Essays on Strategic Communication

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Essays on Strategic Communication

Essays over strategische communicatie

Thesis

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Preface

The seemingly endless ordeal of doctoral studies has dominated the last few years of my life. Persevering through it is possibly the most challenging thing I have done. It brings a surprising amount of satisfaction now. The many errors, the frustrating dead-ends, the circling thoughts that lingered for days on end, have all been a continuous source of learning and self-growth. The entire process has been a wonderful journey that I am truly grateful to have experienced.

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This list can go on, many others have contributed one way or another to my experiences... Meher, Maryam, Max, Rei, Sander, Oke, Jindi... my people from back home, colleagues, friends, foes - thank you all and wish you success in life!

I am most grateful to my family, particularly my parents. You two have always supported me on this journey. You have given me the confidence and freedom to be where I am today, which does not come easily to many women in Pakistan. You have done everything you could have, often sacrificing your own needs, in order to provide me with all sorts of exposure and opportunities in life. I could not have done it without your love and support. I thank you with all my heart and soul. My brother and sisters, I love you all! My grandmother, may you rest in peace - thank you for your prayers and for your gentle demeanour.

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Chapter 1

Introduction

Information is one of the most important input to the choices we make, whether in our personal lives, as part of society, or as a formal member of an organization. Like any other input, information is scarce. Most of our decisions are made under conditions of uncertainty. Some types of uncertainties are out of our control. We simply cannot know whether a coin will land heads or tails. Other types of uncertainties, we have (some) control over. We can refer to weather reports to reduce the chance of encountering bad weather on a holiday.

Uncertainty that we can control (to whatever degree) occurs primarily due to information asymmetries, i.e. different economic agents (individuals, firms, governments) know different things. One reason for asymmetries, quite naturally, is that individuals know themselves (their skills, intentions, motivations) better than others. Another reason is the economic process itself. In the market economy, information is produced by and dispersed across various economic agents. Whatever the reasons may be, information asymmetries are pervasive, and some of the most interesting developments in economics are by virtue of information asymmetries.

One such development, which is also the topic of my dissertation, concerns transmission of information between economic agents (broadly speaking, signalling games). Communication serves a powerful tool that can help reduce uncertainty in decision making. One has to tread carefully though as communication suffers from issues of credibility. It is well understood that agents in a position to inform others on decision relevant matters can, and often do, attempt to manipulate information.

In situations where an informed party and uninformed party (the decision maker) have no conflict of interest, that is, they have the same end goal, then there is no issue of credibility. Once there is a conflict of interest, even to slight degree, the informed party has an incentive to manipulate information to influence the decision taken by the uninformed party. Communication is thus strategic. A seller of a good, for instance, has incentive to exaggerate the quality of his product to make a sale. Likewise, a job applicant would like an employer to believe that he is of high ability.

Two aspects are of particular interest in the presence of conflicted goals. The first concerns the amount of information that the better informed party can credibly communicate to the decision maker. The second concerns the extent to which a better informed party is able to influence the decision towards his own interest. Broadly speaking, I explore these two concerns in strategic communication. An early contribution by Milgrom and Roberts (1986) shows that competition between two parties with opposing preferences, such as in a legal dispute, leads to full information decisions. The reason is that any piece of information that is harmful for one party, is beneficial for the other party. Competition thus, provides incentive to either of the two parties to reveal information.

There are two crucial assumptions for this result. The first is that each party is fully informed. If this assumption fails, then full revelation of information breaks down. The second is that information can be credibly transmitted. This brings us to an important distinction between hard and soft information. Hard information is verifiable and cannot be fabricated (at least not without a cost). Credibility of hard information is thus not a concern. Soft information, on the other hand, is not verifiable. It consists of plain conversation such that any statement is permissible in equilibrium. Credibility in transmission of soft information requires that preferences or goals of agents are not too conflicted (Crawford and Sobel, 1982).

In this dissertation, I relax one or both of these assumptions. The first paper considers a scenario where competing parties are not fully informed, but information is hard and thus can be credibly transmitted. The second and third papers consider scenarios where parties are fully or partially informed, but information is soft so credibility is a concern. In the second, information transmitted by the sender is relevant for multiple decisions taken by an uninformed receiver. In the third, the sender communicates with a receiver who has private (non-overlapping) information. In each paper, we analyze how much information the sender is able to credibly communicate to the decision maker, and to what extent, if at all, the sender is able to influence the final outcome towards his own interest by communicating strategically.

Below I provide a brief overview of each paper. The first two, chapters 2 and 3 of this manuscript, are coauthored with my supervisor Otto Swank.

Chapter 2: In the first paper, we consider a scenario where a policy maker or a judge requires information to resolve a distributional dispute between two competing parties, such as lobby groups. The judge wants to make the right decision. This depends on an unknown state. Each party wants the decision to be in its own favor irrespective of the state. They must first exert costly effort to acquire hard information about the unkown state. The main question we are interested in is whether parties with easier access to information have a disproportionate influence on outcomes. To this end, we allow the two parties to differ in their (marginal) cost of effort. The more effort a party exerts to collect information, the higher is the probability that a party finds verifiable information. Although hard information cannot be fabricated, it can be concealed. Thus if information is found, the party has to determine whether to reveal it or conceal it.

We show that the party that is relatively advantaged in terms of collecting information has stronger incentives to reveal it. The reason is that if the stronger party does not reveal information, the decision maker (judge) is skeptical and is inclined to believe that the party has something to hide. As a result, when neither party presents evidence, the decision is biased towards the interest of the weaker party. We show, however, that in expected terms the final decision does not depend on the relative strength of the parties. This is a neutrality result. Our model predicts that, in line with the literature, relatively powerful interest groups frequently provide information that shapes policy. However, our model also predicts that if powerful interest groups do not provide information, decisions are made against their interests. In expected terms, these effects cancel out. Finally, we show that a policy that compels parties to reveal information destroys their incentives to collect information.

We regard our neutrality result as a benchmark. Lobbying groups may systematically affect policies in case the assumptions underlying our model are violated. Neutrality requires that the decision maker correctly assess the abilities of interest groups to collect information. Underestimation of the stronger parties ability will bias the decision in its favor. Clearly, neutrality does not hold anymore if the decision maker is biased or can be bribed.

Chapter 3: In the second paper, we consider the interaction between a politician and a bureaucrat to analyze decision making under an open rule. Under an open rule, bureaucrats play a purely informational role in the policy making arena. Politicians make their decisions based on the information provided by bureaucrats. Under a closed rule, on the other hand, bureaucrats have agenda setting power whereby they make take-it-or-leave-it offers to politicians. A closed rule yields predictions in line with the work of Niskanen (1971, 1975) who emphasized that agenda setting power enables bureaucrats to induce politicians to accept high budgets. Under an open-rule, however, bureaucrats are less likely to increase public spending. The reason is that rational decision makers anticipate that information supplied by bureaucrats is flawed. As a results, decision may be based on poor information, but budgets are not too large or too small on average.

We re-visit policy making under an open-rule, where the novel feature of our model is that the politician has to make two decisions. He not only has to decide on the amount of spending to allocate for a project, but also whether to implement the project in the first place. For instance, he has to decide whether to build a public library, and also has to decide on the size of the book collection for the library. A bureaucrat is informed about the public demand for library services. We assume that the bureaucrat wants the provision of the public service for a lower demand, relative to the politician. Moreover, he also wants a relatively higher budget allocated to the service.

We show that concerning the size of public projects, information asymmetry and misaligned preferences do not lead to distortions in expected terms. Bureaucrats try to exaggerate the demand for a public service, but rational politicians see through their attempts. However, concerning the implementation decision, we show that bureaucrats are able to increase the likelihood of the provision of a public service. Politicians implement projects they would not implement if they were fully informed themselves. Together these two results predict that public swimming pools, libraries, parks or museums, are not too large (or too luxurious) on average, but that there are too many of them.

We also derive some theoretical results for the literature on communication with unverifiable information, i.e. the cheap talk literature. First, we show that if information communicated by the sender is to effect the both types of decisions, then there is a spill-over between the spending decision and the implementation decision. Large distortions in the spending decision make implementation less attractive. Second, we show that if the sender of information wants project implementation, then his message must convince the decision maker that the state is good enough. We call this an implementation constraint. It imposes a limit on the maximum number of messages the sender can use in equilibrium. In other words, communication deteriorates in the presence of multiple decisions. Third, we show that the sender may benefit from less communication than an equilibrium permits. This is unlike the typical cheap talk outcomes. Finally, we show that if the sender is biased with respect to one decision, then the receiver wants the sender to be biased about the second type of decision as well.

Chapter 4: In the final paper, we analyze communication with a decision maker who is privately informed. This is typical of most real world settings. In organizations, for instance, managers typically possess private information about the projects they wish to implement in the firm. A consultant may advice the manager about market conditions, however, whether the stated market conditions are suitable for the objective of the firm depends on the personal view of the manager. It is well understood that if the view of the manager is shared by others in the organization, then it leads to less influence activities via strategic communication. Casual observation however, shows that managers are often inclined to take advice from external market participants, such as management consultants, instead of from individuals within the firm. In this paper, we rationalize these opposing views to show that informed firm managers may sometimes prefer to receive information from external market participants who do not internalize the private values of the manager. This paper addresses two main questions. First, how does communication from a sender differ if the manager is privately informed? Second, does a sender who values the information of the manager reveal more of his own private information in comparison to sender who does not value it?

To address these questions, we model a simple cheap talk game between a manager and an agent. The manager has to choose whether or not to implement a project. Project quality is privately observed by the agent. The key feature of the model is that the manager has private information. The important assumption concerning the information structure is that the private information of both players is non-overlapping, or independently distributed. This can be interpreted in two ways. First, the manager may have a personal taste concerning the project. Second, the manager may be informed about costs and funding opportunities for the project that agent does not observe. We assume that there are two kinds of the agent. An agent with shared values internalizes the manager's private information while an agent without shared values only cares about project quality. Both types of agents earn some private rents from project implementation, such as intrinsic rewards.

The communication results show that an agent with shared values can reveal rich information. The agent fine-tunes his information into numerous intervals (messages), and reveals relatively precise information. An agent without shared values can use at most two messages. The reason for richer communication is that an agent who values the manager's information internalizes costs associated with implementation of projects that are not suitable for the firm. This encourages him to reveal less noisy information. With respect to the quality, in terms of the informativeness of messages, we show that communication with shared values deteriorates at a relatively faster rate if the agent's private rents increases. As a result an informative equilibrium breaks down relatively faster under shared values, and the benefit of a finer partition is undermined. Specifically, if private rents of the agent are sufficiently small (large), then communication is stronger with (without) shared values. This results is robust to common knowledge of the manager's information. We also show that this difference in communication effects the agent's incentives to collect information. If rents are sufficiently small (large), then an agent with (without) shared values exerts relatively higher effort.

These results contribute to various streams in the literature. With respect to corporate culture and homogeneity of preferences, they imply that shared values may lead to stronger influence activities in an organization. With respect to theory of the firm, they highlight costs in communication as a determinant of firm boundaries. In particular, they show that it is not trivial to assume that integrating various functions in a firm leads to stronger communication or information flows. Finally, these results also add to the cheap-talk literature. First, the private information of the receiver allows him to extract relatively more precise information from an agent, conditional on its payoff relevance for the agent and on the size of private rents. Second, a privately informed receiver does not lose real authority over an implementation decision, unlike an uninformed receiver. The implication is that the sender is not able to bias the decision towards his own interest. Third, the receiver will prefer to fully share his information with an agent who values it even though this biases the decision towards the sender's interests. The reason is that the agent is able to fully utilize his information.

Chapter 2

Do Parties With Easier Access to Information Have a Disproportionate Influence on Policy?

Coauthored with Otto H. Swank

2.1 Introduction

In a wide variety of situations, people make decisions on the basis of information supplied by other people. Often those who provide information have a ”stake” in the final decision. A prominent example of such a situation is a civil lawsuit involving a dispute between two parties about a distributional issue. Each party supplies information in an attempt to influence the judge's decision in its own favor. Another well-known example is a politician who makes a decision that affects various interest groups. Again each group may provide information with an eye on influencing the politician's final decision to its own benefit. When decisions are made on the basis of information provided by interested parties, there are usually two (related) concerns. First, interested parties have incentives to reveal information that is favorable for them, but to conceal information that is unfavorable for them. As a result, the decision maker possibly does not hear all available information. Second, the means of interest groups vary widely. An implication is that decisions may be biased towards the interests of groups with easier access to information.

The main objective of this paper is to shed light on these two concerns. To this end, we develop a game-theoretical model in which a neutral person has to resolve a distributional dispute between two parties; say, an amount of money is to be distributed. The socially optimal decision depends on the state of the world. The parties, however, have opposite interests that do not depend on the state of the world. As to learning the state, the decision maker has to rely on information provided by the parties. We assume that the parties do not observe the state of the world,[1] but each party can exert effort to find verifiable information about it. The more effort a party puts in collecting information, the higher is the probability that a party receives verifiable information about the state. If information is found, a party has to determine whether to reveal or conceal it. An important feature of our model is that parties may differ in the (marginal) cost they attach to exerting effort. The implication is that there is a relatively advantaged party and a relatively disadvantaged party. In this way, we are able to address the concern regarding the influence of powerful interest groups on decisions. Another important feature of our model is that given the available information, the decision maker aims at making the socially optimal decision.

We derive four main results. The first one is neither novel nor surprising. Parties reveal information that promotes their interests, but conceal information that damages their interests.

Our second result is more subtle. The party that is relatively advantaged in terms of collecting information has stronger incentives to reveal it. The reason for this result is that when the advantaged party does not reveal information, the decision maker is inclined to believe that the party has something to hide. As a result, when neither party presents evidence, the decision is biased towards the interest of the disadvantaged party.

Third, in expected terms, the final decision does not depend on the relative strength of the parties. This neutrality result sheds light on the role of powerful interest groups in politics. Our model predicts that indeed relatively powerful interest groups frequently provide information that shapes policy. However, our model also predicts that if powerful interest groups do not provide information, decisions are made against their interests. In expected terms, these effects cancel out because of

[1] In section 2.8 we show that our main results also hold when parties observe the state of the world but must exert effort to communicate information.

the Martingale property.

Our final result is that a policy that compels parties to reveal information destroys their incentives to collect information.

Together our results indicate that the concern that interested parties have incentives to conceal information is justified. However, compelling parties to supply information does not help. It would only weaken incentives to collect information. The concern for biased decisions because some parties have easier access to information than others is less justified. Rational decision makers take the relative strength of parties into account in such a way that differences in the power of parties do not lead to biases in decisions.

It is important to point out from the outset that we obtain our results from a model of informational lobbying in which the decision maker is unbiased. Of course, if the decision maker is biased or can be bribed our result that in expected terms the relative power of parties is irrelevant does not hold any more.

2.2 Literature

Our paper is related to two broad strands of economic literature. First is the literature on law and economics; researchers have investigated attorneys' incentives to collect and convey information in adversarial systems. An early paper is by Milgrom and Roberts (1986) who show that communication between interested parties with opposed interests leads to full-information decisions. Crucial assumptions for this result are (1) that information can be credibly transmitted, and (2) that parties are fully informed. When parties are not always fully informed, full revelation disappears (Austen-Smith, 1994; Shin, 1994; Swank, 2011). Dewatripont and Tirole (1999) show that parties with opposing preference have also strong incentives to collect information (Dur and Swank, 2005; Kim, 2012). In the literature on adversarial systems, our paper is closest to Sobel (1985), who examines parties' incentives to report information in case of a dispute over an indivisible asset. As in our paper, in Sobel one party might be more advantageous in reporting information than the other party. Sobel examines how different rules of proof of evidence affect parties' incentives. Our paper deviates from Sobel in that we focus on a dispute over a divisible asset. Moreover, we explicitly distinguish between incentives to collect information and incentives to transfer information.

Second, our paper is related to the voluminous literature on interest groups.[2]

[2]For surveys, see Mitchell and Munger (1991); Mueller Dennis (2003); Austen-Smith (1997).

Olson (1965) argues that smaller groups face lower costs to organize themselves, and consequently may have a disproportionate influence on policy. In Tullock (1980) and Becker (1983) interest groups decide how many resources to spend on lobbying. The amount of resources affects the probability of influencing the decision. It is this type of literature that predicts that an interest group with more resources has a bigger say in policy decisions. The early literature on lobbying posits the existence of an influence function describing how lobbying efforts affect policy. Potters and Van Winden (1992) provide a micro-foundation for these influence functions. A key assumption of their model is that an interest group possesses information that is relevant for a legislator. By paying a cost an interest group can credibly transmit information to the legislator. Potters and Van Winden show that the more the preferences of the interest group and the legislator are aligned, the wider is the scope for information transmission.[3] Austen-Smith and Wright (1992), like us, model two groups that try to influence the decision of a legislator. Each group decides whether or not to become informed. This decision is observed by the legislator. Next, the two groups send messages to the legislator who makes the final decision. Our model deviates from Austen-Smith and Wright in three main respects. First, in our model, the decision and states are continuous rather than binary. Second, in our model, the decision-maker does not observe whether or not parties are informed. Finally, one of the main questions we address is whether more powerful interest groups have a bigger say in decisions, whereas the model by Austen-Smith and Wright is very suitable for understanding groups decisions on whether to lobby or not.

Similarly, some studies consider a group's choice of whether to use informational lobbying for influence or whether to use an alternative instrument such as campaign contributions (Bennedsen and Feldmann, 2006) or political pressure (Dahm and Porteiro, 2008). These models, though closely related to ours, are more suitable for understanding groups choice of the type of instrument to use for influence. Cotton (2012) considers the question of whether rich groups have a disproportionate influence on policy in a model where contributions determine access to the politician. They show that rich interest groups gain more access than poor groups, but that they are not better off compared to poor groups due to the politicians rent extracting strategy. While Cotton's focus is on the influence of strong groups due to better access to politicians, our focus is on the influence due to better information collection capabilities. Grossman and Helpman (2001) develop a cheap-talk model

[3] See also Grossman and Helpman (2001).

where interest groups are fully informed, but information is not verifiable.[4] Their model too is more suitable to understand group decisions on whether to lobby or not. Moreover, their focus lies on the requirements for credibility when talk is cheap. They show that credibility improves with the amount of resources a group spends and thus provide a rationale for why interest groups spend more than is necessary to communicate messages. Lastly, common knowledge of the marginal cost of information collection allows the decision maker in our model to make an unbiased decision, which points towards the benefits of lobbying disclosure laws. In contrast, Denter et al. (2011) model lobbying as a contest between groups to show that mandated transparency of lobbying costs leads to an over-investment by groups and decreases expected allocative efficiency.

2.3 The Model

Our model describes a situation where a decision has to be made with important distributional consequences. One can think of, for example, the allocation of a tax. We assume that it is common knowledge that there is a socially optimal decision in the sense that reasons may exist why one party should be favored to the detriment of another party. To learn these reasons, the decision maker relies on the information supplied by the interested parties. We consider a setting in which each party wants to make a case for itself.

A decision maker has to choose x, where $x \in [l, h]$. One can think of the decision maker as a politician, a CEO, or a judge. The problem is that the proper decision is uncertain. This uncertainty is reflected by the stochastic term μ, the state of the world, which is uniformly distributed[5] on the interval $[l, h]$. The decision maker chooses x so as to minimize the expected deviation of x from μ, given the information (I) it possesses: $\min_x : E(|x - \mu| \, |I)$.

To learn μ, the decision maker has to rely on information provided by two interested parties, $i \in \{a, b\}$. One can think of a party as an interest group, a manager of a division, or an attorney. Neither party knows μ initially. However, each party may collect information to learn μ and receive a signal $s_i \in \{\phi, \mu\}$. Collecting information is costly. Specifically, we assume that each party i chooses effort $\pi_i \in [0, 1)$, where π_i denotes the probability with which party i finds verifiable information about μ, $s_i = \mu$. With probability $1 - \pi_i$ party i does not find information, $s_i = \phi$. For sim-

[4] See also Krishna and Morgan (2001), and Visser and Swank (2007).

[5] The uniform distribution does not alter our results qualitatively. See also footnote 8.

plicity, we assume that the cost of information collection is quadratic: $\frac{1}{2}\lambda_i\pi_i^2$, with $\lambda_i > \frac{1}{2}(h-l)$.[6]

An important feature of our model is that λ_a may differ from λ_b. If $\lambda_a < \lambda_b$, we say that party a is the more powerful party. The parameter λ_i may capture a few things. First, λ_i may depend on the resources party i possesses to collect information. Second, the efficiency with which a party collects information may affect λ_i. Third, λ_i may depend on party i's position in the economy. For instance, information about the impact of a deregulation in an industry often lies in the hands of that industry. In this paper, we take a broad view of the various factors that may determine λ_i.

We assume that the two parties have opposing preferences. Party a wants the decision maker to choose a high value of x, whereas party b wants the decision maker to choose a low value of x. The payoffs to party a and b are given by:

$$U_a(x) = x - \frac{1}{2}\lambda_a\pi_a^2 \tag{2.1}$$

and

$$U_b(x) = -x - \frac{1}{2}\lambda_b\pi_b^2 \tag{2.2}$$

respectively.

After the parties have collected information, the communication stage starts. In this stage, the two parties simultaneously send a message, m_i, to the decision maker. A party conditions its message on the information it received, $m_i(s_i)$. We assume that information cannot be forged but can be concealed. Thus, if party i did not find information in the collection stage, it cannot supply information, $m_i(\phi) = \phi$. If, by contrast, party i found information, say $s_i = \mu'$, it either sends $m_i(\mu') = \mu'$ (reveals) or sends $m_i(\mu') = \phi$ (conceals). After the parties have sent their messages, the decision maker chooses x.

We assume that the structure of the game and the distribution of μ is common knowledge. Our model is a dynamic game with imperfect information. We solve it by backward induction and identify Perfect Bayesian Equilibria (PBE). The decision maker chooses x so as to minimize $E(|x-\mu||m_a, m_b)$. Parties anticipate the decision maker's decision rule.

[6] In the appendix we show that if $\lambda_i \leq \frac{1}{2}(h-l)$, an equilibrium exists in which party i chooses $\pi_i = 1$ and always reveals information to the decision maker. As a result, party $-i$ is redundant. By assuming $\lambda_i > \frac{1}{2}(h-l)$, we ensure that the model focuses on environments where both parties have incentives to collect information. This is the most relevant environment to investigate how the relative strength of parties affects decisions.

2.4 Communication Stage

Each party enters the communication stage either with the possibility to present evidence to the decision maker or without this possibility. This depends on whether or not a party was successful in the information collection stage. We call a party that is able to reveal information "informed", and a party that is not able "uninformed". By assumption, an uninformed party sends $m_i(\phi) = \phi$. The question remains for which values of μ an informed party sends $m_i(\mu) = \phi$ and for which values of μ it sends $m_i(\mu) = \mu$. Proposition 1 presents the equilibrium communication strategy of an informed party.

Proposition 1. *In a PBE, parties' communication strategies can be characterized by a single threshold, μ^T. An informed party a chooses $m_a(\mu) = \mu$ if and only if $\mu \geq \mu^T = E(\mu|m_a = m_b = \phi)$. An informed party b chooses $m_b(\mu) = \mu$ if and only if $\mu \leq \mu^T$.*

Proposition 1 is an implication of our assumption that the parties have opposing preferences. Information that is favorable for party a is unfavorable for party b, and vice versa. At $\mu = \mu^T$, both parties are indifferent between revealing information ($m_i(\mu) = \mu$) and concealing it ($m_i(\mu) = \phi$). The decision of a party to reveal information or not is only relevant in case the other party does not reveal information. As the decision maker chooses $x = \mu$ if either party reveals information, $m_i(s_i)$ is not relevant if $m_{-i}(\mu) = \mu$. So, to determine party a's decision whether or not to report information, suppose $m_b(s_b) = \phi$ and $s_a = \mu' \in \{l, h\}$. Clearly, $m_a(\mu') = \phi$ induces the decision maker to choose $x = E(\mu|m_a = m_b = \phi)$, while $m_a(\mu') = \mu'$ induces the decision maker to choose $x = \mu'$. Hence, party a is indifferent between $m_a(\mu') = \mu'$ and $m_a(\mu') = \phi$ if,

$$\mu' = \mu^T = E(\mu|m_a = m_b = \phi) \tag{2.3}$$

For party b, the same equation can be derived.

A direct implication of Proposition 1 is that in case both parties are able to provide evidence, the decision maker makes the full-information decision. This result is similar to the result derived by Milgrom and Roberts (1986) that competition between informed parties whose preferences are opposed leads to full-information decisions. Proposition 1 also implies that parties never provide evidence that conflicts with their own interests.

2.5 Information Collection Stage

We now turn to a party's decision on how much effort to put in collecting verifiable information. Consider party a. When choosing π_a party a anticipates that it will only reveal information in the communication stage if $\mu \geq \mu^T$. Moreover, it anticipates that if party b finds information, it will reveal it if and only if $\mu \leq \mu^T$. Finally, it knows that revealing μ leads to $x = \mu$. The expected payoff to party a when choosing π_a equals,

$$Pr(\mu \geq \mu^T)[\pi_a \frac{1}{2}(h + \mu^T) + (1 - \pi_a)\mu^T] + \cdots$$
$$Pr(\mu \leq \mu^T)[\pi_b \frac{1}{2}(\mu^T + l) + (1 - \pi_b)\mu^T] - \frac{1}{2}\lambda_a \pi_a^2 \tag{2.4}$$

The first (second) term of (2.4) pertains to the range of μ for which party a (b) reveals information if it is found. The third term gives the cost of effort.

Differentiating (2.4) with respect to π_a, and using $Pr(\mu \geq \mu^T) = \frac{h-\mu^T}{h-l}$ and $Pr(\mu \leq \mu^T) = \frac{(\mu^T - l)}{h-l}$, we attain[7]

$$\pi_a = \frac{(h - \mu^T)^2}{2\lambda_a(h - l)} \tag{2.5}$$

Equation (2.5) shows that the higher is the deviation of μ^T from h, the more effort party a puts in collecting information. Of course, the reason for this result is that the deviation of μ^T from h is directly related to the probability that party a will utilize its information. To put it somewhat differently, party a has stronger incentives to collect information when it anticipates that the information is likely to be favorable to its cause. Obviously, it also has stronger incentives when the cost of collecting information is small.

In a similar way, one can derive the amount of effort party b exerts:

$$\pi_b = \frac{(\mu^T - l)^2}{2\lambda_b(h - l)} \tag{2.6}$$

Note that party b's effort strategy is the converse of party a's strategy. When party b anticipates that it is likely to find information that is favorable to its cause, it has strong incentives to collect information.

[7]Due to our assumption $\lambda_i > \frac{1}{2}(h - l)$, we have $\pi_a < 1$.

2.6 The Threshold μ^T

In Section 2.4, we have identified the communication strategies of the two parties. In these strategies, the threshold μ^T plays an important role. Party a reveals information if and only if it has found that $\mu \geq \mu^T$, while the opposite holds for party b. In the previous section, we have examined the incentives of parties to collect information. Again the threshold μ^T turned out to be important. In the present section, we use parties' strategies to determine the threshold μ^T.

In Section 2.4, we have shown that the threshold μ^T equals the expected value of x, conditional on $m_a = \phi$ and $m_b = \phi$. The decision maker knows that if both parties had found information, one of them would have revealed it. He can therefore infer from $m_a = \phi$ and $m_b = \phi$ that at most one party found information. As a consequence, parties not revealing information can be a result of three events. First, party a found information, but decided not to reveal it. Then, $\mu < \mu^T$. Second, party b found information, but decided not to reveal it, so that $\mu > \mu^T$. Third, neither party found information. As π_a and π_b are independent of μ, in the third event the expected value of μ equals $\frac{1}{2}(l+h)$. Together these events imply the following expression for μ^T,

$$\mu^T = \frac{\pi_a(1-\pi_b)\left(\frac{\mu^T-l}{h-l}\right)\frac{l+\mu^T}{2} + \pi_b(1-\pi_a)\left(\frac{h-\mu^T}{h-l}\right)\frac{\mu^T+h}{2} + (1-\pi_a)(1-\pi_b)\frac{l+h}{2}}{\pi_a(1-\pi_b)\left(\frac{\mu^T-l}{h-l}\right) + \pi_b(1-\pi_a)\left(\frac{h-\mu^T}{h-l}\right) + (1-\pi_a)(1-\pi_b)} \tag{2.7}$$

which can be rewritten as,

$$(\mu^T)^2(\pi_a - \pi_b) + 2\mu^T[h(1-\pi_a) - l(1-\pi_b)] - h^2(1-\pi_a) + l^2(1-\pi_b) = 0 \tag{2.8}$$

To better understand how μ^T depends on π_a and π_b, first suppose that $\pi_a = \pi_b$. Then, (2.8) reduces to $\mu^T = \frac{1}{2}(l+h)$. This implies that in the absence of information, the decision maker chooses a neutral decision when parties exert the same amount of effort. Now suppose $\pi_a = \pi_b$. Straightforward, but tedious, algebra shows that μ^T is increasing in π_b and decreasing in π_a. A direct implication is that for $\pi_a > \pi_b$, in the absence of information, a decision is made that is biased against party a. The intuition is straightforward. If $\pi_a > \pi_b$, the decision maker attributes a relatively high probability to the event that party a possesses information. Consequently, in case neither party provides information in the communication stage, the decision maker is especially suspicious that party a wants to hide information. Likewise for $\pi_b > \pi_a$ and $m_a = \phi$ and $m_b = \phi$, a decision is made that is biased against party b.

The effect of $\pi_a = \pi_b$ on the decision on x influences parties' incentives to collect information. Recall that party a's effort equals $\pi_a = \frac{(h-\mu^T)^2}{2\lambda_a(h-l)}$. Clearly, the lower is μ^T, the higher is π_a. Again, this effect has a clear intuition. Party a anticipates that in case the decision maker does not receive information about μ, he will make a decision that is biased against its interest. This gives a stronger incentive for party a to collect information.

Proposition 2. *In equilibrium, μ^T is implicitly determined by (2.8). If $\lambda_i < \lambda_{-i}$ and $m_a = m_b = \phi$, a decision is made that is biased against party i.*

Proof. See appendix. ■

Proposition 2 sheds a new light on the claim that powerful interest groups are able to put a stamp on policy. Our model predicts that indeed powerful interest groups frequently provide evidence that heavily influences policy. In this sense, it is true that powerful interest groups have a disproportionate influence on policy. However, we have also shown that in case a powerful interest group does not provide information, the decision is biased against its interest.

The next proposition shows that the relative strength of interest groups does not affect the expected decision on x.

Proposition 3. *In expected terms, the value of λ_i relative to λ_{-i} does not affect the decision on x.*

Proof. See appendix. ■

Proposition 3 is a direct implication of the Martingale property and we interpret it as a neutrality result.Of course, when one of the assumptions of our model is relaxed the neutrality result may break down.[8] For example, we have assumed that the decision maker knows the relative strength of parties. If the decision maker were to have a wrong perception of λ_i, the neutrality result would no longer hold. Underestimation of the relative strength of a party induces the decision maker, in expected terms, to choose a policy that is favorable for that party. It is also important to emphasize that the neutrality result only holds for informative lobbying. Evidently, allowing for bribes may alter our results since they will directly influence the preferences of the decision maker.

[8] It is important to note that relaxing the assumption that μ is uniformly distributed does not break down this result. In the proof provided in the appendix, we show that neutrality holds for a general distribution function.

2.7 Forcing Parties to Reveal Their Information

In the previous sections we have analyzed incentives of parties to collect and supply information. We have shown that a party only reveals information that benefits its cause. In the current section we examine the implications of a policy that forces each party to reveal its information, whether that information is favorable for it or not. Such a policy in our model is akin to the assumption that information cannot be concealed. Consequently, the communication strategy of party i becomes: $m_i(s_i) = \mu$ for $s_i \in [l, h]$, and $m_i(\phi) = \phi$. Note that in this setting the expected value of μ when the decision maker does not receive information equals $E(\mu | m_a = \phi, m_b = \phi) = \frac{1}{2}(l + h)$.

The resulting model revolves around information collection. When choosing the amount of effort to exert, parties anticipate that any information they find will be revealed, leading to $x = \mu$. Thus, the expected payoff to party a when choosing π_a is,

$$(1 - \pi_a)(1 - \pi_b)\left(\frac{h + l}{2}\right) + [1 - (1 - \pi_a)(1 - \pi_b)]\left(\frac{h + l}{2}\right) - \frac{1}{2}\lambda_a \pi_a^2 \tag{2.9}$$

The first term is the expected payoff in case neither party finds information. The second term is the expected payoff in case either of the two (or both) parties find information. The last term is the cost of effort. The first-order condition with respect to π_a implies that the amount of effort party a exerts is $\pi_a = 0$. Similarly, one can show that party b has no incentive to collect information. Hence, compelling parties to reveal their information completely eliminates their incentives to become informed. This brings us to Proposition 4.

Proposition 4. *A policy that compels parties to reveal their information eliminates their incentives to collect information.*

Proposition 4 casts doubts on rules in legal systems that compel prosecutors to disclose exculpatory evidence to the defendant. One primary purpose of these rules is to ensure that all parties go to trial with as much knowledge as possible. Our result suggests that these rules may have an unintended consequence of discouraging parties to collect information in the first place.

2.8 Costly Communication

So far, we have focused on a situation where parties have to exert effort to find information. An alternative situation is that parties have information but have to make effort to convey it to the decision maker.[9] To analyze the latter case, we assume that when choosing their strategies on effort, parties know μ. In the new model, π_i denotes the probability that party i is able to provide verifiable evidence to the decision maker, and λ_i can be interpreted as a measure of party i's accessibility to the decision maker. Specifically, in the alternative game we have that (1) nature chooses μ and reveals it to the parties, but not to the decision maker; (2) each party chooses effort on the basis of μ, $\pi_i(\mu)$; (3) if party i is able to reveal information, it reveals it or conceals it; (4) the decision maker chooses x.

The assumption about the observability of μ does not have consequences for the strategies followed in the communication stage. The communication strategies can again be characterized by a single threshold, μ^T. Each party only reveals information when it perceives that it will lead to a more favorable decision.

Incentives to exert effort, however, are different in the present model. Because each party observes the state, effort is conditional on the state. The more favorable is the state to party i, the stronger are its incentives to exert effort.[10] Moreover, if $\mu \leq \mu^T$, party a does not exert effort, and if $\mu \geq \mu^T$ party b does not exert effort. Thus, either party a or party b tries to convey information.

The assumption about the observability of μ does not affect our main result that in expected terms, the relative power of parties does not influence the decision on x. Of course, the reason is that also in the present model the Martingale property implies that the expected value of x equals $\frac{1}{2(l+h)}$.

2.9 Conclusion

Do more powerful interest groups have a disproportionate influence on policy? We have shown in this paper that in an environment where interest groups try to influence decisions by concealing or revealing information, the answer to this question is in the negative. By often providing information, more powerful interest groups

[9] Empirical research suggests that interest groups expend resources to convey their messages to policy makers. For a review of empirical models of interest group influence see Potters and Sloof (1996) and Stratmann (2005).

[10] Specifically, $\pi_a(\mu) = \frac{\mu - \mu^T}{\lambda_a}$ for $\mu > \mu^T$ and $\pi_a(\mu) = 0$ for $\mu \leq \mu^T$, and $\pi_b(\mu) = \frac{\mu^T - \mu}{\lambda_b}$ for $\mu < \mu^T$ and $\pi_b(\mu) = 0$ for $\mu \geq \mu^T$.

do frequently influence policies. However, when they abstain from providing information, decisions are biased against their interests. In expected terms, these effects cancel out.

We regard our neutrality result as a benchmark. Interest groups may systematically affect policies in case the assumptions underlying our model are violated. For instance, we have assumed that the decision maker forms expectations in a rational way. In practice, this means that the decision maker should distinguish between cases where more powerful interest groups do not provide information and cases where less powerful interest groups do not provide information. Moreover, our neutrality result requires that the decision maker correctly assess the abilities of interest groups to collect information. Finally, we have ignored the possibilities that interest groups bribe decision makers and that decision makers may already have ideological preferences over policies.

Chapter 3

Bureaucracy and Overprovision of Public Goods

Coauthored with Otto H. Swank

3.1 Introduction

An important determinant of public policy is the interaction between politicians and interested, informed parties. Politicians have to make numerous decisions on topics about which they have little expertise. As a result, they have to rely on other people, like bureaucrats, who possess information. Niskanen (1971, 1975) developed a model of the interaction between poorly informed politicians and well-informed bureaucrats. In his work, their information advantage gives bureaucrats agenda-setting power that enables them to influence public policies considerably.

In the last four decades, several authors have built on Niskanen's seminal work. Most of them have maintained the assumptions that relative to politicians, bureaucrats have an information advantage, and that the preferences of politicians and bureaucrats differ. Progress has been made in (i) the analysis of alternative decision-making procedures, and (ii) modeling the transmission of information from bureaucrats to politicians. Gilligan and Krehbiel (1987, 1989, 1990) distinguish between decision-making under a closed rule and an open rule. Under a closed rule, bureaucrats have agenda-setting power. They offer take-it-or-leave-it proposals to politicians. Under an open rule, bureaucrats play a purely informational role. Politicians make decisions on the basis of information provided by bureaucrats. Most of these studies employ signaling models to better understand the transmission of information between bureaucrats and politicians (see also Austen-Smith (1993), and Banks (1990).

Generally, models, describing decision making under a closed rule, yield predictions that are in line with Niskanen's work. Agenda setting power enables bureaucrats to induce politicians to accept high budgets. Under an open decision-making procedure, bureaucrats are less likely to increase public spending. The reason is that rational politicians anticipate that information provided by biased bureaucrats is flawed. As a result, decisions are made on the basis of poor information. However, in expected terms, budgets are not too small or too high.

In the present paper, we employ a cheap-talk model to analyze decision-making under an open rule. The novel feature of our model is that the politician has to make two decisions. First, she has to make an implementation decision, say, to build a library or not. Second, she has to make a spending decision, say, how much money to spend on the collection of books for the library. The sender of information, the bureaucrat, has superior information about the demand for the public service. Moreover, he wants the public service to be implemented for a lower demand than the receiver of information, the politician. Another assumption is that given implementation, for each level of demand, the bureaucrat wants higher public spending than the politician. The assumptions about the distribution of information and the players' preferences are in line with the spirit of earlier Niskanen models. The introduction of an implementation decision allows us to investigate how the interaction between bureaucrats and politicians affects both the number of projects and the size of projects.

We derive a couple of results. Our first result is that concerning the size of public projects, information asymmetry and misaligned preferences do not lead to distortions in expected terms. Bureaucrats do try to exaggerate the demand for public services, but politicians see through these attempts. This result is in line with the results from cheap-talk models à la Crawford and Sobel (1982). Our second result is that bureaucrats are able to distort implementation decisions. Politicians implement projects that they would not implement if they possessed full information. Together these results predict that public swimming pools, libraries, public parks or museums are not too large or too luxurious, but that there are too many of them.

Apart from our results regarding public decision-making, we derive a few theoretical results. First, there is a spill-over between the spending decision and the implementation decision. A large distortion in the spending decision makes implementation less attractive. Second, when the sender wants to induce implementation, his message must reveal that the demand is sufficiently high. We show that this "implementation constraint" deteriorates communication by imposing a limit on the maximum number of intervals. Third, the equilibrium in which the maximum number of intervals are used is not always the equilibrium that yields the highest payoff to the sender. The sender may benefit from less communication. The reason is that more communication leads to low public spending for lower levels of demand. Finally, the receiver wants the sender to have identical preferences as himself. This is a well-known feature of all cheap-models and is sometimes referred to as the Ally Principle (Bendor et al., 2001). In our model, however, if the preferences of the sender deviate in one dimension, say the implementation decision, then the receiver also wants the preferences to deviate in the second dimension, say the spending decision.

This paper is organized as follows. The next section describes the extended cheap-talk game. Section 3.3 presents the analysis. Section 3.4 deals with the Ally Principle. In Section 3.5 we discuss how the senders's bias affects the receiver's decisions. This section applies the game to communication between bureaucrats and politicians. Finally, Section 3.6 concludes.

3.2 Model

We investigate a situation where a decision-maker (D) has to make two decisions. First, he has to decide whether to implement a project ($x = 1$) or to maintain status quo ($x = 0$). Second, in case of implementation, D has to determine how much money to spend on the project, $d \in [0, h]$.

The optimal decisions for D depend on the state of the world, t. We assume that t is uniformly distributed on the interval $[0, h]$. D does not observe t. An interested party, the sender (S), does observe t. Having observed t, S sends a message m from an infinite message set M to D. After D has received m, he chooses x and d.

Let $U_I(x, d, t)$ (with $I \in \{D, S\}$) denote player I's payoff function. Maintaining status quo (and thereby $d = 0$) yields a payoff to player I equal to,

$$U_I(0, 0, t) = a_I - (t + b_I) \tag{3.1}$$

Implementation ($x = 1$) yields a payoff to I equal to,

$$U_I(1, d, t) = t - |d - (t + b_I)| \tag{3.2}$$

Players' preferences with respect to the spending decision are captured by the term $-|d-(t+b_I)|$. If implemented, player I wants to spend $(t+b_I)$ on the project. Throughout we assume that $b_D = 0$ and $b_S > 0$. S prefers a higher amount of spending than D. We refer to b_S as S's spending bias. Note that if the project is not implemented, $-|d-(t+b_I)|$ reduces to $-(t+b_I)$. Maintaining status quo therefore leads to a distorted spending decision.

Players' preferences with respect to the implementation decision depend on this distorted spending and on their predisposition, a_I. We assume that players only want the project to be implemented if the state is sufficiently high. If $d = t + b_I$ for $x = 1$, then player I prefers implementation if $t > \frac{a_I - b_I}{2}$. We assume that,

(i) $a_I - b_I > 0$, to ensure that a range of t exists for which I prefers $x = 0$,

(ii) $a_S \leq a_D$, so that S is relatively more inclined towards $x = 1$ compared to D.

Note that if $a_S = a_D$, then S is still relatively biased towards $x = 1$ given our assumptions on b_I. With $a_S < a_D$, this conflict becomes stronger.

To illustrate what the above payoff functions try to capture, suppose that D is a local politician, and S is a librarian. The politician has to make two decisions concerning a library. First, whether it should be established, and second, about how large the collection of books should be if it is established. The state of the world represents public's demand for library services. The librarian knows this demand, but the politician does not. The assumption that $b_S > b_D$ implies that for any t, the librarian wants to have a larger collection than the politician. The inequality $a_S \leq a_D$ reflects that relative to the politician, the librarian wants the library to be established for a lower demand for library services. One possible reason for this bias is that the librarian wants to have a job in the new library. The assumption $a_S - b_S > 0$ implies that the librarian is only in favor of establishing a library if the demand for library services is sufficiently large. Equation (3.1) captures that in case D decides against establishing a library, the librarian and the politician dislike that the demand for library services is not satisfied.

The structure of the payoff functions is rather specific. We have two reasons for adopting it. First, it nicely combines existing cheap-talk models with a binary decision, and cheap-talk models with a continuous decision.[1] Second, the current linear form of the payoff function makes the model tractable. We could have made the payoff functions more general. For instance, a parameter for D and S could be added to weigh the importance of the implementation decision relative to the importance of the spending decision. We set this parameter to one to reduce notation. Adding it, however, does not lead to important new insights. We could also have assumed that players do not incur a loss of distorted spending from maintaining status quo (i.e. $U_I(0, 0, t) = a_I$). This specification would have reduced tractability, however. A monotonicity condition might fail in the sense that low and high types of S may pool together to send the same message.[2]

A Perfect Bayesian Equilibrium of our game consists of a message strategy, beliefs, an implementation strategy, and a spending strategy. Following Crawford and Sobel (1982), we identify equilibria in which the message strategy is an interval strategy. Specifically, we identify Perfect Bayesian Equilibria in which the interval $[0, h]$ is partitioned in a finite number of intervals, and S reports to which interval t belongs. We denote a partition by (r_{i-1}, r_i), and a partition strategy by $R \equiv (r_{i-1}, r_i)$, $i = \{1, \cdots, n\}$, where $n \geq 1$ denotes the number of pooling intervals. We denote D's beliefs about t by $G(t|m)$. Having received m, D's implementation strategy is $x = \xi(m)$. If $x = 0$, then $d = 0$. If $x = 1$, then D follows $d = \sigma(m)$. Our game belongs to the class of cheap-talk games. It is well-known that in this class of games a pooling equilibrium always exists. In such a pooling equilibrium, S's message does not contain information, and D ignores S's message. Throughout this paper we ignore such babbling equilibria. In fact, we focus on equilibria in which at least two pooling intervals exist, one of which leads to status quo.

[1]Our model can be related to the cheap talk models that extend Crawford and Sobel (1982) to allow players' to have an exogenous outside option. In Che et al. (2013), a project must be selected from a set of available projects (see also Rantakari (2014) for more on project selection). Preferences are biased only in terms of different outside options. More closely related is Chiba and Leong (2014), in which a spending and an implementation decision has to be made concerning a project. In their model, the decision to implement does not depend on the state of the world, but instead on the optimality of the spending decision such that players' prefer to implement the project only if the distortion in the spending decision is smaller than their outside option. In our model, players may prefer their outside option even if there is no distortion on the spending decision.

[2]For such equilibria, see for instance Chiba and Leong (2014).

3.3 Analysis

3.3.1 Decision Maker's Strategy

Suppose D has received a report $m \in (r_{i-1}, r_i)$. From this report she infers that $t \in (r_{i-1}, r_i)$. It directly follows that if D chooses to implement the project, she chooses $d = \frac{1}{2}(r_{i-1} + r_i)$. Status quo yields a payoff to D equal to,

$$a_D - \frac{1}{2}(r_{i-1} + r_i) \tag{3.3}$$

Implementation yields a payoff,[3]

$$\frac{1}{2}(r_{i-1} + r_i) - \frac{1}{4}(r_i - r_{i-1}) \tag{3.4}$$

$x = 1$ yields a higher payoff than $x = 0$ if,

$$\frac{3}{4}r_i + \frac{5}{4}r_{i-1} > a_D \tag{3.5}$$

The assumption that $a_D > 0$, implies a bias towards $x = 0$. To choose $x = 1$, D must believe that the state is sufficiently high. As a result, higher values of r_{i-1} and r_i, widen the range of a_D for which D chooses implementation. In (3.4), the term $-\frac{1}{4}(r_i - r_{i-1})$ reflects that D dislikes uncertainty about the state when the project is implemented. The wider is the interval, the more d deviates from t in expectation. The term $-\frac{1}{2}(r_{i-1} + r_i)$ in (3.3) denotes the distortion in the spending decision when the status quo is maintained. In fact, for given r_{i-1} and r_i, $x = 0$ leads to a larger distortion in the spending decision than $x = 1$. The reason is that $x = 0$ implies the extreme of zero spending $d = 0$, whereas $x = 1$ implies moderate spending, $d = \frac{1}{2}(r_{i-1} + r_i)$. Introducing risk-aversion with respect to the spending decision will strengthen this effect.

3.3.2 Sender's strategy

In this section, we assume that only in case S reports $m \in [0, r_1)$, D chooses $x = 0$. In the next section, we come back to this assumption. At $t = r_1$, S has to be indifferent between $x = 0$ on the one hand, and $x = 1$ with $d = \frac{1}{2}(r_1 + r_2)$ on the

[3] Note that $\frac{-1}{r_i - r_{i-1}} \left(\int_{r_{i-1}}^{\frac{1}{2}(r_i + r_{i-1})} (\frac{1}{2}(r_i + r_{i-1}) - t) dt + \int_{\frac{1}{2}(r_i + r_{i-1})}^{r_i} (t - \frac{1}{2}(r_i + r_{i-1})) dt \right) = -\frac{1}{4}(r_i - r_{i-1})$.

other. Two cases have to be distinguished. First, in case $\frac{1}{2}(r_1+r_2) > (r_1+b_S)$, S is indifferent between $x=0$ and $x=1$ if,

$$a_S - (r_1+b_S) = r_1 - \left[\frac{1}{2}(r_1+r_2) - (r_1+b_S)\right]$$

$$r_1 = \frac{2a_S + r_2 - 4b_S}{5} \tag{3.6}$$

Second, in case $(r_1+b_S) > \frac{1}{2}(r_1+r_2)$, R is indifferent between $x=0$ and $x=1$ if,

$$a_S - (r_1+b_S) = r_1 - \left[(r_1+b_S) - \frac{1}{2}(r_1+r_2)\right]$$

$$r_1 = \frac{2a_S - r_2}{3} \tag{3.7}$$

Generally, both $x=0$ and $x=1$ lead to a distorted spending decision. $x=0$ always means that too little is spent. If $\frac{1}{2}(r_1+r_2) > (r_1+b_S)$, then $x=1$ leads to too much spending. In this case, an increase in r_2 makes implementation less attractive. If $\frac{1}{2}(r_1+r_2) < (r_1+b_S)$, then $x=1$ leads to too little spending. Now an increase in r_2 makes $x=1$ more attractive. Given $x=1$, in the absence of a spending distortion, meaning $\frac{1}{2}(r_1+r_2) = (r_1+b_S)$, we get $r_1 = \frac{1}{2}(a_S - b_S) > 0$.[4] The effect of r_2 on r_1 in (3.6) and (3.7) describes a spillover between the spending decision and the implementation decision. In case $x=0$, the distortion in the spending decision always equals (r_1+b_S). In case of $x=1$, the distortion depends on r_1 and r_2.

At $t=r_i$ for $1<i<n$, S should be indifferent between sending $m \in (r_{i-1}, r_i)$ and sending $m \in (r_i, r_{i+1})$. Given that D chooses $d = \frac{1}{2}(r_{i-1}+r_i)$ for $i>1$, this means that,

$$r_i - \left(r_i + b_S - \frac{r_{i-1}+r_i}{2}\right) = r_i - \left(\frac{r_i+r_{i+1}}{2} - (r_i+b_S)\right)$$

which reduces to,

$$(r_{i+1}-r_i) = (r_i - r_{i-1}) + 4b_S \tag{3.8}$$

Equation (3.8) is the indifference equation that would also result from a uniform-linear version of the Crawford and Sobel cheap-talk model. It implies that partitions closer to h are larger than partitions closer to r_1. The reason why $(r_{i+1}-r_i) > (r_i - r_{i-1})$ is that at $t=r_i$, S has to be indifferent between sending $m \in (r_{i-1}, r_i)$

[4] Recall that we have assumed $a_I > b_I$ to ensure that for a range of t, player I prefers $x=0$ to $x=1$.

and sending $m \in (r_i, r_{i+1})$. If two adjacent partitions were of equal length, at $t = r_i$, S would strictly prefer sending $m \in (r_i, r_{i+1})$ to sending $m \in (r_{i-1}, r_i)$, because he wants D to overestimate t. The partition (r_i, r_{i+1}) must be wide enough that sending $m \in (r_i, r_{i+1})$ at $t = r_i$ induces D to overestimate t so much that it hurts S. This discourages S from sending $m \in (r_i, r_{i+1})$. The system of equations (3.6), (3.7) and (3.8) has multiple solutions for r_i. These are outlined in the following Lemma.

Lemma 1. *Define $\bar{n}$ as the largest integer below $\frac{1}{2}\sqrt{\frac{2(h-\frac{1}{2}a_S)}{b_S}+1}+\frac{3}{2}$. With $n \leq \bar{n}$ and $\frac{1}{2}(r_1+r_2) > r_1 + b_S$, the borders of the second interval are,*

$$r_1 = \frac{h + 2(n-1)a_S - 2n(n-1)b_S}{4n-3} \tag{3.9}$$

$$r_2 = \frac{5h + 2(n-2)a_S - 2(5n-3)(n-2)b_S}{4n-3} \tag{3.10}$$

With $n \leq \bar{n}$ and $\frac{1}{2}(r_1+r_2) < r_1 + b_S$, the borders of the second interval are,

$$r_1 = \frac{2(n-1)a_S - h + 2(n-1)(n-2)b_S}{4n-5} \tag{3.11}$$

$$r_2 = \frac{3h + 2(n-2)a_S - 6(n-1)(n-2)b_S}{4n-5} \tag{3.12}$$

The borders of the third to the $(n-1)$th intervals are,

$$r_i = (i-1)r_2 - (i-2)r_1 + 2(i-2)(i-1)b_S \tag{3.13}$$

Proof. See appendix. ∎

The border of the first interval is important as it determines the implementation decision. For $n = \bar{n}$, a value of b_S exists for which $r_1 = r_2 = \frac{1}{2}a_S$. The term $\frac{1}{2}a_S$ can be interpreted as a lower bound of r_1. A slightly higher value of b_S implies that the maximum number of intervals reduces by one. At this point, r_1 remains the same and r_2 jumps above $\frac{1}{2}a_S$ [(3.9) and (3.10) become relevant for S's strategy]. If b_S increases further, r_1 and r_2 gradually decrease, until (3.11) and (3.12) become relevant. After this point a further increase in b_S shifts r_1 upwards and r_2 downwards until they reach the lower bound at $r_1 = r_2 = \frac{1}{2}a_S$. At this point an increase in b_S implies that n again reduces by 1.[5]

[5]Specifically, for a given n, equations (3.9) and (3.10) are relevant for $b_S < \frac{2h-a_S}{4n^2-8n+3}$, while (3.11) and (3.12) are relevant for $b_S > \frac{2h-a_S}{4n^2-8n+3}$. And $r_1 = r_2 = \frac{1}{2}a_S$ for $b_S = \frac{2h-a_S}{4n^2-12n+8}$.

3.3.3 Equilibria

In deriving S's partition strategy, we have assumed that if S sends a message $m \in (r_{i-1}, r_i)$ with $i > 1$, then D prefers implementation to status quo. As relative to $x = 0$, $x = 1$ is more attractive for higher values of t, we should verify whether $x = 1$ yields a higher payoff than $x = 0$ to D when $m \in (r_1, r_2)$. Clearly, if $m \in (r_1, r_2)$ were to induce $x = 0$, then S's first two messages would be equivalent. We refer to the restriction that $m \in (r_1, r_2)$ should lead to $x = 1$ as the *implementation constraint.* We first demonstrate that given S's strategy described by Lemma 1, D possibly prefers $x = 0$ to $x = 1$ if $m \in (r_1, r_2)$. Suppose that $n = \bar{n}$ and that the second interval is infinitely small such that $r_1 = r_2 = \frac{1}{2}a_S$. In this situation, D prefers $x = 0$ to $x = 1$ after having received $m \in (r_1, r_2)$, if

$$a_S < a_D$$

as we have assumed in the model section. The intuition is clear. If $r_1 = r_2 = \frac{1}{2}a_S$, at $t = r_1$, S is indifferent between $x = 0$ and $x = 1$. As, relative to S, D is biased towards $x = 0$, D prefers $x = 0$ at $t = r_1$. For D to prefer $x = 1$, r_2 has to be sufficiently large. Given S's strategy, this means that the second interval has to be sufficiently wide.

The lengths of the intervals depend on the total number of intervals n. The implication is that if for $n = \bar{n}$ D prefers $x = 0$ to $x = 1$ after $m \in (r_1, r_2)$, then for $n < \bar{n}$ she possibly prefers $x = 1$ to $x = 0$ after $m \in (r_1, r_2)$. More generally, we can show that the implementation constraint requires that n is sufficiently small.[6]

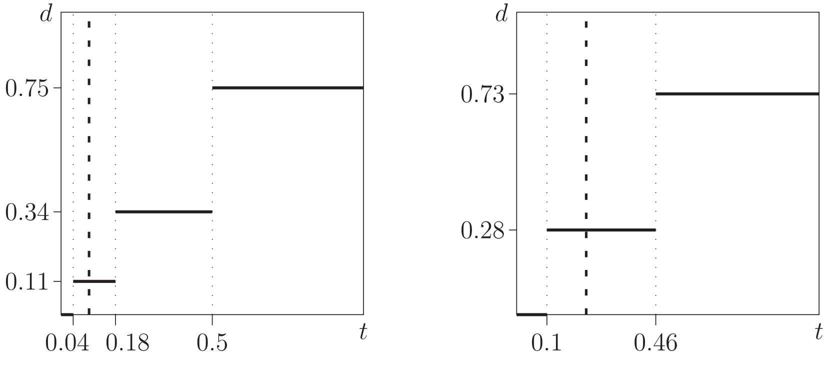
Let $\hat{n}$ denote the maximum value of n for which (3.5) with $i = 2$ holds. Proposition 5 describes equilibrium behavior.

Proposition 5. *In any PBE equilibrium with $n > 1$ and $n \leq n^* = \min\{\hat{n}, \bar{n}\}$, the strategy of S is given by (3.9 − 3.13), and D chooses $x = 0$ if $m \in (0, r_1)$ and chooses $x = 1$ with $d = \frac{1}{2}(r_i + r_{i+1})$ if $m \in (r_i, r_{i+1})$ for $i > 0$.*

To better understand how a smaller value of n can induce D to choose $x = 1$ when $m \in (r_1, r_2)$, consider the following example. Suppose $h = 1$, $a_S = 0.1$ and $b_S = 0.045$. For these values $\bar{n} = 4$, and $r_1 = 0.04$, $r_2 = 0.18$ and $r_3 = 0.5$ (see Figure 3.1a). This strategy of S can be part of an equilibrium, if D prefers $x = 1$ to $x = 0$ after $m \in (r_1, r_2)$. This requires that $a_D < 0.185$. D should not be too biased

[6] To this end, substitute (3.9) and (3.10) into (3.5). Next, define the resulting expression in terms of n and $n - 1$, and substract. It directly follows that the requirement (3.5) is satisfied for a wider range of parameters for smaller values of n.

towards maintaining status quo This is depicted by the dashed line at $\frac{0.185}{2}$. Suppose that $a_D > 0.185$, implying that no equilibrium exists with $n = 4$. With $n = 3$, S's message strategy leads to $r_1 = 0.10$ and $r_2 = 0.46$. In this case, D prefers $x = 1$ to $x = 0$ after $m \in (r_1, r_2)$ if $a_D < 0.46$, a much weaker condition than with $n = 4$ (see figure 3.1b). Finally, one can verify that for $n = 2$, D prefers $x = 1$ to $x = 0$ when $m \in (r_1, r_2)$ if $a_D < 1.0$.

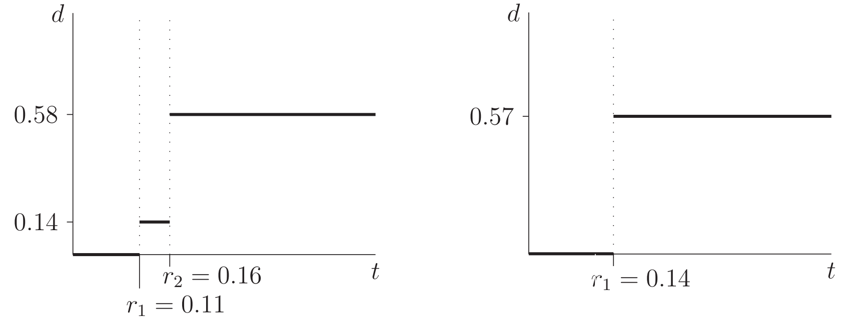


(a) $n = 4$ requires $a_D < 0.185$. (b) $n = 3$ requires $a_D < 0.46$.

Figure 3.1: Implementation constraint (dashed line) relaxes with smaller number of intervals (n): parameter values $a_S = 0.1$ and $b_S = 0.045$.

How do the equilibria described by Proposition 5 compare with the equilibria of a standard linear-uniform cheap-talk model? There are three main differences. The first difference is the nature of the first interval. In the extended model, $m \in (0, r_1)$ induces D to choose $x = 0$ with $d = 0$. At $t = r_1$, S is indifferent between status quo and implementation. In a standard linear-uniform cheap-talk model, in any equilibrium with $n > 1$ the second interval is always wider than the first one. If the second interval were wider, S would prefer $m \in (r_1, r_2)$ to $m \in (0, r_1)$. In the extended cheap-talk model, the second interval can be narrower than the first one. The range of t for which S prefers status quo to implementation can be wide.

Second, introducing the implementation decision into a cheap-talk model adds a new restriction: from the second to the nth interval D has to prefer $x = 1$ to $x = 0$. As a higher value of t makes $x = 1$ more attractive relative to $x = 0$, this restriction is most binding for the second interval. We have shown that the restriction becomes weaker if n decreases. As a result, adding an implementation decision to a standard cheap-talk model may make communication less precise in the sense that it may



(a) Equilibrium with $n = 3$. (b) Equilibrium with $n = 2$.

Figure 3.2: Sender prefers an equilibrium with $n = 2$ while an equilibrium with $n = 3$ is possible: parameter values $b_S = 0.2$, $a_S = 0.25$, $a_D = 0.26$.

reduce the number of messages that can be used in equilibrium.

Third, generally, cheap-talk models suffer from a multiple-equilibrium problem. Our cheap-talk model is not an exception to this. If an equilibrium exists with $n > 1$ intervals, equilibria also exist with fewer intervals. In the special "uniform-linear" cheap-talk model without an implementation decision, both D and S are better-off in equilibria with the highest number of intervals. The introduction of an implementation decision alters this feature.

As an illustration, consider the following example (see figure 3.2). Let $h = 1$, $a_S = 0.25$, $b_S = 0.2$, and $a_D = 0.26$. For these parameter values, the maximum number of messages in equilibrium equals $n = 3$. With three intervals, $r_1 = 0.11$ and $r_2 = 0.16$. Note that in this equilibrium, if $t \in (r_1, r_2)$ then spending on the project is much too low from S's perspective. For the same parameter values an equilibrium exists with $n = 2$, where $r_1 = 0.14$. In comparison to the equilibrium with $n = 3$, the probability of implementation slightly decreases. However, spending on the project is more in line with S's preferences. As a result, the expected payoff to S is higher for $n = 2$ than for $n = 3$.

3.4 The Ally Principle

In standard cheap-talk games, be it binary or continuous, D is potentially best-off when S's preferences coincide with his own preferences. The idea that D should listen to an informed person who shares his own preferences is called the Ally Principle (Bendor et al., 2001).

To determine the optimal preferences of S from D's perspective in our model, we write D's expected payoff as a function of a_S and b_S. Maximizing this expected payoff with respect to a_S and b_S yields the following two first-order conditions,[7]

$$b_S = \frac{3(a_S - a_D)}{4n^2 - 8n + 6} \tag{3.14}$$

$$a_S = a_D + nb_S \tag{3.15}$$

These conditions show that the Ally Principle also holds in the extended cheap-talk model: D's expected payoff is maximized if $a_S = a_D$ and $b_S = 0$. The first-order conditions also demonstrate the spill-over between the spending decision and the implementation decision. If $b_S > 0$, then D wants a_S to deviate from a_D. In fact, D wants S to be biased towards $x = 0$. Unfortunately, as argued earlier, in most real-world situations senders who want to spend more are also likely to be biased towards implementation. As a result, the distortion in the implementation decision and the distortion in the spending decision generally tend to reinforce each other.

3.5 Do Biased Senders Lead to too High Expenditures?

In Niskanen (1971, 1975), agenda control and an information advantage enable bureaucrats to induce politicians to spend too much from a social perspective. In a standard linear-uniform cheap-talk model, S does not have agenda-setting power, and the ultimate spending decision does not involve too much spending. Biased senders lead to less communication, and in turn to less precise spending decisions. However, in expected terms, the spending decision accords with D's preferences. A well-known implication is that both D and S suffer from S's incentive to exaggerate the state.

With regard to the spending decision, our results are similar to the standard cheap-talk models. In expected terms the spending decision is in line with D's preferences.[8] This means that our model predicts no bias concerning the size of a public project. As to the implementation decision, however, a bias does exist. The implementation constraint implies that in expected terms D must prefer implementation to status quo. We have argued that this requires the second interval to be sufficiently

[7]These first-order conditions are for the case that in equilibrium $\frac{1}{2}(r_1 + r_2) > r_1 + b_S$.
[8]This follows directly from D's strategy to choose $d = \frac{1}{2}(r_{i-1} + r_i)$.

wide. For low values of the state in the second interval, choosing to implement is generally not in D's interest. To see this consider again the example below Proposition 5. Suppose that $a_D = 0.4$. In the example, this means that the maximum value of n equals 3. Moreover, D chooses $x = 1$ if $t > 0.10$. If D were to observe t, she would choose $x = 1$ if $t > 0.2$. Hence, S can induce $x = 1$ even though it is not in D's interest.

The implication is that the extended cheap-talk model predicts overproduction of public goods. It is not that there is too much spending on the public goods that should be provided. Rather sometimes public goods should not be provided at all. To put it differently, on average the collections of books in public libraries are not too large, and public swimming pools are on average not too big. The problem is that from D's perspective there are too many small libraries and too many small swimming pools.

3.6 Conclusion

The contribution of this paper is both theoretical and applied. Theoretically, we have shown that introducing an implementation decision into a standard cheap-talk model imposes an additional constraint on the sender's strategy. A sender's desire to induce implementation deteriorates communication about the decision on how much to spend. In the standard cheap-talk model, the sender always prefers equilibria that allow for more communication. In our extended model, the sender may benefit from less communication. Our final theoretical result is that in the extended model more aligned preferences do not always improve communication. Once preferences of the sender and receiver differ in one dimension, say, the implementation decision, the decision maker benefits if the preferences also differ in the other dimension. Our main more applied result is that decision making under an open rule leads to higher public spending through an excess provision of public goods, but does not lead to excessive spending on specific projects in expected terms.

Throughout this paper, we have phrased our model as an extension of a standard cheap-talk model with an implementation decision. We could have phrased our model as an extension of a binary cheap-talk model with a continuous decision. Provided that the preferences of the receiver and the sender are not too much misaligned, in a binary version of a cheap-talk model the sender has real authority and the receiver has formal authority Aghion and Tirole (1997). The receiver "rubber-stamps" the sender's recommendation. In the extended cheap-talk model, there exists a spill-over between the spending decision and the implementation decision. As a result of this spill-over, the implementation decision becomes more in line with the receiver's preferences. In this sense, from the receiver's point of view, the introduction of a continuous decision into a cheap-talk model of a binary decision improves communication.

Chapter 4

Shared Values and Communication

4.1 Introduction

Shared beliefs and values are often considered an important aspect of organizations. One benefit is that they lead to more communication, and thus to less influence activities (Van den Steen, 2010a). This is in line with Crawford and Sobel (1982) who show that communication from an agent to a decision maker is more informative if players' preferences are similar. Relatedly, a few studies on firm boundaries argue that integration, as opposed to market transactions, can facilitate stronger information flows and knowledge transfers (Malmgren, 1961; Arrow, 1975). It is not clear in this literature why information flows are stronger within firms, as also pointed out by Bresnahan and Levin (2012). One potential rationale relates to shared organizational values, or corporate culture. If members of an organization share similar beliefs and values, then integration can facilitate communication. Some practitioners, management consultants in particular, disagree. According to them a primary benefit of an external consultant is detachment from the organization and its culture.[1] This paper rationalizes these opposing views, and shows that an agent who shares the values of the decision maker can sometimes reveal less information compared to an agent who does not share these values.

[1]For example, Peter Drucker who is often considered to be the father of modern day consulting industry writes in an essay that a management consultant"... brings to the practice of management what being professional requires: detachment." Drucker (1981)

The key feature of this paper is that the decision-maker has a personal view about the right course of action. This is in line with the literature which argues that organizational leaders differ in their beliefs and values. See for instance, Van den Steen (2005) and more generally the management literature on corporate culture and managerial vision. Empirical studies also confirm this. Bertrand and Schoar (2003), for instance, show that managers may differ, all else equal, in the benchmark they use in investment decisions, and in their 'style' such as taste for aggressive strategies. Similarly, Malmendier and Tate (2005, 2009) find that overconfident CEOs are more likely to engage in value-destroying mergers.

Given that the decision-maker has a personal view about the right course of action for the firm, I address two main questions in this paper. First, how does communication from an agent differ if he shares the decision-maker's view? Second, does an agent who shares the decision-maker's view reveal more information?

To address these questions, I model a cheap-talk game between an agent and a firm manager. The manager has to choose whether or not to implement a project, where project quality is observed by the agent. The optimal decision for the manager depends on the sum of both players' private, independently distributed information. The manager's private information (type) is interpreted as his vision concerning the best course of action for the firm.[2] The agent may share the manager's vision, in which case the agent internalizes the manager's information. In addition, the agent may derive exogenously determined rents from project implementation, such as intrinsic rewards. I analyze how the quality of communication varies with these rents given that the agent either shares or does not share the manager's vision.[3]

The first result concerns the nature of communication. In terms of cheap talk equilibria à la Crawford and Sobel (1982), an agent who values the manager's type is able to partition his information into relatively fine intervals, while an agent who does not value it can use a maximum of two intervals. The former reveals, for example, that market demand is low, medium, or high, or he may reveal that project quality is unacceptable, below average, average, above average, or excellent. The latter agent, on the other hand, makes a recommendation for or against the project. Communication is thus (potentially) richer under shared values. The reason is uncertainty and payoff relevance of the manager's type. Due to private rents, both

[2]The main results are robust to common knowledge of the manager's information. The manager's information can also be interpreted as a project dimension, such as costs.

[3]This distinction between shared organizational values and exogenous rents is crucial to the analysis in this paper. For simplicity, I consider the extreme case. An agent either fully internalizes the manager's information, or he does not internalize it at all.

types of agents have an incentive to inflate project quality to increase the likelihood of implementation. This can lead to implementation of projects that are not in line with the manager's vision. Cost associated with implementation of bad projects is payoff relevant for an agent who shares the manager's vision. It gives him the ability to fine-tune his information as different messages generate different costs. An agent who does not value the manager's type does not internalize the cost. He prefers implementation as long as project quality is sufficiently high.

The second result concerns the quality of communication. We show that if the agent shares the manager's vision, then communication incentives are more sensitive to changes in exogenous rents. Specifically, incentive to reveal information deteriorates relatively rapidly as private rent increases. As a result an informative equilibrium breaks down sooner under shared values. The reason is that noisy information about project quality makes it less likely for the manager to implement the project. Conditional on implementation, the agent infers that the manager's type is high. (For instance, he infers that the manager has a strong taste for aggressive strategies). This boosts his incentive to inflate project quality even more, and undermines the benefit of a finer partition.

Section 4.6 shows that the ability of an agent with shared values to use a fine partition depends on the common knowledge of manager's type. Similar to the agent without shared values, he now resorts to making a recommendation for or against the project instead of using a fine partition. However, he fully utilizes the manager's information in forming his recommendation. This strictly improves communication. Moreover, the manager is willing to follow the recommendation, conditional on sufficiently low rents of the agent. In case the project is implemented, the outcome is biased towards the interest of the agent. Again, if rents are substantial, more information is revealed from an agent who does not share the manager's vision.

In section 4.7, we show that delegation of decision rights to the agent performs at most as well as communication. From the viewpoint of the manager, communication sometimes outperforms delegation and at other times communication is outcome equivalent to conditional delegation. The reason is that the manager has private information. He cannot circumvent communication altogether by means of delegation to an agent with shared values. While an agent without shared values disregards the manager's information altogether.

Finally, in section 4.8, we analyze the agent's incentives to collect information. Here we assume that the manager is ex-ante informed. We show that an agent with (without) shared values exerts higher effort if his private rents are sufficiently small (large). This is of course due to agent's communication incentives.

This paper contributes to the literature on corporate culture and homogeneity of preferences. Management literature, and a few studies in economics, show that managerial vision is important for the development of an organization's culture (Crémer, 1993; Lazear, 1995; Van den Steen, 2005, 2010a,b).[4] It is well understood that homogeneity or strong culture has both costs and benefits. Van den Steen (2010a) shows that shared beliefs and values leads to more delegation, less monitoring, higher execution effort, more communication, but also to less experimentation and information collection. In this paper, we show that shared values do not necessarily lead to more communication and information collection. If private rents from project implementation are substantial, then influence activities via manipulation of information are likely to be high.

This paper also contributes to the literature on the theory of the firm. It highlights that communication costs are relevant for a firm's make-or-buy decision. These costs take the form of a loss of information due to noisy communication. The role of information flows or knowledge transfers has received little attention in the economic literature on firm boundaries. Holmström and Roberts (1998) for instance point out that '...leading economic theories of firm boundaries have paid almost no attention to the role of organizational knowledge.' The focus has largely been on tangible goods, and hence on the hold-up problem and asset specificity. A few papers have assumed that information transmission can be facilitated by vertical integration, such as Malmgren (1961), Alchian and Demsetz (1972), and Arrow (1975). However, the question of *why* information flows are stronger within firms (or difficult across firms) has been sidestepped in the literature. We show that it is not trivial to assume that integration can facilitate stronger information flows. The justification we offer relates closely to transaction cost theory (Coase, 1937, and Williamson, 1975, 1985), and adds to it by highlighting the nature of costs that effect a firm's make-or-buy decision in relation to information flows. The intuition is most clearly applied to the consulting industry, where a primary benefit of external consultants is their detachment from the organization.[5]

[4]It should be noted that shared values differs from shared beliefs, where the latter allows for differing priors along the lines of Aumann (1976). This paper only analyzes shared values. Moreover, this paper also differs from a related literature that defines culture as equilibrium selection in the presence of multiple equilibria.

[5]In the context of this paper, the use of a management consultant is purely informational. Consultants are of course hired for other reasons as well, for example to find problems in organizations. Moreover, external consultants have exposure to numerous firms and industries which gives them an informational advantage over internal employees of an organization. We do not take such information asymmetries into account.

Finally, the model in this paper is closely related to studies on cheap-talk with a privately informed decision-maker (DM), and in particular to studies where the information sets of the DM and the agent are non-overlapping. These studies show mixed results of the effect of the DM's private information on communication. Some show that it improves while others show that it has no effect on communication.[6] Results are mixed because communication from the agent depends on how information translates into actions and payoffs. For instance, in Watson (1996) the agent receives a perfect signal of the state but is confused about the 'meaning' of the signal. The DM is privately informed about how to read the agent's signal, but does not observe the signal itself. He shows that full revelation of information from the agent may be viable. Theoretically, the reason for this is that the agent in Watson (1996) only cares about the decision that is taken while the DM cares about both the information and the decision. My paper shows that the private information of a DM can improve communication if, 1) the DM's information has payoff relevance to the agent, and 2) different messages of the agent affect differently how the DM translates his own information into actions. That is, it requires that the agent is uncertain about his payoff conditional on his messages, and that different messages induce different levels of signalling costs. Harris and Raviv (2008) extend the Crawford and Sobel (1982) model to one where the DM also has a private type. They show that communication is unaffected. The reason is that the agent's messages have no effect on how the DM utilizes his own information in the decision.[7]

The rest of the paper is organized as follows. The model is described in section 4.2. Players' equilibrium strategies are derived in section 4.3. Equilibrium communication is characterized and analyzed in section 4.4, followed by the firm's make-or-buy decision in section 4.5. The assumption that the manager's information is private knowledge is relaxed in 4.6. Delegation and incentives to collect information are analyzed in sections 4.8 and 4.7, respectively. A brief discussion on factors influencing a firm's make-or-buy decision with respect to knowledge transfers is provided in section 4.9. Finally, section 4.10 concludes the paper.

[6] In settings where information sets of the two players is over-lapping, the DM is typically assumed to have a weak signal of the agent's information. This typically deteriorates communication. See for instance, Olszewski (2004), Lai (2014), Ishida and Shimizu (2009), De Barreda (2010).

[7] In their model, if the agent were to care slightly less about the DM's type in comparison to his own type, then communication will improve.

4.2 Model

There are two players, a firm manager (M) and an agent (A). The manager (M) must decide whether to implement a project ($d = 1$) or to maintain status quo ($d = 0$). One can view this as an acquisition decision, or a decision to enter a new market, or launch a new product.

The optimal decision for the manager depends on the quality of the project and on the type (vision) of the manager. Denote by $q \in Q$ the quality of the project, and denote by $t \in T$ the type of the manager, where Q and T are convex subsets of $\mathbb{R}$. Assume that q and t are independent random variables with cumulative distribution functions F_q and F_t supported on Q and T, respectively.

The status quo ($d = 0$) yields a normalized payoff to each player, $u^M(t, q, 0) = u^A(t, q, 0) = 0$. If the project is implemented ($d = 1$), then M's payoff is given by,

$$u^M(t, q, 1) = t + q \tag{4.1}$$

This payoff captures that managers may differ in their vision about the right course of action. M of high (low) type prefers implementation for a larger (smaller) range of project quality. Of course, for any given M type, the better the project quality, the higher are the returns from the project, or the more likely it is that M chooses project implementation. As an example, a manager who is overconfident or has a preference for growth may choose to acquire another firm if the returns are not large or are more uncertain, whereas a manager who is conservative may prefer to acquire a firm only if the returns are high and less uncertain. Malmendier and Tate (2005, 2008), for instance, provide evidence that over-confident CEOs are significantly more likely to conduct value-destroying mergers.

I assume that the manager privately observes his type t, but is uninformed about project quality, q. To learn the quality, M consults A who privately observes q. The payoff to A if the project is implemented ($d = 1$) is given by,

$$u^A(t, q, 1) = b + vt + q \tag{4.2}$$

Conflict in players' preferences is captured by two parameters, v and b. Throughout I assume that both parameters are common knowledge. The term v captures the agent's valuation of the manager's vision. If A shares M's vision, then $v = 1$, and if A does not share M's vision, then $v = 0$. I restrict attention to $v \in \{0, 1\}$ for simplicity.

The term $b > 0$ captures a private benefit that A derives from project implementation.[8] A benefit may exist for various reasons, such as intrinsic rewards or a bonus. I compare the effect of b on the quality of communication from an agent who values M's type ($v = 1$) with the effect of b quality of communication from an agent who does not value M's type ($v = 0$).

The timing is as follows. Players first learn their private information: M learns t and A learns q. Then A sends a report to M containing information about q, denoted by $r \in R$ where R is a large space. Communication from A is cheap talk, that is, the report is non-verifiable and costless to produce. After hearing report r, M chooses $d \in \{0, 1\}$. Payoffs are then realized. Apart from the realizations of t and q all aspects of the game are common knowledge.

I study Perfect Bayesian Nash Equilibria (PBE). A pure PBE consists of a triple, a reporting strategy for the agent denoted by $r = \rho(q) \in R$, a decision strategy for the manager denoted by $\delta(t, r) \in \{0, 1\}$, and beliefs denoted by $G(q|r)$, such that:

(i) $\rho(q)$ maximizes $\mathrm{E}(u^A|\delta(t, r))$,

(ii) $\delta(t, r)$ maximizes $\mathrm{E}(u^M|G(q|r))$,

(iii) $G(q|r)$ follows Bayes' Rule on equilibrium path.

As is well known, a babbling equilibrium always exists in a game of cheap talk, i.e. an equilibrium where all sender types pool together and use the same reporting strategy. In this case, the receiver ignores any information contained in the message and takes an action based on his prior belief about the sender's information (q). The analysis will focus on equilibria where cheap talk is influential, i.e. where some information can be credibly transmitted by the sender.

4.3 Preliminaries

It is straightforward that the manager prefers $d = 1$ if the expected payoff from implementation, $u^M(t, q, 1) = \mathrm{E}(t + q|r)$, is larger than the outside option, $u^M(t, q, 0) = 0$. Thus M chooses $d = \delta(t, r) = 1$ if $t > -\mathrm{E}(q|r)$.[9] The Lemma below follows.

Lemma 2. *After a report r, the manager follows a threshold strategy such that he chooses $d = 1$ if $t > t^*(r)$ and chooses $d = 0$ otherwise, where $t^*(r) = -\mathrm{E}[q|r]$.*

[8] $b > 0$ is without loss of generality. $b < 0$ is symmetric for all results.

[9] Without loss of generality attention is restricted to pure strategy equilibria.

That is, M chooses to implement the project if his type is sufficiently high given his belief about project quality. The higher is his belief, the lower is the threshold $t^*(r)$, and the more likely it is that he chooses $d = 1$.

As is common in cheap talk models the exact reporting strategy of the sender is not relevant. Rather it is the action induced in equilibrium that is relevant. The action taken by the manager depends on his belief about q conditional on the report of the agent. It is embodied in the threshold, $t^*(r)$. The equilibrium report $r = \rho(q)$ sent by A induces $t^*(\rho(q))$ such that it maximizes $\mathrm{E}(u^A|t^*(\rho(q)))$ for any q. The following lemma shows that similar to Crawford and Sobel (1982), all equilibria of the game are of the interval form.

Lemma 3. *In any equilibrium the agent follows an interval strategy such that* $\exists$ *a finite set* $\{q_i\}$ *of marginal types, where* $q_{i-1} < q_i$*, and all types* $q \in (q_{i-1}, q_i)$ *pool by sending a report* r_i*.*

Proof. See appendix. ■

In an interval equilibrium of size N, the agent partitions his information into N intervals and only reveals which interval his information lies in.[10] Denote the boundaries of the intervals along an N-step partition of the support of q by q_i for all $i \in \{0, \cdots, N\}$ such that $q_0 < q_1 < \cdots < q_N$. Under this reporting strategy, for each q in the interval (q_{i-1}, q_i) the agent reveals his information to belong to the ith interval of the partition by sending a report r_i. Attention can be restricted to N distinct reports in an equilibrium of size N, where each report induces a distinct action from M. Report r_i induces action plan $\delta(t, r_i)$ for all $q \in (q_{i-1}, q_i)$. Denote the equilibrium thresholds along the support of t by t_i for all $i \in \{1, \cdots, N\}$ such that $t_1 > \cdots > t_N$. In equilibrium, higher reports are associated with lower thresholds.

4.4 Equilibrium Communication

To characterize equilibria, I assume from hereon that both t and q are independently uniformly distributed over $[-1, 1]$.[11] For all $i \in \{1, \cdots, N-1\}$, the indifference

[10] This reporting strategy is equivalent to another strategy where for each q in an interval, C randomizes his report over that interval.

[11] The assumption that t and q have the same support $[-1, 1]$ restricts attention to interior solutions, i.e. $t_i \in (-1, 1)$. If, for instance, the support of q is larger than the support of t, then it is possible that $t_1 > 1$ (or $t_N < -1$). In this case, the lowest report induces $d = 0\,\forall t$ and the remaining reports induce interior solutions as in proposition 6. Such corner solutions increase the set of equilibria but add little insight to the discussion at hand.

equation of A at boundary q_i is given by $\mathrm{E}[u^A(t_i, q_i, 1)] = \mathrm{E}[u^A(t_{i+1}, q_i, 1)]$,

$$\frac{1-t_i}{2}\left(b + v\frac{1+t_i}{2} + q_i\right) = \frac{1-t_{i+1}}{2}\left(b + v\frac{1+t_{i+1}}{2} + q_i\right)$$

which reduces to,

$$q_i = -b - v\left(\frac{t_i + t_{i+1}}{2}\right) \tag{4.3}$$

This indifference equation holds for both types of agents, $v = 0$ and $v = 1$. To understand it better, I analyze them separately. I begin with an agent who shares M's values ($v = 1$). The following proposition characterizes all equilibria with $v = 1$.

Proposition 6. *Suppose $b > 0$ and $v = 1$. Then all equilibria are outcome equivalent to one in which the maximum number of intervals $N(b)$ used by the agent in equilibrium is the maximum integer below $\left(\frac{1}{2} + \frac{1}{2}\sqrt{1 + \frac{4}{b}}\right)$.*
For any $N \in \{1, \cdots, N(b)\}$, A sends a report $r = r_i$ if $q \in (q_{i-1}, q_i)$, where $q_0 = -1$ and $q_N = 1$, and $\forall\, i \in \{1, \cdots, N-1\}$ the boundaries q_i are determined by,

$$(q_{i+1} - q_i) = (q_i - q_{i-1}) + 4b \tag{4.4}$$

The manager implements the project ($d = 1$) after r_i if $t > t_i$ and maintains status quo otherwise, where $\forall i \in \{1, \cdots, N\}$ the threshold $t_i \in (-1, 1)$ is given by,

$$t_i = -\frac{q_{i-1} + q_i}{2} \tag{4.5}$$

Proof. See appendix. ■

The proposition implies that A truthfully reports the interval (q_{i-1}, q_i) in which his information lies. The manager believes $q = \frac{1}{2}(q_{i-1} + q_i)$, and chooses to implement the project if and only if his own type is sufficiently high. The intuition behind this proposition entails two aspects. First, for any given q the agent with shared values prefers $d = 1$ if $t > -(b + q) \equiv t^C$, while the manager prefers $d = 1$ if $t > -q \equiv t^M$. For all q, $t^C < t^M$ due to A's private benefit $b > 0$. The implication is that for any given q, A prefers implementation ($d = 1$) if $t \in \left(t^C, t^M\right)$, while M prefers the status quo ($d = 0$). Due to this conflict, A has an incentive to inflate his information and induce M to choose $d = 1$ for $t \in \left(t^C, t^M\right)$.

A, however, is uncertain about the manager's type. This leads to the second aspect. Inflating project quality comes at a cost to the agent. It induces some unfavorable M types to choose $d = 1$, that is some $t < t^C$. The implication is that A is not only uncertain whether his report will induce $d = 0$ or $d = 1$, but he is also uncertain whether, in case of $d = 1$, the outcome will be favorable for him or not.

Together, these two aspects imply that the incentive compatibility constraint of A at a boundary $q = q_i$ is given by equation (4.4).[12] It shows that for any two adjacent intervals, the higher interval is longer than the lower interval. At $q = q_i$, A incurs a cost from both reports, low or high. Reporting low quality induces some favorable M types to choose $d = 0$ (type II error). Reporting high quality induces some unfavorable M types to choose $d = 1$ (type I error). If two adjacent intervals are of equal length, then both reports are equally costly. In this case, A strictly prefers to send the high report at boundary $q = q_i$. Since a high report results in a type I error, part of the cost is compensated by a positive benefit b. The high report, therefore, must entail a relatively higher cost. A wider interval is precisely what creates such a cost. Figure 4.1 provides this intuition in an equilibrium with three reports. The implementation region is shaded. A is indifferent at q_2 because the expected cost is the same from either message. The two equilibrium thresholds, t_2 and t_3, are equally far from his first-best, $t^C_{q_2}$.

This outcome bears similarity to the standard Crawford and Sobel (1982) model (CS from hereon). In both models, the incentive to inflate information arises due to an upward bias of the sender, and the resulting costs restrict this incentive. The difference is that in the current model the costs are associated with the sender's uncertainty, where as in CS the sender is fully informed.[13] Similar to CS, the equilibrium with the highest number of words is preferred by both players' as I show later. The reason is that costs from noisy signalling are decreasing in N.

An interesting point to take from this equilibrium with an agent who values M's private information is that A can partition his information into relatively fine intervals. This is unlike the typical model of cheap talk with a binary decision where the payoff relevant information is one-dimensional (the receiver does not have a private type). The sender in those model can use a maximum of two intervals in equilibrium. The following proposition shows that communication with agent who does not value M's private information ($v = 0$) bears similarity to the typical model. The indifference equation (4.3) with $v = 0$ reduces to $q_i = -b$.

[12] Follows from substituting out t_i and t_{i+1} from equation (4.3) with $v = 1$ using equation (4.5).

[13] The similarity of the incentive constraint (4.4) is coincidental. However, as in most cheap talk games, the point to take from it is that higher messages are noisier than lower messages. Another distinction is that in CS, actions are unbounded. In the current model, the thresholds (that define the receiver's action) are bounded (implementation probability lies in $[0, 1]$). This can result in corner solutions (although I exclude these from my analysis).

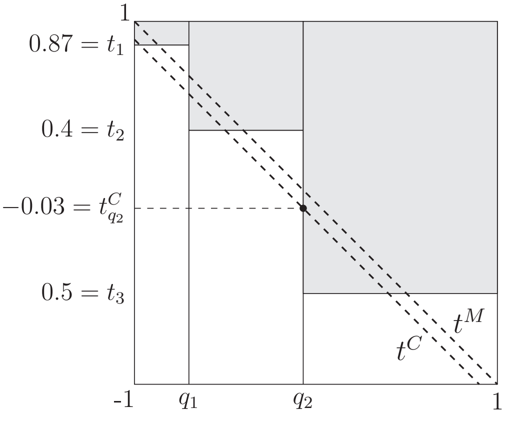


Figure 4.1: An equilibrium with an agent with shared values ($v = 1$): $b = 0.1$

Proposition 7. *Suppose $b > 0$ and $v = 0$. Then, all equilibria are outcome equivalent to one in which the agent uses a maximum of $N = 2$ reports in equilibrium, $r \in \{r_1, r_2\}$.*
A reports $r = r_1$ if $q \in [-\bar{q}, -b)$, and reports $r = r_2$ if $q \in (-b, \bar{q}]$.
For $i \in \{1, 2\}$, the manager implements the project ($d = 1$) after r_i if $t > t_i$ and maintains status quo otherwise, where the threshold $t_i \in (-1, 1)$ is given by,

$$t_1 = \frac{1+b}{2} \quad \textit{and} \quad t_2 = -\frac{1-b}{2} \tag{4.6}$$

The proposition implies that A makes a recommendation for or against project implementation. The manager chooses to implement the project after a recommendation if and only if his own information is sufficiently high. The intuition for this proposition is straightforward. The payoff from $d = 1$ to an agent who does not internalize M's information is given by, $u^A(t, q, 1) = b + q$. For all $q > -b$, A prefers $d = 1$ irrespective of t, and makes a recommendation to implement the project. For all $q < -b$, he recommends against project implementation. In other words, he has no incentive to use a finer partition. Unlike an agent with $v = 1$, uncertainty about t does not restrict his incentive to inflate q. As before, M chooses $d = 1$ if t is sufficiently large. A is uncertain whether reporting high quality will lead to $d = 1$ or $d = 0$, but he is not uncertain about his payoff conditional on implementation. An equilibrium is depicted in figure 4.2.

Note the difference from the typical cheap talk game with a binary decision where

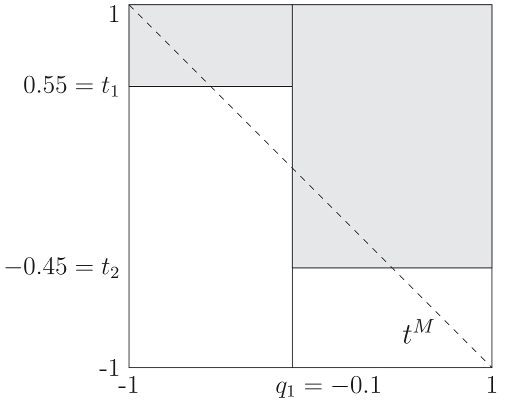


Figure 4.2: An equilibrium with an agent who does not share values ($v = 0$): $b = 0.1$

only the sender has payoff relevant information. In the standard setting, the sender is able to persuade the decision maker to rubber-stamp his recommendation. He achieves his first-best outcome. As a result, the receiver has no real authority over the decision. In the current model, M does not rubber-stamp the agent's recommendation. As a result, A does not achieve his first-best outcome. M maintains real authority over the decision (for both $v = 0$ and $v = 1$). The reason of course is that M has a private type.

4.4.1 Quality of Communication

Propositions 6 and 7 show that there is a difference in the nature of communication from an agent who values M's type. Such an agent has the ability to partition his information into relatively fine intervals, while an agent who does not value M's type uses at most two intervals. As is well-known in cheap talk games, the finer is a partition (higher is N) the smaller is the loss of information due to noisy communication. In this section, I show that an agent's ability to use a relatively finer partition under shared values does not necessarily translate into better quality of communication. In comparison, an agent without shared values may reveal more precise information.[14]

[14] A note on equilibrium selection: with $v = 1$, multiple economically different equilibria exist. That is, an equilibrium exists for all $N \in \{1, \cdots, N(b)\}$. In the appendix, I show that the expected payoff to both players, M and A, is increasing in N (and decreasing in b). Thus, I assume in this section, where ever necessary, that players coordinate on the equilibrium with the maximum intervals, i.e. on the partition of size $N(b)$.

Proposition 8. *If b is sufficiently small (large), then communication with $v = 1$ ($v = 0$) is more informative than communication with $v = 0$ ($v = 1$).*
An $N(b) > 1$ equilibrium exists for $v = 1$ if $b < \frac{1}{2}$, and for $v = 0$ if $b < 1$.

Proof. See appendix. ■

Generally speaking, and consistent with the literature, the quality of communication deteriorates as b increases whether $v = 0$ or $v = 1$. However, the rate at which it deteriorates from an agent with shared values ($v = 1$) is relatively higher. To see this note that the incentive compatibility constraint in proposition 6 is a stronger restriction than the incentive compatibility constraint in proposition 7. The indifference equation of an agent with $v = 1$ requires that for any two adjoining intervals, the high interval is sufficiently wider than the low interval. In comparison, the incentive constraint of an agent with $v = 0$ requires that there exist a second interval. Due to this, an informative equilibrium under $v = 1$ breaks down quicker as b increases than it does under $v = 0$. The former requires $b < \frac{1}{2}$, while the latter requires $b < 1$. To put it another way, the private benefit has a stronger influence on the incentive of the agent with shared values to add noise in his messages. The boundaries along a partition shift (towards left) at a greater rate with $v = 1$.[15]

The reason that communication with $v = 1$ deteriorates faster is as follows. As b increases, A's incentive to inflate project quality becomes stronger (the same as for $v = 0$). The manager accordingly, becomes less inclined to implement the project. M chooses $d = 1$ for a smaller range of t, or in other words, fewer types of M choose $d = 1$. The implication is that conditional on implementation, the expected type of the manager increases if the report is noisier. In other words, conditional on implementation, A expects that M has a strong type (or vision). This further adds to A's incentive to inflate his information if he values M's type. The incentive of the agent who does not value M's type remains unaffected by any change in the expected type of M.

An agent with shared values can thus have stronger incentive to add noise in his communication. In fact, the quality of communication with shared values can be worse even if a relatively finer partition is used, i.e. $N(b) > 2$. This is because the highest message can be much noisier. In particular, if $b \in (0.08, 0.17)$, the maximum intervals with $v = 1$ is given by $N(b) = 3$. As b increases from $b = 0.08$, the width the third interval increases and eventually becomes wider than the width of the high

[15] Specifically, with $v = 0$ the incentive is one-to-one, $\frac{\partial}{\partial b}(q_1) = -1$. With $v = 1$, the incentive is larger than one, $\frac{\partial}{\partial b}(q_k) = -2(N - 2k + 1)$.

interval under $v = 0$. This happens if $b > 0.11$. The finer partition however is still more beneficial. It becomes less efficient if $b > 0.14$. An example is depicted in figure 4.3, where $b = 0.15$. With $v = 1$, a partition with three intervals is defined by boundaries $q_1 = -0.93$ and $q_2 = -0.27$. With $v = 0$, a partition with two intervals is defined by boundary $q_1 = -0.15$.

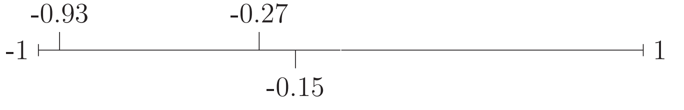


Figure 4.3: A partition of q with $v = 1$ (above line) that is less efficient than the partition with $v = 0$ (below line): $b = 0.15$.

4.5 Make or Buy?

The qualitative difference in communication that is analyzed in the previous section effects the manager's make-or-buy decision. As mentioned in the introduction, agents within an organization are likely to share similar beliefs and values. In this section, I assume that an agent within the organization fully internalizes M's type, i.e. $v = 1$. An external agent, such as a management consultant, does not value the manager's type, $v = 0$. The expected payoff to M if A values M's type ($v = 1$) is given by,

$$\begin{aligned} EU^M(v=1) &= \frac{1}{4}\sum_{i=1}^{N}\int_{t_i}^{1}\int_{q_{i-1}}^{q_i}(t+q)dqdt \\ &= \frac{1}{12N^2}\left[4N^2 - 1 - (N^2-1)N^2b^2\right] \end{aligned} \tag{4.7}$$

and his expected payoff if A does not value M's type ($v = 0$) is given by,

$$\begin{aligned} EU^M(v=0) &= \frac{1}{4}\sum_{i=1}^{2}\int_{t_i}^{1}\int_{q_{i-1}}^{q_i}(t+q)dqdt \\ &= \frac{1}{16}\left(5 - b^2\right) \end{aligned} \tag{4.8}$$

Subtracting equation (4.8) from (4.7) gives us,

$$\frac{1}{48N^2}\left((N^2-4) - N^2b^2(4N^2-7)\right) \tag{4.9}$$

Clearly, the manager's payoff in both cases is decreasing in b, which is consistent with any cheap talk game. It can be verified that expression (4.9) is positive for $N > 3$, and negative for $N < 3$. For $N = 3$, it is positive if $b < 0.14$. Thus, internal communication dominates external communication if and only if $b < 0.14$. Figure 4.4 summarizes the above for all $b \in [0, 1]$.

The implication of our analyses is straightforward. Costs due to noisy communication, or information losses, are relevant for a firm's make-or-buy decision. Communication inside organizations may generate larger costs, due to which a manager may prefer to buy information from agents that are detached from the organization. In particular, these results predict that projects which generate relatively large private rents for the agent are more likely to be outsourced.

<table>
<tr><td>b</td><td>0</td><td>0.08</td><td>0.14</td><td>0.17</td><td>0.5</td><td>1</td></tr>
<tr><td>if $v = 0$</td><td colspan="6">$N = 2$</td></tr>
<tr><td>if $v = 1$</td><td>$N(b) > 3$</td><td colspan="2">$N(b) = 3$</td><td>$N(b) = 2$</td><td colspan="2">BABBLING</td></tr>
<tr><td>Quality & EU^M</td><td colspan="2">$v = 1$ dominates</td><td colspan="4">$v = 0$ dominates</td></tr>
</table>

Figure 4.4: Quality of communication and manager's payoff for all $b \in [0, 1]$.

4.6 Common Knowledge of Manager's Vision

In this section I analyze how the previous discussion hinges on the assumption that the manager's type is private information. Assume that the agent fully observes the manager's information, i.e. t is common knowledge.

First consider the agent who does not value M's type ($v = 0$). His incentive to communicate does not depend on t, as shown in proposition 7. It is straightforward that observing the manager's type has no affect on his incentive to communicate. The only difference is that A is not uncertain whether his report will induce M to choose $d = 1$ or $d = 0$.

On the other hand, if the agent values M's type ($v = 1$), then his communication incentives do depend on the manager's type. The following proposition characterizes the equilibria.

Proposition 9. *Assume $b > 0$, $v = 1$, and t is common knowledge. Then all equilibria are outcome equivalent to one in which the agent, for any given realization of t, uses a maximum of $N = 2$ reports in equilibrium, $r \in \{r_1, r_2\}$.*
C sends $r = r_1$ if $q \in [-1, q_1(t))$ to recommend M to choose $d = 0$, and he sends $r = r_2$ if $q \in (q_1(t), 1]$ to recommend $d = 1$, where boundary $q_1(t)$ is given by,

$$q_1(t) = -b - t$$

M follows A's recommendation if $b < t + 1$, and otherwise chooses $d = 0$.

The above proposition shows that if an agent values M's type and is informed about it, then his communication strategy bears similarity to the strategy of an agent who does not value M's type. Both kinds of agents make a recommendation for or against the project. However, unlike the agent with $v = 0$, an agent with $v = 1$ conditions his recommendation on the realization of t. In other words, he fully utilizes the manager's type in forming his recommendation. As a result, the manager is willing to follow the recommendation. Notice however, that only some types of M are willing to rubber-stamp A's recommendation. The reason is that the final decision is biased towards the interest of A, who achieves his first-best outcome. Due to the biased outcome, only types $t > b - 1$ are willing to rubber-stamp A's recommendation. The manager again maintains some control over the final decision.

Figure 4.5 depicts a communication equilibrium for $b = 0.2$. The players' first-best outcomes are depicted as before by the diagonals. For any given t, A recommends to implement the project if q lies above diagonal t^C, and recommends to maintain status quo otherwise. All M types $t > t^* = b - 1 = -0.8$ follow the recommendation, and all M types $t < t^*$ choose $d = 0$.

Notice that a report from A with shared values now reveals less about project quality, in comparison to communication if t is private information. M only learns whether q is above $q_1(t)$. However, reports now reveal more precisely whether project quality is sufficiently good for a given type of the manager. The following comparison shows that M is strictly better off if A observes t in comparison to if he does not observe t. M's expected payoff if A with $v = 1$ observes t is given by,

$$\begin{aligned} EU^M(v = 1) &= \frac{1}{4} \int_{b-1}^{1} \int_{-b-t}^{1} (t + q) dq dt \\ &= \frac{1}{12} (2 - b)^2 (1 + b) \end{aligned} \tag{4.10}$$

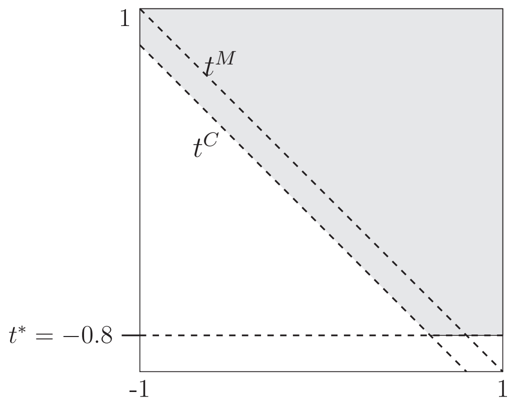


Figure 4.5: An equilibrium if A observes M's type and values it ($v = 1$).

Subtracting (4.7) from equation (4.10) gives us,

$$\frac{1}{12N^2}(N^2b^3 + N^2(N^2 - 4)b^2 + 1) \tag{4.11}$$

which is positive for all $N \geq 2$.

The reason that M is better off if the agent observes t is that A with shared values can fully utilize information about t in his recommendation. The gains associated with this are sufficiently large to compensate for the biasedness of the final outcome.[16]

Finally, in line with our results on the quality of communication and the manager's make-or-buy decision, M only conditionally prefers to receive information from an agent with shared values. Subtracting equation (4.8) from equation (4.10) gives us,

$$\frac{1}{48}\left(4b^3 - 9b^2 + 1\right) \tag{4.12}$$

It can be verified that this expression is positive if and only if $b < 0.36$. Thus, communication from an agent with $v = 1$ is more informative if b is not too large, but it is more informative with $v = 0$ if b is substantial. Again, projects that generate relatively large private rents to the agent are likely to be outsourced.

[16] The logic is similar to the one in the delegation literature where communication is less efficient than delegation even though delegation leads to a biased outcome.

4.7 Delegation

In the previous sections we have analyzed incentives of the agent to communicate his information, and the manager's payoffs under communication. Dessein (2002) shows for the Crawford and Sobel (1982) model that delegation of decision rights to the agent improves outcomes over communication because information is better utilized in the final decision. In this section we analyze whether delegation is beneficial for the manager also in our model. We show that M cannot do better under delegation in comparison to communication.

In our model, it is trivial to note that the manager will not find it beneficial to delegate the decision to an agent without shared values ($v = 0$). The reason is that such an agent will not utilize any information that the manager possesses. This holds whether M's information is private knowledge or common knowledge.[17]

It remains to determine whether M will find it beneficial to delegate the decision to an agent who shares his values ($v = 1$). It turns out that delegation under $v = 1$ has no effect on the final outcome if the M's information is private knowledge. The reason is that a privately informed M cannot circumvent communication by delegating decision rights. Instead, M must communicate his information to the agent, who then makes the final decision. The simplest way to see that delegation will not alter the outcome is to note that A's benefit b is a normalization and communication incentives of M will be symmetric to those of A. This equivalence is formally provided by Chakraborty and Yilmaz (2013). They analyze a cheap-talk communication game between a board and management that is similar to the communication game with $v = 1$ of this paper.

If M's information is common knowledge, then communication under shared values is outcome equivalent to conditional delegation. This is trivially seen from proposition 9. There we have shown that M follows the agent's recommendation if $b < t+1$, and otherwise chooses to maintain status quo. If M follows A's recommendation, then A achieves his first-best outcome. In other words, under communication the project is implemented if $b + t + q > 0$ conditional on $b < t + q$. If instead A has decision rights, then he will prefer to implement the project if $\mathrm{E}(b + t + q) > 0$. The implication is that full delegation is sub-optimal for the manager in comparison to communication. M will prefer to delegate the decision if and only if $b < t + 1$. The outcome however, will be equivalent to communication. Thus, in our model delegation of decision rights performs at most as well as communication.

[17] M's payoff under delegation to A with $v = 0$ is given by, $\frac{4-4b^2}{16}$. Compare with equation 4.8.

4.8 Incentives to Collect Information

In the previous sections we have analyzed communication incentives. In this section, we analyze players' incentives to collect information. I restrict attention to a simple scenario and assume that M observes t and only A has to exert effort to learn q. This allows a simple comparison of the effort exerted by the two kinds of agents.

The baseline model can be easily extended to include a stage in which A has to exert costly effort to learn q. The timing is as follows. Nature determines t and q, and reveals t to M. In stage 1, A exerts effort π_j^A to learn q. In stage 2, the communication game of section 4.2 takes place. Payoffs are then realized.

Assume a quadratic cost of effort that is given by $\frac{1}{2}\lambda(\pi_j^A)^2$. Parameter $\lambda > 0$ captures the marginal cost of effort to A. I assume for simplicity that λ is common knowledge, and that both kinds of agents, $v = 1$ and $v = 0$, have the same marginal cost of effort. Term $\pi_j^A \in [0,1]$ denotes the effort exerted by A, where the subscript $j = v \in \{0,1\}$ distinguishes the effort of A with $v = 1$ from the effort of A with $v = 0$.[18] Effort π_j^A determines the probability with which A becomes informed. If A exerts effort, then he successfully learns q with probability π_j^A, and remains uninformed with probability $1 - \pi_j^A$. If A is uninformed, then he sends an empty message, $m = \phi$, which is equivalent to babbling.

The expected payoff to the agent with $v = 1$ and $v = 0$ is respectfully given by,

$$EU^A(v=1) = \pi_1^A \left(\frac{1}{4} \sum_{i=1}^{N} \int_{t_i}^{1} \int_{q_{i-1}}^{q_i} (b+t+q)dqdt \right) + \cdots$$
$$+ (1-\pi_1^A) \left(\frac{1}{4} \int_{-1}^{1} \int_{-1}^{1} (b+t+q)dqdt \right) - \frac{1}{2}\lambda(\pi_1^A)^2 \tag{4.13}$$

$$EU^A(v=0) = \pi_0^A \left(\frac{1}{4} \sum_{i=1}^{2} \int_{t_i}^{1} \int_{q_{i-1}}^{q_i} (b+q)dqdt \right) + \cdots$$
$$+ (1-\pi_0^A) \left(\frac{1}{4} \int_{-1}^{1} \int_{-1}^{1} (b+q)dqdt \right) - \frac{1}{2}\lambda(\pi_0^A)^2 \tag{4.14}$$

The first (second) term on the right is the expected payoff if A finds (does not find) information, and the last term is the cost of effort. Notice that in case A

[18] I assume for simplicity that effort is observable, also that players observe whether the other player is informed or not. This does not effect our results since in our model a player does not have incentive to conceal whether he is informed or uninformed.

does not find information, then an informed M prefers to implement the project if $t + \mathrm{E}(q) > 0$. The first-order-conditions of equation 4.13 and equation 4.14 with respect to π_1^A and π_0^A respectfully, imply that

$$\pi_1^A = \frac{(N^2 - 1)(1 - N^2 b^2)}{12\lambda N^2} \tag{4.15}$$

$$\pi_0^A = \frac{1 - b^2}{16\lambda} \tag{4.16}$$

The higher is λ and b, the lower is the effort exerted by both kinds of agents. It is not so obvious whether π_1^A is larger or smaller than π_0^A since an increase in b results in a decrease in N. Figure 4.6 depicts the effort levels under $v = 1$ and $v = 0$ as a function of b. The two curves intersect at $b = 0.14$. As can be seen, π_1^A is larger (smaller) than π_0^A if b is sufficiently small (large). Notice that the effort of an agent with shared values decreases ($\pi_1^A \to 0$) at a higher rate as b increases.[19] The reason is that communication incentives of such an agent are more sensitive to b, as shown in the previous analysis. In fact, if the marginal cost of effort is the same for both types of agents, then π_1^A is relatively higher for the same range of b for which an agent with shared values reveals more information to M. The implication is that an agent with shared values does not necessarily exert higher effort to become informed.

Above we assumed that marginal costs of collecting information are symmetric. This is likely not the case in reality. If an agent has a smaller (higher) marginal cost, then his effort is higher (the curve in figure 4.6 will shift up for all b). Whether agents within an organization have a larger (or smaller) marginal cost of collecting information in comparison to external management consultants is likely to depend on various factors. First, marginal costs will depend on the type of information that is required by the manager. For example, management consultants interact with numerous firms and industries, due to which they are likely to have easier access to information about consumer demand, best practices, and international markets. On the other hand, internal agents are likely to have easier access to information about the firm. Second, marginal costs of effort will also depend on concerns related to multi-tasking. An worker in the organization is likely to have a higher λ if doing so pulls him away from other tasks.

In the analysis above, we assumed that M's information, t, is private knowledge. In section **??** we showed that if t is common knowledge, then communication from an agent with shared values is strictly better than if t is private knowledge. Moreover,

[19] As can also be seen from the partial derivative of equilibrium efforts with respect to b.

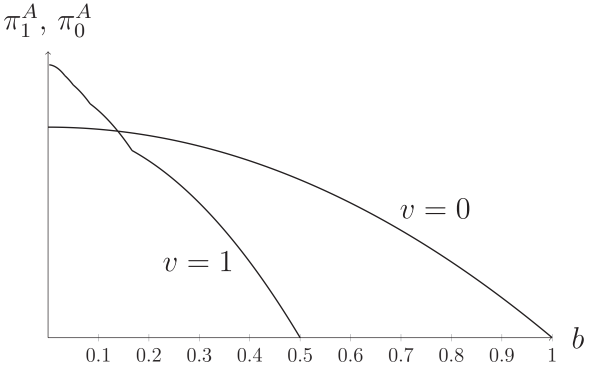


Figure 4.6: Agent's effort, π_1^A and π_0^A, as a function of b.

A achives his first-best outcome in case the project is implemented. If A is able to achieve his first-best outcome (conditionally), then it is likely that A will have stronger incentives to become informed. Indeed, this is true in our model. If A observes t, then his expected payoff is given by,

$$EU^A(v=1) = \pi_1^A \left(\frac{1}{4} \int_{b-1}^{1} \int_{-b-t}^{1} (b+t+q) dq dt \right) + \cdots$$
$$+ (1-\pi_1^A) \left(\frac{1}{4} \int_{-1}^{1} \int_{-1}^{1} (b+t+q) dq dt \right) - \frac{1}{2} \lambda (\pi_1^A)^2 \tag{4.17}$$

The first-order-condition with respect to π_1^A implies,

$$\pi_1^A = \frac{2 + (6-7b)b^2}{24\lambda} \tag{4.18}$$

It can be verified that equation 4.18 is strictly larger than the effort levels given in equations 4.15 and 4.16. Note that this is in line with Aghion and Tirole (1997). If the agent is able to achieve his first-best (even if conditionally so as in our model), then it motivates the agent to exert higher effort. An implication of these results is that a manager will have incentive to reveal his information to an agent if doing so will improve the incentives of A to collect information. To put it another way, M can motivate an agent to exert higher effort by communicating with the agent. Note that this mechanism differs from the mechanism in Aghion and Tirole (1997). There, it is primarily delegation of decision rights that motivates the agent. Whether M can credibly reveal his information fully to A is question for future research.

4.9 Discussion

This paper provides a rationale for communication to differ internally (within firms) and externally (across firms). In the context of consultancy services, and more broadly in the context of knowledge transfers, other factors may influence a firm's make-or-buy decision. Clearly, the frequency of the need for this service is important. A firm that requires a consultant's advice rarely has smaller incentive to integrate the service within the firm. Below I briefly discuss some other aspects relevant for a firm's decision to integrate services related to knowledge transfers within the firm.

First, external consultant's have a relatively stronger information advantage with respect to competitive best practices in the industry and market characteristics. This is due to their interaction with numerous firms and markets. Thus, a downside of an internal consultant is relatively smaller exposure. This is relevant particularly when an organization requires a consultant's guidance on how to improve strategy or workspace productivity. A model of project selection will be useful to analyze how an external consultant's information advantage and an internal consultant's proximity advantage effect a firm's choice over the make-or-buy decision.

Second, costs associated with information flows or knowledge transfers are not limited to those arising from noisy communication. Market transactions give outsiders access to valuable information, particularly information that gives an organization its competitive edge in the market. Thus, a disadvantage of market transaction relates to loss in the value of information. It requires a firm to *implicitly* share its knowledge with actual or potential competitors. From the society's point of view this need not be a bad thing. There is a positive externality on the market due to the dispersion of competitive best practices. Moreover, it may increase a firm's incentive to further innovate. However, it can also be socially inefficient since it can discourage incentives to exert effort into research and development, and increase incentive to free-ride, or imitate, competitors. Whether this is socially efficient or not is a question for future research.

Third, the decision to use an external and internal consultant is not so black and white. Organizations can, and often do, make use of internal and external agents. Whether this combines the best of both worlds and improves outcomes, by way of market discipline, or whether it worsens communication incentives is also a question for future research. Typically, competition tends to improve communication, however this is not necessary. Krishna and Morgan (2001), for instance, show that consulting two experts who are biased in the same direction is never beneficial over a single expert. Finally, concerning incentives to collect information, agency problems are likely to be central similar to the choice of using an external sales agent or creating an internal sales force, such as in Anderson (2008), and Holmström and Milgrom (1991, 1994). If effort is unobservable, the use of internal and external consultants together can create tensions related to free-riding and measurement of effort to become informed.

4.10 Conclusion

In this paper we have studied the incentives of an agent to communication with an informed decision maker, such as a firm manager who has a personal view about the right course of action. Our objective was to analyze how the agent's valuation for the decision maker's information effects his communication incentives. We have derived four main results. First, if the agent values the decision maker's information, then the agent has incentive to fine-tune his information and reveals relatively precise information. Second, we have shown that communication incentives of an agent are more sensitive to changes in private rents if the agent values the decision maker's information. If rents are sufficiently small (large), then he reveals more information if he values (does not value) the decision maker's information. Third, we have shown that if the decision maker has private information, then delegation performs at most as well as communication. The fourth result concerns the agent's incentives to collect information. In line with the communication result, we find that if rents are sufficiently small (large), then an agent exert's relatively higher effort if he values (does not value) the decision maker's information.

These results imply that communication costs are relevant for a firm's make-or-buy decision concerning knowledge transfers. Specifically, a firm may prefer to buy advice from external sources who are detached from the organization, instead of relying on information from workers in the organization.

Chapter 5

Summary

Three essays on strategic communication are discussed in this dissertation. These essays consider different settings in which a decision maker has to rely on another agent for information. In each essay, we analyze how much information the sender is able to credibly communicate to the decision maker, and to what extent, if at all, the sender is able to influence the final outcome towards his own interest by communicating strategically.

The first essay addresses whether relatively stronger parties, in terms of ability to collect information, have a disproportionate influence on decisions. If information is verifiable and costly to acquire, then our model predicts that relatively powerful interest groups frequently provide information that shapes policy. However, our model also predicts that if powerful interest groups do not provide information, decisions are made against their interests. In expected terms, these effects cancel out and as a result the final decision does not depend on the relative strength of the parties. This result is a benchmark. Lobbying groups may systematically affect policies in case the assumptions underlying our model are violated. For instance, the ability of the decision maker to correctly estimate the strength of parties matters. Underestimation of the strong party's ability will bias the decision in its favor. Clearly, if the decision maker is biased or can be bribed, then the final decision is also biased.

The second essay addresses whether bureaucrats can influence the provision of public goods towards their own interests. If information supplied by the bureaucrat effects multiple decisions concerning a project, then we show that concerning the size

of public projects, information asymmetry and misaligned preferences do not lead to distortions in expected terms. Bureaucrats try to exaggerate the demand for a public service, but rational politicians see through their attempts. However, we also show that bureaucrats are able to increase the likelihood of the provision of a public service. Politicians implement projects they would not implement if they were fully informed themselves. Together these two results predict that public swimming pools, libraries, parks or museums, are not too large or too luxurious on average, but that there are too many of them.

The final essay addresses whether shared values in an organization lead to better communication and less influence activities inside organizations. We adopt a setting in which the decision maker has some information that the agent is uninformed about, but he has to rely on the agent for some other information. We show that if the agent cares about the information of the decision maker, and thus shares the values of the decision maker, then he has strong incentives to reveal his own information and does so relatively precisely. If the agent does not care about the information of the decision maker, then his communication incentives are weak and he only reveals whether or not he favors the implementation a project. However, we also show that with shared values the incentives to reveal information are more sensitive to changes in the agent's private rents, such as intrinsic rewards. If these rents are sufficiently large, then less information is revealed with shared values. Our model predicts that firm managers are more likely to use external management consultants for advice on larger projects, and rely on in-house advice for relatively smaller projects.

These essays contribute to the theoretical literature on signaling games. Some of the conventional assumptions in the literature are relaxed to gain a better understanding of factors that effect communication incentives. The details are left to the main text. Broadly speaking we show that communication deteriorates if the decision maker has to make multiple decisions and communication potentially improves if the decision maker has private information. Interestingly, they also show that if the preferences of the decision maker and the agent are not perfectly aligned, then the decision maker sometimes prefers that the conflict exists across many dimensions of the decision problem instead of only in one dimension.

Chapter 6

Nederlandse Samenvatting (Summary in Dutch)

Deze dissertatie bevat drie essays over strategische communicatie. De essays beschouwen verschillende situaties waarin een beslisser een beroep moet doen op een andere agent om informatie te krijgen. In ieder hoofdstuk analyseren we hoeveel informatie de verzender (de agent) geloofwaardig kan communiceren naar de beslisser. En we analyseren in welke mate de verzender in staat is de uitkomst te benvloeden in haar eigen voordeel door strategisch te communiceren.

Het eerste essay bestudeert of relatief sterkere partijen, in termen van vermogen om informatie te verzamelen, een disproportioneel grote invloed hebben of beslissingen. Ons model voorspelt dat, als informatie verifieerbaar is en kostbaar is om te verwerven, relatief sterkere belangengroepen vaak informatie leveren die beleid vormt. Echter, ons model voorspelt ook dat als sterkere belangengroepen geen informatie leveren, beslissingen worden gemaakt die niet in hun belang zijn. Naar verwachting heffen deze effecten elkaar op en hangt de uiteindelijke beslissing niet af van de relatieve macht van de partijen. Dit resultaat is een benchmark. Lobbygroepen kunnen systematisch beleid benvloeden wanneer the onderliggende assumpties van het model worden geschonden. Bijvoorbeeld, het vermogen van de beslisser om de macht van de partijen juist in te schatten. Onderschatting van de sterkere partij zorgt voor een afwijking van de beslissing in het voordeel van de sterkere partij. Als de beslisser bevooroordeeld is of kan worden omgekocht, dan is de uiteindelijke beslissing ook afwijkend van de optimale beslissing.

Het tweede essay bestudeert of bureaucraten de voorziening van publieke goederen kunnen benvloeden in hun eigen voordeel. We zien dat met betrekking tot de grootte van publieke projecten, informatie asymmetrie en uiteenlopende voorkeuren in verwachte termen niet leiden tot verstoringen, wanneer informatie die aangeboden wordt door een bureaucraat meerdere beslissingen benvloedt. Bureaucraten proberen de vraag naar publieke goederen te overdrijven, maar rationele politici doorzien hun pogingen hiertoe. We laten echter ook zien dat bureaucraten in staat zijn om de kans op de voorziening van publieke goederen te verhogen. Politici implementeren projecten die ze niet zouden implementeren als ze volledig genformeerd zouden zijn. Tezamen voorspellen deze twee resultaten dat publieke zwembaden, bibliotheken, parken en musea gemiddeld niet te groot of te luxueus zijn, maar dat er hier wel te veel van zijn.

Het laatste essay bestudeert of gedeelde waarden in een organisatie leiden tot betere communicatie binnen organisaties. We bestuderen een setting waarin de beslisser private informatie heeft, en op de agent moet vertrouwen voor andere informatie. We laten zien dat als de agent geeft om de informatie van de beslisser, hij sterke prikkels heeft om zijn informatie te onthullen en dat relatief precies doet. Als de agent niet geeft om de informatie van de beslisser, dan zijn de communicatie prikkels van de agent zwak, en onthult hij alleen of hij wel of niet voor implementatie van het project is. Echter, we laten ook zien dat met gedeelde waarden de prikkels om informatie te onthullen meer gevoelig zijn voor veranderingen in de private belangen, zoals intrinsieke beloningen. Als deze belangen groot genoeg zijn, dan wordt er minder informatie onthult wanneer de beslisser en agent dezelfde waarden hebben. Ons model voorspelt dat managers van bedrijven meer geneigd zijn om externe management consultants om advies te vragen bij grotere projecten, en in-house consultants voor advies te vragen bij relatief kleinere projecten.

Deze essays dragen bij aan de theoretische literatuur van signalling games. Sommige van de conventionele aannames in de literatuur zijn versoepeld om beter inzicht te krijgen in factoren die invloed hebben op communicatie prikkels. De details zijn te lezen in de hoofdstukken. Maar in het algemeen laten deze essays zien dat communicatie verslechterd als de beslisser meerdere beslissingen moet maken, en communicatie mogelijk verbeterd als de beslisser private informatie heeft. Verder laten de essays zien dat als de voorkeuren van de beslisser en de agent niet perfect bij elkaar aansluiten, de beslisser wil dat de voorkeuren verschillen over meerdere dimensies in plaats van over een dimensie.

Appendix A

Appendices

A.1 Appendix to Chapter 2

As mentioned in the model section, we assume $\lambda_i > \frac{1}{2}(h-l)$ to ensure that both parties have an incentive to acquire information. If $\lambda_i \leq \frac{1}{2}(h-l)$, then $\pi_i = 1$ and the decision maker relies entirely on party i. To see this, suppose $\lambda_i \leq \frac{1}{2}(h-l)$. Suppose that if $m_a = \phi$, then $\mu^T = l$. Then, party a chooses π_a so as to maximize,

$$\pi_a \frac{1}{2}(h+l) + (1-\pi_a)l - \frac{1}{2}\lambda_a(\pi_a)^2$$

yielding,

$$\frac{1}{2}(h-l) = \lambda_a \pi_a$$

Then, $\pi_a = 1$ for $\lambda_a \leq \frac{1}{2}(h-l)$.

Proof of Proposition 2.
First we show μ^T is decreasing in π_a and increasing in π_b. Equation (2.8) solves for,

$$\mu^T = \begin{cases} \frac{1}{\pi_b - \pi_a}\left(h(1-\pi_a -) - l(1-\pi_b) - (h-l)\sqrt{(1-\pi_a)(1-\pi_b)}\right) & \text{if } \pi_a \neq \pi_b \\ \frac{1}{2}(h+l) & \text{if } \pi_a = \pi_b \end{cases} \tag{A.1}$$

This implies,

$$\frac{\partial \mu^T}{\partial \pi_a} = \frac{\sqrt{(1-\pi_a)(1-\pi_b)}}{(\pi_b-\pi_a)^2(1-\pi_a)}\left(\pi_a+\pi_b+2\sqrt{(1-\pi_a)(1-\pi_b)}-2\right)$$

The first term is positive. We need to show, $(\pi_a+\pi_b+2\sqrt{(1-\pi_a)(1-\pi_b)}-2)<0$:

$$\begin{aligned}
\pi_a+\pi_b+2\sqrt{(1-\pi_a)(1-\pi_b)}-2 &< 0\\
4(\pi_a-1)(\pi_b-1) &< (2-\pi_a-\pi_b)^2\\
4(\pi_a-1)(\pi_b-1)-(2-\pi_a-\pi_b)^2 &< 0\\
-(\pi_a-\pi_b)^2 &< 0
\end{aligned}$$

Thus, $\frac{\partial \mu^T}{\partial \pi_a} < 0$. Symmetry implies, $\frac{\partial \mu^T}{\partial \pi_b} > 0$.

Next we can show that $\pi_a > \pi_b \Leftrightarrow \mu^T < \frac{1}{2}(l+h)$:
$\Rightarrow$: Assume $\pi_a > \pi_b$. Let $\mu^T = \frac{1}{2}(l+h)+e$, so $e<0$ implies $\mu^T < \frac{1}{2}(l+h)$. Substituting in (A.1) gives us,

$$\begin{aligned}
\frac{1}{\pi_b-\pi_a}\left(h(1-\pi_a-)-l(1-\pi_b)-(h-l)\sqrt{(1-\pi_a)(1-\pi_b)}\right) &= \frac{1}{2}(l+h)+e\\
\frac{1}{\pi_a-\pi_b}\left(\pi_a+\pi_b+2\sqrt{(\pi_a-1)(\pi_b)-1}-2\right) &= e
\end{aligned}$$

The first term on the left-hand side is positive, and the second is negative. Thus, if $\pi_a > \pi_b$, then $e<0$ which implies $\mu^T < \frac{1}{2}(l+h)$.

$\Leftarrow$: Assume $\mu^T < \frac{1}{2}(l+h)$. Then (A.1) implies,

$$\begin{aligned}
\frac{1}{\pi_b-\pi_a}\left(h(1-\pi_a-)-l(1-\pi_b)-(h-l)\sqrt{(1-\pi_a)(1-\pi_b)}\right) &< \frac{1}{2}(l+h)\\
\frac{1}{\pi_a-\pi_b}\left(\pi_a+\pi_b+2\sqrt{(\pi_a-1)(\pi_b)-1}-2\right) &< 0
\end{aligned}$$

Since the second term on the left-hand side is negative, we must have $\pi_a > \pi_b$.

Lastly, we show that $\lambda_a < \lambda_b \Leftrightarrow \mu^T < \frac{1}{2}(l+h)$.

$\Leftarrow$: Assume $\mu^T < \frac{1}{2}(l+h)$. This implies $\pi_a - \pi_b > 0$, thus,

$$\frac{(h-\mu^T)^2}{2\lambda_a(h-l)} - \frac{(\mu^T-l)^2}{2\lambda_b(h-l)} > 0$$

$$\lambda_b(h-\mu^T)^2 - \lambda_a(\mu^T-l)^2 > 0$$

$$\lambda_b(h - \frac{1}{2}(l+h) - e)^2 - \lambda_a(\frac{1}{2}(l+h) + e - l)^2 > 0$$

$$(\lambda_b - \lambda_a)\left(\frac{h-l+2e}{2}\right)^2 > 0 \implies \lambda_b > \lambda_a$$

$\Rightarrow$: Assume $\lambda_a < \lambda_b$. Similar to the last derivation we obtain,

$$\pi_a - \pi_b = \frac{1}{2(h-l)\lambda_a\lambda_b}(e)^2(\lambda_b - \lambda_a) > 0$$

Thus, if $\lambda_a < \lambda_b$ then $\pi_a > \pi_b$, which implies $\mu^T < \frac{1}{2}(l+h)$. ■

Proof of Proposition 3.

We need to show that $E(x) = E(\mu)$. For simplicity, assume $h = -l$. This does not alter our results. In fact, below we show that this result holds for any general distribution function. If $h = -l$, then equation (2.8) implies that μ^T is implicitly determined by,

$$(\mu^T)^2(\pi_a - \pi_b) + 2\mu^T h(2 - \pi_a - \pi_b) + h^2(\pi_a - \pi_b) = 0 \tag{A.2}$$

We need to show $\mathrm{E}(x) = \mathrm{E}(\mu) = \frac{h+l}{2} = 0$.

$$\begin{aligned}\mathrm{E}(x) =& \pi_a\pi_b\mathrm{E}(\mu) + \pi_a(1-\pi_b)\left(\mathrm{E}(\mu|\mu > \mu^T) + \frac{\mu^T - l}{h-l}\mu^T\right) + \cdots \\ & \pi_b(1-\pi_a)\left(\mathrm{E}(\mu|\mu < \mu^T) + \frac{h-\mu^T}{h-l}\mu^T\right) + (1-\pi_a)(1-\pi_b)\mu^T \end{aligned} \tag{A.3}$$

Substituting out $\mathrm{E}(\mu) = 0$, $\mathrm{E}(\mu|\mu > \mu^T) = \frac{h-\mu^T}{h-l}\frac{\mu^T+h}{2}$, and $\mathrm{E}(\mu|\mu < \mu^T) = \frac{\mu^T-l}{h-l}\frac{\mu^T+l}{2}$, and reducing the expression gives us,

$$\mathrm{E}(x) = \frac{1}{4h}\left((\mu^T)^2(\pi_a - \pi_b) + 2\mu^T h(2 - \pi_a - \pi_b) + h^2(\pi_a - \pi_b)\right)$$

Using expression (A.2), implies that $\mathrm{E}(x) = 0$.

General distribution: Here we show that this result also holds for the general distribution function. Assume that the random variable μ has a probability density function $f(\mu)$. Let $p = \Pr(\mu > \mu^T) = \int_{\mu^T}^{h} f(\mu)d(\mu)$. For this general case, equation (2.8) is given by,

$$\mu^T = \frac{\pi_a \pi_b (1-p)\mathrm{E}(\mu|\mu < \mu^T) + \pi_b(1-\pi_a)p\mathrm{E}(x|\mu > \mu^T) + (1-\pi_a)(1-\pi_b)E(\mu)}{\pi_a\pi_b(1-p) + \pi_b(1-\pi_a)p + (1-\pi_a)(1-\pi_b)} \tag{A.4}$$

which implies that the threshold is implicitly determined by the following,

$$\begin{aligned}[1 - p\pi_a - (1-p)\pi_b]\mu^T =& \pi_a(1-\pi_b)(1-p)\mathrm{E}(\mu|\mu < \mu^T) + \cdots \\ & \pi_b(1-\pi_a)p\mathrm{E}(\mu|\mu > \mu^T) + (1-\pi_a)(1-\pi_b)\mathrm{E}(\mu)\end{aligned} \tag{A.5}$$

Similarly, for the general case, the final decision in expectation is given by,

$$\begin{aligned}\mathrm{E}(x) =& \pi_a\pi_b\mathrm{E}(\mu) + \pi_a(1-\pi_b)\left[p\mathrm{E}(\mu|\mu > \mu^T) + (1-p)\mu^T\right] + \cdots \\ & \pi_b(1-\pi_a)\left[(1-p)\mathrm{E}(\mu|\mu < \mu^T) + (1-p)\mu^T\right] + (1-\pi_a)(1-\pi_b)\mu^T\end{aligned} \tag{A.6}$$

which can be rewritten as,

$$\begin{aligned}\mathrm{E}(x) =& \pi_a\pi_b\mathrm{E}(\mu) + \pi_a(1-\pi_b)p\mathrm{E}(\mu|\mu > \mu^T) + \pi_b(1-\pi_a)(1-p)\mathrm{E}(\mu|\mu < \mu^T)\cdots \\ & + [1 - p\pi_a - (1-p)\pi_b]\mu^T\end{aligned} \tag{A.7}$$

The last term in this expression can be substituted out using equation A.5. Equation A.7 reduces to,

$$\mathrm{E}(x) = \mathrm{E}(\mu) + (\pi_a + \pi_b - 2\pi_a\pi_b)\left[p\mathrm{E}(\mu|\mu > \mu^T) + (1-p)\mathrm{E}(\mu|\mu < \mu^T) - \mathrm{E}(\mu)\right] \tag{A.8}$$

Note that $E(x) = E(\mu)$ if the second term on the right hand side equals zero. This follows directly from the law of total expectation, which states that we must have, $p\mathrm{E}(\mu|\mu > \mu^T) + (1-p)\mathrm{E}(\mu|\mu < \mu^T) = \mathrm{E}(\mu)$, and thus, $E(x) = E(\mu)$. ■

A.2 Appendix to Chapter 3

Proof of Lemma 1.

We proceed in three steps. In step one, we show that if a message induces $x = 0$, then this message must be the first message (lowest interval). In step two, we prove the interval strategy of the sender. In step three, we derive the border of the intervals that define the sender's strategy.

Step 1: We prove by contradiction that if a message induces $x = 0$, then this message must be the first message (lowest interval). Let there be sender types v and w, where $v < w$. Let v send a message m^v that induces his most preferred actions in equilibrium, $(x = 1, d = d^v)$. Let w send a message m^w that induces his most preferred actions in equilibrium, $(x = 0, d = 0)$. This implies:

i) $U_S(1, d^v, v) = v - |d^v - (v + b)| \ > \ U_S(0, 0, v) = a - (v + b)$:

$$2v - |d^v - (v + b)| > a - b \tag{A.9}$$

ii) $U_S(1, d^v, w) = w - |d^v - (w + b)| \ > \ U_S(0, 0, w) = a - (w + b)$:

$$2w - |d^v - (w + b)| < a - b \tag{A.10}$$

Together, expressions (A.9) and (A.10) imply, $|d^v - (v + b)| < |d^v - (w + b)|$. Since $d^v > 0$, $b > 0$, and $v < w$, we have a contradiction. Thus, it cannot be that a type v prefers $x = 1$ and a type $w > v$ prefers $x = 0$.

Step two: We show that the sender follows an interval strategy. We will show that if two types prefer to send a message that induces the same actions in equilibrium, then all types in between these two types will also prefer to induce the same actions in equilibrium. That is, all types that induce the same actions (x, d) in equilibrium, must form a convex set. We prove by contradiction. Let there be sender types v and w, where $v < w$. Let v and w send a message m^v that induces their most preferred actions in equilibrium, $(x = x^v, d = d^v)$. Now let there be a type t', such that $v < t' < w$. Let t' send a message m' that induces his most preferred action $(x = x', d = d')$. The preference of each type over the two messages imply that,

$$U_S(x^v, d^v, v) > U_S(x', d', v) \tag{A.11}$$

$$U_S(x^v, d^v, w) > U_S(x', d', w) \tag{A.12}$$

$$U_S(x^v, d^v, t') < U_S(x', d', t') \tag{A.13}$$

We need to show that in equilibrium $x^v = x'$ and $d^v = d'$. We prove by contradiction. Assume that $x^v \neq x'$ and/or $d^v \neq d'$. We consider the different cases.

Case A: Assume $x^v \neq x'$ and $d^v \neq d'$: Assume m^v induces the status quo, $(x^v = 0, d^v = 0)$, and m' induces implementation, $(x = 1, d = d')$. Expressions (A.11), (A.12), and (A.13) respectively imply that,

$$a - (v + b) > v - |d' - (v + b)| \implies (d' - v - b)^2 - (2v + b - a)^2 > 0 \quad \text{(A.14)}$$
$$a - (w + b) > v - |d' - (w + b)| \implies (d' - w - b)^2 - (2w + b - a)^2 > 0 \quad \text{(A.15)}$$
$$a - (t' + b) < v - |d' - (t' + b)| \implies (d' - t' - b)^2 - (2t' + b - a)^2 < 0 \quad \text{(A.16)}$$

Subtracting (A.16) from (A.14), and simplifying the resulting expression gives us, $(t' - v)\left[3(t' + v) + 2(d' + b - 2a)\right] > 0$. Since $t' > v$, it must be that,

$$(t' + v) > -\frac{2}{3}(d' + b - 2a) \quad \text{(A.17)}$$

Similarly, subtracting (A.16) from (A.15), and simplifying the resulting expression gives us, $(t' - w)\left[3(t' + w) + 2(d' + b - 2a)\right] > 0$. Since $t' < w$, it must be that,

$$(t' + w) < -\frac{2}{3}(d' + b - 2a) \quad \text{(A.18)}$$

Together, expressions (A.17) and (A.18) imply,

$$(t' + w) < -\frac{2}{3}(d' + b - 2a) < (t' + v) \implies (t' + w) < (t' + v)$$

This is a contradition since $v < w$. This established that it cannot be that types v and w prefer the status quo, $(x^v = 0, d^v = 0)$, and a type $t' \in (v, w)$ prefers implementation, $(x = 1, d = d')$. A similar analysis shows that it cannot be that types v and w prefer implementation, $(x^v = 1, d = d^v)$, and type t' prefers the status quo, $(x = 0, d' = 0)$.

Case B: Assume $x^v = x'$ and $d^v \neq d'$.
We need only consider the case of $x^v = x' = 1$, since $x = 0$ implies $d = 0$. Assume m^v induces implementation, $(x^v = 1, d = d^v)$, and m' also induce implemetation, $(x' = 1, d = d')$, such that $d^v \neq d'$. Expressions (A.11), (A.12), and (A.13)

respectively imply that,

$$v - |d^v - (v+b)| > v - |d' - (v+b)| \quad \Rightarrow \quad (d' - v - b)^2 > (d^v - v - b)^2 \tag{A.19}$$

$$w - |d^v - (w+b)| > w - |d' - (w+b)| \quad \Rightarrow \quad (d' - w - b)^2 > (d^v - w - b)^2 \tag{A.20}$$

$$t' - |d^v - (t'+b)| < t' - |d' - (t'+b)| \quad \Rightarrow \quad (d' - t' - b)^2 < (d^v - t' - b)^2 \tag{A.21}$$

Subtracting (A.21) from (A.19), and simplifying the resulting expression gives us,

$$2(d^v - d')(v - t') > 0$$

Since $v < t'$, it must be that, $d^v < d'$.

Similarly, subtracting (A.21) from (A.20), and simplifying the resulting expression gives us,

$$2(d^v - d')(w - t') > 0$$

Since $w > t'$, it must be that, $d^v > d'$. This is a contradiction again. Thus, it cannot be that types v and w prefer $x = 1$ with $d = d^v$, and a type $t' \in (v, w)$ prefers $x = 1$ with $d = d'$ such that $d^v \neq d'$.

Step 3: We derive the borders of the intervals presented in Lemma 1. Most of these are derived in the main text. For convenience, we present these here again: If $(r_1 + b_S) < \frac{1}{2}(r_1 + r2)$, then

$$r_1 = \frac{2a_S + r_2 - 4b_S}{5} \tag{A.22}$$

If $(r_1 + b_S) > \frac{1}{2}(r_1 + r2)$, then

$$r_1 = \frac{2a_S - r_2}{3} \tag{A.23}$$

Borders r_i for all $i > 2$ are determined by,

$$(r_{i+1} - r_i) = (r_i - r_{i-1}) + 4b_S \tag{A.24}$$

To derive the expression r_i for all $i > 2$, we can rewrite expression (A.24) as

$r_{i+1} = 2r_i - r_{i-1} + 4b_S$ which implies,

$$\begin{aligned}
r_3 &= 2r_2 - r_1 + 4b_S \\
r_4 &= 2r_3 - r_2 + 4b_S = 3r_2 - 2r_1 + (3)4b_S \\
r_5 &= 2r_4 - r_4 + 4b_S = 4r_2 - 3r_1 + (6)4b_S \\
&\dots \\
r_i &= (i-1)r_2 - (i-2)r_1 + 2(i-2)(i-1)b_S \qquad \text{(A.25)}
\end{aligned}$$

Using this expression for r_i in (A.25), along with the expression for r_1, (equations (A.22) and (A.23)), we can derive the solutions for r_1 and r_2 for each of the two cases.

Case 1: $\frac{1}{2}(r_1 + r_2) > r_1 + b_S$**:**

$$r_1 = \frac{h + 2(n-1)a_S - 2n(n-1)b_S}{4n-3} \qquad \text{(A.26)}$$

$$r_2 = \frac{5h + 2(n-2)a_S - 2(5n-3)(n-2)b_S}{4n-3} \qquad \text{(A.27)}$$

Case 2: $\frac{1}{2}(r_1 + r_2) < r_1 + b_S$**:**

$$r_1 = \frac{2(n-1)a_S - h + 2(n-1)(n-2)b_S}{4n-5} \qquad \text{(A.28)}$$

$$r_2 = \frac{3h + 2(n-2)a_S - 6(n-1)(n-2)b_S}{4n-5} \qquad \text{(A.29)}$$

To derive the maximum number of words $\bar{n}$, we express the length of a partition as the sum of all intervals.

$$\begin{aligned}
h - l &= (r_1 - r_0) + (r_2 - r_1) + (r_3 - r_2) + \cdots + (r_n - r_{n-1}) && \text{(A.30)} \\
&= (r_1 - r_0) + (n-1)(r_2 - r_1) + 4b \sum_{k=1}^{n-2} k && \text{(A.31)} \\
&= (r_1 - r_0) + (n-1)(r_2 - r_1) + (n-1)(n-2)2b && \text{(A.32)}
\end{aligned}$$

We first note that as b_S increases, the length of the second interval $(r_2 - r_1)$ goes to zero before the length of the first interval $(r_1 - r_0)$ goes to zero. Specifically, the length of interval $(r_2 - r_1)$ goes to zero under case 2 where r_1 and r_2 are given by

(A.28) and (A.29) respectively. Rewriting (A.32) implies,

$$(r_2 - r_1) = \frac{1}{n-1}(h - r_1) - (n-2)2b > 0$$

Substituting out r_1 using (A.28), and solving the resulting expression for n gives us,

$$n < \frac{1}{2}\sqrt{\frac{2(h - \frac{1}{2}a_S)}{b_S} + 1} + \frac{3}{2}$$

■

The expected payoff to D is given by,

$$\int_{r_0}^{r_1} (a_D - t)\, dt + \sum_{i=2}^{n-1}\left(\int_{r_i}^{r_{i+1}} \left(t - \left|\frac{r_i + r_{i+1}}{2} - t\right|\right) dt\right)$$
$$= \int_{r_0}^{r_1} (a_D - t)\, dt + \sum_{i=2}^{n-1}\left(\int_{r_i}^{\frac{r_i+r_{i+1}}{2}} \left(2t - \frac{r_i + r_{i+1}}{2}\right) dt + \int_{\frac{r_i+r_{i+1}}{2}}^{r_{i+1}} \frac{r_i + r_{i+1}}{2} dt\right)$$

The expected payoff to S is given by,

$$\int_{r_0}^{r_1} (a_S - t - b_S)\, dt + \sum_{i=2}^{n-1}\left(\int_{r_i}^{r_{i+1}} \left(t - \left|\frac{r_i + r_{i+1}}{2} - t - b_S\right|\right) dt\right)$$
$$= \int_{r_0}^{r_1} (a_S - t - b_S)\, dt + \sum_{i=2}^{n-1}\left(\int_{r_i}^{\frac{r_i+r_{i+1}}{2}} \left(2t - \frac{r_i + r_{i+1}}{2} + b_S\right) dt + \int_{\frac{r_i+r_{i+1}}{2}}^{r_{i+1}} (\frac{r_i + r_{i+1}}{2} - b_S) dt\right)$$

A.3 Appendix to Chapter 4

Proof of Lemma 3.

We show that the sender follows an interval strategy. In this proof, denote the realization of q as the sender's type. In step 1, we will show by contradiction that if two sender types prefer to induce the same threshold in equilibrium, then all types in between these two types also prefer to induce the same threshold in equilibrium. That is, all types that prefer the same threshold in equilibrium form a closed convex set. In step 2, we will show that if two sender types prefer to induce two different thresholds, then the higher (lower) type must prefer a lower (higher) threshold.

Step 1: Let C of types q_1 and q_3, with $q_1 < q_3$, send a report r_1 that induces their most preferred threshold $t^*(r_1) = t_1$. Let there be a type q_2 such that $q_1 < q_2 < q_3$, and let q_2 send a report r_2 that induces his most preferred threshold $t^*(r_2) = t_2$ such that $t_1 \neq t_2$. This implies:
(i) $u^A(q_1, r_1) > u^A(q_1, r_2)$,

$$\int_{t_1}^{\bar{t}} (b + vt + q_1) dF_t - \int_{t_2}^{\bar{t}} (b + vt + q_1) dF_t > 0 \tag{A.33}$$

(ii) $u^A(q_3, r_1) > u^A(q_3, r_2)$,

$$\int_{t_1}^{\bar{t}} (b + vt + q_3) dF_t - \int_{t_2}^{\bar{t}} (b + vt + q_3) dF_t > 0 \tag{A.34}$$

(iii) $u^A(q_2, r_1) < u^A(q_2, r_2)$,

$$\int_{t_1}^{\bar{t}} (b + vt + q_2) dF_t - \int_{t_2}^{\bar{t}} (b + vt + q_2) dF_t < 0 \tag{A.35}$$

Then subtracting equation (A.35) from equation (A.33) implies,

$$(q_1 - q_2) \left(\int_{t_1}^{\bar{t}} dF_t - \int_{t_2}^{\bar{t}} dF_t \right) > 0$$

Since $q_1 < q_2$ it must be that $\int_{t_1}^{\bar{t}} dF_t - \int_{t_2}^{\bar{t}} dF_t < 0$, which implies $t_1 > t_2$.
Similarly, subtracting equation (A.35) from equation (A.34) implies,

$$(q_3 - q_2) \left(\int_{t_1}^{\bar{t}} dF_t - \int_{t_2}^{\bar{t}} dF_t \right) > 0$$

Since $q_2 > q_3$ it must be that $\int_{t_1}^{\bar{t}} dF_t - \int_{t_2}^{\bar{t}} dF_t > 0$, which implies $t_1 < t_2$. Thus a contradiction. It must be that in equilibrium if types q_1 and q_3 prefer to induce a threshold t_1 over t_2, then all types $q \in (q_1, q_3)$ also prefer t_1 over t_2. In other words, all types (q_1, q_3) form a convex set.

Step 2: We show by contradiction that if in equilibrium two sender types prefer to induce different thresholds, then the higher (lower) type must prefer a lower (higher) threshold. Let there be A of types q_1 and q_2, with $q_1 < q_2$. Let there be two thresholds induced in equilibrium t_1 and t_2, with $t_1 < t_2$. Assume that,
(i) type q_1 weakly prefers the lower threshold t_1, $E[u^A|t_1, q_1] \geq E[u^A|t_2, q_1]$:

$$\int_{t_1}^{\bar{t}} (b + vt + q_1) dF_t - \int_{t_2}^{\bar{t}} (b + vt + q_1) dF_t \geq 0 \tag{A.36}$$

and (ii) type q_2 strictly prefers the higher threshold t_2, $E[u^A|t_1, q_2] < E[u^A|t_2, q_2]$:

$$\int_{t_1}^{\bar{t}} (b + vt + q_2) dF_t - \int_{t_2}^{\bar{t}} (b + vt + q_2) dF_t < 0 \tag{A.37}$$

Subtracting expression A.37 from expression A.36 implies,

$$(q_1 - q_2) \left(\int_{t_1}^{\bar{t}} dF_t - \int_{t_2}^{\bar{t}} dF_t \right) \geq 0$$

Since $q_1 < q_2$, it must be that $\int_{t_1}^{\bar{t}} dF_t - \int_{t_2}^{\bar{t}} dF_t \leq 0$, which implies $t_1 \geq t_2$. This is a contradiction, thus, higher types must prefer a lower threshold.

■

Proof of Proposition 6.

Assume $t \in [-\bar{t}, \bar{t}]$ and $q \in [-\bar{q}, \bar{q}]$. The agent with $v = 1$ is indifferent between sending a report r_i and r_{i+1} $\forall\, i = \{1, \cdots, N-1\}$ at $q = q_i$ if,
$\mathrm{E}[u^A(t_i, q = q_i)] = \mathrm{E}[u^A(t_{i+1}, q = q_i)]$. Thus,

$$\frac{\bar{t} - t_i}{2\bar{t}} \left(b + \frac{\bar{t} + t_i}{2} + q_i \right) = \frac{\bar{t} - t_{i+1}}{2\bar{t}} \left(b + \frac{\bar{t} + t_{i+1}}{2} + q_i \right)$$

This reduces to,

$$q_i = -b - \frac{t_i + t_{i+1}}{2} \tag{A.38}$$

Substituting out $t_i = -\frac{q_{i-1} + q_i}{2}$ and $t_{i+1} = -\frac{q_i + q_{i+1}}{2}$, the incentive constraint can be rewritten as,

$$(q_{i+1} - q_i) = (q_i - q_{i-1}) + 4b \tag{A.39}$$

The maximum number of intervals that satisfy this constraint for any given b is determined as follows. Since an increase in b shifts all boundries q_i to the left, the length of the first interval along a partition of size N approaches zero as b increases. For the N-step paritition to exist, the first interval must be of a positive length. Define the length of an interval along $[-\bar{q}, \bar{q}]$ as $l_i = q_i - q_{i-1}$ for $i \in \{1, \cdots, N\}$. The incentive constraint can be expressed as, $l_{i+1} = l_i + 4b$. Using this, along with the boundary conditions $q_0 = -\bar{q}$ and $q_N = \bar{q}$, the sum of all intervals along $[-\bar{q}, \bar{q}]$ for an N-step partition can be written in terms of $l_1 = q_1 - q_0$ as,

$$2\bar{q} = \sum_{i=1}^{N} l_i = Nl_1 + \frac{N(N-1)}{2} 4b$$

which implies that,

$$l_1 = \frac{2\bar{q}}{N} - 2(N-1)b \tag{A.40}$$

Solving $l_1 > 0$ for N gives the expression for the maximum incentive compatible intervals for a given b,

$$N < \bar{N}(b) = \frac{1}{2} + \frac{1}{2}\sqrt{1 + \frac{4\bar{q}}{b}}$$

■

Proof of Proposition 8.

Assume $t \in [-\bar{t}, \bar{t}]$ and $q \in [-\bar{q}, \bar{q}]$. It needs to be shown that, i) b has a stronger effect on a boundary along a partition of $[-\bar{q}, \bar{q}]$ if $v = 1$ than if $v = 0$, and ii) that an informative equilibrium breaks down quicker under $v = 1$. The first is straightfoward to show. If $v = 0$, boundary $q_1 = -b$ always shifts one-to-one. The boundaries if $v = 1$ can be derived as follows. Expression (A.40) implies,

$$q_1 = \frac{(2-N)\bar{q}}{N} - 2(N-1)b \tag{A.41}$$

Using equations (A.39), (A.41), and the boundary conditions $q_0 = -\bar{q}$, and $q_N = \bar{q}$, the following expression for q_i can be derived for all $i \in \{1, \cdots, N\}$,

$$q_i = \frac{2i - N}{N}\bar{q} - 2i(N-i)b \tag{A.42}$$

The partial derivative with respect to b is $-2i(N-i)$. It is straightforward that the absolute value is larger than 1 for all N and i.
The second is also straight foward to derive now. A length of an interval l_i can be derived for internal communication using expression (A.42),

$$l_i = q_i - q_{i-1} = \frac{2\bar{q}}{N} - 2(N+1-2i)b \tag{A.43}$$

An informative equilibrium with $v=1$ breaks down if l_1 approaches zero for $N=2$. Thus, if $b > \frac{1}{2}\bar{q}$. Communication with $v=0$ breaks down if q_1 approaches $q_0 = -\bar{q}$. Thus if $b > \bar{q}$. ■

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