, you can proceed to the game. If you fail five times, your HIT will be rejected. Make sure you understand all of the instructions.

In this task, you have to guess the color of an urn together with two automated players in a group.

Just like in the previous task, the urn can be blue or red. Both colors are equally likely. As before, you and the automated players are shown random balls that were drawn successively out of an urn. Each ball is either red or blue. In the blue urn there are **60** blue balls and **40** red balls. In the red urn there are **60** red balls and **40** blue balls. This time, the game consists of two steps:

In the beginning, every player is shown between **0 and 2 balls**. No other player knows how many or which balls you saw.
In the first part of the game you have to decide whether you want to **share the color of the balls with the automated players or hide it from them**. If you **share** a ball, the automated players take its color into account when making their vote choice in the second step. If you **hide** a ball, the automated players cannot take its color into account when making their vote choice.

The exact probability of seeing 0, 1, or 2 balls is shown in the table below.

Number of balls	Probability
0	1%
1	18%
2	81%

The automated players always share all of the balls they see.

After your decision to share or hide your ball(s), you will **see all shared balls** (both, from you and the automated players) and you have to **make a vote choice** on the probable color of the urn.

The automated players will see all balls that were shared as well and base their vote decision on the different colors of these balls.
You have information about the players previous guesses for the six urns you have faced in the previous game:

	Balls	Guess
Urn 1	blue, red, red, red, blue, red	blue
Urn 2	blue, blue, red, red, blue	blue
Urn 3	red	red
Urn 4	red, red, blue, red	blue
Urn 5	blue, red, red, blue, blue, blue	blue

During the game you can use the yellow button above to re-read the information about the automated players' behavior.

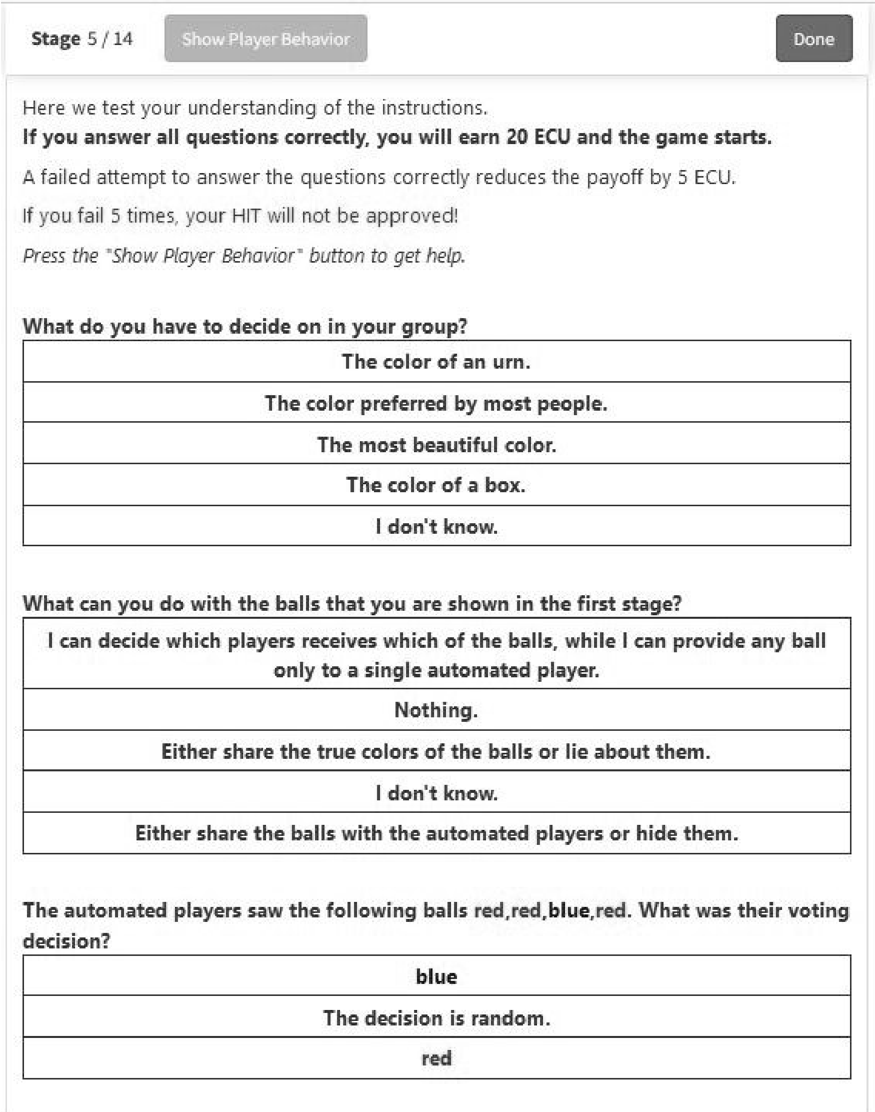
In the end all the votes for 'blue' and 'red' are counted and the **color with more votes is the group decision**.
The task is **repeated six times**. Only two randomly chosen rounds of these six are paid in US$ in the end.
If the **group decision** and the **true color** of the urn **match**, the possible payoff for the round is **30 ECU** (Experimental Currency).
Remember, 10 ECU are equal to $0.25.
After the task you can earn **more money by completing additional tasks**.
If you understand the instructions press the 'Done' button to proceed to a quiz about the instructions.
Only if you can answer all questions in the quiz correctly, you can proceed to the task.

Stage 5 / 14 Hide Player Behavior Done

Behavior of automated players

The automated players are identical and made the following guesses after seeing the colored balls given below:

	Balls	**Guess**
Urn 1	blue,red,red,red,blue,red	blue
Urn 2	blue,blue,red,red,blue	blue
Urn 3	red	red
Urn 4	red,red,blue,red	blue
Urn 5	blue,red,red,blue,blue,blue	blue



Stage 5 / 14 Show Player Behavior Done

Here we test your understanding of the instructions.

If you answer all questions correctly, you will earn 20 ECU and the game starts.

A failed attempt to answer the questions correctly reduces the payoff by 5 ECU.

If you fail 5 times, your HIT will not be approved!

Press the "Show Player Behavior" button to get help.

What do you have to decide on in your group?

The color of an urn.
The color preferred by most people.
The most beautiful color.
The color of a box.
I don't know.

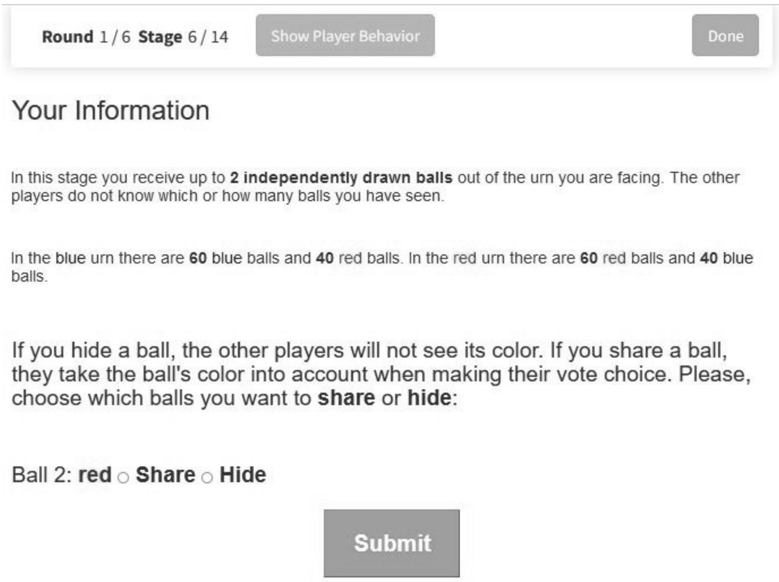
What can you do with the balls that you are shown in the first stage?

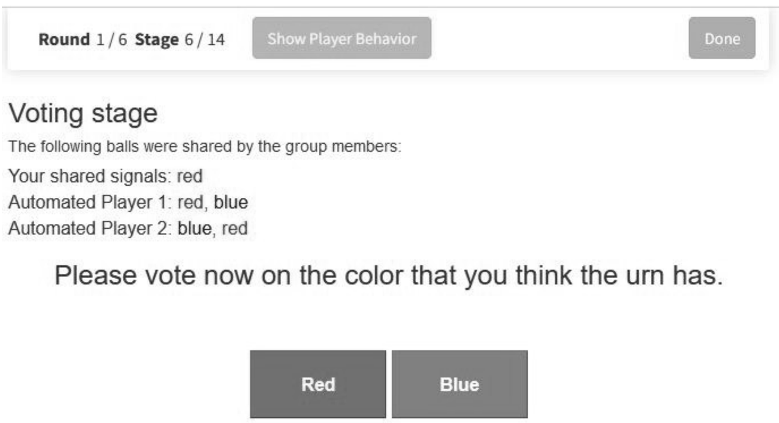
I can decide which players receives which of the balls, while I can provide any ball only to a single automated player.
Nothing.
Either share the true colors of the balls or lie about them.
I don't know.
Either share the balls with the automated players or hide them.

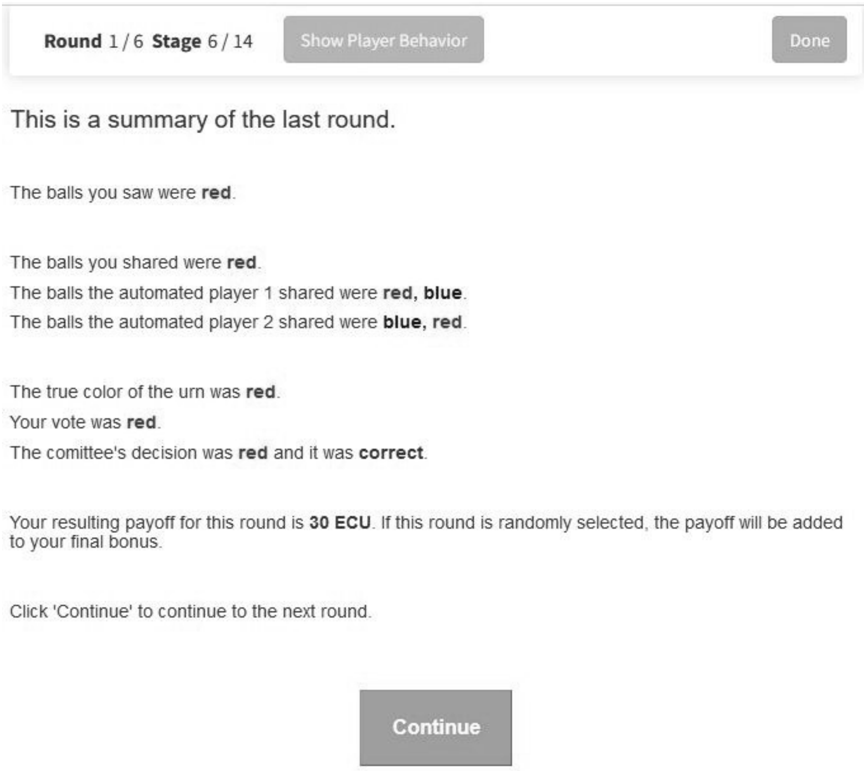
The automated players saw the following balls red,red,blue,red. What was their voting decision?

blue
The decision is random.
red

Game Displays






Round 1 / 6 Stage 6 / 14
Show Player Behavior
Done
This is a summary of the last round.
The balls you saw were red.
The balls you shared were red.
The balls the automated player 1 shared were red, blue.
The balls the automated player 2 shared were blue, red.
The true color of the urn was red.
Your vote was red.
The comittee's decision was red and it was correct.
Your resulting payoff for this round is 30 ECU. If this round is randomly selected, the payoff will be added to your final bonus.
Click 'Continue' to continue to the next round.
Continue

Belief Elicitation

Stage 7 / 14 Show Player Behavior Done

This is a summary of all guesses that the automated players made in the last rounds.

Balls	Automated Players' Guess
blue, red, red, red, blue, red	red
blue, blue, red, red, blue	blue
red	red
red, red, blue, red	red
blue, red, red, blue, blue, blue	blue
red, red, blue, blue, red	red
red, blue, blue, red, blue	blue
blue, blue, red, red, blue, red	red
red, blue, red, red, red, red	red
red, red, blue, red, blue, red	red
red, red, , red, red	red

Based on the guesses above, what would you say the automated players usage of the balls' colors?

- ○ **Automated players consider red balls more important compared to blue balls.**
- ○ **Automated players consider red balls less important compared to blue balls.**
- ○ **Automated players equally consider red balls and blue balls.**

If your guess about the automated players evaluation of red and blue balls is correct, you will receive 40 ECU.

Click 'Send' to send your guess and continue to the next stage.

Send

Appendix C

Chapter 4

First, I show conditions for which seeing $l_i = 1$ can be considered semi-separating. Second, I characterize equilibria with an unconstrained agenda, then with a constrained agenda, and finally, I show when the DG prefers constraining the agenda to not constraining.

C.1 Semi-Pooling and Semi-Separating Signals

The analysis of equilibria described in the next section depends on conditions about the informativeness of signals for each state of the world. When seeing $l_i = 1$, the belief of the DG about the $\omega_i = 1$ before verifying the signal is given by β_i^{ver}.

Without verification, the DG is only willing to issue i in the policy if

$$\begin{aligned}
\beta_i^{ver}(l_i = 1) &\geq \theta \\
\frac{\pi_i \lambda_i(1)}{\pi_i \lambda_i(1) + (1-\pi_i)\lambda_i(0)} &\geq \theta \\
\lambda_i(1) &\geq \lambda_i(0)\frac{\theta(1-\pi_i)}{\pi_i(1-\theta)}
\end{aligned}$$

Since $\lambda_i(1) \in [0,1]$, we also have to check the conditions for $\lambda_i(0)$ to keep $l_i = 1$ a credible signal

$$\begin{aligned}
\beta_i^{ver}(l_i = 1) &\geq \theta \\
\frac{\pi_i}{\pi_i + (1-\pi_i)\lambda_i(0)} &\geq \theta \\
\lambda_i(0) &\leq \frac{\pi_i(1-\theta)}{\theta(1-\pi_i)}
\end{aligned}$$

For $\pi_i \geq \theta$ there might be equilibria for which a semi-pooling strategy with $l_i = 0$ is beneficial. Such a semi-pooling strategy would be $\lambda_i(0) = 0$ and $\lambda_i(1)$ is chosen such that

$$\begin{aligned}
\beta_i^{ver}(l_i = 0) &\geq \theta \\
\frac{(1-\lambda_i(1))\pi_i}{(1-\lambda_i(1))\pi_i + (1-\pi_i)(1-\lambda_i(0))} &\geq \theta \\
\frac{(1-\lambda_i(1))\pi_i}{(1-\lambda_i(1))\pi_i + (1-\pi_i)} &\geq \theta \\
\lambda_i(1) &\leq \frac{\pi_i - \theta}{\pi_i(1-\theta)}
\end{aligned}$$

These conditions determine any (semi-) separating or pooling strategies for the following analysis.

C.2 Full Characterization of Equilibria for an Unconstrained Agenda

To characterize possible equilibria in this setting I unroll the game backwards. If the agenda is unconstrained, the decision about implementation of policy $i \in \{1, 2\}$ only depends on $Pr(p_i = 1) = \beta_i$. The DG wants to implement the policy for:

$$\begin{aligned} u_i(p_i = 1) &\geq u_i(p_i = 0) \\ \beta_i(1 - \theta) + (1 - \beta_i)(-\theta) &\geq 0 \\ \beta_i &\geq \theta \end{aligned}$$

Let beliefs of the DG about β as follows: For $l_i = a_i = 1$, the DG knows ω_i, so $\beta_i = \omega_i$. For $\lambda_i(0) \in [0, \frac{\pi_i(1-\theta)}{1-\pi_i}]$ and $\lambda_i(1) \geq \lambda_i(0)\frac{\theta(1-\pi_i)}{\pi_i(1-\theta)}$, we know $\beta_i(l_i = 1, a_i = 0) \geq \theta$. For $\pi_i \geq \theta$, $\lambda_i(0) = 0$, and $\lambda_i(1) \leq \frac{\pi_i - \theta}{\pi_i(1-\theta)}$, we know $\beta_i(l_i = 0, a_i = 0) \geq \theta$. Else, $\beta_i(l_i, a_i) < \theta$.

For $l_1 = l_2 = 1$, the DG decides on a_i based on the expected costs for deciding $a_i = 0$:

$$\begin{aligned} &\text{for } Ec(a_1 = 0) = EC(a_2 = 0) \rightarrow Pr(a_1 = 1) = Pr(a_2 = 1) = \frac{1}{2} \\ &\text{for } Ec(a_1 = 0) > EC(a_2 = 0) \rightarrow a_1 = 1, a_2 = 0 \\ &\text{for } Ec(a_1 = 0) < EC(a_2 = 0) \rightarrow a_1 = 0, a_2 = 1 \end{aligned}$$

with $Ec(a_i = 0)$ generally:

$$
\begin{aligned}
Ec(a_i = 0) =& (1-\theta)\cdot Pr(a_i = 0, a_{-i} = 1, p_i = 0, p_{-i} = 1, \omega_i = 1, \omega_{-i} = 1) \quad \text{(C.2.1)} \\
&+ (1-\theta)\cdot Pr(a_i = 0, a_{-i} = 1, p_i = 0, p_{-i} = 0, \omega_i = 1, \omega_{-i} = 0) \\
&+ \theta\cdot Pr(a_i = 0, a_{-i} = 1, p_i = 1, p_{-i} = 1, \omega_i = 0, \omega_{-i} = 1) \\
&+ \theta\cdot Pr(a_i = 0, a_{-i} = 1, p_i = 1, p_{-i} = 0, \omega_i = 0, \omega_{-i} = 0)
\end{aligned}
$$

Let β_i^{ver} be the belief after seeing l_i but before making the decision about a_i. Then, for $\beta_i^{ver} \geq \theta$,

$$
\begin{aligned}
Pr(a_i = 0, a_{-i} = 1, p_i = 0, p_{-i} = 1, \omega_i = 1, \omega_{-i} = 1) = 0 \\
Pr(a_i = 0, a_{-i} = 1, p_i = 0, p_{-i} = 0, \omega_i = 1, \omega_{-i} = 0) = 0
\end{aligned}
$$

so,

$$Ec(a_i = 0) = \theta(1 - \beta_i^{ver})$$

and else

$$Ec(a_i = 0) = (1-\theta)\beta_i^{ver}$$

Where β_i^{ver} is given by Bayes' rule.

The stakeholder i tries to maximize its expected utility Ev_i with the decision on the informativeness of a signal $\lambda_i(\omega_i)$:

$$\begin{aligned} Ev_i(\lambda_i(\omega_i) =& \lambda_i(\omega_i) \cdot [Pr(l = (1,1), a_i = 1, p_i = 1) \\ &+ Pr(l = (1,1), a_i = 0, p_i = 1) \\ &+ Pr(l = (1,0), a_i = 1, p_i = 1)] \\ &+ (1 - \lambda_i(\omega_i)) \cdot [Pr(l = (0,1), p_i = 1) \\ &+ Pr(l = (0,0), p_i = 1)] \\ &- c(\lambda_i(\omega_i)) \end{aligned} \tag{C.2.2}$$

For $\pi_i \geq \theta$, $\lambda_i(1) \leq \frac{\pi_i - \theta}{\pi_i - \theta\pi_i}$, and $\lambda_i(0) = 0$

$$\begin{aligned} Pr(l = (1,1), a_i = 1, p_i = 1) =& \omega_i\gamma_i[\lambda_{-i}(1) \cdot \pi_{-i} + \lambda_{-i}(0) \cdot (1 - \pi_{-i})] \\ Pr(l = (1,1), a_i = 0, p_i = 1) =& (1 - \gamma_i)[\lambda_{-i}(1) \cdot \pi_{-i} + \lambda_{-i}(0) \cdot (1 - \pi_{-i})] \\ Pr(l = (1,0), a_i = 1, p_i = 1) =& \omega_i[(1 - \lambda_{-i}(1)) \cdot \pi_{-i} + (1 - \lambda_{-i}(0)) \cdot (1 - \pi_{-i})] \\ Pr(l = (0,1), p_i = 1) =& \lambda_{-i}(1) \cdot \pi_{-i} + \lambda_{-i}(0) \cdot (1 - \pi_{-i}) \\ Pr(l = (0,0), p_i = 1) =& (1 - \lambda_{-i}(1)) \cdot \pi_{-i} + (1 - \lambda_{-i}(0)) \cdot (1 - \pi_{-i}) \end{aligned}$$

with $\gamma_i \equiv Pr(a_i = 1 | l = (1,1))$. Then

$$Ev_i(\lambda_i(\omega_i)) = \lambda_i(\omega_i)[(1 - \omega_i)(1 - \gamma_i)(\lambda_{-i}(1)\pi_{-i} + \lambda_{-i}(0)(1 - \pi_{-i})) + \omega_i] + 1 - \lambda_i(\omega_i) - c(\lambda_i(\omega_i))$$

Then we know that for $\omega_i = 1$

$$Ev_i(\lambda_i(1)) = 1 - c(\lambda_i(1))$$

and for $\omega_i = 0$

$$Ev_i(\lambda_i(0)) = 1 - \lambda_i(0)(1 - (1-\gamma_i)(\lambda_{-i}(1)\pi_{-i} + \lambda_{-i}(0)(1-\pi_{-i}))) - c(\lambda_i(0))$$

since $c(0) = 0$ and $\frac{dc}{d\lambda_i} > 0$, $Ev_i(\lambda_i(\omega_i))$ is strictly decreasing in $\lambda_i(\omega_i)$. So $\lambda_i(\omega_i) = 0$.

For $\pi_i < \theta$, $\lambda_i(1) \geq \lambda_i(0)\frac{\theta(1-\pi_i)}{\pi_i(1-\theta)}$, and $\lambda_i(0) \leq \frac{\pi_i - \theta}{\pi_i(1-\theta)}$

$$\begin{aligned}
Pr(l = (1,1), a_i = 1, p_i = 1) =& \omega_i\gamma_i[\lambda_{-i}(1)\cdot\pi_{-i} + \lambda_{-i}(0)\cdot(1-\pi_{-i})] \\
Pr(l = (1,1), a_i = 0, p_i = 1) =& (1-\gamma_i)[\lambda_{-i}(1)\cdot\pi_{-i} + \lambda_{-i}(0)\cdot(1-\pi_{-i})] \\
Pr(l = (1,0), a_i = 1, p_i = 1) =& \omega_i[(1-\lambda_{-i}(1))\cdot\pi_{-i} + (1-\lambda_{-i}(0))\cdot(1-\pi_{-i})] \\
Pr(l = (0,1), p_i = 1) =& 0 \\
Pr(l = (0,0), p_i = 1) =& 0
\end{aligned}$$

Then

$$Ev_i(\lambda_i(\omega_i)) = \lambda_i(\omega_i)[(1-\omega_i)(1-\gamma_i)(\lambda_{-i}(1)\pi_{-i} + \lambda_{-i}(0)(1-\pi_{-i})) + \omega_i] - c(\lambda_i(\omega_i))$$

optimality conditions lead to

$$\frac{dEv_i}{d\lambda_i} = (1-\omega_i)(1-\gamma_i)(\lambda_{-i}(1)\pi_{-i} + \lambda_{-i}(0)(1-\pi_{-i})) + \omega_i - \frac{dc(\lambda_i)}{d\lambda_i} = 0$$

So, for $\omega_i = 0$

$$\frac{dEv_i}{d\lambda_i} = (1-\gamma_i)(\lambda_{-i}(1)\pi_{-i} + \lambda_{-i}(0)(1-\pi_{-i})) - \frac{dc(\lambda_i)}{d\lambda_i} = 0$$

For $\pi_{-i} \geq \theta \rightarrow \lambda_{-i}(\omega_{-i}) = 0$, then $\lambda_i(0) = 0$. Else, i chooses $\lambda_i(0)$ such that $(1-\gamma_i)(\lambda_{-i}(1)\pi_{-i} + \lambda_{-i}(0)(1-\pi_{-i})) = \frac{dc(\lambda_i)}{d\lambda_i}$. For $\omega_i = 1$

$$\frac{dEv_i}{d\lambda_i} = 1 - \frac{dc(\lambda_i)}{d\lambda_i} = 0$$

C.3 Conditions for Including Issue i for $l_i = l_{-i} = 0$ in a Constrained Agenda

For a constrained agenda, $\pi_1 > \pi_2 \geq \theta$ and $\lambda_1 \leq \frac{\pi_1-\theta}{\pi_1-\pi_1\theta}$ and $\lambda_2 \leq \frac{\pi_2-\theta}{\pi_2-\pi_2\theta}$, for both players, $\beta_1 \geq \theta$ and $\beta_2 \geq \theta$. For an unconstrained agenda, the DG would include both issues in the policy. For a constrained agenda, the DG chooses $p_1 = 1$ and $p_2 = 0$ for

$$\frac{(1-\lambda_1(1))\pi_1}{(1-\lambda_1(1))\pi_1 + (1-\lambda_1(0))(1-\pi_1)} > \frac{(1-\lambda_2(1))\pi_2}{(1-\lambda_2(1))\pi_2 + (1-\lambda_2(0))(1-\pi_2)}$$

$$((1-\lambda_1(1))\pi_1)\left((1-\lambda_2(1))\pi_2 + (1-\lambda_2(0))(1-\pi_2)\right) > ((1-\lambda_2(1))\pi_2)\left((1-\lambda_1(1))\pi_1 + (1-\lambda_1(0))(1-\pi_1)\right)$$

$$(\pi_1 - \pi_1\pi_2)(1-\lambda_1(1)-\lambda_2(0)+\lambda_1(1)\lambda_2(0)) > (\pi_2 - \pi_1\pi_2)(1-\lambda_2(1)-\lambda_1(0)+\lambda_2(1)\lambda_1(0))$$

$$\frac{\pi_1(1-\pi_2)}{\pi_2(1-\pi_1)} > \frac{1-\lambda_2(1)-\lambda_1(0)+\lambda_2(1)\lambda_1(0)}{1-\lambda_1(1)-\lambda_2(0)+\lambda_1(1)\lambda_2(0)}$$

Accordingly, the DG chooses $p_1 = 0$ and $p_2 = 1$ for

$$\frac{\pi_1(1-\pi_2)}{\pi_2(1-\pi_1)} < \frac{1-\lambda_2(1)-\lambda_1(0)+\lambda_2(1)\lambda_1(0)}{1-\lambda_1(1)-\lambda_2(0)+\lambda_1(1)\lambda_2(0)}$$

and is indifferent, choosing $Pr(p_1 = 1) = Pr(p_2 = 1) = \frac{1}{2}$ for

$$\frac{\pi_1(1-\pi_2)}{\pi_2(1-\pi_1)} = \frac{1-\lambda_2(1)-\lambda_1(0)+\lambda_2(1)\lambda_1(0)}{1-\lambda_1(1)-\lambda_2(0)+\lambda_1(1)\lambda_2(0)}$$

C.4 Full Characterization of Equilibria for a Constrained Agenda

When the DG constrains the agenda, it cannot implement both proposals at the same time anymore. A policy proposal $i \in \{1,2\}$ is implemented for $\beta_i \geq \theta$ and the expected costs are smaller than for implementing $-i$:

$$\begin{aligned} Ec(p_i = 1, p_{-i} = 0)) <& Ec(p_i = 0, p_-i) \\ \theta \cdot (1-\beta_i) + (1-\theta)\beta_{-i} <& (1-\theta) \cdot \beta_i + \theta(1-\beta_{-i}) \\ \beta_{-i} <& \beta_i \end{aligned}$$

The DG is indifferent between implementing β_i or β_{-i} for $\beta_i = \beta_{-i}$.

Beliefs about β_i and its relation to θ are given as in the unconstrained case. Further for $a_i = 1$, $\beta_i \geq \beta_{-i}$ if $\omega_i = 1$ and $\beta_i \leq \beta_{-i}$ if $\omega_i = 0$.

The access decision a_i for $l_1 = l_2 = 1$ depends again on the expected costs. The DG decides $a_1 = 1$ if $Ec(a_1 = 0) > Ec(a_2 = 0)$. If $\beta_i^{ver} \geq \theta$ for all $i \in \{1,2\}$

$$\begin{aligned} Ec(a_i = 0) >& Ec(a_{-i} = 0) \\ (1-\theta)\beta_i^{ver}\beta_{-i}^{ver} + \theta(1-\beta_i^{ver})(1-\beta_{-i}^{ver}) >& (1-\theta)\beta_{-i}^{ver}\beta_i^{ver} + \theta(1-\beta_{-i}^{ver})(1-\beta_i^{ver}) \\ 0 >& 0 \lightning \end{aligned}$$

Which is always equal, so $Pr(a_1 = 1) = Pr(a_2 = 1) = \frac{1}{2}$. If $\beta_i^{ver} \geq \theta$ for all $i \in \{1, 2\}$

$$
\begin{aligned}
Ec(a_i = 0) >& Ec(a_{-i} = 0) \\
(1-\theta)\beta_i^{ver} >& (1-\theta)\beta_{-i}^{ver} \\
\beta_i^{ver} >& \beta_{-i}^{ver}
\end{aligned}
$$

If $\beta_i^{ver} \geq \theta$ and $\beta_{-i} < \theta$

$$
\begin{aligned}
Ec(a_i = 0) >& Ec(a_{-i} = 0) \\
(1-\theta)\beta_i^{ver}\beta_{-i}^{ver} + \theta(1-\beta_i^{ver})(1-\beta_{-i}^{ver}) >& (1-\theta)\beta_{-i}^{ver} \\
\theta >& \beta_{-i}^{ver}
\end{aligned}
$$

which is always true. So, for $\beta_i^{ver} \geq \theta$ and $\beta_{-i} < \theta$ the DG chooses $a_i = 1$.

For $l_i = 0$ beliefs are given by with $\beta_i = \frac{(1-\lambda_i(1))\pi_i}{(1-\lambda_i(1))\pi_i + (1-\lambda_i(0))(1-\pi_i)}$. For $\pi_i < \theta$ or $\lambda_i(1) > \frac{\pi_i - \theta}{\pi_i - \pi_i\theta}$, $\beta_i(l_i = 0) < \theta$.

For the analysis of stakeholders' information strategy I limit the analysis to the case in which $\beta_i^{ver}(l_i = 1) \geq \theta$, so $Pr(a_1 = 1) = Pr(a_2 = 1) = \frac{1}{2}$ for $l_1 = l_2 = 1$. A stakeholder i tries to maximize the expected utility as given in C.2.2.

For $\pi_i \geq \theta$ probabilities are given by

$$
\begin{aligned}
Pr(l = (1,1), a_i = 1, p_i = 1) =& \frac{1}{2}\omega_i(\lambda_{-i}(1)\pi_{-i} + \lambda_{-i}(0)(1-\pi_{-i}) \\
Pr(l = (1,1), a_i = 0, p_i = 1) =& \frac{1}{2}\lambda_{-i}(0)(1-\pi_{-i}) \\
Pr(l = (1,0), a_i = 1, p_i = 1) =& \omega_i((1-\lambda_{-i}(1))\pi_{-i} + (1-\lambda_{-i}(0))(1-\pi_{-i}))
\end{aligned}
$$

For $Pr(l = (0,1), p_i = 1)$ and $Pr(l = (0,0), p_i = 1)$ we have to differentiate three distinct cases:

1. $\lambda_i(0) \leq \lambda_i(1)\frac{\pi_i - \pi_i\theta}{1-\pi_i}$, $\lambda_i(1) \leq \frac{\pi_i - \theta}{\pi_i - \pi_i\theta}$, and $\frac{\pi_i(1-\pi_{-i})}{\pi_{-i}(1-\pi_i)} < \frac{1-\lambda_{-i}(1)-\lambda_i(0)+\lambda_{-i}(1)\lambda_i(0)}{1-\lambda_i(1)-\lambda_{-i}(0)+\lambda_i(1)\lambda_{-i}(0)}$

2. $\lambda_i(0) \leq \lambda_i(1)\frac{\pi_i - \pi_i\theta}{1-\pi_i}$, $\lambda_i(1) \leq \frac{\pi_i - \theta}{\pi_i - \pi_i\theta}$, and $\frac{\pi_i(1-\pi_{-i})}{\pi_{-i}(1-\pi_i)} > \frac{1-\lambda_{-i}(1)-\lambda_i(0)+\lambda_{-i}(1)\lambda_i(0)}{1-\lambda_i(1)-\lambda_{-i}(0)+\lambda_i(1)\lambda_{-i}(0)}$

3. $\lambda_i(0) \leq \lambda_i(1)\frac{\pi_i - \pi_i\theta}{1-\pi_i}$, $\lambda_i(1) \leq \frac{\pi_i - \theta}{\pi_i - \pi_i\theta}$, and $\frac{\pi_i(1-\pi_{-i})}{\pi_{-i}(1-\pi_i)} = \frac{1-\lambda_{-i}(1)-\lambda_i(0)+\lambda_{-i}(1)\lambda_i(0)}{1-\lambda_i(1)-\lambda_{-i}(0)+\lambda_i(1)\lambda_{-i}(0)}$

A last case we have to consider is $\lambda_i(0) \leq \lambda_i(1)\frac{\pi_i - \pi_i\theta}{1-\pi_i}$, $\lambda_i(1) > \frac{\pi_i - \theta}{\pi_i - \pi_i\theta}$ or $\pi_i < \theta$, for which also the other probabilities change.

For case (1) probabilities are given by

$$\begin{aligned} Pr(l = (0,1), p_i = 1) =& \lambda_{-i}(0)(1-\pi_{-i}) \\ Pr(l = (0,0), p_i = 1) =& 0 \end{aligned}$$

Leading to

$$\begin{aligned} Ev_i(\lambda_i(\omega_i)) =& \lambda_i(\omega_i)[\omega_i(1 - \frac{1}{2}\lambda_{-i}(1)\pi_{-i} - \frac{1}{2}\lambda_{-i}(0)(1-\pi_{-i})) + \frac{1}{2}\lambda_{-i}(0)(1-\pi_{-i})] \\ &+ (1-\lambda_i(\omega_i))(\lambda_{-i}(0)(1-\pi_{-i})) - c(\lambda_i(\omega_i)) \\ \frac{dEv_i}{d\lambda_i} =& \omega_i(1 - \frac{1}{2}\lambda_{-i}(1)\pi_{-i} - \frac{1}{2}\lambda_{-i}(0)(1-\pi_{-i})) + \frac{1}{2}\lambda_{-i}(0)(1-\pi_{-i}) \\ &- \lambda_{-i}(0)(1-\pi_{-i}) - \frac{dc}{d\lambda_i} \end{aligned}$$

Here, for $\omega_i = 0$, $\lambda_i(0)$ solves

$$-\frac{1}{2}\lambda_{-i}(0)(1-\pi_{-i}) = \frac{dc}{d\lambda_i}$$

which cannot be solved, so $\lambda_i(0) = 0$.

For $\omega_i = 1$, first order conditions require

$$1 - \frac{1}{2}\lambda_{-i}(1)\pi_{-i} - \lambda_{-i}(0)(1 - \pi_{-i}) = \frac{dc}{d\lambda_i}$$

For case (2) probabilities are given by

$$\begin{aligned}
Pr(l = (0,1), p_i = 1) =& \lambda_{-i}(0)(1 - \pi_{-i}) \\
Pr(l = (0,0), p_i = 1) =& (1 - \lambda_{-i}(1))\pi_{-i} + (1 - \lambda_{-i}(0))(1 - \pi_{-i})
\end{aligned}$$

Leading to

$$\begin{aligned}
Ev_i(\lambda_i(\omega_i)) =& \lambda_i(\omega_i)[\omega_i(1 - \frac{1}{2}\lambda_{-i}(1)\pi_{-i} - \frac{1}{2}\lambda_{-i}(0)(1 - \pi_{-i})) + \frac{1}{2}\lambda_{-i}(0)(1 - \pi_{-i})] \\
&+ (1 - \lambda_i(\omega_i))(1 - \lambda_{-i}(1)\pi_{-i}) - c(\lambda_i(\omega_i)) \\
\frac{dEv_i}{d\lambda_i} =& \omega_i(1 - \frac{1}{2}\lambda_{-i}(1)\pi_{-i} - \frac{1}{2}\lambda_{-i}(0)(1 - \pi_{-i})) + \frac{1}{2}\lambda_{-i}(0)(1 - \pi_{-i}) - 1 + \lambda_{-i}(1)\pi_{-i} \\
&- \frac{dc}{d\lambda_i}
\end{aligned}$$

Here, for $\omega_i = 0$, $\lambda_i(0)$ solves

$$\frac{1}{2}\lambda_{-i}(0)(1 - \pi_{-i}) - 1 + \lambda_{-i}(1)\pi_{-i} = \frac{dc}{d\lambda_i}$$

This condition can never be fulfilled, as $\frac{dc}{d\lambda_i} > 0$:

$$\begin{aligned}\frac{1}{2}\lambda_{-i}(0)(1-\pi_{-i}) - 1 + \lambda_{-i}(1)\pi_{-i} >& 0 \\ \frac{1}{2}\lambda_{-i}(0) + \pi_{-i}(\lambda_{-i}(1) - \frac{1}{2}\lambda_{-i}(0)) - 1 >& 0 \qquad \text{assume } \lambda_{-i}(0) = \lambda_{-i}(1) = 1 \\ \pi_{-i} - 1 >& 0\end{aligned}$$

Which can never be true. So, $\lambda_i(0) = 0$.

For $\omega_i = 1$, first order conditions require

$$\frac{1}{2}\lambda_{-i}(1)\pi_{-i} = \frac{dc}{d\lambda_i}$$

For case (3) probabilities are given by

$$\begin{aligned}Pr(l = (0,1), p_i = 1) =& \lambda_{-i}(0)(1-\pi_{-i}) \\ Pr(l = (0,0), p_i = 1) =& \frac{1}{2}((1-\lambda_{-i}(1))\pi_{-i} + (1-\lambda_{-i}(0))(1-\pi_{-i}))\end{aligned}$$

Leading to

$$\begin{aligned}Ev_i(\lambda_i(\omega_i)) =& \lambda_i(\omega_i)[\omega_i(1 - \frac{1}{2}\lambda_{-i}(1)\pi_{-i} - \frac{1}{2}\lambda_{-i}(0)(1-\pi_{-i})) + \frac{1}{2}\lambda_{-i}(0)(1-\pi_{-i})] \\ &+ \frac{1}{2}(1-\lambda_i(\omega_i))(1 + \lambda_{-i}(0)(1-\pi_{-i}) - \lambda_{-i}(1)\pi_{-i}) - c(\lambda_i(\omega_i)) \\ \frac{dEv_i}{d\lambda_i} =& \omega_i(1 - \frac{1}{2}\lambda_{-i}(1)\pi_{-i} - \frac{1}{2}\lambda_{-i}(0)(1-\pi_{-i})) + \frac{1}{2}\lambda_{-i}(0)(1-\pi_{-i}) \\ &- \frac{1}{2}(1 + \lambda_{-i}(0)(1-\pi_{-i}) - \lambda_{-i}(1)\pi_{-i}) - \frac{dc}{d\lambda_i}\end{aligned}$$

Here, for $\omega_i = 0$, $\lambda_i(0)$ solves

$$-\frac{1}{2}(1 - \lambda_{-i}(1)\pi_{-i}) = \frac{dc}{d\lambda_i}$$

which cannot be solved for $\pi_{-i} < 1$, so $\lambda_i(0) = 0$.

For $\omega_i = 1$, first order conditions require

$$\frac{1}{2}(1 - \lambda_{-i}(0)(1 - \pi_{-i})) = \frac{dc}{d\lambda_i}$$

For case (4) probabilities are given by

$$\begin{aligned} Pr(l = (0,1), p_i = 1) =& 0 \\ Pr(l = (0,0), p_i = 1) =& 0 \end{aligned}$$

Leading to

$$\begin{aligned} Ev_i(\lambda_i(\omega_i)) =& \lambda_i(\omega_i)[\omega_i(1 - \frac{1}{2}\lambda_{-i}(1)\pi_{-i} - \frac{1}{2}\lambda_{-i}(0)(1 - \pi_{-i})) + \frac{1}{2}\lambda_{-i}(0)(1 - \pi_{-i})] \\ & - c(\lambda_i(\omega_i)) \\ \frac{dEv_i}{d\lambda_i} =& \omega_i(1 - \frac{1}{2}\lambda_{-i}(1)\pi_{-i} - \frac{1}{2}\lambda_{-i}(0)(1 - \pi_{-i})) + \frac{1}{2}\lambda_{-i}(0)(1 - \pi_{-i}) - \frac{dc}{d\lambda_i} \end{aligned}$$

For $\omega_i = 0$ first order conditions give

$$\frac{1}{2}\lambda_{-i}(0)(1 - \pi_{-i}) = \frac{dc}{d\lambda_i}$$

So, for $\lambda_{-i}(0) = 0 \rightarrow \lambda_i(0) = 0$.

For $\omega_i = 1$

$$1 - \frac{1}{2}\lambda_{-i}(1)\pi_{-i} = \frac{dc}{d\lambda_i}$$

C.5 The DG's Decision on Constraining the Agenda

The *DG*'s decision to constrain the agenda depends on the expected costs for constraining the agenda. The decision to constrain the agenda or not can be based on the difference between the expected costs for having an unconstrained agenda or a constrained agenda such that

$$Ec(not) - Ec(con) > 0 \rightarrow \text{constrain the agenda}$$
$$Ec(not) - Ec(con) < 0 \rightarrow \text{do not constrain the agenda}$$
$$Ec(not) - Ec(con) = 0 \rightarrow \text{indifferent}$$

For $\pi_1 > \pi_2 \geq \theta$ both stakeholder choose $\lambda_i(\omega_i) = 0$ and the *DG* implements both proposals. Expected costs for not constraining are then given by

$$Ec(not) = \theta(2 - \pi_1 - \pi_2)$$

For the expected costs of constraining the agenda, we have to differentiate between three cases:

1. $\lambda'_1(1) \leq \frac{\pi_1-\theta}{\pi_1-\pi_1\theta}$ and $\lambda'_2(1) \leq \frac{\pi_2-\theta}{\pi_2-\pi_2\theta}$

2. $\lambda'_1(1) \leq \frac{\pi_1-\theta}{\pi_1-\pi_1\theta}$ and $\lambda'_2(1) > \frac{\pi_2-\theta}{\pi_2-\pi_2\theta}$

3. $\lambda'_1(1) > \frac{\pi_1-\theta}{\pi_1-\pi_1\theta}$ and $\lambda'_2(1) > \frac{\pi_2-\theta}{\pi_2-\pi_2\theta}$

Let $\lambda'_i(\omega_i)$ be i's strategy under a constrained agenda and $\lambda_i(\omega_i)$ under an unconstrained agenda.

The expected costs for constraining the agenda if $\lambda'_1(1) \leq \frac{\pi_1-\theta}{\pi_1-\pi_1\theta}$ and $\lambda'_2(1) \leq \frac{\pi_2-\theta}{\pi_2-\pi_2\theta}$ are given by

$$\begin{aligned} Ec(con) =& \theta(1-\pi_1-\pi_2) + \rho_1(0,0)(\pi_2 - \pi_1 - \lambda'_2(1)(\pi_2 - \pi_1\pi_2) \\ & + \lambda'_1(1)(\pi_1 - \pi_1\pi_2)) \\ & + \pi_1(1-\lambda'_1(1))(1-\lambda'_2(1)) \end{aligned}$$

where $\rho_i(0,0) \equiv Pr(l_i = 0, l_{-i} = 0, p_i = 1, p_{-i} = 0)$. So the difference between these two is

$$\begin{aligned} Ec(not) - Ec(con) = \theta & - \rho_1(0,0)(\pi_2 - \pi_1 - \lambda'_2(1)(\pi_2 - \pi_1\pi_2) \\ & - \lambda'_1(1)(\pi_1 - \pi_1\pi_2)) \\ & - \pi_1(1-\lambda'_1(1))(1-\lambda'_2(1)) \end{aligned}$$

which is strictly increasing in θ. So generally a high θ makes a constraining the agenda more attractive. Depending on the quotient $\frac{\theta}{\pi_1}$ and the cost function.

The expected costs for constraining the agenda if $\lambda'_1(1) \leq \frac{\pi_1-\theta}{\pi_1-\pi_1\theta}$ and $\lambda'_2(1) >$

$\frac{\pi_2-\theta}{\pi_2-\pi_2\theta}$ are given by

$$Ec(con) = \theta(1-\pi_1-\pi_2) + \pi_2(1-\lambda_2'(1)(1-\pi_1))$$

So the difference between these two is

$$Ec(not) - Ec(con) = \theta - \pi_2(1-\lambda_2'(1)(1-\pi_1))$$

which is strictly increasing in θ. So generally a high θ makes a constraining the agenda more attractive.

The expected costs for constraining the agenda if $\lambda_1'(1) > \frac{\pi_1-\theta}{\pi_1-\pi_1\theta}$ and $\lambda_2'(1) > \frac{\pi_2-\theta}{\pi_2-\pi_2\theta}$ are given by

$$Ec(con) = \theta(1-\pi_1)(1-\pi_2)\lambda_1'(0)\lambda_2'(0) + (1-\theta)(\pi_1(1-\lambda_1'(1)) + \pi_2(1-\lambda_2'(1)) + \pi_1\pi_2\lambda_1'(1)\lambda_2(1))$$

So the difference between these two is

$$\begin{aligned} Ec(not) - Ec(con) = &\theta(2-\lambda_1'(0)\lambda_2'(0)(1-\pi_1\pi_2) - (\pi_1+\pi_2)(1-\lambda_1'(0)\lambda_2'(0))) \\ &- (1-\theta)(\pi_1(1-\lambda_1'(1)) + \pi_2(1-\lambda_2'(1)) + \pi_1\pi_2\lambda_1'(1)\lambda_2'(1)) \end{aligned}$$

Again, the difference is strictly increasing in θ. So a large θ makes constraining the agenda more attractive.

For $\pi_1 \geq \theta > \pi_2$, the expected costs for the unconstrained agenda are given by

$$Ec(not) = \pi_2(1-\lambda_2(1))(1-\pi_1(1-\theta))$$

the expected costs for constraining the agenda if $\lambda_1'(1) \leq \frac{\pi_1-\theta}{\pi_1-\pi_1\theta}$ are given by

$$Ec(con) = \theta(1-\pi_1-\pi_2) + \pi_2(1-\lambda_2'(1)(1-\pi_1))$$

So, the difference between these two is

$$\begin{aligned} Ec(not) - Ec(con) =& \pi_2(\lambda_2'(1)(1-\pi_1) - \lambda_2(1)) - \pi_1\pi_2(1-\lambda_2(1)) \\ & - \theta(1-\pi_1-\pi_2-\pi_1\pi_2(1-\lambda_2(1))) \end{aligned}$$

If $\lambda_1'(1) > \frac{\pi_1-\theta}{\pi_1-\pi_1\theta}$ the expected cost for constraining the agenda are given by

$$\begin{aligned} Ec(con) =& \theta(1-\pi_1)(1-\pi_2)\lambda_1'(0)\lambda_2'(0) \\ & + (1-\theta)(\pi_1(1-\lambda_1'(1)) + \pi_2(1-\lambda_2'(1)) + \pi_1\pi_2\lambda_1'(1)\lambda_2'(1)) \end{aligned}$$

and the difference is

$$\begin{aligned} Ec(not) - Ec(con) =& \theta(1-\pi_1-\pi_2) + \pi_2(1-\lambda_2'(1)(1-\pi_1)) \\ & - \theta(1-\pi_1)(1-\pi_2)\lambda_1'(0)\lambda_2'(0) \\ & - (1-\theta)(\pi_1(1-\lambda_1'(1)) + \pi_2(1-\lambda_2'(1)) + \pi_1\pi_2\lambda_1'(1)\lambda_2'(1)) \end{aligned}$$

For the case of $\theta > \pi_1 > \pi_2$ the expected costs for the unconstrained agenda are

$$\begin{aligned} Ec(not) =& \theta(\pi_1(1-\pi_2)\lambda_1(1)\lambda_2(0)\gamma_1 + (1-\pi_1)\pi_2\lambda_1(0)\lambda_2(1)(1-\gamma_1) + (1-\pi_1)(1-\pi_2)\lambda_1(0)\lambda_2(0)) \\ & + (1-\theta)(\pi_2(1-\lambda_2(1)) + \pi_1(1-\lambda_1(1))) \end{aligned}$$

and for constraining the agenda

$$\begin{aligned}Ec(con) =&\theta(1-\pi_1)(1-\pi_2)\lambda_1'(0)\lambda_2'(0)\\&+(1-\theta)(\pi_1(1-\lambda_1'(1))+\pi_2(1-\lambda_2'(1))+\pi_1\pi_2\lambda_1'(1)\lambda_2'(1))\end{aligned}$$

and a difference of

$$\begin{aligned}Ec(not)-Ec(con) =&\theta(\pi_1(1-\pi_2)\lambda_1(1)\lambda_2(0)\gamma_1+(1-\pi_1)\pi_2\lambda_1(0)\lambda_2(1)(1-\gamma_1)\\&+(1-\pi_1)(1-\pi_2)\lambda_1(0)\lambda_2(0))\\&+(1-\theta)(\pi_2(1-\lambda_2(1))+\pi_1(1-\lambda_1(1)))\\&-\theta(1-\pi_1)(1-\pi_2)\lambda_1'(0)\lambda_2'(0)\\&-(1-\theta)(\pi_1(1-\lambda_1'(1))+\pi_2(1-\lambda_2'(1))+\pi_1\pi_2\lambda_1'(1)\lambda_2'(1))\end{aligned}$$

Since $\lambda_i(\omega)\geq\lambda_i'(\omega)$ in equilibrium, the difference is increasing in θ. Therefore, an increase in θ makes constraining the agenda more attractive for $\theta>\pi_1>\pi_2$.

C.6 Existence of Equilibria

To show that all the equilibria exist, I assume a cost function $c(\lambda_i)=\lambda_i^2$ which fulfills $c(0)=0$, $\frac{dc}{d\lambda_i}>0$ for $\lambda_i>0$, and is twice differentiable.

C.6.1 Equilibria for $\pi_1>\pi_2\geq\theta$

Following the characterization of equilibria above, we know that for $\pi_1>\pi_2\geq\theta$, beliefs for $l_i=a_i=1$ are given by $\beta_i(\omega_i)=\omega_i$. If the agenda is unconstrained, there is no reason for any stakeholder to send informative signals for any state of the world, and given these strategies for $l_i = 0$, $\beta_i^{ver}(l_i) \geq \theta$ and the policy will be implemented for both stakeholders as described in equilibrium (1).

For a constrained agenda, assume that for $l_1 = l_2 = 0$, the DG always decides $p_1 = 1$ and $p_2 = 0$, which is always true for any small enough $\lambda_1^{'}(1)$ since $\pi_1 > \pi_2$. Then, strategies for stakeholder 1 are given by

$$\lambda_1'(0) = 0$$
$$\lambda_1'(1) = \frac{1}{4}\lambda_2'(1)\pi_2$$

For stakeholder 2, best responses are given by

$$\lambda_2'(0) = \frac{1}{4}\lambda_1'(0)(1-\pi_1)$$
$$\lambda_2'(1) = \frac{1}{2} - \frac{1}{4}\lambda_1'\pi_1$$

Solving these best responses lead to the following strategies

$$\lambda_i'(0) = 0$$
$$\lambda_1'(1) = \frac{\pi_2}{8 + \frac{1}{2}\pi_1}$$
$$\lambda_2'(1) = \frac{1}{2} - \frac{\pi_1\pi_2}{32 + 2\pi_1}$$

The DG decides to constrain the agenda if

$$
\begin{aligned}
Ec(not) - Ec(con) \geq& 0 \\
\theta \geq& \pi_2(1 - (\frac{1}{2} - \frac{\pi_1\pi_2}{32 + 2\pi_1})(1 - \pi_1))
\end{aligned}
$$

For different π_i and θ, it can be an equilibrium for the DG to constrain the agenda or not, e.g. for $\pi_1 = \frac{4}{5}$ and $\pi_2 = \frac{1}{5}$, for a $\theta = \frac{19}{100}$ the DG would decide to not constrain the agenda, while for a $\theta = \frac{9}{50}$ the DG would constrain the agenda.

C.6.2 Equilibria for $\theta > \pi_1 > \pi_2$

Following the characterization of equilibria above, we know that for $\theta > \pi_1 > \pi_2$, beliefs for $l_i = a_i = 1$ are given by $\beta_i(\omega_i) = \omega_i$. For $a_i = 0$ or before a verifying a signal are $\beta_i^{ver}(l_i = 1) \geq \theta$ and $\beta_i^{ver}(l_i = 0) < \theta$. So, any issue is only included in the policy proposal for $\beta_i^{ver} \geq \theta$. And implementation strategies are given as explained in the full characterization

If the agenda is unconstrained, information strategies of stakeholders are given by

$$
\begin{aligned}
\lambda_i(1) =& \frac{1}{2} \\
\lambda_1(0) =& \frac{\frac{1}{8}\pi_2 + \frac{1}{32}\pi_1(1 - \pi_2)}{1 - \frac{1}{16}(1 - \pi_1)(1 - \pi_2)} \\
\lambda_2(0) =& \frac{1}{8}\pi_1 + (1 - \pi_1)\frac{\frac{1}{32}\pi_2 + \frac{1}{128}\pi_1(1 - \pi_2)}{1 - \frac{1}{16}(1 - \pi_1)(1 - \pi_2)}
\end{aligned}
$$

If the agenda is constrained, information strategies of stakeholders are given by

$$\lambda_1'(1) = \frac{\frac{1}{2} - \frac{1}{8}\pi_2}{1 - \frac{1}{16}\pi_1\pi_2}$$
$$\lambda_2'(1) = \frac{1}{2} - \pi_1\frac{\frac{1}{8} - \frac{1}{32}\pi_2}{1 - \frac{1}{16}\pi_1\pi_2}$$
$$\lambda_i'(0) = 0$$

For these strategies, $\gamma_1 = \frac{1}{2}$. The DG decides to constrain the agenda if

$$\begin{aligned}
Ec(not) - Ec(con) \geq& 0\\
\theta(\pi_1(1-\pi_2)\frac{1}{4}(\frac{1}{8}\pi_1 + (1-\pi_1)\frac{\frac{1}{32}\pi_2 + \frac{1}{128}\pi_1(1-\pi_2)}{1 - \frac{1}{16}(1-\pi_1)(1-\pi_2)})+&\\
(1-\pi_1)\pi_2\frac{1}{4}\frac{\frac{1}{8}\pi_2 + \frac{1}{32}\pi_1(1-\pi_2)}{1 - \frac{1}{16}(1-\pi_1)(1-\pi_2)}+&\\
(1-\pi_1)(1-\pi_2)\frac{\frac{1}{8}\pi_2 + \frac{1}{32}\pi_1(1-\pi_2)}{1 - \frac{1}{16}(1-\pi_1)(1-\pi_2)}&\\
(\frac{1}{8}\pi_1 + (1-\pi_1)\frac{\frac{1}{32}\pi_2 + \frac{1}{128}\pi_1(1-\pi_2)}{1 - \frac{1}{16}(1-\pi_1)(1-\pi_2)})) \geq&\\
&(1-\theta)(\pi_1(1 - \frac{\frac{1}{2} - \frac{1}{8}\pi_2}{1 - \frac{1}{16}\pi_1\pi_2})+\\
&\pi_1\pi_2\frac{\frac{1}{2} - \frac{1}{8}\pi_2}{1 - \frac{1}{16}\pi_1\pi_2}(\frac{1}{4} - \pi_1\frac{\frac{1}{8} - \frac{1}{32}\pi_2}{1 - \frac{1}{16}\pi_1\pi_2})
\end{aligned}$$

For different π_i and θ, it can be an equilibrium for the DG to constrain the agenda or not, e.g. for $\pi_1 = \frac{4}{5}$ and $\pi_2 = \frac{3}{5}$, for a $\theta = \frac{41}{50}$ the DG would decide to not constrain the agenda, while for a $\theta = \frac{9}{10}$ the DG would constrain the agenda.

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