INFORMATION AND POLITICS

Lars Frisell

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Information and Politics

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to my family and friends

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Stockholm, July 2001

Lars Frisell

INTRODUCTION AND SUMMARY

Someone once told me that every theoretical paper should contain a surprise. I think this is a good rule, for two reasons. To do research is to explore, to find or at least illuminate new facts or aspects of the world. Revealing new facts is not enough, however. In order to surprise someone, not only must I present him or her with previously unknown facts, these facts must also be of some interest. This captures the fact that research must be valuable, at least for someone, somewhere, some time. Why? Because research is costly, it consumes large amounts of scarce resources: time, money, and talent. If I manage to surprise the reader at least once, I will consider my efforts worthwhile.

This thesis is purely theoretical. This is not because I think empirical work is either fruitless or not important; it is just that I find the development of new concepts and ideas more interesting than actually testing them. Hopefully, you will find my work not too abstract or hypothetical to have a bearing on real-life phenomena.

CHAPTERS 1 & 2

The first two papers are variants of the same idea. An uninformed principal, e.g., a government, will make a decision. In order to gain more information it may consult two experts, however, these experts have a private interest in certain policies being implemented. To get an incentive for honest revelation, I assume in the first paper that experts derive some exogenous utility from truthtelling ("prestige"), while in the second one I let the principal reward truthful experts. The question is, to gain as much information as possible, should the principal consult experts who are biased in the same direction, or experts who prefer different decisions? The main result is that, as long as collusion between experts can be prevented, homogeneous panels are superior to heterogeneous ones, and this advantage increases with the experts' informational precision. This is in contrast to several papers on strategic advice, e.g., Gilligan and Krehbiel (1989) and Milgrom and Roberts (1986). In the second paper I also show that the principal's welfare is independent of the order of advice (simultaneous or sequential), which challenges the findings in Krishna and Morgan (2000).

CHAPTER 3

The third paper is inspired by the literature on herd behavior, e.g., Banerjee (1992) and Bikhchandani, Hirschleifer and Welch (1992), and especially Zhang (1997). In Zhangs paper, a number of agents choose between two decision alternatives, and no agent knows for certain which alternative is the better. This means that there are informational spillovers: agents can learn valuable information simply by observing other agents' actions. This results in a waiting game where agents try to outwait each other in order to make more informed decisions themselves. Zhang shows that in (the symmetric) equilibrium, the best informed agent takes the first action. In my paper I combine informational spillovers with a direct payoff externality. Two firms consider entry in a new product market, and must decide when to enter the market and how to design their product. The payoff externality has then a natural interpretation as the strategic substitutability/complementarity between products. The addition of the direct externality has two effects on the waiting game. First, it reduces delay per se. Second, if the externality is negative and very strong the decision order is reversed, so that poorly informed agents take action before well-informed ones.

CHAPTER 4

This paper asks the following question: Could it be that parties in a two party-system can benefit from using several candidates in the same election? To investigate this issue, I use a simple, one-dimensional model, with purely policy-motivated and risk-averse parties. To promote the use of multiple candidates I assume that the median voter always is decisive, that is, a party never runs the risk of having its votes split up among its candidates. Despite this, parties have a strong incentive to restrict their number of candidates. It turns out that the more uncertain parties are about voter opinion, the fewer candidates they want to use, and in the case of a uniform prior distribution, the optimal number of candidates is one.

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Bikhchandani, S., Hirschleifer, D., and Welch, I. (1992): "A Theory of Fads, Fashion, Custom and Cultural Change as Informational Cascades". *Journal of Political Economy*, 100 (5), 992-1026.

Gilligan, T. and Krehbiel, K. (1989): "Asymmetric Information and Legislative Rules with a Heterogeneous Committee". *American Journal of Political Science*, 33, 459-90.

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Chapter 1

Taking Advice from Imperfectly Informed Experts I: When to Match Hawks with Hawks

Taking Advice from Imperfectly Informed Experts I: When to Match Hawks with Hawks

Lars Frisell*

Abstract

We study a sender-receiver game between an uninformed government and two imperfectly informed lobbyists. Lobbyists are extreme in the sense that they prefer a certain policy irrespective of the contingency, and a single lobbyist would not provide any information. If inaccurate messages impose a cost on the sender, i.e., if some *external force* is present, there may still be an informative equilibrium with two lobbyists. The main result is that as long as the external force is small, and the lobbyists' accuracy relatively high, a homogeneous committee is strictly preferred to a heterogeneous one.

1 Introduction

How do poorly informed policy-makers persuade collaborators - or adversaries - to share their competence? To be sure, any decisionmaker will to the largest possible extent seek advice from experts sharing her own ideals and consequently, with little reason to mislead her. However, such loyal advisors may or may not arrive on the scene. Moreover, a legislator, as opposed to a decisionmaker within the market, may not be free to use pecuniary rewards to align incentives. An important research agenda in political science has therefore been to examine under what circumstances legislators can effectively extract information from other interested parties, such as experts or committee members.[1] A major tenet of this literature is that heterogeneous committees, i.e., committees where the participating experts have opposing interests, are informationally superior to homogeneous ones. (Gilligan and Krehbiel 1989, Krishna and Morgan 1999, 2000, Milgrom

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[1]For an overview of informational theories of institutional design, see, e.g., Krishna and Morgan 1999.

and Roberts 1986). In this paper we set up a simple institutional environment in order to focus on the composition of the expert committee. The central result is that, from a strictly informational viewpoint, homogeneous committees may be preferable to heterogeneous ones.

Imagine a government that chooses between two policy alternatives. The effect of each policy is uncertain but the government has a prior belief over which one produces the higher welfare. The government takes advice from two biased experts, "lobbyists", who, in turn, can be of two different types. After the government has chosen what types of lobbyists to hear, each lobbyist recommends a policy. The government then updates its prior over the two alternatives and implements the policy with the highest expected payoff. A lobbyist's payoff from the two policies is independent of the state so that lobbyists are biased in an absolute sense. This also means that lobbyists of different types never agree on what policy should be implemented.

We hypothesize that lobbyists derive some (positive) utility from providing good advice. Many papers on information transmission model talk as "cheap"; an individual's utility from maintaining a good reputation per se, or from having a "clear conscience", etc., is believed to be negligible - at least relative to monetary rewards. However, not only may the presence of reputational concerns improve the efficiency of a given committee, but - as we will see - it also has implications for which committee should be chosen.[2] We think there is little reason to doubt that such concerns do affect experts or committee-members, as well as other members of the community. In Terry Moe's words (1989, p. 172):

Most individuals in the expert market come with reputations that speak to their job-relevant traits: expertise, intelligence, honesty, loyalty, policy preferences, ideology. "Good" reputations provide reliable information. The reason is that individuals value good reputations, they invest in them - by behaving honestly, for instance, even when they could realize short-term gains through cheating ...

We shall model these concerns in a "reduced form", i.e., as an instantaneous reward to the lobbyist whenever he recommended the correct policy. We will think of the reward as the lobbyist's "prestige value". Utility from honest behavior could alternatively be modeled as a penalty for lying. Such a penalty, or statement-specific cost, is an example of what McCubbins and Lupia (1998) denote "external forces". Importantly, while

[2] Frisell (2001) presents a model where rewards are determined by the principal. The results of the two approaches are similar.

McCubbins and Lupia recognize that external forces can be a substitute for common interests, they may also serve as a substitute for informational precision.

The assumption of a binary space is, of course, a simplification. The reason for choosing this setup is twofold: First, we want to model a situation where advisors are only imperfectly informed, which is cumbersome to formalize with a richer space. Second, and more importantly, we are interested in situations where experts with different bias prefer different decisions. A binary state space, which really permits only two kinds of advisor bias, immediately provides such an environment.

The results of the paper rest on the assumption that lobbyists are unable to coordinate their strategies. The intuition why homogeneity of interests promote informational efficiency, in this non-cooperative environment, is in a sense the opposite of competition: the absence of competing interests makes it easier for the government to implement a decision rule that deters both lobbyists from dishonest behavior. More specifically, if a lobbyist reports his unpreferred state he will be pivotal to the decision with higher probability in a heterogeneous committee than in a homogeneous one. This deters lobbyists in heterogeneous committees from revealing unfavorable information.

The paper is structured as follows. Section 2 presents the formal model. The government starts out with one lobbyist that benefits from an uninformed decision, a "hawk". It then chooses with what type of lobbyist to complement the hawk. Section 3 contains the results. We show that, despite these lobbyists being a priori less inclined to share information, the government may prefer to match the hawk with another hawk. Ceteris paribus, higher informational precision works in favor of the homogeneous committee while higher prestige value works the other way around. Section 4 concludes.

2 The Model

An imperfectly informed government will make a policy decision, $d \in \{r, s\}$. There are two possible states of the world, $\omega \in \{0, 1\}$. In state 0, the government prefers to hold on to its current policy choice, "status quo" (s), while state 1 signifies that a policy change, "reform" (r), is desirable. The government wants to maximize its *accuracy*, i.e., the probability of making a correct decision.[3] Before the decision is made, the government may consult two lobbyists. Each lobbyist receives a signal of the state, s.t. $s_i \in \{0, 1\}$, $i = 1, 2$. Then, they independently send a message to the government, $m_i \in \{0, 1\}$. Finally, the government decides whether to initiate a reform or stick to the status quo.

[3]That is, the government maximizes $\Pr(d = s \cap \omega = 0) + \Pr(d = r \cap \omega = 1)$.

There are two types of lobbyists, i.e., a lobbyist is either a dove or a hawk. A dove receives a nonnegative payoff, his "vested interest", if reform is initiated, while the reverse holds for a hawk. For simplicity we let this payoff be the same for both doves and hawks, normalized to unity. A lobbyist's payoff from the "wrong" policy is zero. In addition, a lobbyist also cares about his prestige, which means that he gets a nonnegative utility u whenever his message turns out to be true.[4] Prestige gains are thus independent of the policy decision. Finally, we assume the vested interest to be more important than the value of prestige, i.e., $u \in [0, 1)$.

The players have a common prior over the states where we let $p = Pr(\omega = 0)$. We assume 0 to be the ex ante more probable state, i.e., $p > 0.5$.[5] The lobbyists' signals are statistically independent conditional on the state and their realization is private information. For simplicity we shall assume that the probability of a correct signal is identical in both states (and for both types of lobbyists), denoted q. Parameter q may be interpreted as a lobbyist's competence or informational precision. To rule out some uninteresting cases we make the following assumption:

Assumption 1 $p < q < 1$.

$p < q$ implies that signals are "influential" in the sense that a lobbyist's posterior of state 1 (0) given signal 1 (0), is larger than one half. $q < 1$ means that both signals are possible in each state, which pins down out-of-equilibrium beliefs.

To simplify the exposition, we will assume that the government has to consult at least one hawk. Hence, the government chooses between two types of committees, a homogeneous hawk committee and a heterogeneous committee. Note that since $p > 0.5$, a government that receives no additional information will implement policy s. Since hawks prefer s they will, other things equal, be less inclined to share information than doves. This means that if the homogeneous committee is preferred to the heterogeneous one, it must be for strategic reasons.[6]

[4]Note that this is not a concern for honest revelation per se. If the lobbyist had access to other information, reputational concerns could clearly drive him to misreport his signal. See, e.g., Ottaviani and Sörensen (1997).

[5]For simplicity, we ignore the case when the two states are equally probable.

[6]It is easily shown that a homogeneous dove committee is always (weakly) preferred to the other committees.

Strategies and Equilibrium

A pure strategy for the government is a mapping $d : \{0,1\}^2 \rightarrow \{r, s\}$. A pure strategy for lobbyist i is a mapping $l_i : \{0,1\} \rightarrow \{0,1\}$. Mixed strategies are defined accordingly. In order to eliminate some equilibria where the meaning of messages ("talk") is simply reversed, we impose the following intuitive restriction: a hawk (dove) always reports signal 0 (1) honestly. In other words, a lobbyist never lies in the "wrong" direction. This is a weak restriction since, if the government is aware of it and acts rationally, it is indeed in a lobbyist's interest to comply with it.

The game described has multiple equilibria. In particular, there are uninformative equilibria where hawks always send message 0, and the government gains no information relative to its prior (i.e., its accuracy is exactly p). To compare the efficiency of the two committees we shall focus on the most informative (perfect Bayesian) equilibrium for any set of parameters.

Definition 1 *In an informative equilibrium the government's accuracy is higher than* p.

3 Results

Suppose for a moment that the government takes advice from a single hawk. If the hawk sends message 0, the best thing the government can do is to implement policy s, since $p > 0.5$. This implies that the hawk would never reveal having received signal 1, since sending message 0 gives him his vested interest (which is larger than the value of prestige). When the government has access to two lobbyists, the situation improves. From each individual lobbyist's perspective, the government is now - at least potentially - better informed than before, and a hawk cannot be certain that sending message 0 leads to policy s being implemented.

Lemma 1 *In an informative equilibrium, the probability that a hawk (dove) sends message* 1 (0) *is positive.*

Proof. See the Appendix. ∎

3.1 The Hawk Committee

Consider first the government's decision rule. Recall that a hawk always reports signal 0 honestly. By Assumption 1, an optimal decision rule must have

$$d^*(0,0) = s,$$
$$d^*(1,1) = r.$$

The question is which policy the government should implement after one message of each kind. This, however, depends on the lobbyists' degree of dishonesty which, in turn, may depend on the government's decision rule. Consider a hawk's situation after signal 1. Let $\sigma \in [0,1]$ be the probability that the government implements policy s after receiving mixed messages. Further, let x be the probability that the other lobbyist is dishonest after receiving signal 1. Conditional on signal 1, the probability of the state being 0 and 1, respectively, is

$$\frac{p(1-q)}{q(1-p)+p(1-q)}, \text{ and } \frac{(1-p)q}{q(1-p)+p(1-q)}.$$

Further, the probability that the other lobbyist received signal 0 and 1, respectively, is

$$\frac{q(1-q)}{q(1-p)+p(1-q)}, \text{ and } \frac{(1-p)q^2+p(1-q)^2}{q(1-p)+p(1-q)}.$$

It follows that the lobbyist prefers to send message 1 if and only if

$$(1-p)qu + q(1-q)\sigma + ((1-p)q^2 + p(1-q)^2)x\sigma \geq$$
$$p(1-q)u + q(1-q) + ((1-p)q^2 + p(1-q)^2)(x + (1-x)\sigma).$$

Solving for u gives that

$$u \geq \frac{q(1-q) + \sigma\,(2q-1)\,(q-p)}{q-p} + x(1-2\sigma)\frac{((1-p)q^2 + p(1-q)^2)}{q-p}. \tag{1}$$

By Lemma 1, this constraint must be fulfilled for both lobbyists in an informative equilibrium. Note that, unless $\sigma = 0.5$, the minimum u depends on the other lobbyist's degree of dishonesty, x. Therefore, in the equilibrium with the lowest restriction on the prestige value, both lobbyists are equally dishonest. This enables us to characterize the value of x. In turn, using this x in (1) reveals that the minimum u is increasing in σ, which means that $\sigma = 0$ in the most informative equilibrium. Intuitively, by implementing policy r whenever at least one of the hawks sends message 1, the government minimizes each lobbyist's chances of changing the decision from r to s, and hence their incentive to be dishonest. We now have all components for characterizing the most informative equilibrium with the hawk committee.

Lemma 2 *With the hawk committee, the optimal decision rule has* $d^*(1,0) = d^*(0,1) = 1$.

Proof. See the Appendix. ■

Proposition 1 *With the hawk committee, the government's accuracy in the most informative equilibrium is*

$$q\frac{(1-p)(2pq-2p+q)}{2pq+q^2-2q^2p-p}. \tag{2}$$

The minimum prestige value that sustains informative equilibria, $\underline{u}^{HA}$, *is*

$$\frac{2pq(1-q)(1-2q-p+2pq)}{(2q^2p+p-2pq-q^2)(q-p)}. \tag{3}$$

Proof. See the Appendix. ■

For illustration, the necessary prestige value as a function of p (Figure 1) and q (Figure 2) is plotted below.

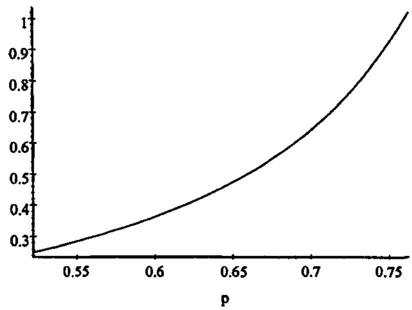

Figure 1. $\underline{u}^{HA}$ as a function of p ($q = 0.9$).

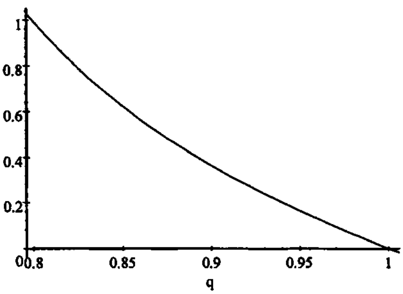

Figure 2. $\underline{u}^{HA}$ as a function of q ($p = 0.6$).

The necessary prestige value to induce honesty increases with p, the prior probability of state 0. The intuition is as follows. Suppose one hawk receives signal 1. The higher is p, the higher is the (conditional) probability that the other hawk received signal 0 and thus, that he sends message 0. In those cases the first hawk is pivotal to the decision, i.e., his message completely determines which policy is implemented. Since his vested interest is worth more than the prestige value, high p increases his incentive to be dishonest. High competence works in the opposite direction. The higher is q, the higher is the probability that the other lobbyist also received signal 1. If the other hawk sends message 1 the decision will be r independent of the first hawk's message, so the first hawk should be honest in order to maximize his chances to gain prestige.

3.2 The Heterogeneous Committee

We now perform the same analysis with a heterogeneous committee as with the hawk committee. Consider first the government's decision rule. Recall that a hawk reports signal 0 honestly, and that a dove reports signal 1 honestly. Let the first message in each message pair (m_1, m_2) be that of the dove. By Assumption 1, an optimal decision rule must have

$$d^*(1,1) = r,$$
$$d^*(0,0) = s,$$
$$d^*(0,1) = s.$$

To see that the last part of the decision rule is optimal, note that if the dove sends message 0, and the hawk sends message 1, both lobbyists have been honest; since $p > 0.5$, the government should implement policy s. Now, let $w \in [0,1]$ be the probability of the government implementing policy r after message pair (1,0). Further, let $\lambda \in [0,1)$ be the probability that a hawk is dishonest after signal 1, and $\mu \in [0,1)$ that of a dove being dishonest after signal 0. After receiving signal 1, the hawk (weakly) prefers to be honest if

$$(1-p)qu + q(1-q)(1-\mu) \geq$$
$$p(1-q)u + ((1-p)q^2 + p(1-q)^2)(1-w) + q(1-q)((1-\mu) + \mu(1-w)).$$

Rearrange this as

$$u \geq \frac{(q^2 + p - 2pq)(1-w)}{q-p} + \mu\frac{q(1-q)(1-w)}{q-p}.$$

The second term in this expression is nonnegative, which means that the necessary prestige value to induce honesty from the hawk increases with μ, i.e., the dove's degree of dishonesty. Since a lower μ also improves the government's accuracy, it must be true that $\mu = 0$ in the most informative equilibrium.[6] The hawk's incentive constraint is reduced to

$$u \geq (1-w)\frac{(q^2 + p - 2pq)}{q-p}. \tag{4}$$

[6]By Lemma 1, the dove must (weakly) prefer to be honest after signal 0 in an informative equilibrium, so setting $\mu = 0$ does not violate the dove's incentive constraint.

The second bracket in the expression is positive, which means that the necessary prestige value to induce honesty from a hawk decreases with w. Intuitively, the higher the probability that the government implements s after receiving mixed messages, the higher is the incentive for a hawk to be dishonest. Now consider the dove's situation. After signal 0, the dove prefers to be honest if

$$pqu \geq (1-p)(1-q)u + (pq^2 + (1-p)(1-q)^2)w + q(1-q)(\lambda w + (1-\lambda)).$$

Rearrange this as

$$u \geq \frac{q(1-\lambda)(1-q)}{p+q-1} + w\left[\frac{(1-q)^2 + p(2q-1) + q(1-q)\lambda}{p+q-1}\right]. \quad (5)$$

The second bracket in the above expression is positive, which means that the necessary prestige value from inducing honesty from a dove is increasing in w. By Lemma 1, both incentive constraints (4) and (5) must be satisfied in an informative equilibrium. Since the minimum u decreases with w in (4), and increases with w in (5), we obtain the optimal value for w by equalizing the RHS of the two constraints, which is done in the Appendix. For the moment, we note that in informative equilibria, $w \in (0,1)$.[7] In other words, after receiving message pair (1,0), the government randomizes between r and s.

Finally, we derive the equilibrium value of λ. Since the government randomizes between the two policies, it must be indifferent between them. This is possible if and only if $\Pr(\omega = 0) = \Pr(\omega = 1)$, or

$$pq(1-q) + pq^2\mu + pq(1-q)\lambda\mu + p(1-q)^2\lambda =$$
$$(1-p)q(1-q) + (1-p)q^2\lambda + (1-p)q(1-q)\lambda\mu + (1-p)(1-q)^2\mu.$$

Using that $\mu = 0$ and rearranging gives that

$$\lambda = \frac{q(1-q)(2p-1)}{(1-p)q^2 - p(1-q)^2}.$$

[7] Setting $w = 0$ in (4) or $w = 1$ in (5) gives a contradiction.

We now have all components for characterizing the most informative equilibrium with the heterogeneous committee.

Proposition 2 *With the heterogeneous committee, the government's accuracy in the most informative equilibrium is q. The minimum prestige value that sustains informative equilibria,* $\underline{u}^{HE}$, *is*

$$\frac{(2pq-q+1-p)\left(2pq+q^2-p-2pq^2\right)(q^2+p-2pqp)}{2p^2(1-p)+qp(8p^2-8p-1)+4pq^2(3p-3p^2+1)+2pq^3(4p^2-4p-3)+q^4(7p-2p^2-1)+q^5(1-2p)}. \tag{6}$$

Proof. See the Appendix. ■

The government's accuracy in the most informative equilibrium is exactly q with a heterogeneous committee; the same accuracy that it would achieve with a single lobbyist that was completely honest. This should be compared to the accuracy with a hawk committee (2). In fact, it is easily shown that this is always lower than q.[8] Hence, the hawk committee is (strictly) preferred to the heterogeneous one if and only if an informative equilibrium is sustainable with the former but not the latter. This finding is summarized below.

Proposition 3 *The hawk committee is strictly preferred to the heterogeneous one if and only if* $\underline{u}^{HA} \leq u < \underline{u}^{HE}$.

In Figure 3 we have plotted the difference in necessary prestige values (hawk minus heterogeneous). As defined, a negative z-value means that the informative equilibrium is "cheaper" to sustain with a hawk committee than with a heterogeneous one. Using the same intuition as in Proposition 1, this occurs when q is high and p is relatively small. As q is reduced, or p is increased, the necessary prestige value increases for both committees, but more so for the hawk committee than for the heterogeneous one. When q is small but not too small - so that an informative equilibrium still exists - the heterogeneous committee is "cheaper" than the conservative one. Importantly, an informative equilibrium with a heterogeneous committee always requires that $u > 0.5$. To the contrary, if informational precision is high, an informative equilibrium can be sustained with a hawk committee even if the prestige value is relatively small. In

[8] Suppose, to the contrary, that (2) $\geq q$. Some algebra reduces this to $-(2p-1)(1-q)(q-p) \geq 0$, a contradiction.

particular, if $q = 1$, the equilibrium is sustainable for any $u > 0$, i.e., when talk is "almost cheap".

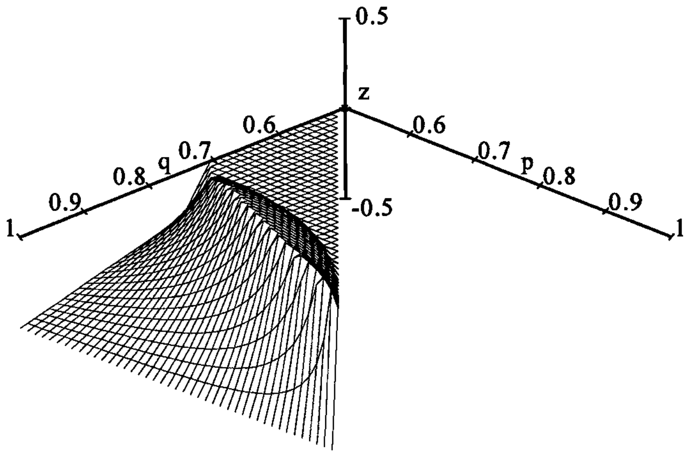

Figure 3. Difference in necessary prestige values $(\underline{u}^{HA} - \underline{u}^{HE})$.

4 Discussion

We have studied a simple game of information transmission between a government and two informed lobbyists. In previous works on strategic advice, decisionmakers optimally use advisors with opposing interests; heterogeneous committees foster "informational competition" among them, which is exploited by the decisionmaker. However, we show that diverging preferences may be harmful when one advisor prefers an uninformed decision. If this advisor refuses to pass on any knowledge, the conflict of interests will hamper the other one's ability to transmit information - which indeed induces the first advisor to retain his information. In real political situations, it is probably not uncommon that informed parties prefer uninformed decisions. Our results suggest that - as long as collusion among advisors can be prevented - such parties should sometimes be matched with more of the same kind. Although the issue has not been investigated here, nothing suggests that the intuition behind this result would be less valid if more than two advisors were available.

In several previous models, the existence of informative equilibria requires that advisors are perfectly informed, which is evidently an unrealistic assumption. In the current paper we relax this assumption but imagine that inaccurate messages impose a cost on the sender, i.e., a loss of prestige. We show that this external force works as a substitute for informational precision. The intuition is straightforward: the less certain is the assessment of one advisor, the higher is the probability that the other will benefit from distorting his own information. A higher prestige value may then "resurrect" the informative equilibrium.

Alternatively, the necessary prestige value may be considered as the minimum reward the decisionmaker must offer to induce honesty. Our results then suggest two things: First, if such rewards are limited in an absolute sense (in the model, if $u < 0.5$), heterogeneous committees can only do worse than homogeneous ones. Second, these rewards should primarily be directed to policy areas where the informational conditions are the weakest. The latter conclusion is in contrast with results from the principal-agent literature, where noisy environments are usually associated with less "powered" incentive schemes - due to agents' risk-aversion.

5 Appendix

Proof of Lemma 1.

Consider first a hawk committee. Suppose, contrary to the lemma, that one hawk always sends message 0. Since his message is completely uninformative, the government is in the same informational position as with a single hawk. Realizing this, the other hawk will also send message 0 always, in order to get his vested interest. Hence, no information is provided.

Consider now a heterogeneous committee. Suppose first that the dove always sends message 1. Then, the government had better choose policy s whenever the hawk sends message 0, because $p > 0.5$. However, this would induce the hawk to always send message 0, and no information is provided. Conversely, suppose the hawk always sends message 0. Consider the government's decision if the dove sends message 1. In equilibrium, the government must now be indifferent between policy r and s. If policy s was preferred, the dove would be induced to always report his signal honestly, to maximize prestige gains. If so, r should be implemented when the dove sends message 1. But if policy r is chosen, the dove is induced to always send message 1, and we have returned to the case above. Hence, the government must be indifferent between the two policies. Finally, if the government is indifferent after one message of each kind, its accuracy is no higher than what it would be if it were to choose policy s always, hence, no information is gained.

Proof of Lemma 2.

Recall that, in the informative equilibrium that puts the least restriction on u, each lobbyist is dishonest after receiving signal 1 with the same probability, x. We now derive the minimum x that supports an informative equilibrium. After one message of each kind the likelihood ratio between state 1 and 0 is

$$\frac{2(1-p)q(1-q)(1-x)+2(1-p)q^2x(1-x)}{2pq(1-q)(1-x)+2p(1-q)^2x(1-x)}.$$

Some algebra gives that the government (weakly) prefers decision r only if

$$x \geq \frac{q(1-q)(2p-1)}{q^2(1-p)-p(1-q)^2}.$$

In the most informative equilibrium, this constraint holds with equality. To simplify the exposition, let

$$A = \frac{q\,(1-q)\,(2p-1)}{(1-p)\,q^2-p\,(1-q)^2}\frac{(1-p)\,q^2+p\,(1-q)^2}{(q-p)}.$$

Substituting for the minimum value for x in (3) and rearranging gives that

$$u \geq q\frac{1-q}{q-p}+A+\sigma\,(2q-1-2A)\,. \tag{A1}$$

Now, if the second bracket on the RHS is positive, σ should be set to zero to minimize the necessary the prestige value. On the other hand, if it is negative σ should be set to one, which would contradict the lemma. Suppose this is the case. Setting $\sigma = 1$ reduces (A1) to

$$u \geq \frac{q^2+p-2qp}{q-p}-A.$$

By assumption, u is less than unity. Hence, an informative equilibrium requires that

$$\frac{q^2+p-2qp}{q-p}-A<1.$$

Rearrange and substitute for A to get

$$-2p\,(1-q)\,(q-p) > 0,$$

a contradiction. Hence, the minimum prestige value cannot be decreasing in σ in an informative equilibrium. This means that if informative equilibria are not sustainable when $\sigma = 0$, they are not sustainable at all, so that setting $\sigma = 0$ is without loss of generality.

Proof of Proposition 1.

Using the equilibrium values for x and σ in (1) gives directly $\underline{u}^{HA}$. Using $\sigma = 0$ gives that, in equilibrium, the probability that the government makes decision r though the state is 0, is

$$2pq(1-q)(1-x) + 2p(1-q)^2x(1-x) + p(1-q)^2(1-x)^2. \tag{A2}$$

The probability that it makes decision s though the state is 1, is

$$(1-p)(1-q)^2 + 2(1-p)q(1-q)x + (1-p)q^2x^2. \tag{A3}$$

Adding (A2) and (A3) gives that an incorrect decision is made with probability

$$\begin{gathered}2pq(1-q)(1-x) + 2p(1-q)^2x(1-x) + p(1-q)^2(1-x)^2 \\ +(1-p)(1-q)^2 + 2(1-p)q(1-q)x + (1-p)q^2x^2.\end{gathered}$$

Using the minimum value of x and subtracting the resulting expression from one gives (2).

Proof of Proposition 2.

The hawk's incentive constraint reads

$$u \geq (1-w)\frac{(q^2+p-2pq)}{q-p}, \tag{A4}$$

and that of the dove reads

$$u \geq \frac{q(1-\lambda)(1-q)}{p+q-1} + w\left(\frac{(1-q)(1-q)+p(2q-1)+q\lambda(1-q)}{p+q-1}\right). \tag{A5}$$

Setting the RHS of these two expressions to equality (using the equilibrium value for λ), and solving for w gives that

$$w = \frac{3q^4p+q^5+2q^4p^2-2q^5p-6p^3q^2-10p^2q^3+11p^2q^2-p^3-6p^2q+p^2+4p^3q+4p^3q^3-q^3+2q^2p-2q^3p}{2p^2(1-p)+qp(8p^2-8p-1)+4pq^2(3p-3p^2+1)+2pq^3(4p^2-4p-3)+q^4(7p-2p^2-1)+q^5(1-2p)}.$$

Using this value for w in either (A4) or (A5) gives (6). Further, given that an informative equilibrium exists, the probability of an incorrect decision is $\Pr(d=r\cap\omega=0)+\Pr(d=s\cap\omega=1)$, or

$$\begin{gathered}pq^2\mu w+pq(1-q)w+pq(1-q)(1-\lambda)\mu+pq(1-q)\lambda\mu w\\ +p(1-q)^2(1-\lambda)+p(1-q)^2\lambda w+(1-p)q^2\lambda(1-w)\\ +(1-p)q(1-q)(1-w)+(1-p)q(1-q)\lambda\mu(1-w)+(1-p)q(1-q)\lambda(1-\mu)\\ +(1-p)q(1-q)(1-\lambda)(1-\mu)+(1-p)(1-q)^2(1-\mu)+(1-p)(1-q)^2\mu(1-w).\end{gathered}$$

Using the equilibrium values for λ and μ reduces this messy expression to $1-q$. Hence, the government's accuracy is q.

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Chapter 2

Taking Advice from Imperfectly Informed Experts II: How Much to Pay for Coalition-Proofness

Taking Advice from Imperfectly Informed Experts II: How Much to Pay for Coalition-Proofness

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Abstract

A decisionmaker may take advice from either a homogeneous or a heterogeneous committee of imperfectly informed experts. Experts are extreme in the sense that they prefer certain policies irrespective of the contingency, and must be rewarded to reveal their information. We show that it is always cheaper to induce honesty from a homogeneous committee, however, experts in these committees have an incentive to collude. Our main result is that the higher the experts' accuracy, the more the principal is willing to pay to prevent such collusion. In addition, simultaneous and sequential advice have the same welfare properties.

1 Introduction

A major conclusion from the literature on strategic advice is that heterogeneous committees, i.e., committees where the participating experts have opposing interests, are informationally superior to homogeneous ones. (Gilligan and Krehbiel 1989, Krishna and Morgan 1999, 2000, Milgrom and Roberts 1986).[1] This means that to encourage information sharing, a decisionmaker should pick advisors who disagree on the desired outcome. In market terminology, the advisors engage in "informational competition", which shifts bargaining power from the informed advisors to the uninformed decisionmaker. By using advisors with opposing interests, the decisionmaker ensures that they compete rather than collude.

The current paper has two purposes. First, we want to clarify that heterogeneous preferences per se do *not* promote informational efficiency. The market analogy is correct in so far that opposing interests preclude collusion between experts, something that

*I am indebted to Karl Wärneryd for valuable comments.

[1]For example, Gilligan and Krehbiel (p. 463) state that "in the presence of uncertainty, diversity of interests on the committee promotes informational efficiency..." Krishna and Morgan (1999, p. 31) conclude that "...the committe is unable to exploit its power...because positive rents to one side mean negative rents to the other."

could thwart information extraction. However, if collusion can be prevented by other means, competition is more effective in homogeneous committees. Second, we want to extend the study on strategic advice to situations where experts have imperfect information. With few exceptions (e.g., Austen-Smith 1993, Battaglini 2000) the literature has modeled experts as perfectly informed. This assumption does not only simplify the analysis but, in Krishna and Morgan's words, "ensures that any improvement in information from combining the advice of the experts arises solely from the strategic interaction" (2000, p. 25). The assumption is not innocuous, however. As will be shown, introducing imperfect information on behalf of the experts has a qualitative effect on their interaction.

Imagine a government that faces a policy decision. The optimal policy depends on the state of nature, which is unknown. The government takes advice from two biased experts, "lobbyists", who can be of two different types. The expert committee can thus be of three types, homogeneous of either kind, or heterogeneous. Lobbyists prefer the same decisions irrespective of the state (they have "vested interests"), so that to induce information sharing the government must commit to reward truthful lobbyists. After receiving the lobbyists' messages, the government updates its prior and implements the policy (or one of the policies) with the highest expected payoff.

To gain as much information as possible, the government ensures that it will induce honest revelation from lobbyists. Given that honesty can be achieved, the government wants to minimize the cost of rewards. The necessary reward to induce honesty will depend on the lobbyist's accuracy and the composition of the committee. In particular, lobbyists in a homogeneous committee may have an incentive to coordinate their messages which, if possible, makes information extraction much more expensive. Alternatively, the cheapest honest PBE with a homogeneous committee is not coalition-proof.[2] The main purpose of this paper is to investigate how much - if anything - the government is willing to pay to prevent collusion between homogeneous lobbyists.

The remainder of the paper is organized as follows. Section 2 reviews some related work and section 3 outlines the formal model. Section 4 contains the results and section 5 concludes.

2 Related literature

Crawford and Sobel (1982) study a signalling game with cheap talk. There is one perfectly informed agent and one uninformed principal. The agent sends a message to the principal, whose subsequent decision affects the welfare of both parties. The state

[2]In the sense of Bernheim, Peleg, and Whinston (1987).

space is the unit interval and the agent's and principal's preferred decision (as a function of the state) differ by a known amount, b. The authors show that as long as $b \neq 0$, the sender must include some noise in his message to be credible, and full information revelation never occurs.

Gilligan and Krehbiel (1989) and Krishna and Morgan (2000) extend the analysis in Crawford and Sobel by letting the principal consult two experts instead of one. Gilligan and Krehbiel consider simultaneous advice while Krishna and Morgan study a sequential order. Both studies find that information extraction is facilitated when experts are biased in opposite directions vis-à-vis the principal (e.g., $b_1 < 0 < b_2$). In particular, contrary to the case with a single advisor, full revelation now occurs in certain states. It is instructive to review the (open rule) mechanism in Gilligan and Krehbiel. The principal adopts a decision rule that, roughly, states the following: "If both experts recommend the same policy, I will follow their advice and implement that policy, call it I (for Informed). However, if their messages disagree - no matter by how little - I will implement some other policy U (for Uninformed)." Now, given the principal's strategy, if one expert reveals the true state, the other expert chooses de facto between decisions I and U. It follows that full revelation is an equilibrium in those states - and only in those states - where both agents prefer an informed decision to an uninformed one.[3]

This argument should however, contrary to the conclusion of Gilligan and Krehbiel, imply that homogeneous committees (e.g., where $b_1 = b_2 < 0$) are preferred to heterogeneous ones. Inevitably, the smaller is the difference in bias between agents, the more states there can be where both agents agree that an informed decision is preferable. Indeed, Krishna and Morgan (2000) note that with simultaneous advice, full revelation in every state is a PBE with a homogeneous committee. The problem with a homogeneous committee, however, is of course that there are decisions that the experts *jointly* prefer to I - in every state of nature. Hence, if experts can coordinate their messages, homogeneous committees will provide very little information.

Milgrom and Roberts (1986) use a multi-dimensional setting with an arbitrary number of advisors. Importantly, they assume that the true state must be included in any advisor's message to the decisionmaker. In a sense, an advisor must here tell "the whole truth" but not necessarily "nothing but the truth". Due to this assumption, we get a stronger result: Provided that in any state, there is at least one advisor who prefers the full-information decision to any other decision (i.e., advisors are heterogeneous), the

[3]In Gilligan and Krehbiel, U is always the same decision. Krishna and Morgan (1999) show that by letting U depend on the nature of the disagreement, it is possible to achieve full revelation in *every* state. However, this requires that preferences are not too divergent, e.g., that $|b_1| + |b_2| < \frac{1}{2}$ in the "uniform-quadratic" specification.

full-information decision will be the outcome in any pure-strategy Nash equilibrium.

Austen-Smith (1993) studies strategic advice with two imperfectly informed experts. His principal finding is that, in contrast to Krishna and Morgan (2000), sequential advice is informationally superior to simultaneous advice. However, this result is due to the experts' risk-aversion, which gives a strong incentive for information-sharing. Briefly, a (biased) risk-averse expert is more inclined to send an informative message when he knows the other expert's information, since the consequences of his message then are easier to foresee.

Less related papers include Dewatripont and Tirole (1998) and Shin (1994). Dewatripont and Tirole provide a rationale for the use of partisan advocates. They conclude that competition among enfranchised agents generates better results than using neutral advocates who are "impaired by their pursuing several conflicting causes at one time" (p. 33). However, these efficiency gains stem from the advocates' interests being aligned with those of their clients, rather than from the heterogeneity of interests as such. In Shin's model, an arbitrator is to determine the appropriate compensation to a plaintiff. Shin shows that the arbitrator's optimal decision rule changes with the informational precision of the parties involved. In the present model, a change in informational precision changes the cost of inducing honesty from a homogeneous committee.

3 The Model

A government is about to make a policy decision, $d \in [0,1]$. There is a continuum of states, $\omega \in [0,1] = \Omega$, and the government's objective is to match the state of nature with the corresponding policy, i.e., it maximizes $\Pr(d = \omega)$. Before the decision is made, the government consults two informed lobbyists. There are two types of lobbyists, leftists and rightists. A leftist lobbyist's payoff from the policy is $1 - d$, and a rightist's is d. Hence, unlike the government, lobbyists are not interested in what is the state of nature (their interests are "vested"). In addition, lobbyists get utility from monetary rewards.

The game works as follows. The government starts out by instituting rewards for truthtelling. We assume that the government can commit ex ante to reward lobbyists ex post, i.e., it may condition rewards on the state.[4] The lobbyists then receive a signal of the state, $s_i \in [0,1]$, $i = 1,2$. After receiving their signals, each lobbyist sends a message to the government, $m_i \in [0,1]$. The government then makes a decision. Finally, the state is revealed and players collect their payoffs. All aspects of the game except the lobbyists' signals are common knowledge.

[4] For simplicity we assume that the state is known with certainty ex post, but this is not crucial.

Players have a common, atomless prior over states, $F(\omega)$ which, for simplicity, we assume to be uniform. The lobbyists' signals are statistically independent and their realization is private information. With probability $q \in (0,1]$ a lobbyist becomes informed of the state (i.e., the signal reflects the true state), and with probability $1-q$ the signal is completely uninformative (random). We will refer to q as the lobbyists' *competence*. Hence, a lobbyist's posterior belief, after receiving signal t, is given by

$\Pr(\omega = t) = q$,
and the density function $g(\omega) = (1-q); \qquad \forall \omega \neq t.$

The government wants to maximize the probability of making a correct decision, which means that it will induce honest revelation from at least one of the lobbyists. Given that honesty is achieved, the government minimizes the expected cost of rewards. We shall assume that negative rewards are not enforceable. If they were, the government could deter dishonesty at zero cost by penalizing erroneous lobbyists severely enough. The composition of the committee would then be of little interest. On the other hand, there is no reason to pay the same reward for all truthful messages, since lobbyists have different interests in different policies.

Note that honesty from more than one lobbyist serves no informational purpose. In case of two identical (honest) messages, the second serves obviously no purpose, and in case of two different messages, the government is indifferent between those policies. This means that the only virtue of consulting more than one lobbyist is the impact this may have on rewards.

Strategies and Equilibrium

We will consider both simultaneous and sequential advice. With simultaneous advice, a (pure) strategy for lobbyist i is simply a mapping $l_i : [0,1] \rightarrow [0,1]$, $i = 1,2$. With sequential advice the lobbyist who reports second gets to observe the message of the first lobbyist. Hence, the second lobbyist's strategy is now a mapping $l_2 : [0,1]^2 \rightarrow [0,1]$. The first lobbyist's strategy remains unchanged. A (mixed) strategy for the government is (i) a decision rule $d : [0,1]^2 \rightarrow X$, where X is the space of (Borel) probability measures over the unit interval, and (ii) two reward schemes $r_i : \Omega \times [0,1]^2 \rightarrow \Re_+$.

In honest equilibria, which are the only ones considered here, the strategies take simple forms. To eliminate mirror image equilibria, i.e., equilibria that are functionally equal to each other, we assume that the government interprets messages literally. This means that an honest lobbyist reports his actual signal, $m_i = s_i$, $\forall s_i$. Given honesty, after two identical messages m, the posterior of state m is one. (The possibility that both lobbyists received signal m in some other state is a zero probability event.) After two different messages m and n the posterior probability of these two states is the same.[5] Hence, in an honest (perfect Bayesian) equilibrium, the government's decision rule must be of the following form:

$d^*(m,m) = m.$
$d^*(m,n) \in \triangle^{\{m,n\}}.$

Below, we characterize the reward schemes that minimize expected reward costs for a heterogeneous committee and a homogeneous committee. Finally, we briefly discuss the implications of letting the lobbyists coordinate their strategies.

4 Results

4.1 Single Lobbyist/Heterogeneous Committee

As a benchmark, we start by solving for the necessary rewards to induce honesty from a single lobbyist. Clearly, an optimal reward scheme has the following form:

$$r = \begin{matrix} f(m) & \text{if } m = \omega, \\ 0 & \text{otherwise.} \end{matrix}$$

Suppose, e.g., that the government consults a rightist lobbyist and has committed to pay reward $f(m)$ if the lobbyist reports the true state. If the lobbyist reveals signal s honestly his direct payoff is s, since that policy will be implemented. He also gets $f(s)$ with probability q. Hence, on expectation, honesty pays

$$s + qf(s).$$

The best deviation from honesty for a rightist lobbyist is naturally to send message 1. The probability that the state is 1 given some other signal is zero. Hence, to deter dishonesty, $f(m)$ must satisfy

[5]Specifically, the posterior probability of state m and n are $\frac{q(1-q)}{2q(1-q)+(1-q)^2}$ and the posterior density function is $\frac{(1-q)^2}{2q(1-q)+(1-q)^2}$ $\forall \omega \neq m, n$.

$$m + qf(m) \geq 1; \qquad \forall m.$$

In other words, the optimal reward scheme is

$$r^* = \begin{cases} \frac{1-m}{q} & \text{if } m = \omega, \\ 0 & \text{otherwise.} \end{cases}$$

Intuitively, the necessary reward decreases with q, i.e., the lobbyist's competence. For any given prior, the lower is q the lower is the probability that the lobbyist will reap the reward. However, by the same argument, reward costs are independent of q. The expected cost of inducing honesty is simply

$$q \int_0^1 \left(\frac{1-\omega}{q} \right) d\omega = 0.5.$$

We now turn to the heterogeneous committee. Below, we conjecture that the expected reward cost for a heterogeneous committee (irrespective of the order of advice) is identical to that for a single lobbyist, i.e., 0.5.[6] Moreover, as argued before, the government gains no additional information from consulting two lobbyists instead of one. This means that a heterogeneous committee has no effect on government welfare, as compared to a single lobbyist. The intuition for the result is that the interests of different types of lobbyists are perfectly opposed, so that increasing one lobbyist's incentive for honesty, (i.e., making his message less pivotal to the decision), immediately decreases the other's incentive by the same magnitude.

Conjecture 1 *The expected reward cost for a heterogeneous committee is 0.5.*

Sketch of Proof. See the Appendix.

[6] We have not proven that this holds in general, only for a certain class of decision rules.

4.2 Homogeneous Committees

We now investigate how the situation changes when two lobbyists of the same type are consulted. We first consider simultaneous and then sequential advice. Suppose, e.g., that there are two rightists who send messages m and n, respectively. Consider the decision rule

$d(m,n) = \min(m,n)$.

With this rule, a lobbyist is only pivotal to the decision if he sends the lowest message, which should give the best possible incentive for honest revelation (for rightist lobbyists). Likewise, with a committee of leftists the government should implement the highest message.[7]

Independent advice

Suppose a lobbyist has received signal s. With probability q^2 the other received s as well, and with probability $(1-q^2)$ he received some other signal, say, t. Given that the other lobbyist is honest, honest revelation gives a direct (expected) payoff of

$$q^2 s + (1-q^2)\left[\Pr(t<s)E[t \mid t<s] + \Pr(t>s)s)\right].$$

With a uniform prior, this equals

$$\frac{s(2-s+q^2 s)}{2}.$$

The best deviation for a rightist lobbyist is, naturally, to send message 1. The expected payoff from sending 1 after signal s, given that the other lobbyist is honest, is

$$q^2 s + 0.5(1-q^2).$$

The difference in direct payoff is

[7] However, we do not provide a formal proof that these decision rules are optimal.

$$\frac{-(1-2s+s^2)(1-q^2)}{2}.$$

This means that the cheapest reward scheme that induces honesty is

$$r_i^* = \begin{cases} \frac{(1-2m+m^2)(1-q^2)}{2q} & \text{if } m_i = \omega, \\ 0 & \text{otherwise.} \end{cases}$$

This holds for both lobbyists so that the total (expected) reward cost is

$$2q\int_0^1 \frac{(1-2\omega+\omega^2)(1-q^2)}{2q}d\omega = \frac{(1-q^2)}{3}.$$

Hence, expected reward costs are decreasing in the lobbyists' competence. The intuition is as follows. The higher is the lobbyists' competence, the higher is the probability that they receive the same signal. If they do, a dishonest message can only change the outcome downwards, so that neither lobbyist has a reason to deviate. When informational precision is perfect, the two lobbyists always receive the same signal so that honesty is achieved at zero cost.

Sequential advice

Let s and m denote the first lobbyist's (the lobbyist who reports first) signal and message, respectively, and t and n those of the second lobbyist. Given that the second lobbyist is honest, the first lobbyist is in the same strategic position as before. Hence, his reward scheme is

$$r_1^*(m) = \begin{cases} \frac{(1-2m+m^2)(1-q^2)}{2q} & \text{if } m = \omega, \\ 0 & \text{otherwise.} \end{cases}$$

The expected cost of this reward scheme is, as before, $(1-q^2)/6$. Now, since the second lobbyist observes the message of the first lobbyist, the government may condition his reward on this message. Note that no rewards are necessary to induce honesty from the second lobbyist if $t \geq m$, since a deviation from honesty on his part can only change the decision downwards. However, when $t < m$ the second lobbyist is pivotal to the decision upwards. By sending a message $n \geq m$ the second lobbyist knows that m will be implemented, and he makes a direct gain of $(m-t)$ as compared to honest revelation. The probability that the state is t when $t \neq s$ is

$$\frac{q(1-q)}{2q(1-q)+(1-q)^2}.$$

It follows that the optimal reward scheme for the second lobbyist is

$$r_2^*(m,n) = \begin{cases} (m-n)\frac{2q(1-q)+(1-q)^2}{q(1-q)} & \text{if } n < m \text{ and } n = \omega, \\ 0 & \text{otherwise.} \end{cases}$$

The probability that the second lobbyist receives a lower signal than the first is $(1-q^2)/2$. The expected difference between signals is

$$\int_0^1 \int_0^1 |t-s|\, dsdt = \frac{1}{3}.$$

Hence, the expected reward cost for the second lobbyist is $(1-q^2)/6$, which is identical to that of the first lobbyist.[8] This leads to the following result.

Conjecture 2 *The expected reward cost for a homogeneous committee is* $\frac{(1-q^2)}{3}$.

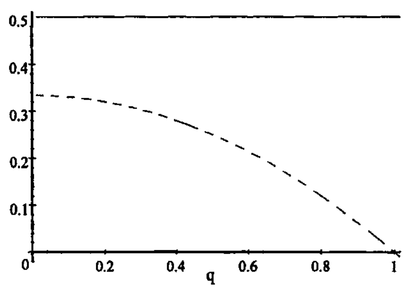

Figure 1. Reward costs for a heterogeneous (solid) and a homogeneous committee (dotted).

[8]The reward r_2^* is only paid in a fraction $\frac{q(1-q)}{2q(1-q)+(1-q)^2}$ of all cases.

We summarize our findings in the proposition below.

Proposition 1

(i) A homogeneous committee is superior to both a single lobbyist and a heterogeneous committee.
(ii) Simultaneous and sequential advice have the same welfare properties.
(iii) The advantage of homogeneous committees increases with the lobbyists' informational precision.

The first result is in contrast to a large part of the previous literature on strategic advice. Certainly, Krishna and Morgan (2000) recognize that a homogeneous committee is informationally superior to a heterogeneous one with simultaneous advice.[9] However, they argue that this informational advantage is neither robust to a sequential order, nor the introduction of imperfect information. They also conclude that simultaneous advice is informationally superior to a sequential order. Our results show that these conclusions are not true in general. In particular, with sequential advice the government will only reward the second lobbyist when he sends a less favorable message than the first. Since experts are risk-neutral, the government can reward the second lobbyist in direct proportion to the implicit cost of his message, so that the government is no worse off than under simultaneous advice. The third result has, to our knowledge, no precedents in the literature. As mentioned before, most previous studies assume that experts are perfectly informed. The result suggests that, ceteris paribus, we should expect to find homogeneous committees more often in environments where experts are relatively well-informed. Potentially, this hypothesis could be tested empirically.

Collusion

We have modeled this game of advice in a standard, non-cooperative setting. However, in many contexts, it may be natural to assume that players can freely discuss their strategies. If such communication is possible, the honest equilibrium described with a homogeneous committee is not plausible.[10] For example, given the decisionmaker's

[9]Specifically, in their model, full revelation is a PBE for a wider parameter range with a homogeneous committee than with a heterogeneous one.
[10]Formally, the equilibrium is not "coalition-proof". For more on this, see Bernheim, Peleg, and Whinston (1987).

strategy above, two rightist lobbyists could achieve payoff one by agreeing to always send message 1. On the other hand, if the government is aware that communication is possible, it may take (potentially costly) steps to prevent it from taking place. Hence, the difference between the two curves in Figure 1 gives the government's willingness to pay to prevent collusion.

5 Conclusion

In this paper we model strategic advice in a risk-neutral environment. An uninformed principal takes advice from two imperfectly informed experts. Experts prefer certain decisions irrespective of the state, so that there are no exogenous incentives for information sharing. We show that, as long as communication between experts is prevented, homogeneous committees enable information extraction at a lower cost than heterogeneous ones. This holds notwithstanding if advice is simultaneous or sequential.

The intuition for the result is as follows. If the experts' messages disagree when the committee is homogeneous, the decisionmaker can ignore the expert who reported their most preferred state, and trust the other lobbyist. This strategy makes each expert pivotal to the decision only in states that he dislikes, which reduces the necessary compensation to induce honesty. In the terminology of Milgrom and Roberts (1986), with a homogeneous committee the decisionmaker has a credible *skeptical* strategy. This is not the case when experts are heterogeneous. If their messages disagree, the principal must decide which expert was dishonest. A decision rule encouraging one expert to be honest immediately makes dishonesty more attractive for the other one.

The main result is that the "informational advantage" of homogeneous committees increases with informational precision. In particular, when experts are perfectly informed, full information revelation is achieved at zero cost. On the other hand, if experts could coordinate their strategies, inducing honesty from homogeneous committees would become very costly. This means that the higher the experts' accuracy, the more the decisionmaker is willing to pay to prevent collusion.

6 Appendix

Proof sketch of Conjecture 1.

Consider decision rules that are "monotone" in the following sense: Suppose that after receiving messages m and o, where $m < o$, the decisionmaker implements policy o with probability $\lambda \in [0, 1]$. The government's decision rule is monotone only if after messages n and o, where $n < o$, the probability that policy o is implemented is larger (smaller) than λ if $n > (<)\ m$. In words, holding the highest message o as fixed, the probability that o is implemented must not decrease with the other expert's message. The analogous constraint is required to hold when the lowest message is held as fixed. We claim, but do not prove, that restricting attention to monotone rules is without loss of generality.

Let the first message be the leftist lobbyist's. Consider the government's decision rule after message pair $(0,1)$. In a PBE, the decision rule must be

$$d(0,1) = \begin{matrix} 0 \text{ with probability } \lambda, \\ 1 \text{ with probability } 1-\lambda, \end{matrix}$$

for some $\lambda \in [0,1]$. Now, consider the leftist lobbyist's decision after receiving some message s. The probability that the rightist lobbyist also received signal s is q^2, and the probability that he received some other signal, $t \neq s$, is $(1-q^2)$. Given a monotone decision rule, the leftist's best deviation from honesty is to send message 0. If he deviates, the leftist gets a direct payoff of at least $\lambda(1-0)+(1-\lambda)(1-m)$, where m is the rightist's message. Let b_i, $i = L, R$, be the (expected) reward for honestly revealing a certain signal. It follows that, given that the rightist lobbyist is honest, the leftist is honest if and only if

$$\begin{gathered} q^2[1-s]+(1-q^2)[1-d(s,t)]+b_L \geq \\ q^2[\lambda(1-0)+(1-\lambda)(1-s)]+(1-q^2)[\lambda(1-0)+(1-\lambda)(1-t)]. \end{gathered}$$

Recall that all signals are equally probable and that the expected value of the signals is 0.5. Using this and rearranging gives that the expected value of the leftist's reward satisfies

$$E[b_L] \geq \frac{q^2+\lambda-1}{2} + (1-q^2)\iint d(s,t)dsdt.$$

Analogously, given that the leftist lobbyist is honest, the rightist is honest after signal t if

$$\begin{gathered} q^2t+(1-q^2)d(s,t)+b_R \geq \\ q^2[\lambda t+(1-\lambda)]+(1-q^2)[\lambda s+(1-\lambda)]. \end{gathered}$$

Rearranging gives that

$$E[b_R] \geq \frac{1-q^2-\lambda}{2} - (1-q^2)\iint d(s,t)dsdt.$$

Adding the expected cost of the two rewards gives that the total reward cost satisfies

$$E[b_L] + E[b_R] \geq 0.5.$$

Finally, it is easy to find a decision rule with exactly expected cost 0.5. For example, this is achieved by the rule that always assigns the same probability to each lobbyist's message (whenever the messages differ).

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Chapter 3

On the Interplay of Informational Spillovers and Payoff Externalities

On the Interplay of Informational Spillovers and Payoff Externalities

Lars Frisell*

Abstract

Informational spillovers induce agents to outwait each other's actions in order to make more informed decisions. If waiting is costly we expect the best informed agent, who has the least to learn from other agents' decisions, to take the first action. In this paper we study the interplay between informational spillovers and a direct payoff externality. We show that when the payoff externality is positive or relatively weak, the above intuition is validated. On the contrary, if the externality is negative and very strong the best informed agent has the most to gain from outwaiting the other agent.

1 Introduction

A fundamental insight from information economics is that informational asymmetries, rather than "material" differences, such as preferences or capabilities, often explain behavioral variations among agents. For an economist the former kind of asymmetries is of greater interest since information (but not personal characteristics) can be shared and exchanged. Furthermore, even if agents are not engaged in an exchange of information per se, if behavioral variations are caused by private information, actions will carry informational content in themselves. Such informational spillovers are interesting both from a welfare perspective (like any externality, it gives rise to inefficiencies), and from a behavioral perspective, since agents take the informational value of their own actions as well as those of others into account. In particular, the literature has studied the occurrence of herd behavior, a situation where agents take the same, possibly nonoptimal, action regardless of their private information (Banerjee 1992, Bikhchandani, Hirschleifer and Welch 1992, Gale-Chamley 1994, Scharfstein and Stein 1990).

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In this paper we extend the study on informational spillovers to situations where agents' payoffs are directly linked through their actions. This link, or payoff externality, could represent numerous mechanisms, such as movements in asset prices, crowding-out effects, or environmental consequences. Indeed, we can think of few circumstances where informational spillovers are present but payoff externalities are not. The focus of the paper is on how the payoff externality, depending on its sign and size, affects the timing of actions.

We model a situation where two firms are about to enter a new product market. A firm must both choose where to position itself in product space (the firm's "niche"), as well as when to enter the market. Demand varies depending on which niche a firm chooses, but the exact demand structure is unknown. Both firms have some private information which they use - possibly together with the other firm's entry decision - to infer where demand is high. The payoff externality reflects how firms interact in the market: a negative externality means that products are strategic substitutes (which drives firms further apart in product space), a positive externality that products are strategic complements (which drives firms towards the same niche).

In Banerjee (1992) and Bikhchandani, Hirschleifer and Welch (1992), a large number of agents make a binary decision in an exogenously given order. The outcome of the two alternatives is uncertain and each agent receives an imperfect signal of which alternative is the better. Agents' interests are fully aligned, so that the only impact of one agent's choice on another is the informational value his or her action provides. Zhang (1997) uses the same setting but endogenizes the decision order. Moreover, each agent's accuracy is now private knowledge so that any agent with less than perfect information could potentially benefit from observing another agent's action. Zhang shows that, by assuming delay to be costly, the best informed agent takes the first action in the unique symmetric PBE. The intuition is of course that poorly informed agents, on expectation, have more to gain from observing others' decisions.[1] In fact, this result was conjectured by Bikhchandani, Hirschleifer and Welch (1992).

Other papers that study the endogenous decision order with asymmetric agents include Bolton and Farrell (1990), Gul and Lundholm (1995), and Hendricks and Kovenock (1989). However, none of these papers studies the interplay of informational spillovers and direct externalities.[2] In Gul and Lundholm, two agents receive a signal of the value of a project. Their task is to correctly estimate the size of the project,

[1] Zhang's starkest conclusion is that an informational cascade starts immediately after the first agent's action. Then all agents mimic her decision, since the first agent's action is more informative than any private signal.

[2] In Martensen (2000), asymmetrically informed firms enter a market where post-entry competition takes place. However, the decision order is then exogenous.

which always equals the sum of the two signals. The second agent will thus be able to forecast the project with certainty, hence a strong informational spillover is present. Due to discounting, a high signal - indicating high future profits - implies that delay is more costly. As a result, in the symmetric PBE, types with higher signals make their estimates first.[3] In Bolton and Farrell, two firms consider entry in a natural-monopoly market and differ with respect to the cost they incur in case of entry. Time is discrete so that there is a positive probability that both firms choose to enter at the same time, which hurts a high-cost firm more than a low-cost firm. The authors show that in the symmetric equilibrium, low-cost firms enter earlier (in a specific sense) than high-cost firms.

This paper is organized as follows. In section 2, we set up the model. Both time and action space are continua.[4] It is important to note that the only asymmetry between firms ex ante is their informational precision. Section 3 contains the results. We focus on a symmetric equilibrium where the firms' waiting strategy is strictly monotone and differentiable. The main result is that if products are close substitutes (in a specific sense), the *worst* informed firm enters first in equilibrium. Section 4 concludes and discusses some extensions. All proofs are found in the Appendix.

2 The Model

Two firms $i \in \{A, B\}$ will enter a new product market. Each firm must make two decisions: it must choose a product design $\theta_i \in \Re$, and when to enter the market $t_i \in [0, \infty) = T$. Entry decisions are irreversible and the first firm's decision is observed by the other firm. Profits depend on entry decisions in two ways. First, firm i:s profit decreases with the distance between θ_i and ρ, where ρ is an unknown parameter. Firms receive an unbiased signal of ρ, such that $\rho_i = \rho + \epsilon_i$, where ϵ_i is a normally distributed s.v. with mean zero and variance v_i. Hence, each firm has two pieces of private information, a signal of the state and the precision of that signal. In words, ρ represents the (a priori) most profitable market niche. If θ_i is far from ρ the firm has chosen an unattractive product design, an event that is more likely the higher v_i

[3]Importantly, Gul and Lundholm identify a phenomenon they call *anticipation*. Briefly put, as delay decreases monotonically with the signal, the first agent to make an estimate (in equilibrium) will rationally revise her expectation of the project's size downwards - simply because the other agent has not made an estimate so far. In the present model, there is a phenomenon closely related to anticipation; in the symmetric equilibrium we investigate, the second firm is able to infer the first firm's informational quality, which allows it to make a more precise estimate.

[4]With a continuous space, we avoid payoff discontinuities like that in Zhang (1997). To achieve existence of equilibrium, Zhang must add an unknown cost that is revealed after the first agent's entry. A similar construction could have been used here.

is. For simplicity we assume that variances are drawn from a uniform distribution on $[0, \bar{v}] = V$. All draws are conditionally independent.

Second, both firms' profits are affected by the distance between θ_A and θ_B, which captures the market interaction between firms. If products are (strategic) complements, firms benefit from choosing similar designs, and vice versa if products are (strategic) substitutes. For example, think of the entry decision as the introduction of a new color of house paint. Though each consumer has a genuine preference for certain colors (which determines the demand structure), the purchasing decision may also be influenced by the color of the neighbors' houses. Hence, whether products are complements or substitutes is determined by whether consumers like or dislike living in neighborhoods with similarly painted houses.

Finally, firm i:s payoff is decreasing in t_i, the time the firm enters the market. This could, e.g., reflect the fact that corporate resources are tied up as long as the decision is delayed, resources that could have been put to use elsewhere. A simple payoff function with these properties is

$$\pi_i(\theta_i, \theta_j, t_i) = -(\theta_i - \rho)^2 - \alpha(\theta_i - \theta_j)^2 - \delta t_i,\ i \neq j.$$

Parameter α characterizes how firms interact in the market. If α is positive (negative), products are strategic complements (substitutes), since firms benefit from decreasing (increasing) the distance between θ_A and θ_B. If $\alpha = 0$, the externality is absent and we have a case of pure informational spillovers. Parameter $\delta > 0$ measures the degree of urgency; the higher is δ, the more costly it is to delay the entry decision.

The Waiting Game

Since signals are unbiased, a firm's particular signal realization has no effect on the incentive to learn of the other firm's information, and should therefore have no effect on the choice of timing. This allows us to consider the entry decision (the choice of θ) and the timing decision (the choice of t) separately. Consider first the entry decision. There are two possibilities, either firm i enters as the leader or as the follower. Below, we impose sufficient conditions to ensure that the leader's and the follower's optimal decision, as a function of their available information, are unique. In turn, this allows us to characterize expected payoffs in terms of variances v_A and v_B only, which is done in the next section. At present, denote the leader's expected payoff (excluding delay) $L_i(v_i, v_j)$, and the follower's $F_i(v_i, v_j)$.

Consider now a firm's waiting strategy. Since delay is costly, once one firm has entered the other will follow as soon as possible. For simplicity we assume that there is no involuntary delay, so that both firms' delay is determined by the leader's choice.[5] Hence, it is sufficient to consider strategies that are conditional on the fact that the other firm has not entered. We restrict attention to "stopping time" strategies of the kind $s_i : V \to T$, $i = A, B$. That is, a (pure) waiting strategy is a mapping from a firm's variance to a nonnegative number, i.e., the time the firm enters given that the other firm has not entered up to that moment. For simplicity, we assume that $s_i(v)$ is a strictly monotone and differentiable function. This implies two things. First, since variances are drawn from an interval, the probability that both firms enter at the same time is a set of measure zero, so that event can be ignored. Second, each strategy has an inverse function $s_i^{-1}(\cdot)$ that maps each point in time to a unique variance. This means that when the first firm enters, the other firm can (perfectly) infer its variance.[6] Further, since the prior distribution of variances is uniform, as long as no entry has occurred each firm's posterior of the other's variance is also uniform.

Suppose that firm i draws variance v_i and that the firms use strategies $s_i(v)$ and $s_j(v)$. Firm i:s expected payoff can then be written $(i \neq j)$

$$\hat{\pi}_i(s_i, s_j, v_i) =$$

$$\int\limits_{v_j \in \{V: s_i(v_i) < s_j(v_j)\}} (L_i(v_i, v_j) - \delta s_i(v_i)) dv_j \quad + \int\limits_{v_j \in \{V: s_i(v_i) > s_j(v_j)\}} (F_i(v_i, v_j) - \delta s_j(v_j)) dv_j. \qquad (1)$$

Let μ_i be firm i:s posterior over firm j:s variance. A strategy profile $s = \{s_i, s_j\}$ and a belief system $\mu = \{\mu_i, \mu_j\}$ constitute a perfect Bayesian equilibrium if $\hat{\pi}_i$ and $\hat{\pi}_j$ are maximized given μ and the other firm's strategy, and μ is consistent with s in terms of Bayesian updating.[7] In the following we shall focus on the symmetric PBE, which is natural given the ex ante symmetry between firms. That is, we impose the condition

[5] This assumption simplifies matters since we do not have to be concerned with the "monopoly profits" the first firm would make before the other firm enters. However, the introduction of a period of monopoly profits would not change any results. (As long as these profits are not too large compared with overall profits.)

[6] Without this inference, the follower must base his entry decision on an expectation of the leader's variance. Though this does not have a qualitative effect on incentives - the worst informed firm is still the worst informed - it severely complicates derivations. In particular, we have not been able to prove that the equilibrium in Proposition 1 is unique in the class of symmetric equilibria. (There are clearly asymmetric equilibria.)

[7] Formally, let maps $S_i^V : V_i \to S_i$ be a firm's set of pure strategies in the "expanded game" (Fuden-

$$s_A(v) = s_B(v), \quad \forall v \in V.$$

3 Results

3.1 Entry Decisions

We now characterize the leader's and follower's expected payoff as a function of their variances. In order to guarantee interior equilibria we must put a lower bound on α, i.e., we have to assume that products are not too close substitutes. If they were, there would be an equilibrium where firms ignored their private information and resorted to "maximal differentiation", which, in fact, would result in infinite profits. Alternatively, the bound below ensures that the leader actually uses its private information.[8]

Assumption 1 $\alpha > \frac{\sqrt{5}-3}{2} \approx -0.38$.

Lemma 1 *Suppose firm A is the leader. Let m denote B:s conditional expectation of ρ (on observing θ_A). Under Assumption 1, in a PBE firm A sets*

$$\theta_A = \rho_A, \tag{2}$$

and firm B sets

$$\theta_B = \frac{m + \alpha\theta_A}{1+\alpha}. \tag{3}$$

berg and Tirole 1996), i.e., before v_i is realized. Recall that v_i is drawn from a uniform distribution on $[0, \bar{v}]$. The strategy profile $s = \{s_i, s_j\}$ is a perfect Bayesian equilibrium if for each firm,

$$s_i(\cdot) \in \arg\max_{\acute{s}_i \in S_i^V} \int_{v_i}\int_{v_j} \hat{\pi}_i(\acute{s}_i(v), s_j(v), (v_i, v_j)) \left(\frac{1}{\bar{v}}\right)^2 dv_i dv_j, \; i \neq j.$$

[8]Unlike the "journalist" in Bénabou and Laroque (1992), agents here have no other means of influencing each other's beliefs than through their actions.

Proof. See the Appendix. ■

The expressions when B is the leader are analogous. The expression in (3) captures the follower's trade-off between the informational value the leader's entry provides and the externality it imposes. If α is positive (people like similarly painted houses), the follower will choose a color closer to the leader's as compared with its expectation of ρ. If α is negative (people want their house to be different), the follower will choose a color less similar to the leader's. The fact that the leader chooses its color according to its signal is important; hereby the follower has de facto access to both signals. Since the follower also infers the leader's variance, its expectation of ρ simply is a linear combination of ρ_A and ρ_B. Expected payoffs therefore take simple expressions.

Lemma 2 *Excluding delay costs, firm A:s expected payoff from being the leader and the follower are, respectively,*

$$L_A = -v_A - \frac{\alpha v_A^2}{(1+\alpha)^2(v_A+v_B)}, \tag{4}$$

and

$$F_A = -\frac{v_B\left(v_B\alpha + (1+\alpha)v_A\right)}{(1+\alpha)\left(v_A+v_B\right)}. \tag{5}$$

Proof. See the Appendix. ■

The corresponding payoffs for firm B are analogous. To reiterate, under Assumption 1, the leader's expected payoff always decreases with its variance. (To get the boundary case, set $v_B = 0$ in (4)). On the other hand, treating the entry time as given, the follower's payoff may either be decreasing or increasing in the leader's variance. Differentiating (5) w.r.t. v_B gives

$$-\frac{v_A^2 + \alpha(v_A+v_B)^2}{(1+\alpha)\left(v_A+v_B\right)^2}. \tag{6}$$

If $\alpha \geq 0$, the nominator is positive so that the expression is negative. That is, if products are complements the follower wants the leader to be as well-informed as possible. However, if $\alpha < 0$ and v_B is high relative to v_A, (6) is positive. In other words, if products are substitutes and the follower is well-informed, it prefers to have a poorly informed leader. The reason is that, in this case, the follower has little need for informational spillovers and benefits from the leader choosing a niche far from ρ.

3.2 Timing

When considering their waiting strategy, firms strike a trade-off between expected delay costs and the possibility of being the follower instead of the leader. (This possibility is not necessarily of positive value, but in the symmetric equilibrium, it is never negative.) Consider firm A. Conditional on B:s strategy and its own variance v_A, A chooses an optimal entry time, t. Equivalently, A can choose the variance v that, given B:s strategy, corresponds to t. For example, suppose firm B uses an increasing strategy, $s_B(v)$. Using the payoff expressions (4) and (5) in the maximization problem (1) gives that v must maximize the sum of

$$-\int_{v}^{\bar{v}} \left(v_A + \frac{\alpha v_A^2}{(1+\alpha)^2(v_A+v_B)} + \delta s_B(v)\right) \frac{1}{\bar{v}} dv_B \tag{7}$$

and

$$-\int_{0}^{v} \left(\frac{v_B\left(v_B\alpha + (1+\alpha)v_A\right)}{(1+\alpha)\left(v_A+v_B\right)} + \delta s_B(v_B)\right) \frac{1}{\bar{v}} dv_B. \tag{8}$$

The integral in (7) is firm A:s expected payoff from being the leader, which happens if A picks a v that is smaller than v_B. Likewise, the integral in (8) is the expected payoff from being the follower, which happens when v is larger than v_B. The case of decreasing strategies is completely analogous. Now we characterize the equilibrium waiting function, which is unique for all values of α but one. The proposition uses the following definition:

Definition 1 $\alpha^* = \frac{\sqrt{13}-5}{4} \approx -.35$.

Proposition 1

(a) If $\alpha > \alpha^*$, the best informed firm enters first. The equilibrium waiting function is

$$\mathrm{s}(v) = \frac{(2\alpha + 1)}{2\delta\,(1+\alpha)^2}\left[\bar{v}\ln\bar{v} - v - \bar{v}\ln(\bar{v} - v)\right].$$

(b) If $\alpha < \alpha^*$, the worst informed firm enters first. The equilibrium waiting function is

$$\mathrm{s}(v) = \frac{(2\alpha + 1)}{2\delta\,(1+\alpha)^2}\left(\bar{v} - v\right).$$

(c) If $\alpha = \alpha^*$, both equilibria are possible.

Proof. See the Appendix. ∎

Excluding boundary cases, firms are willing to incur some cost for the opportunity to observe the other firm's entry decision. When products are complements or weak substitutes, the time a firm is prepared to wait is increasing in its variance - much like in Zhang (1997). Here, Farrell and Saloner's (1986) "penguin effect" dominates: firms wait because they hope to get more information about the unknown parameter ρ. Moreover, the function is exponential so poorly informed firms are prepared to wait a disproportionately longer time than better informed ones. The waiting function for case (a) is illustrated below.

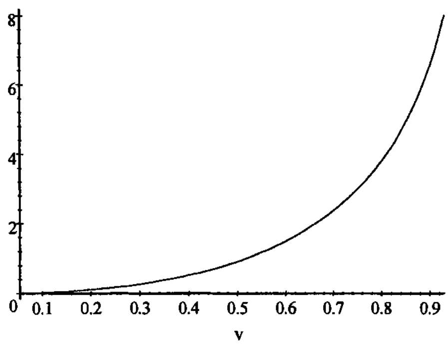

Figure 1. Waiting time as a function of variance when products are weak substitutes ($\bar{v} = 1, \delta = 1, \alpha = -0.2$).

As α is reduced, i.e., as products become closer and closer substitutes, a well informed firm's incentive to outwait a poorly informed firm becomes relatively stronger. The intuition is as follows. When products are substitutes, the follower always chooses a niche too close to the leader's - from the leader's point of view. Moreover, the worse informed the follower is relative to the leader, the more the follower relies on the leader's choice. Hence, a poorly informed follower imposes a larger externality on the leader than a well-informed one, and more so the lower is α. When α passes below α^*, a well-informed firm's incentive to wait becomes stronger than that of a poorly informed firm's. For this parameter region, the negative externality a poorly informed firm imposes as a follower, through its "penguin-like" behavior, is larger than the informational spillover a well informed firm would generate as a leader. Alternatively, when competition is sufficiently harmful a well informed firm gains more from enjoying "monopoly" in a good market niche than what a poorly informed firm loses from choosing a bad niche.

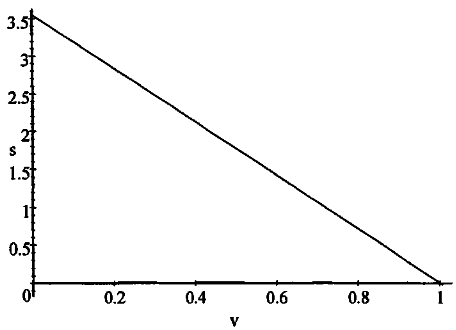

Figure 2. Waiting time as a function of variance when products are strong substitutes ($\bar{v} = 1, \delta = 1, \alpha = -0.35$).

Delay

We conclude by a couple of remarks on delay. Inspection of the waiting functions in Proposition 1 gives that delay is proportional to the factor

$$\frac{(2\alpha + 1)}{2\delta (1 + \alpha)^2}. \tag{9}$$

Note that expected delay decreases geometrically with δ and thus, that delay *costs* are independent of the degree of urgency. Differentiating (9) w.r.t. α gives

$$-\frac{\alpha}{\delta(1+\alpha)^3}.$$

Ceteris paribus, the longest delay occurs when $\alpha = 0$. Whenever an externality is present, consumers to some extent choose color based on the color of their neighbors' houses, rather than according to genuine preferences. Hence, the stronger the externality - whether positive or negative - the less important (for profits) becomes a firm's particular choice of color. This reduces the incentive to observe the other firm's decision, and delay decreases. Note from (9) that delay appears to go to zero as α goes to $-.5$. However, Proposition 1 presumes that the leader enters in accordance with its signal, which is no longer optimal if $\alpha < -.38$ (the limit in Assumption 1).

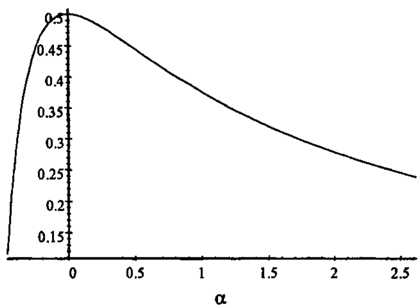

Figure 3. Expected delay as a function of α.

Finally, note that with a positive payoff externality, delay decreases relatively slowly as the externality grows stronger. Hence, firms suffer substantial delay costs despite there being large gains from sharing information. This is not very realistic; at some point these gains will induce firms to overcome any potential coordination costs. In particular, if firms can engage in cheap talk, they can reach the first-best solution whenever $\alpha \geq 0$ by revealing their private information and enter without delay (at the same location).

4 Conclusion

Informational spillovers induce agents to outwait each other in order to make more informed decisions themselves. If delay is costly, the presence of spillovers leads to a classic war of attrition between agents. Zhang (1997) showed that if agents have different informational precision, the best informed agent takes the first action in a symmetric equilibrium. In this paper we combine informational spillovers with a direct payoff externality. Still, the only difference between agents ex ante is the quality of their private information.

The addition of the direct externality has two effects on the waiting game. First, it reduces delay per se. The stronger is the externality - whether positive or negative - the smaller becomes the (relative) importance of being well informed. This attenuates the second-mover advantage and decreases delay. Interestingly, the externality may have a more qualitative effect. When the externality is negative and very strong, it turns out that poorly informed agents take action before well-informed ones. The intuition is that poorly informed agents mimic the behavior of others to a larger extent. Hence, as a follower, they impose a larger negative externality on the leader than do well-informed agents. If the externality is sufficiently strong, this effect outweighs informational concerns, which makes well-informed agents wait the longest.

We have illustrated these mechanisms as an entry game between two firms. In this context, the direct externality has a straightforward interpretation as a measure of the strategic complementarity/substitutability between products. However, the model should apply to any situation where informational spillovers and payoff externalities co-exist. For example, the agents could be investors in the stock market. A trading decision has a direct effect on the price of the asset in question, but also reveals something about the investor's private information or expectations. Will a purchase trigger other investors to buy or sell the stock? Gamblers in betting markets with moving odds face a similar situation. As a political application, consider candidates choosing what policy platform to adopt on a complex issue. Not only does a candidate want to endorse policies that appeal to a large share of the electorate, he may be even more anxious to represent a policy that stands out from those of other politicians. Hence, the order in which politicians take stands will depend on how well informed they are as well as how badly they are in need of publicity. It may be important to recognize that, in some circumstances, the politicians who choose policies first are those with the least knowledge, and that the sooner a politician decides, the less he knows.

5 Appendix

For ease of exposition, we let $v_A = a$ and $v_B = b$ in the entire appendix. Let the cumulative distributions $F(\rho)$ and $G(\rho_j)$ denote firm i:s posterior of ρ and ρ_j $(i \neq j)$, respectively.

Proof of Lemma 1.

Given θ_A, firm B solves the following problem:

$$\underset{\theta_B}{Max} \int_{\rho} \left[-(\theta_B - \rho)^2 - \alpha(\theta_B - \theta_A)^2 - \delta\tau_i \right] dF(\rho).$$

Let $m = E[\rho \mid \rho_B, \theta_A]$ denote B:s expectation of ρ. The first-order condition reads

$$-2\theta_B(1+\alpha) + 2m + 2\alpha\theta_A = 0. \tag{A1}$$

As long as $\alpha > -1$, the LHS of (A1) is everywhere decreasing in θ_B so that the first-order condition gives a global maximum. Rearrange (A1) to get

$$\theta_B = \frac{m + \alpha\theta_A}{1+\alpha},$$

which proves the second part of the lemma. Anticipating this, the leader (firm A) solves

$$\underset{\theta_A}{Max} \iint_{\rho_B, \rho} \left[-(\theta_A - \rho)^2 - \alpha(\theta_A - \frac{m + \alpha\theta_A}{1+\alpha})^2 \right] dF(\rho), dG(\rho_B).$$

In a perfect Bayesian equilibrium, firm B must have the correct expectation of ρ_A. Suppose therefore, without loss of generality, that B:s expectation of ρ is a linear combination of the two signals, i.e., $m = \lambda\rho_A + (1-\lambda)\rho_B$ for some $\lambda \in [0,1]$. Firm A:s expectation of ρ is simply ρ_A. Firm A:s first-order condition then reads

$$-2\theta_A + 2\rho_A - \frac{\alpha}{(1+\alpha)^2} \left[2\theta_A - 2\int_{\rho_B} (\lambda\rho_A + (1-\lambda)\rho_B) dG(\rho_B) \right] = 0. \tag{A2}$$

Both estimators are unbiased so $E[\rho_B] = \rho_A$. (A2) becomes

$$-2\left(\theta_A - \rho_A\right)\left[1 + \frac{\alpha}{(1+\alpha)^2}\right] = 0. \tag{A3}$$

If the expression in square brackets is positive, the derivative is everywhere decreasing in θ_A and (A3) gives a global maximum. This occurs as long as $\alpha > \frac{\sqrt{5}-3}{2}$, i.e., as long as Assumption 1 is satisfied. The solution is, naturally, to set $\theta_A = \rho_A$.

Proof of Lemma 2.

Consider first the case when A is the follower. By Lemma 1, $\theta_B = \rho_B$, so upon observing B:s entry decision and its own signal ρ_A, firm A:s posterior distribution over ρ is normal with the expected value

$$m = \frac{b\rho_A + a\rho_B}{a+b},$$

and the variance

$$w = \frac{ab}{a+b}.$$

Conditional on observing θ_B, A:s expected payoff is

$$\int_\rho \left[-(\theta_A - \rho)^2 - \alpha(\theta_B - \theta_A)^2\right] dF(\rho)$$

$$= \int_\rho \left[-(1+\alpha)\theta_A^2 + 2\theta_A\rho - \rho^2 + 2\alpha\theta_A\theta_B - \alpha\theta_B^2\right] dF(\rho).$$

Substitute for $E[\rho]$ and $E[\rho^2]$ and the equilibrium expressions for θ_A and θ_B, and extend the expression by $(1+\alpha)$ to get

$$\frac{-(w+m^2)(1+\alpha)+2\alpha m\rho_B+m^2-\alpha\rho_B^2}{1+\alpha}.$$

Substituting for m and w and extending by $(a+b)^2$ gives

$$b\frac{-ab-\alpha ab-a^2-\alpha a^2-\alpha b\rho_A^2+2\alpha b\rho_A\rho_B-\alpha b\rho_B^2}{(a+b)^2(1+\alpha)}.$$

We want the "unconditional" expected value of this (i.e., before A observes θ_B). Since the two estimators are unbiased and conditionally independent, we have that, conditional on ρ_A, $E[\rho_B]=\rho_A$ and $E[\rho_B^2]=\rho_A^2+a+b$, $\forall\rho_A,\rho_B$. Hence, we have

$$\int_{\rho_B}\left(b\frac{-ab-\alpha ab-a^2-\alpha a^2-\alpha b\rho_A^2+2\alpha b\rho_A\rho_B-\alpha b\rho_B^2}{(a+b)^2(1+\alpha)}\right)dG(\rho_B)$$

$$=b\frac{-ab-\alpha ab-a^2-\alpha a^2-\alpha b\rho_A^2+2b\alpha\rho_A^2-b\alpha[\rho_A^2+a+b]}{(a+b)^2(1+\alpha)}$$

$$=\frac{-b\,(b\alpha+(1+\alpha)a)}{(1+\alpha)\,(a+b)},$$

which proves the second part of the lemma. Now suppose A is the leader. In equilibrium, its expected payoff is (ignoring delay costs)

$$\int_{\rho_B}\int_{\rho}[-(\theta_A-\rho)^2-\alpha(\theta_A-\rho_B)^2]dF(\rho)dG(\rho_B)$$

$$=-a-\alpha\int_{\rho_B}\left(\rho_A-\left(\frac{b\rho_A+a\rho_B}{(a+b)(1+\alpha)}+\frac{\alpha\rho_A}{1+\alpha}\right)\right)^2dG(\rho_B).$$

Extend the integral by $(1+\alpha)(a+b)^2$ and rearrange to get

$$= -a - \frac{\alpha}{(1+\alpha)^2(a+b)^2} \int\limits_{\rho_B} \left[\rho_A^2 a^2 - 2\rho_A \rho_B a^2 + \rho_B^2 a^2\right] dG(\rho_B).$$

Finally, substitute for $E[\rho_B^2]$ to get

$$= -a - \frac{\alpha a^2}{(1+\alpha)^2(a+b)}.$$

Proof of Proposition 1.

(a) $\alpha > \alpha^*$. Suppose that firm B uses an increasing strategy $s(v)$ so that firm A:s posterior over B:s variance at time t, given that no firm has entered, is uniform over $[s^{-1}(t), \bar{v}]$. Firm A chooses v to maximize

$$-\int_v^{\bar{v}} \left(a + \frac{\alpha a^2}{(1+\alpha)^2(a+b)} + \delta s(v)\right) \frac{1}{\bar{v}} db$$

$$-\int_0^v \left(\frac{b\,(b\alpha + (1+\alpha)a)}{(1+\alpha)\,(a+b)} + \delta s(b)\right) \frac{1}{\bar{v}} db.$$

The integral reads

$$-\frac{1}{\bar{v}} \left[ab + \frac{\alpha a^2 \ln(a+b)}{(1+\alpha)^2} + \delta s(v) b\right]_v^{\bar{v}}$$

$$-\frac{1}{\bar{v}} \left[\frac{1}{1+\alpha}\left((\frac{b^2}{2} + ab)\alpha - a^2 \ln(a+b) + ab(1-\alpha)\right) + S(b)\right]_0^v.$$

The first-order condition w.r.t. v reads

$$\frac{3\alpha a^2 + a^2 + a^2\alpha^2 - v^2\alpha - v^2\alpha^2}{(1+\alpha)^2\,(a+v)} - \delta s'(v)[\bar{v} - v] = 0. \tag{A4}$$

Firm B naturally solves the analogous problem. Now, if there is a symmetric PBE, (A4) is satisfied for all $v = a$. In other words, in equilibrium both firms must find it optimal to use the strategy that they postulate the other firm uses. Let us confirm that (A4) indeed solves a maximum. The simplest way of doing this is to differentiate (A4) w.r.t. a instead of v. If the resulting second-order condition is *positive* at $v = a$, we know that (A4) gives a maximum. We have

$$\frac{d}{da}\left(\frac{3\alpha a^2 + a^2 + a^2\alpha^2 - v^2\alpha - v^2\alpha^2}{(1+\alpha)^2(a+v)}\right) =$$

$$\frac{3\alpha a^2 + 6a\alpha v + a^2 + 2av + a^2\alpha^2 + 2a\alpha^2 v + v^2\alpha + v^2\alpha^2}{(1+\alpha)^2(a+v)^2}.$$

Setting $v = a$ gives

$$\frac{10\alpha + 3 + 4\alpha^2}{4(1+\alpha)^2}. \tag{A5}$$

As long as $\alpha > \alpha^*$, (A5) is positive. Further, in the increasing equilibrium we have the boundary condition that s(0) = 0. Otherwise a firm with variance zero would suffer a positive delay cost yet enter first almost surely. Setting $v = a$ in (A4) gives

$$\frac{a(2\alpha+1)}{2(1+\alpha)^2[\bar{v}-a]} = \delta s'(a). \tag{A6}$$

Integrate and use the boundary condition to get case (a) of the proposition.

(b) $\alpha < \alpha^*$. Suppose instead that firm B uses a decreasing strategy so that firm A:s posterior over B:s variance at time t is uniform over $[0, s^{-1}(t)]$. Firm A chooses v to maximize

$$-\int_0^v \left[a + \frac{\alpha a^2}{(1+\alpha)^2(a+b)} + \delta s(v)\right]\frac{1}{\bar{v}}db$$

$$-\int_v^{\bar{v}} \left[\frac{b(b\alpha + (1+\alpha)a)}{(1+\alpha)(a+b)} + \delta s(b)\right]\frac{1}{\bar{v}}db.$$

The integral reads

$$-\frac{1}{\bar{v}}\left[ab+\frac{\alpha a^2\left(\ln(a+b)-\ln a\right)}{(1+\alpha)^2}+\delta s(v)b\right]_0^v$$

$$-\frac{1}{\bar{v}}\left[\frac{1}{1+\alpha}\left((\frac{b^2}{2}+ab)\alpha-a^2\ln(a+b)+ab(1-\alpha)\right)+\delta S(b)\right]_v^{\bar{v}}.$$

The first-order condition reads

$$-\left(\frac{a^2+3\alpha a^2+a^2\alpha^2-v^2\alpha-\alpha^2v^2}{(1+\alpha)^2(a+v)}\right)+\delta s'(v)v=0. \tag{A7}$$

In analogy with case (a), (A7) gives a maximum as long as $\alpha<\alpha^*$. Setting $v=a$ in (A7) gives

$$-\frac{(1+2\alpha)a}{2(1+\alpha)^2}=\delta s'(a)a.$$

In the decreasing equilibrium we have the boundary condition $s(\bar{v})=0$. Using this proves case (b) of the proposition. Finally, if $\alpha=\alpha^*$, the second derivative is exactly zero so that both equilibria are possible.

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Chapter 4

One Office, Two Parties, Multiple Candidates - Why Not?

One Office, Two Parties, Multiple Candidates - Why Not?

Lars Frisell*

Abstract

This paper investigates whether parties in a two-party system can benefit from nominating several candidates to the same office. Parties are modeled as policy-motivated teams in full control of the nomination procedure. To promote the use of multiple candidates we assume that the median voter always is decisive. Paradoxically, it seems that the more uncertain parties are about voter opinion, the less desirable the use of multiple candidates becomes. In the standard case of a uniform prior distribution the optimal number of candidates is one. Hence, it is in the interest of each party - though detrimental to voters - to institutionalize the use of a single candidate.

"The fears of strong parties include a concern that they will freeze out some interests from participation and that their choice of nominees will reflect the status quo; ...that we will not be able to hold them accountable because our choices will be limited to what and whom they choose to offer in each election."[1]

1 Introduction

The aim of this paper is to investigate an aspect of elections in two-party systems, namely that each party by custom or rule nominates exactly one candidate to the office at stake. Indeed, the one-party-one-candidate convention seems to be a logical extension of Duverger's law. If Duverger and Downs were right about voter sophistication, plurality rule should deter additional candidates in a two-party environment by the same token that it drives out third parties in a multi-party environment. However, this paper - joining a vast literature - treats the two-party system as an institutionalized

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[1] Kayden and Mahe (1986, p. 208).

feature. Third parties are absent or marginalized, not because they could not compete successfully in the election, but because the barriers to participation (economic, administrative, or even legal) are too large. The question we address is, in the classic single-member/plurality-rule setting, under what circumstances a party would use the option to be represented by several candidates in the same election.

Clearly, any party - office-motivated or otherwise - would almost certainly be eager to nominate "vote stealers", i.e., candidates located at the opposite side of the spectrum with the sole purpose of reducing the number of votes for the other party. More interestingly, if the voter distribution is unknown, parties may have an interest in nominating several "sincere" candidates. For example, imagine that the republican party has nominated a candidate for a public office and that the democratic party may choose to support either one or two candidates. Suppose that the first candidate has fairly centrist opinions, which gives him good chances in the election, and that the other has more traditional liberal views, i.e., views closer to the party line. If the democratic party nominates both candidates it runs the risk of the majority of votes being split up between them, and plurality is shifted to the republican. However, the possibility that the more partisan democrat wins could make this risk acceptable. Briefly put, the smaller is the dispersion within the electorate, and the more uncertain the voter distribution is at large, the more advantageous the use of multiple candidates seems.

Our analysis shows this intuition to be wrong. If a party has more candidates under its control, and lacks the power to precommit itself to their positions, it will spread its candidates over a larger part of the spectrum. Ceteris paribus, this shifts election chances from the other party to this party. However, the move propels the other party to draw back its own candidates to more partisan positions. In equilibrium, the only result of using more candidates may be a larger risk for extreme outcomes which, if their utility is concave, makes parties worse off. In addition, it seems that the more uncertain is voter opinion, the *less* candidates a party wants to use.

Our model is inspired by Wittman (1973, 1983), who introduced policy concerns in the spatial theory of voting. In particular, Wittman (1983) shows that if candidates are exclusively policy-oriented and every platform wins with positive probability (against any other platform), the median voter theorem does not hold, i.e., there is not complete policy convergence. Whether ideological concerns have a substantial influence on politicians' behavior has been debated extensively. In this literature, parties and candidate have interchangeably been regarded as the relevant political units.[2] In our view, an important distinction should be made between the individual candidate, who is probably

[2]For an overview of the literature on candidate motivation, see Wittman (1983). For an overview of spatial election models, see Osborne (1995).

primarily office-motivated, and the political party, which has ideological concerns. If a party is defined in terms of its members, who in most cases add up to many thousands of people, it is probably not a serious fallacy to approximate a party's "spoils of office" to zero.

Wittman (1973) concludes that policy divergence hurts the parties, and that it is in their interest to collude and present the same platform. Our results extend this finding in the following way: not only would parties like to reach a binding agreement as to the positions of their candidates, a party is also willing to restrict itself *unilaterally* to a limited number of candidates.

2 A Simple Model

Imagine an election to an office, where the winner is determined by the plurality of votes. There are two parties, Left and Right, with quadratic utility functions over policy. Office possession in itself is of no value to the parties.[3] The policy space is the real line where we let the Left have ideal point zero and the Right have ideal point one. The utility of a party's ideal point is normalized to zero. Hence, if p is the chosen policy, Left's utility is $-p^2$ and Right's utility is $-(1-p)^2$. The election game works as follows. First there is a "constitutional" stage where the parties set the maximum number of candidates they can use in the election. For simplicity we assume that the Right party is already restricted to a single candidate. The Left party, on the other hand, may set the limit to any finite number of candidates, r. Note that since r is only an upper bound for the Left's nominees, it could later choose to nominate less candidates. Left's decision in the constitutional stage is public knowledge. In order to promote the use of multiple candidates, we assume that there are no nomination or campaign costs. After r has been chosen, nominations (or primaries) take place. This means that the parties simultaneously decide which positions their candidates will occupy in policy space and, in the Left party's case, also how many candidates n it will actually nominate, such that $n \leq r$. Once these decisions have been made the candidates' positions are made public and the election takes place.

We assume that candidates are committed to the policies they endorsed at the nomination stage and, for simplicity, that there is no uncertainty involved in the implementation of a policy. Hence, as in Black's (1958) formulation, a candidate is completely characterized by his position in policy space. The reader may wonder why a (purely) office-motivated candidate would ever choose to endorse a policy at, e.g., the extreme

[3]This assumption is not crucial but simplifies the analysis. For more details, see Wittman (1983).

end of the political spectrum. First, the presence of multiple candidates may make an extreme position no less desirable than a centrist one. Second, since campaigning is free and the party has absolute control over who is nominated, parties have all the bargaining power. If a party wishes to launch an extremist candidate, it will also find one.

In order to carry out the analysis we shall assume that the entire electorate in fact consists of a single voter.[4] This assumption may seem absurd but embodies the case of a totally concentrated voter distribution. Indeed, such an electorate should provide the most favorable conditions possible for the use of multiple, "sincere", candidates. The Left party can thus place a number of candidates next to each other in policy space without decreasing its overall chances of winning office. In turn, this assumption allows us to sidestep the issue of voter sophistication. If all citizens are known to have the same opinion, there is of course no reason to vote insincerely.

The voter has a symmetric utility function over policy space with ideal point v, which implies that the candidate closest to v will be elected. Parties are not aware of v but have a common prior $F(v)$ over its realization. In section 3.1, we study the case of a uniform prior and in section 3.2, we look at different normal priors. An electoral equilibrium in this game is a number of leftist candidates n and candidate positions $c_1 < c_2 < ... < c_{n+1}$, such that the Left cannot profit from a (unilateral) change in n or in any of $c_1, c_2, ..., c_n$, and the Right cannot profit from a change in c_{n+1}. If this equilibrium is unique for each r, there is a "constitutional equilibrium" if and only if Left chooses r optimally.[5]

3 Results

Although we will stick to quadratic preferences in the remainder of the paper, we begin by presenting a slightly more general result (which covers the quadratic case). The lemma below demonstrates a risk-averse party's desire to reduce the risk for extreme outcomes. The Left achieves this by nominating all available candidates, in order to "cover" as much of the policy space as possible.

Lemma 1 *Let $u_i : \Re \rightarrow \Re_-$, $i = \{L, R\}$ be party i:s utility function over policies, with $u_L(0) = u_R(1) = 0$. Suppose $u_i(\cdot)$ is differentiable and strictly concave and that $F(v)$ is differentiable with $f(v) > 0$ $\forall v \in [0, 1]$. Then, the Left party sets $n = r$.*

[4]Alternatively, the median voter is assumed to be decisive always.

[5]Formally, we require that the choice of n, r, and $c_1, c_2, ..., c_n$, and c_{n+1} is supported by a perfect Bayesian Equilibrium.

Proof. See the Appendix. ■

3.1 Uniform prior

We now look at the case when the prior distribution of v is uniform over the unit interval. Suppose the Left has set the limit to r candidates. By Lemma 1, we know that all candidates will be used in equilibrium. Consider first the position c_i of a Left interior candidate, with neighbor candidates positioned at c_{i-1} and c_{i+1}. A necessary condition for equilibrium is that c_i is chosen optimally, given the position of all other candidates. The Left party solves

$$\underset{c_i}{Max} \qquad -c_1^2 \Pr(c_1) - c_2^2 \Pr(c_2) - ... - c_i^2 \Pr(c_i) ... - c_{n+1}^2 \Pr(c_{r+1}).$$

With a uniform prior, the probability that the candidate at c_i is elected is simply

$$\Pr(c_i) = \frac{(c_{i+1} + c_i)}{2} - \frac{(c_i + c_{i-1})}{2} = \frac{c_{i+1} - c_{i-1}}{2}.$$

Using this and the analogous expressions for the candidates at c_{i-1} and c_{i+1}, we arrive at the unique solution

$$c_i^* = \frac{c_{i+1} + c_{i-1}}{2}.$$

Hence, an interior candidate will be placed exactly in between his neighbors. Similar calculations show that the most leftist candidate is placed at $c_1^* = \frac{c_2}{3}$, and that the Right's candidate is placed at $c_r^* + \frac{2(1-c_r)}{3}$. From the system of first-order-conditions, we get equilibrium positions

$$\frac{1}{2(r+1)}, \frac{3}{2(r+1)}, \ldots \frac{2r+1}{2(r+1)}.$$

This means that candidates will be positioned symmetrically along the unit interval.[6] Since each position is a unique solution given the neighbors' positions, the equilibrium

[6] These are exactly the positions predicted by Palfrey, p. 154. In his model there are n different parties that simultaneously choose one position each. The parties have no ideological concerns, but foresee the entry of one additional party.

is unique. From the equilibrium positions above it follows that both parties' utility in equilibrium is

$$-\frac{1}{r+1}\sum_{i=1}^{i=r+1}\left(\frac{2i-1}{2(r+1)}\right)^2$$

It is straightforward to show that this expression is decreasing in r, which means that the Left party maximizes its utility by setting $r = 1$. This finding is summarized below.

Proposition 1 *If v is uniformly distributed over the unit interval, there is a unique constitutional equilibrium where the Left party sets $r = 1$.*

It might be no surprise that, as soon as vote stealing is excluded, a policy-motivated party becomes worse off as the other party introduces more candidates.[7] What is surprising about Proposition 1 is that also the Left party's utility decreases with a higher r. This result is paradoxical, since more candidates *could* benefit the Left. To see this, note that each new candidate could be located in the region between the previously leftmost candidate and the Left's ideal point. This would not affect the Right party's response and in some instances a candidate closer to the Left's ideal point would be elected. Such a strategy, however, is not part of an equilibrium.

When the Left has more candidates at its disposal, it pushes the most centrist one towards the Right's candidate, in order to steal chances to be elected from him. Anticipating this, the Right party will move its own candidate away from the center, which triggers an even larger push from the Left party, and so forth. With uniform prior, the equilibrium distribution of candidates is perfectly symmetric, which implies that each candidate has the same probability of being elected. In other words, a higher n is equivalent to a mean-preserving spread of policy alternatives. Hence, since parties are risk-averse, their utility is strictly decreasing in the number of candidates.

The Left party's dilemma has the flavor of a time-consistency problem. As an analogy, recall Coase's (1972) dynamic monopoly. Lacking the power to commit to its price, a monopolist producing a durable good will reduce its price after each round of purchase, in order to sell to costumers with lower valuations. However, anticipating this behavior, consumers with high valuations will also wait, and if price adjustments

[7] It is not necessary that the prior has positive density over the unit interval only. Proposition 1 holds for all priors $F(v)$, such that $F(\frac{1}{2}) = 0.5$, and $f(v) = f > 0$, $\forall\, v \in [0,1]$.

can be made instantaneously the equilibrium monopoly price is driven down to the competitive level. In the present case, by using more candidates the Left party reduces the variance of the policy outcome. However, it is unable to resist the temptation to move its candidates towards the center (and beyond) since, given the position of the Right's candidate, this will shift probability to more partisan candidates. Of course, the Right party's response makes this strategy ineffective - and actually detrimental. Much like Coase's monopolist would like to commit himself to a single price, the Left party prefers to restrict itself to a single candidate. Finally, the ex ante utility of the voter (i.e., before v is realized) obviously increases with the number of candidates from which she can choose. Hence, like the buyers of the durable good, the voter would prefer that no commitment was possible.

3.2 Normal Priors

In this section, we solve the election game numerically for quadratic preferences and some normal priors, starting with distributions centered at 0.5. The main result is that the higher the variance of the distribution, the *less* candidates the Left party wishes to use. The intuition is as follows. When the Left party moves its rightmost candidate to the right, the Right party responds by moving its own candidate to the right. This response is more harmful to the Left party when there is a lot of probability mass in the tails of the distribution. In this sense the uniform distribution is a "neutral" case. For normal distributions with mean 0.5 and standard deviation σ we arrived at the following optimal number of candidates:

σ	0.15	0.17	0.20	0.22	0.25	0.28
r^*	10	5	3	2	1	1

Table 1. Optimal number of nominees.

Finally, we look at distributions that are shifted towards either side of the spectrum. If $\mu < 0.5$, for example, the Left party has an a priori advantage. Such an advantage promotes the use of multiple candidates much in the same way low variance does: the Right party's response is less harmful the less probability mass there is in the right tail of the distribution. For normal distributions with mean μ and standard deviation 0.2, we arrived at the following optimal number of candidates:

μ	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
r^*	4	4	4	3	3	2	2	1	1

Table 2. Optimal number of nominees ($\sigma = 0.2$).

4 Conclusion

This paper investigates competition between two policy-motivated parties in a single-dimensional setting. The novel feature is that parties have the option of using several candidates in the same election. We show that, despite of there being no risk that a party's votes are split up among its candidates, its utility may be decreasing in the number of candidates. If a party is unable to commit to the positions of its candidates, it will be tempted to push new candidates towards the other side of the spectrum which, when the other party responds strategically, makes it worse off than before.

The ideology/party-centered view of political competition does not apply to all contexts. For example, in elections where the individual candidates' ability to raise funds is important, notably the American presidential election, policy concerns may have little bearing on nominations. Furthermore, and especially in less developed democracies, office spoils may be important for the party's survival at large, and thus, policy considerations must be secondary. In many instances, however, the "strong party"-view is probably more or less accurate. Several authors have stressed the regained power of the American parties since the 1980's. According to Kayden and Mahe (1985), one important reason is the campaign finance legislation in the 1970s, which severely limited contributions to candidates from other groups than the parties themselves. In Europe, parties' dominance in political life, as well as the degree of centralism within parties, is of course even more profound. Ranney (1965) concludes that "in Britain as in other western democracies the party processes of candidate selection rather than the legal processes of entering nomination papers and making deposits have set the alternatives for the voters." It is our contention that strong parties - by definition - shift political power from the voters to themselves, and that the use of single candidates is but one expression of that power.

5 Appendix

Proof of Lemma 1.

We will prove the lemma by contradiction, showing that there cannot be an equilibrium such that the Left has unused candidates. Note first that no candidate will be placed outside the unit interval. By differentiability and strict concavity of u_i, an equilibrium therefore exists. A necessary condition for equilibrium is that each candidate's position is optimal, given the positions of all other candidates. Consider the position c_1 of the Left party's leftmost candidate. The Left solves

$$\underset{c_1,c_2,\ldots,c_n}{Max} \quad u_L(c_1)\Pr(c_1) - u_L(c_2)\Pr(c_2) - \ldots - u_L(c_{n+1})\Pr(c_{n+1}). \tag{A1}$$

Since the voter will elect the candidate closest to his ideal point, we have

$$\Pr(c_1) = F(\frac{c_1 + c_2}{2}),$$

and

$$\Pr(c_2) = F(\frac{c_2 + c_3}{2}) - F(\frac{c_1 + c_2}{2}),$$

and so forth. Using these expressions in (A1) problem gives the following first-order condition w.r.t. c_1:

$$\frac{u_L(c_1)}{2} f(\frac{c_1 + c_2}{2}) + u_L'(c_1)F(\frac{c_1 + c_2}{2}) - \frac{u_L(c_2)}{2} f(\frac{c_1 + c_2}{2}) = 0. \tag{A2}$$

There must be a candidate such that $c_2 > 0$, since the Right will never place its candidate at the Left's ideal point. Now, note that it is impossible that the leftmost candidate is positioned at the Left's ideal point. Setting $c_1 = 0$ in (A2) gives

$$\frac{u_L(c_2)}{2} f(\frac{c_1 + c_2}{2}) = 0.$$

Since $u_L(c_2) < 0$ and $f(\bullet) > 0$, this is a contradiction. Hence, in equilibrium, all candidates are positioned strictly inside the unit interval. Since the number of candidates is countable (in fact, finite), there will always be a positive distance between zero and the leftmost candidate in equilibrium. The Left could profitably place an unused candidate in this region. Such a candidate would have a positive probability of being elected and would, if elected, give higher utility to the party than the previously leftmost candidate. This implies that in equilibrium, the Left uses all its candidates.

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