Expert Advice with Multiple Decision Makers*

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June 5, 2008

Abstract

Cheap talk models provide a strategic analysis of information transmission between the expert and the decision maker when their preferences are not perfectly aligned. Although the majority of these models analyze the case of a single decision maker, in many important settings the decision-making authority is shared between several agents. Here we consider a commonly used procedure: ultimatum bargaining. We examine how the addition of the second decision maker (the veto player) affects communication and the utilities of the players. Surprisingly, we find that the veto player may be worse off, and the first decision maker may be better off, than in the absence of the veto threat.
JEL classification: D72, D78, D82
Keywords: information, cheap talk, veto power, experts

*We thank Meg Gleason, Ana Espinola-Arrendondo, Alexander Gümbel and Lucy White, as well as seminar audiences at the Ohio State University, University of Pittsburgh, Stanford University, the 16th International Conference on Game Theory at Stony Brook (2005), and the Spring 2006 Midwest Economic Theory Meetings at Michigan State University.

1 Introduction

Decision makers often seek advice from experts before making their choices. Although better informed about the likely consequences of a given action, the expert may have different preferences from the decision maker about what outcomes are most desirable. Crawford and Sobel [4] provide the seminal analysis of strategic information transmission between an informed *sender* and an uninformed *receiver*. A key result of their paper is that any divergence of interest between the two agents has an adverse effect on the flow of information.

Crawford and Sobel's framework has been applied to a variety of settings, including finance (Morgan and Stocken [16]), organizational design (Dessein [5], Harris and Raviv [11]), and political economy (Gilligan and Krehbiel [7], [8], Krishna and Morgan [14]). In almost all of these models, as in Crawford and Sobel's original paper, the decision-making authority lies in the hands of a single agent.[1] In many situations of economic interest, however, several agents collaborate to make the final choice. Many different procedures are used, but in this paper we focus on one in particular: ultimatum bargaining. Here, after listening to whatever advice the expert chooses to give, the first decision maker picks an action; the second decision maker can then approve this action, in which case it becomes the final choice, or he can veto it, so that some *status quo* action results.

This decision-making procedure is commonly used. In many countries, for example, the process of legislation involves a veto player. Consider the United States. After receiving a report from an (expert) lobbyist, or perhaps a draft bill from a legislative committee, Congress passes a final version of the bill. The President then has ten days either to approve the bill or veto it. Between 1789 and 2006, 36 presidents have exercised their veto power on 2,551 occasions. Similar systems are in place in many Latin American countries. Although the parliamentary systems common in European countries function very differently, the same model is appropriate in some cases. In the Netherlands, the Council of Ministers is the primary policy-making body and plays the role of the expert, sending draft legislation to the Lower Chamber. The Lower Chamber can then amend the bill before voting on a final version; lastly, the approval of the Upper Chamber is required before any bill becomes law. Similarly, in the United Kingdom and the European Union (under the co-operation and co-decision procedures) an upper chamber has legislative veto power.[2]

In addition, our model can be applied to various issues in corporate governance. In certain circumstances, formal decision-making power is shared between the Board of Directors

[1] Two notable exceptions are Farrell and Gibbons [6] and Goltsman and Pavlov [9], who analyze cheap talk games between a sender and two receivers, each facing a separate decision problem. The key question addressed by these papers is whether public or private communication leads to more information transmission.

[2] In the UK, the veto power of the House of Lords has been constrained by the Parliament Acts of 1911 and 1949: following a veto, the House of Commons can re-introduce the bill after a one-year delay and vote it into law without approval from the Lords.

and the shareholders, with the latter granted veto power. For instance, under U.S. law shareholders of publicly-traded companies have the right to veto acquisition proposals (as well as other fundamental corporate changes such as charter amendments and sales of assets). Executive compensation is another issue that might fit within the framework, although currently the NYSE Corporate Governance Rules grant shareholders veto power only over equity compensation plans.

In the next section, we use our formal model to analyze the precise effects of the second decision maker's veto power on communication, and the resulting impact on the utilities of all the three players. Section 3 provides a more detailed discussion of various applications of the model, and in section 4 we consider possible extensions and conclude.

2 The model

2.1 The Players, Preferences and Information

We consider a game with three players, the sender, S; the receiver, R; and the vetoer, V. Each player has preferred outcome, or *ideal point*, given by y_S, y_R and y_V for sender, receiver and vetoer respectively, and cares only about how close the actual outcome, y, is to that ideal point. Preferences are given by

$$U_S = -(y_S - y)^2; \qquad U_R = -(y_R - y)^2; \qquad U_V = -(y_V - y)^2.$$

We normalize y_R to 0, so y_S and y_V can be thought of as the *bias* of the sender and vetoer relative to the receiver. y is determined by the action of the the receiver (a), and the decision of the vetoer (*approve* or *veto*), along with the realization of a random variable (θ) that is private information to the sender:

$$\begin{aligned} y &= a - \theta \text{ if vetoer chooses } \textit{approve} \\ y &= a_0 - \theta \text{ if vetoer chooses } \textit{veto} \end{aligned}$$

where $a_0 \in \mathbb{R}$ is some (exogenous) *status quo* action. Before the receiver and vetoer act, the sender sends a message m that may convey information about θ. Formally, the move order of the game is as follows:

1. Nature chooses the value θ of the random variable; $\theta \sim U[0,1]$.

2. The sender observes θ and sends a message, $m \in \mathbb{R}$.

3. The receiver observes m but not θ and chooses an action $a \in \mathbb{R}$.

4. The vetoer observes m and a but not θ, and can *approve* or *veto* the action.

Without loss of generality, we assume that $y_S > 0$, and consider the following three cases: (a) $y_S > 0 > y_V$; (b) $y_S > y_V > 0$; and (c) $y_P > y_V > 0$. In case (a) the sender and the vetoer have opposing biases; in cases (b) and (c), they are biased in the same direction, with the sender more biased than the vetoer in case (b), and the reverse in case (c).

2.2 Strategies and Equilibrium Concept

A strategy for the sender, $m(\theta)$, specifies which message she sends for each realization of θ. These messages have no value other than the information they convey: they are cheap talk. A strategy for the receiver, $a(m)$, specifies which action he chooses given the sender's message. Finally, a strategy for the vetoer involves a decision $d(m,a) \in \{approve, veto\}$ for each message and each action. We use $\mu_R(\theta \mid m)$ and $\mu_V(\theta \mid m)$ to denote the posterior beliefs over θ of the receiver and vetoer respectively. In a (perfect Bayesian) equilibrium, each player's strategy maximizes expected utility given the choices of the others, and the receiver's and the vetoer's posteriors are consistent with Bayes' rules. Let $y(a,d,\theta)$ denote the outcome as a function of a, d and θ. Then formally,

Definition 1 *A perfect Bayesian equilibrium of the cheap talk with veto game is a set of strategies $m^*(\cdot)$, $a^*(\cdot)$, $d^*(\cdot,\cdot)$, and beliefs $\mu_R^*(\cdot)$ and $\mu_V^*(\cdot)$, such that:*

1. *For all $\theta \in [0,1]$, $m^*(\theta) \in \arg\max_m U_S\left(y\left(a^*(m), d^*(m, a^*(m)), \theta\right)\right)$*
2. *For all m, $a^*(m) \in \arg\max_a \int_\theta U_R\left(y\left(a, d^*(m,a), \theta\right)\right) \cdot \mu_R(\theta \mid m)\, d\theta$*
3. *For all m and a, $d^*(m,a) \in \arg\max_d \int_\theta U_V\left(y(a,d,\theta)\right) \cdot \mu_V(\theta \mid m)\, d\theta$*
4. *For all m such that $\int_{\theta\in\Theta_m^*} d\theta > 0$, μ_i^* satisfies $\mu_i^*(\theta \mid m) = \frac{1}{\int_{\theta\in\Theta_m^*} d\theta}$, where $\Theta_m^* = \{\theta \mid m^*(\theta) = m\}$, for $i = R, V$.*

It can be shown that every equilibrium is of a particular type: a *partition equilibrium.* A partition equilibrium is a partially-pooling equilibrium, in which some but not all of the sender's information is revealed. More precisely, the sender's strategy choice partitions the state space into a finite number of intervals, $\{[0,\theta_1), [\theta_1,\theta_2), \ldots, [\theta_{n-1},1]\}$, choosing one of n distinct messages, $m_i \in \{m_1, m_2, ..., m_n\}$, whenever $\theta \in [\theta_{i-1}, \theta_i)$. (The precise values of m_1, m_2 and m_3 do not matter; what is important is that a *different* message is sent in each interval, so that by observing the value of m the receiver and vetoer can figure out which interval θ must be in.) The receiver and the vetoer interpret message m_i to mean that $\theta_{i-1} \leqslant \theta < \theta_i$.

For given parameter values, there are typically several types of partition equilibria of this kind, with varying degrees of information being revealed by the sender. As is standard in applications of cheap talk games, we focus attention on the most informative of these, which we call a *communication equilibrium with veto*. The informativeness of an equilibrium measures how finely the partition divides up the state space. To make this notion precise, suppose that actions are chosen to minimize the variance of the final outcome, y, given only the information that θ lies somewhere in the relevant element of the partition[3]. Clearly a finer partition will result in a lower variance, so the variance of y can be used as a measure of informativeness. Given a partition $\mathcal{P} = \{[0, \theta_1), [\theta_1, \theta_2), \ldots, [\theta_{n-1}, 1]\}$, we define:

$$\text{informativeness}(\mathcal{P}) = -var(\hat{y}) \text{ where } \hat{y}(\theta) = \frac{\theta_{i-1} + \theta_i}{2} - \theta \text{ for } \theta \in [\theta_{i-1}, \theta_1).$$

Given that θ is uniformly distributed, it is easy to show that informativeness$(\mathcal{P}) = \sum_{i=1}^{n} l_i^3$, where $l_i = \theta_i - \theta_{i-1}$ is the length of the ith partition element. Formally then, a communication equilibrium with veto is a perfect Bayesian equilibrium of the cheap talk with veto game with the property that there is no more informative equilibrium.

To analyze the precise effect of the veto, we compare the communication equilibrium with veto to the most informative (perfect Bayesian) equilibrium of the game in which the vetoer does not get to move, a *communication equilibrium without veto*.

2.3 Informational losses versus distributional losses.

The players are involved in a collective decision-making process that has both conflict of interest and prospective gains from cooperation. Reducing the uncertainty about the relationship between actions and outcomes is collectively beneficial and can be distinguished from the distributional effects (the private benefits for each player) of a given action. To analyze these two effects, the (expected) utility of each player can be decomposed into two elements, the first representing the *informational losses* which arise because (in equilibrium) the action chosen is not perfectly responsive to the state θ, causing some variance in the equilibrium outcome y^*; and the second representing *distributional losses*, which arise when the expected value of y^* is not equal to the player's ideal value:

$$U_i = -var(y^*) - (E[y^*] - y_i)^2$$

[3] In fact, this will typically not be the case in equilibrium, because of tension between the preferences of the receiver and the vetoer. We discuss this issue in more detail in the next subsection.

for $i \in \{S, R, V\}$ (where $y_R = 0$).[4]

Note that the first term of this expression, $-var\,(y^*)$, is *not* the same as the measure of the informativeness of a partition used above. In the definition of informativeness of a partition, actions were chosen to minimize the variance of y, i.e. each action was the midpoint of the corresponding interval. Although these actions represent the receiver's ideal choices given his information, he will sometimes be forced to choose differently to avoid a veto. This results in additional informational losses.

To clarify, informational losses result from two sources. First, the sender holds back some of her information, revealing only imperfectly the value of θ. Depending on his bias relative to that of the other players, we shall see that the vetoer can either alleviate or worsen this effect. Second, given the information revealed by the sender, the preference divergence between the vetoer and the receiver produces another informational distortion: in some intervals, actions are chosen in accordance with the receiver's preferences; in others, the vetoer's veto power pulls the chosen action closer to his ideal; the overall effect is a higher variance in the outcome than would result if the receiver alone made the choice. Given that a higher variance is harmful for all the players, *ceteris paribus*, this distortion represents a clear inefficiency.

2.4 Formal analysis

2.4.1 Sender and vetoer have opposing biases ($y_S > 0 > y_V$)

We consider first the case where the sender and the vetoer have opposing biases. The key result of this section is that the communication equilibrium without veto is at least as informative as the communication equilibrium with veto (Proposition 1). A striking implication of this result is that the ability to veto actions not to his liking may actually harm the vetoer. One the one hand his veto threat causes the receiver to propose actions that are more favorable to him, for fear that their preferred choices will be vetoed; but on the other message sent by the sender is less informative, and therefore the action chosen is less responsive to the state, resulting in greater uncertainty in the final outcome. Using the terminology introduced above, the vetoer's distributional losses will be reduced if he has veto power, but his informational losses will increase. As we shall demonstrate below, the overall effect is ambiguous. The sender and receiver are always (weakly) worse off under the communication equilibrium with veto: not only is the informativeness of the sender's message reduced, but the threat of a veto by the vetoer distorts the actions chosen further from their ideals than if the receiver alone were making the decision.

[4] The derivation of this formula is as follows: $U_i = E\left[-(y_i - y^*)^2\right] = -y_i^2 + 2E[y^*]\,y_i - E\left[y^{*^2}\right] = -\left(E\left[y^{*^2}\right] - E[y^*]^2\right) - \left(E[y^*]^2 - 2E[y^*]\,y_i + y_i^2\right) = -var\,(y^*) - (E[y^*] - y_i)^2$.

To understand in more detail the precise effects of the vetoer's veto power, suppose that the communication equilibrium without veto partitions the state space into n steps: $[0, \theta_1)$, $[\theta_1, \theta_2)$, $\ldots [\theta_{n-1,}, 1]$; in the ith step, the sender sends message m_i and the receiver chooses action m_i. In each case m_i is chosen to minimize utility losses: since the receiver's (updated) belief on receiving message m_i is uniform on $[\theta_{i-1}, \theta_i)$, he will choose $a_i = \frac{\theta_{i-1}+\theta_i}{2}$, the midpoint of the interval. Now let us reintroduce the veto, and ask whether the original partition still constitutes an equilibrium. In electing whether or not to exercise his veto power against a particular action a_i, the vetoer is effectively making a choice between a_i and the *status quo*, a_0. Since his ideal action is $\frac{\theta_{i-1}+\theta_i}{2} + y_V$, he will exercise his veto whenever a_0 is closer to this action than is a_i, i.e. whenever

$$\left| a_0 - \frac{\theta_{i-1} + \theta_i}{2} + y_V \right| < \left| \frac{\theta_{i-1} + \theta_i}{2} + y_V - a_i \right|.$$

Substituting $a_i = \frac{\theta_{i-1}+\theta_i}{2}$ and using the fact that $y_V < 0$ gives us

$$a_0 < a_i < a_0 - 2y_V.$$

In words, the vetoer will veto any action between a_0 and $a_0 - 2y_V$. If none of the actions chosen by the receiver in the communication equilibrium without veto fall in this region, then it is also a communication equilibrium with veto.

If one or more of the actions chosen in the original equilibrium do fall in this region, however, we have a new equilibrium. Suppose first that the receiver does not adjust its actions, so that action a_i (say) is vetoed by the vetoer, and the *status quo* a_0 remains in place. The original intervals were constructed so that when the state is θ_i, the sender was indifferent between a_i and a_{i+1}, with strict preference for a_i when $\theta < \theta_i$ and strict preference for a_{i+1} if $\theta > \theta_i$; but if a_i is vetoed by the vetoer in favor of a_0, the sender will now strictly prefer a_{i+1} when the state is θ_i or slightly less. For these values of θ, it does better to send message m_{i+1}, undermining the original equilibrium.

To compute the communication equilibrium with veto, we must take into account the effects of the veto when constructing indifference conditions for sender types on the boundaries between partition elements (as we shall see, these indifference conditions determine how the state space can be partitioned). This is not simply a matter of replacing any action which the receiver would like to choose in the interval $(a_0, a_0 - 2y_V)$ with a_0 itself. The receiver will anticipate likely vetoes by the vetoer and may adjust his actions accordingly. To see how, let $E[\theta \mid m_i]$ denote the receiver's and the vetoer's expectation of θ on receiving message m_i from the sender.[5] The receiver's ideal action is $E[\theta \mid m_i]$, while the vetoer wants

[5] The definition of an equilibrium requires that the receiver and the vetoer have the same beliefs about θ

$E[\theta \mid m_i] + y_V$. We consider three (exhaustive) possibilities:

(*a*) $E[\theta \mid m_i] \leqslant a_0$ or $E[\theta \mid m_i] \geqslant a_0 + 2y_V$. The receiver can choose its ideal action $a_i = E[\theta \mid m_i]$ without fear of veto by the vetoer.

(*b*) $a_0 < E[\theta \mid m_i] \leqslant a_0 - y_V$. Any action above a_0 will be vetoed by the vetoer, since the vetoer's ideal action is $E[\theta \mid m_i] + y_V < a_0$; and any action below a_0 is worse for the receiver than a_0 itself. The receiver can do no better than choose its ideal action $a_i = E[\theta \mid m_i]$ and accept the vetoer's veto, with the *status quo* a_0 remaining in place.[6]

(*c*) $a_0 - y_V < E[\theta \mid m_i] < a_0 - 2y_V$. The vetoer will veto any action that is further from the *status quo* than his ideal action, i.e. any action above $2E[\theta \mid m_i] + 2y_V - a_0$; since this value is still less than $E[\theta \mid m_i]$, it is the closest the receiver can get to his ideal action.

Figure 1 below shows the action that will result as a function of $E[\theta \mid m_i]$.

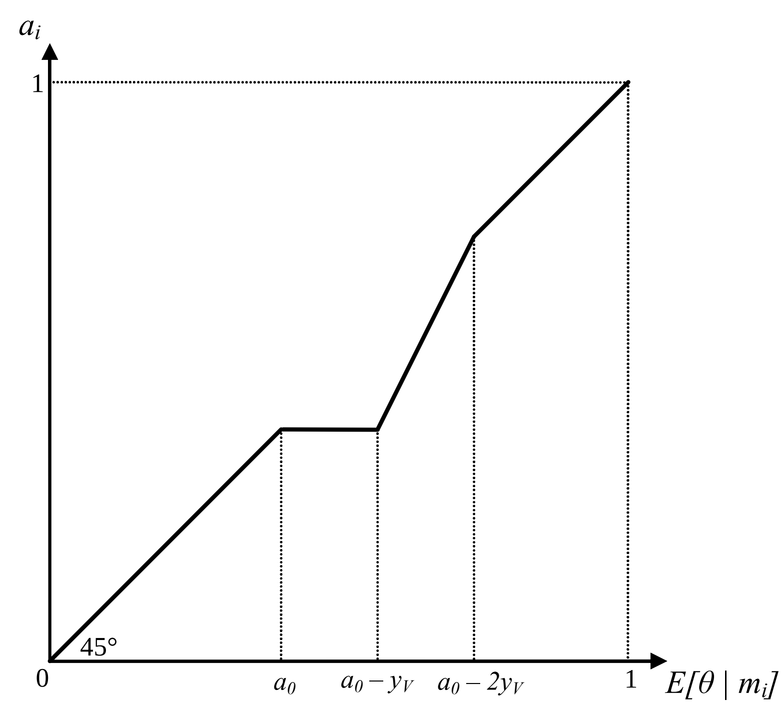

Figure 1: Action chosen as a function of expected value of θ

on the equilibrium path, i.e. if m_i is actually chosen by the sender for some value of θ. Off the equilibrium path this need not be the case. This issue, which does not affect the current analysis, is discussed in more detail in the proof of Proposition 1.

[6]Choosing action $a_i = a_0$ results in the same outcome, with no need for a veto.

To clarify the intuition behind the effects of the veto, we present an example before providing a formal statement of the results.

Example 1

Suppose the sender's bias $y_S = \frac{1}{20}$, the vetoer's bias $y_V = -\frac{1}{5}$, and the *status quo* $a_0 = \frac{2}{3}$.

Without veto: The communication equilibrium without veto is characterized by the intervals $\left[0, \frac{2}{15}\right)$, $\left[\frac{2}{15}, \frac{7}{15}\right)$ and $\left[\frac{7}{15}, 1\right]$, which partition the state space into three elements. The sender sends a different message, m_1, m_2 or m_3, depending on whether θ lies in the first, second or third interval respectively. Since there is no veto in this case, the receiver chooses his favorite bill based on the information learned from the sender. For instance, if message m_1 is sent, the receiver knows that θ must lie between 0 and $\frac{2}{15}$; he will choose action $a_1 = \frac{1}{15}$ (the mid-point of the interval) to minimize distributional losses. And in response to messages m_2 and m_3 the receiver will choose actions $a_2 = \frac{9}{30}$ and $a_3 = \frac{11}{15}$ respectively.

It remains to check that the original strategy of the sender is optimal given these actions chosen by the receiver. Recall that the bias of the sender (her ideal outcome) is y_S. Thus when the state is θ, the sender's ideal action is $a = y_S + \theta$. Since message m_1 induces action a_1 from the receiver, and message m_2 induces action a_2, we must check that whenever $\theta \in \left[0, \frac{2}{15}\right)$, the sender prefers a_1 to a_2, and whenever $\theta \in \left[\frac{2}{15}, \frac{7}{15}\right)$, she prefers a_2 to a_1. This will be true as long the sender is indifferent between the two actions when θ is on the borderline between the two intervals ($\theta = \frac{2}{15}$). At $\theta = \frac{2}{15}$, the sender's ideal action is $\frac{1}{20} + \frac{2}{15} = \frac{11}{60}$, which is precisely the midpoint between a_1 and a_2: the sender is indeed indifferent between the two actions. Similar analysis shows that m_3 is optimal when $\theta \in \left[\frac{7}{15}, 1\right]$, as required.

With veto: It is clear that this cannot be an equilibrium with veto: in the last interval the vetoer prefers the *status quo* $a_0 = \frac{2}{3}$ to the equilibrium action of $\frac{11}{15}$ (his ideal action, given his expectation of θ, is $\frac{11}{15} - \frac{1}{5} = \frac{8}{15}$), so he would exercise his veto power if $a_3 = \frac{11}{15}$ were chosen by the receiver. This in turn alters the incentives of the sender. For values of θ between $\frac{13}{30}$ and $\frac{7}{15}$ (the original cutoff point) the sender now prefers to send message m_3, resulting in a final action of $\frac{2}{3}$, rather than message m_2 which induced a final action of $\frac{9}{30}$.

The communication equilibrium with veto is characterized by the intervals $\left[0, \frac{8}{75}\right)$, $\left[\frac{8}{75}, \frac{31}{75}\right)$ and $\left[\frac{31}{75}, 1\right]$, resulting in actions $a_1' = \frac{4}{75}$, $a_2' = \frac{39}{150}$, and $a_3' = \frac{2}{3}$ respectively. In the first two intervals, the receiver is choosing his ideal action, since the vetoer's veto threat is not credible when his own ideal action is so far from the *status quo*. In the third interval, however, the receiver would like to choose action $a = \frac{53}{75}$ while the vetoer's ideal action is $\frac{38}{75}$. Any action $a > \frac{2}{3}$ will be vetoed, so the best action from the point of view of the receiver which will *not* be vetoed is $a_3' = a_0 = \frac{2}{3}$ itself.

The partitions, which represent the amount of information transmitted in each case, are shown figure 2 below along with the resulting actions. The final outcomes are shown in figure

3.

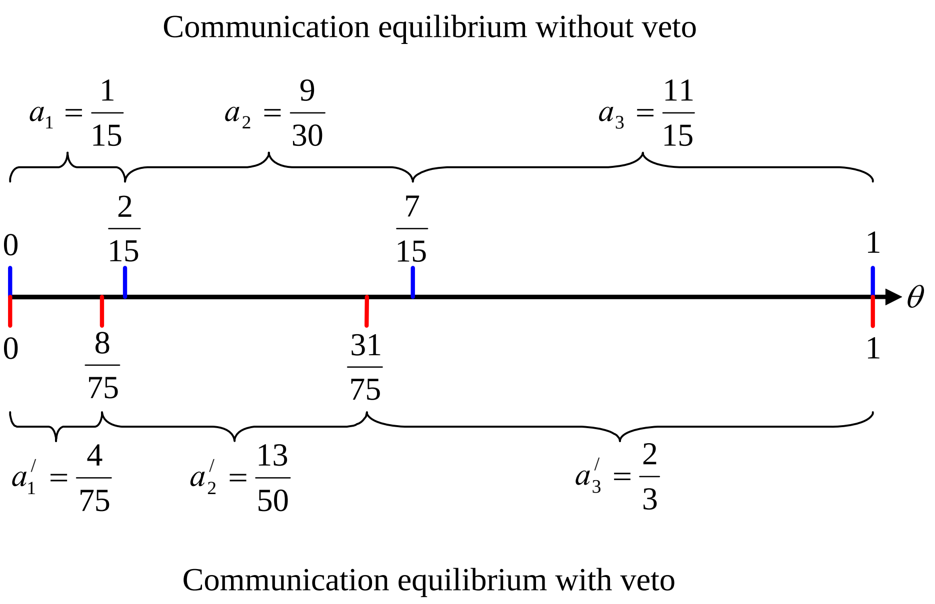

Figure 2: Information transmitted and actions chosen (*example 1*)

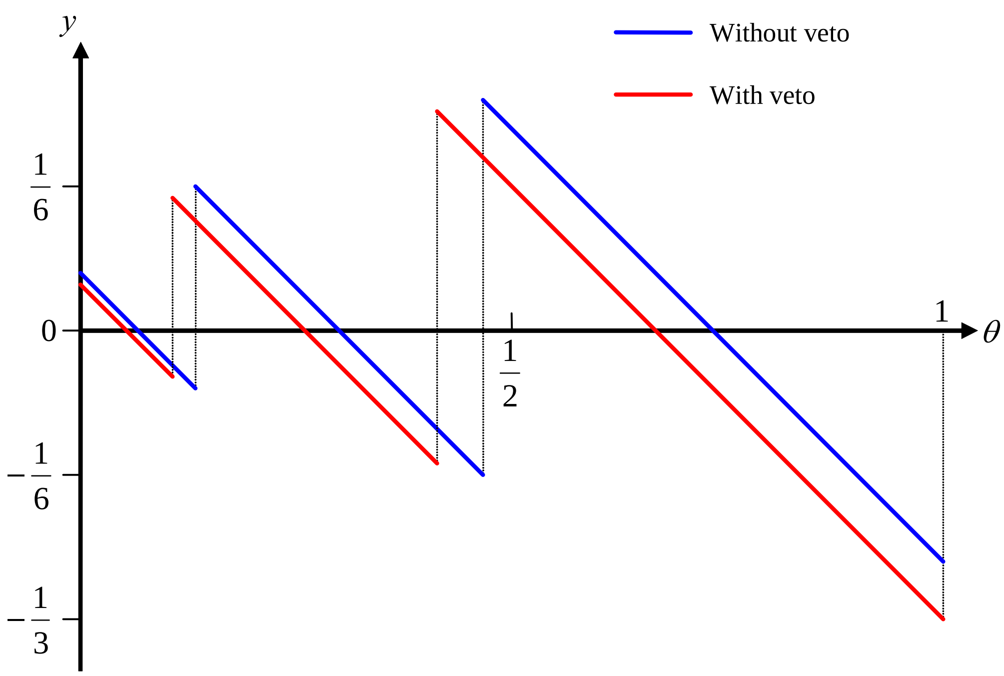

Figure 3: Outcomes (*example 1*)

It is clear from example 1 that the veto power reduces the amount of information transmitted: although there is the same number of intervals in each case, they are more evenly spaced in the equilibrium without veto. Proposition 1 shows that this result is not just a feature of this specific example, but applies whenever the sender and the vetoer have opposing biases, regardless of the position of the *status quo*.

Proposition 1 *If the sender and the vetoer have opposing biases, then the communication equilibrium without veto is at least as informative as the communication equilibrium with veto.*

We relegate the proof of this proposition to the appendix, but it is worthwhile providing some intuition here. First recall that in the model without veto threats, a more informative equilibrium is possible when the agents' interests are more closely aligned. Although our comparison between the equilibria with and without veto fixes preferences and focuses on the impact of the vetoer's veto threat, something similar is going on. When the vetoer has the opposite bias to the sender, his veto power can force the receiver to choose actions that are closer to the vetoer's interests than he would like; and these bills are further away from the sender's interests, effectively driving a larger wedge between the actions chosen by the receiver and the sender's preferred choices than there would be if there were no veto power.

The next three results show how the veto impacts on the utility of the sender, receiver and vetoer respectively.

Corollary 1a *If the sender and the vetoer have opposing biases, the sender's utility is at least as high in the communication equilibrium without veto as in the communication equilibrium with veto.*

Corollary 1b *If the sender and the vetoer have opposing biases, the receiver's utility is at least as high in the communication equilibrium without veto as in the communication equilibrium with veto.*

Corollary 1c *If the sender and the vetoer have opposing biases, the vetoer's utility may be higher, lower or the same in the communication equilibrium without veto as in the communication equilibrium with veto.*

To understand Corollary 1c, recall that we can decompose the vetoer's expected utility into informational losses and distribution losses:

$$U_V = -E(y_V - y)^2 = -var\,[y] - (E\,[y] - y_V)^2 = -(\text{informational losses} + \text{distributional losses}).$$

Informational losses arise because the sender holds back some information in her message, and so the action chosen by the receiver is not perfectly responsive to changes in the state,

θ, causing fluctuations in the final outcome y. Distributional losses arise because given his beliefs about θ, the receiver typically chooses actions that are not ideal from the point of view of the vetoer. Veto power mitigates these distributional losses, allowing the vetoer to veto bills that are unfavorable to him; but informational losses are increased because the sender, now facing a greater divergence between her preferred outcome and action actually chosen, withholds more information than before. Depending on which of these effects dominates, the vetoer may be either better or worse off.

To prove the corollary, we compute the vetoer's utility levels given the biases in example 1, in the communication equilibrium with and without veto, for three different values for the *status quo*, a_0. Table 1 describes the results.

	no veto	veto, $a_0 = \frac{1}{10}$	veto, $a_0 = \frac{1}{2}$	veto, $a_0 = \frac{2}{3}$
informational	0.0159	0.0288	0.0159	0.0202
distributional	0.0400	0.0316	0.0400	0.0197
overall	0.0559	0.0604	0.0559	0.0519

Table 1: Vetoer utility losses in different equilibria

Corollary 1b follows easily from Proposition 1, which states that informational losses are at least as high in the communication equilibrium with veto as without veto; since distributional losses for the receiver are zero in the communication equilibrium without veto, they can only increase when the veto is introduced, giving us the desired result. Similarly, to prove Corollary 1a, observe that the veto threat can also only increase distributional losses for the sender, shifting equilibrium actions further away from her ideal actions.

2.4.2 Sender and vetoer have like biases, with the sender more biased ($y_S > y_V > 0$)

The next case we consider is when the sender and the vetoer are biased in the same direction, with the vetoer less biased than the sender. It turns out that the effects of the veto are reversed compared with the case of opposing biases. Again, this result holds whatever the value of the *status quo*.

Proposition 2 *If the sender and the vetoer have like biases, with the sender more biased than the vetoer, then the communication equilibrium with veto is at least as informative as the communication equilibrium without veto.*

The intuition behind Proposition 2 is basically the opposite of the intuition behind Proposition 1: for certain regions of the state space, the veto forces the receiver to choose actions that are closer to the sender's preferred choices than he would if there were no veto power, resulting in a closer alignment of effective preferences between the two players and therefore (potentially) a more informative equilibrium. Figure 4 illustrates this point, detailing the sender's ideal action $(\theta + y_S)$, along with action that will actually be chosen in the presence of veto power.

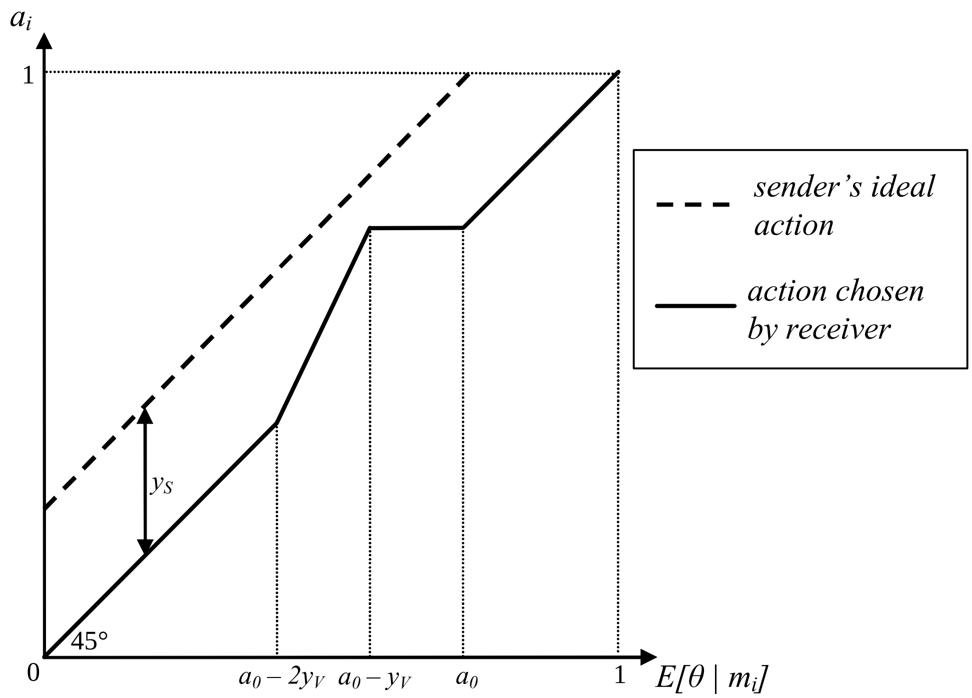

Figure 4: Effective preference alignment in the presence of veto power

Example 2 provides a direct comparison of the communication equilibrium with and without veto for specific parameter values.

Example 2

Suppose the sender's bias $y_S = \frac{1}{20}$, the vetoer's bias $y_V = \frac{1}{30}$, and the *status quo* $a_0 = \frac{1}{3}$.

Without veto: The communication equilibrium without veto is exactly the same as in example 1, since the sender's bias is the same and the vetoer plays no role: the state space is partitioned into three intervals, $\left[0, \frac{2}{15}\right)$, $\left[\frac{2}{15}, \frac{7}{15}\right)$ and $\left[\frac{7}{15}, 1\right]$, resulting in actions $a_1 = \frac{1}{15}$, $a_2 = \frac{9}{30}$, and $a_3 = \frac{11}{15}$ respectively.

With veto: This cannot be a communication equilibrium with veto, since in the second interval the vetoer would veto action a_2 in favor of the *status quo* $a_0 = \frac{1}{3}$, which is in fact his ideal action. This in turn induces the sender to prefer message m_1, signaling that θ lies in the first interval, for values of θ of $\frac{2}{15}$ and slightly higher. In the communication equilibrium with veto, the boundary of the first interval shifts to the right, pushing the second interval to the right as well. The new partition is $\left[0, \frac{7}{45}\right)$, $\left[\frac{7}{45}, \frac{22}{45}\right)$ and $\left[\frac{22}{45}, 1\right]$ (see figure 5 below).

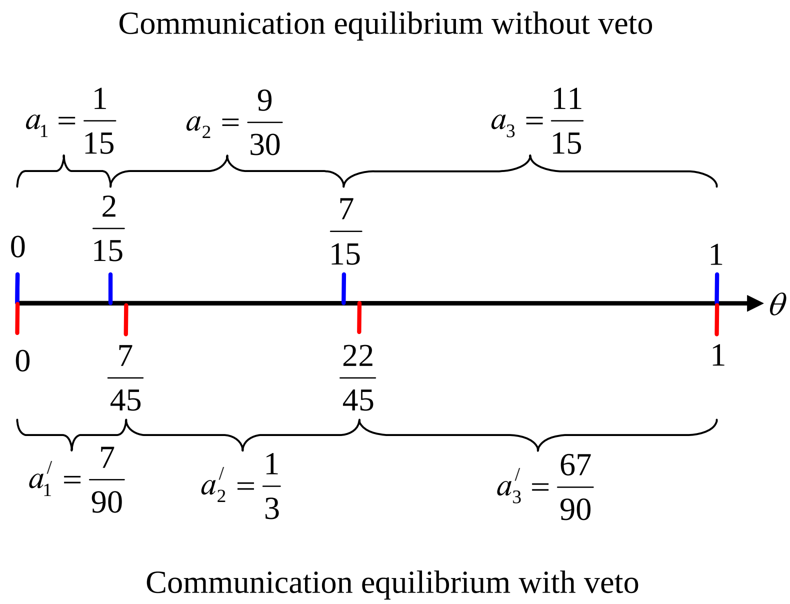

Figure 5: Information transmitted and actions chosen (*example 2*)

The utility implications of the veto in this case are summarized by the following corollaries.

Corollary 2a *If the sender and the vetoer have like biases, with the sender more biased than the vetoer, then the sender's utility will be at least as high in the communication equilibrium with veto as in the communication equilibrium without veto.*

Corollary 2b *If the sender and the vetoer have like biases, with the sender more biased than the vetoer, then the receiver's utility may be higher, lower or the same in the communication equilibrium with veto as in the communication equilibrium without veto.*

Corollary 2c *If the sender and the vetoer have like biases, with the sender more biased than the vetoer, then the vetoer's utility will be at least as high in the communication equilibrium with veto as in the communication equilibrium without veto.*

Corollaries 2a and 2c follow immediately from Proposition 2: if the vetoer's veto power has any effect, it increases the informativeness of the equilibrium; even if the receiver chose its preferred bills given this extra information, the sender and vetoer would be better off. Further, in some intervals the threat of veto may constrain the receiver to choose actions that are closer to the sender's and vetoer's ideals, resulting in an additional increase in their utility.

Corollary 2b is proved by comparing the receiver's utility values with and without the veto. Intuitively, the veto will reduce informational losses at the expense of increased distributional losses, with an ambiguous effect overall. Table 2 shows the informational and distributional losses for the receiver in example 2, with and without the veto, showing that he is better off with the veto in place. With a *status quo* of $a_0 = \frac{1}{2}$, on the other hand, the vetoer's veto power would have no effect, and he would be exactly as well off in the communication equilibrium with veto as without veto.

	no veto	veto, $b_0 = \frac{1}{3}$
informational	0.0159	0.0145
distributional	0.0000	0.0000[7]
overall	0.0159	0.0145

Table 2: Receiver's utility losses in different equilibria

Finally, to show that the veto can harm the receiver, consider an example with $y_S = \frac{1}{3}$, $y_V = \frac{1}{4}$, and $a_0 = \frac{3}{4}$. No information can be transmitted (with or without the veto), because the sender is so biased. In the communication equilibrium without veto, the receiver chooses action $a_1 = \frac{1}{2}$; in the communication equilibrium with veto, on the other hand, any action below $\frac{3}{4}$ will be vetoed by the vetoer: thus the *status quo* remains in place. Without the veto, the receiver's loss is 0.0833, while with the veto his loss is 0.1458.

2.4.3 Sender and vetoer have like biases, with the vetoer more biased $(y_V > y_S > 0)$

The final case we consider is when the sender and the vetoer are biased in the same direction, but the vetoer is more biased than the sender. In this case the effect on information transmission is ambiguous. A vetoer with similar bias to the sender can cause the receiver to choose actions closer to the sender's own ideal choice, increasing the amount of information in equilibrium; but if the vetoer is much more biased than the sender, the receiver may be compelled to choose actions even further from its favorite than the sender would like, potentially reducing the amount of information transmitted. We state this result formally, and then prove it by means of an example.

Proposition 3 *If the sender and the vetoer have like biases, with the vetoer more biased than the sender, then the communication equilibrium with veto may be more, less, or just as informative then the communication equilibrium without veto.*

[7] Distributional losses are 0.0000137174, or 0.0000 to four decimal places.

Example 3.

Suppose the sender's bias $y_S = \frac{1}{15}$ and the *status quo* $a_0 = \frac{2}{3}$.

Without veto: The communication equilibrium without veto is characterized by the intervals $\left[0, \frac{1}{15}\right)$, $\left[\frac{1}{15}, \frac{6}{15}\right)$, and $\left[\frac{6}{15}, 1\right]$. The informativeness of this equilibrium, $-var\left[x\right] = -0.0211$.

We now prove the proposition by holding constant the sender's bias and the *status quo* and introducing the veto, with two different levels of vetoer bias.

With veto, vetoer's bias $y_V = \frac{1}{5}$: In this case, the communication equilibrium with veto is more informative than the communication equilibrium without veto. The communication equilibrium with veto is characterized by the intervals $\left[0, \frac{16}{45}\right)$, $\left[\frac{16}{45}, \frac{31}{45}\right)$, and $\left[\frac{31}{45}, 1\right]$. It is interesting to delve into the mechanics of this equilibrium. In the second interval, the receiver would like to choose $a_2 = \frac{47}{90}$. However, the vetoer's ideal policy is $\frac{47}{90} + \frac{1}{5} = \frac{65}{90}$, and thus he would veto this action. There is nothing the receiver can do better than to choose $a_2' = \frac{47}{90}$ instead, knowing that this will be vetoed and the *status quo* will remain in place. The veto does not constrain the receiver in the first and third intervals, where he chooses $a_1' = \frac{8}{45}$ and $a_3' = \frac{38}{45}$ respectively. It remains to check that the sender's boundary types are indifferent between the actions adopted in equilibrium. The boundary type $\theta_1' = \frac{16}{45}$ has an ideal action of $\frac{16}{45} + \frac{1}{15} = \frac{19}{45}$, which is equal to $\frac{1}{2}\left(\frac{8}{45} + \frac{2}{3}\right) = \frac{19}{45}$, the midpoint of the resulting actions in the first and second intervals. Similarly, the boundary type $\theta_2' = \frac{31}{45}$ has a ideal action of $\frac{31}{45} + \frac{1}{15} = \frac{34}{45}$, which is equal to $\frac{1}{2}\left(\frac{2}{3} + \frac{38}{45}\right) = \frac{34}{45}$, the midpoint of the resulting actions in the second and third intervals.[8] The informativeness of this equilibrium is $-var\left[x\right] = -0.0093$, which is more informative than without the veto.

With veto, vetoer's bias $y_V = \frac{2}{3}$: Next, consider the same parameters except that $y_V = \frac{2}{3}$ (so the vetoer is very biased). In this case, the communication equilibrium with veto is characterized by the intervals $\left[0, \frac{31}{45}\right)$, and $\left[\frac{31}{45}, 1\right]$, with actions $a_1' = \frac{2}{3}$ and $a_2' = \frac{38}{45}$ resulting in the first and second intervals respectively. The three-step equilibrium under the communication equilibrium without veto becomes a two-step equilibrium since the vetoer will veto any action less than the *status quo*. Specifically, he would veto the first two actions, $a_1 = \frac{1}{30}$ and $a_2 = \frac{7}{30}$, chosen in the communication equilibrium without veto. The informativeness of this equilibrium is $-var\left[x\right] = -0.0298$, which is less informative than without the veto.

[8] Note also that for the parameter values in this example, the original three-step equilibrium is still an equilibrium but it is less informative than the legislative equilibrium with veto constructed above; and the partition $\left\{\left[0, \frac{2}{15}\right), \left[\frac{2}{15}, \frac{7}{15}\right), \left[\frac{7}{15}, 1\right]\right\}$ forms another equilibrium. The result is interesting also from a theoretical perspective. Recall that Crawford and Sobel [4] prove that there is exactly one partition equilibrium with n steps. In the case where the vetoer more biased than the sender, this result no longer holds. As shown in our example, there may be several different three-step equilibria (with one being more informative than the other).

Corollaries 3a and 3b point out the possible effects of the veto on the utilities of the sender and receiver. In both cases, the effects are ambiguous. We prove these results by computing utility losses in equilibria with different values of y_V (tables 3 and 4). As in example 3, $y_S = \frac{1}{15}$ and $a_0 = \frac{2}{3}$. We believe that the vetoer must be at least as well off in the communication equilibrium with veto as without, although we have been unable to prove this result. His veto power can only benefit him distributionally, and for it to increase informational losses, he must be much more biased than the sender ($y_V \gg y_S$); in this case, the distributional gains seem always to dominate the informational losses.

Corollary 3a *If the sender and the vetoer have like biases, with the vetoer more biased than the sender, then the sender's utility may be higher, lower or the same in the communication equilibrium without veto as in the communication equilibrium with veto.*

Corollary 3b *If the sender and the vetoer have like biases, with the vetoer more biased than the sender, then the receiver's utility may be higher, lower or the same in the communication equilibrium with veto as in the communication equilibrium without veto.*

	no veto	veto, $y_V = \frac{1}{10}$	veto, $y_V = \frac{1}{5}$	veto, $y_V = \frac{2}{3}$
informational	0.0211	0.0211	0.0140	0.0520
distributional	0.0044	0.0044	0.0003	0.0241
overall	0.0256	0.0256	0.0143	0.0790

Table 3: Sender's utility losses in different equilibria

	no veto	veto, $y_V = \frac{1}{10}$	veto, $y_V = \frac{1}{5}$	veto, $y_V = \frac{2}{3}$
informational	0.0211	0.0211	0.0140	0.0520
distributional	0.000	0.0000	0.0023	0.0493
overall	0.0211	0.0211	0.0163	0.1013

Table 4: Receiver's utility losses in different equilibria

3 Applications

3.1 The U.S. legislative process

The framers of the United States Constitution desired a strong and effective national government, but wanted to avoid concentrating too much power in a single body. They believed that appropriate limits on government could be achieved by the proper balance of state and federal power and by dividing federal power among three separate and distinct branches of government. The power of each of these three branches of federal government is constrained to some extent by the others — a system commonly known as "checks and balances". With respect to the legislative process, Congress's own legislative power is effectively checked by the president's veto, i.e. the laws Congress passes may be vetoed in turn by the president.[9] In the context of our model, then, Congress plays the role of the receiver and the President the role of vetoer. Depending on the situation, the role of sender (expert) might be played by a legislative committee or a lobby group. We discuss each in turn.

First, various empirical and theoretical studies have underlined the informational advantage of congressional committees *vis-à-vis* other legislative actors, and the consequences of this informational asymmetry on the legislative process. In particular, several papers (see e.g. Gilligan and Krehbiel [7], [8] and Krishna and Morgan [14]) have analyzed the amount of information passed from the informed committee to the uninformed floor. These papers provide an informational rationale for the (internal) organization of the legislature, focusing on the comparison between different rules that govern the interaction between the committee and the floor. The role of the presidential veto, however, is not considered. Our model fills that gap, analyzing how presidential veto power affects the transmission of information within the legislative process and consequently policy choices.

Second, it is clear that interest groups and lobbyists play an important role in the legislative process. It has been argued that they exert their influence primarily through their informational advantage. For instance, Austen-Smith [1] writes: "Lobbying is essentially an informational activity... Legislators typically make policy decisions under uncertainty, regarding either their political consequences (e.g., how are reelection chances affected?) or their technical consequences (e.g., how will a revised Clean Air Act hurt employment in the auto industry?). Information is thus valuable, and those possessing it are in a position to influence legislative decisions." He goes on to discuss several models in which lobbyists effect the policy outcome by means of cheap talk statements to the decision makers. Similarly, Grossman and Helpman [10] use the Crawford and Sobel framework to analyze how a biased

[9] Congress can override a presidential veto with a two-thirds majority in both House and Senate. In practice this is a rare occurrence: Congress has challenged the President's veto 307 times and succeed in overriding only on 106 occasions.

lobbyist can have an impact on legislation. Again, the presidential veto is not modeled.

The U.S. constitutional style (with a directly-elected president) has influenced the constitutions of other political systems, particularly in Latin America. Although the veto power of presidents in other political systems varies, it may impact information transmission within the legislative process in a similar way and consequently affect the quality of legislation. In developing economies, which are often at the same time developing democracies, the quality of legislation is crucial for the efficient functioning of the market mechanism.

3.2 Legislation in the European Union

The EU legislative process can also be analyzed within the framework provided by this paper. Different rules govern the EU legislative process, in which the European Commission (the sender) drafts legislation and sends it for approval to the Council of Ministers and the European Parliament. Under the *consultation procedure*, the Council makes a legislative decision on a proposal from the Commission after receiving a non-binding opinion from the Parliament (the Parliament *de jure* and *de facto* has no legislative power in this case). Under the *co-operation procedure*, the Commission drafts a legislative proposal, the Parliament can amend it as it wishes and then the Council can either accept it or veto it. Under the *co-decision procedure*, the roles of the Parliament and the Council are reversed. The results of this paper can shed light on how these procedures affect the flow of information and likely policy outcomes in the EU legislative process.

3.3 Unicameral versus Bicameralism

Bicameralism — the division of a legislature into two parallel but separate political bodies which must act in agreement for legislation to be enacted into law — is a recurrent feature of contemporary national legislatures. A structural arrangement in which two legislative bodies perform essentially similar legislative functions might seem inherently duplicative and inefficient. Despite inevitable criticism, however, legislative bicameralism has been widely advocated and defended in a variety of systems and on a number of diverse grounds, both historically and contemporaneously. Our model can be used as a positive theory to understand the effectiveness of a unicameral versus a bicameral legislature from an informational perspective.

The legislative systems of the Netherlands and of Denmark, for instance, fit closely into our theoretical framework with and without the veto player, respectively. In the Netherlands, the government and the two houses of Parliament share the constitutional legislative power. Only the government and the Tweede Kamer (or Lower House) have the formal power to initiate or amend legislation, however. In practice, the government usually take the legislative initiative and proposes bills which must be then approved by a simple majority with a quorum rule of 50 per cent plus one in the Tweede Kamer. If the legislation is approved, it is then sent to the Eerste Kamer (or Upper House), which can accept or reject it at large. In contrast, according to the Danish Constitution, legislative power is shared by the government and a unicameral Parliament (Folketing). Once again most bills are initiated by the government, and then introduced in Parliament which can amend them as it wishes. More than one half of the MPs must be present for a decision to be made, and the decision rule is 50 per cent plus one of all valid votes (ignoring abstentions). In Denmark, then, there is no veto player.

3.4 Corporate Governance

In addition, our model can be applied to various issues in corporate governance. Consider the mergers and acquisitions process for instance. The sender in our model corresponds to the CEO of a public company, who in practice usually takes the initiative to make the acquisition proposal. The message corresponds to the price for the acquisition, which is debated by the Board of Directors (receiver) which makes a decision. Finally the shareholders play the role of the vetoer: Under United States law, shareholders of publicly-traded companies have the right to veto such proposals (as well as other fundamental corporate changes such as charter amendments and sales of assets), i.e. majority approval is required for the proposal to go ahead. Our analysis could shed light on the likely effects of this shareholder veto power, and thus contribute to the debate over the appropriate extent of shareholder power (see e.g. Bebchuk and Fried [3]). Executive compensation might also fit within the framework. There the proposal comes from a compensation committee not the CEO, and then goes to the Board for approval or modification. As mentioned in the introduction, however, the NYSE Corporate Governance Rules currently grant shareholders veto power only over equity compensation plans.

4 Conclusions and Extensions

In many situations of economic interest, the primary decision maker is constrained by the threat of a veto from another agent. We have shown how this veto power can affect the transmission of information from an expert sender to the decision maker. It is worth emphasizing precisely how the veto power affects the interactions between the agents in the model. First, there is a direct effect: given that the vetoer and the receiver have different preferences, the vetoer may veto actions that are chosen by the receiver when his own preferred action is close to the *status quo*. Depending on exact parameter values, the receiver may modify his chosen action in order to avoid the veto, making a compromise between the vetoer's preferences and his own; or he may simply choose his own ideal action in full knowledge that a veto will be forthcoming. Second, there is an indirect (though potentially large) effect on the information transmission process; depending on the strength and direction of the vetoer's bias compared to that of the sender, more or less information may be transmitted than if the vetoer had no power. Counterintuitively, it is possible that the vetoer may be harmed by his own veto power: although the vetoer is able to veto bills he dislikes, if the sender's message is sufficiently less informative, he might suffer a welfare loss overall. On the other hand, when there are informational gains as a result of the veto threat, the receiver may be made better off notwithstanding the need to modify his behavior in order to avoid vetoes. Finally, the very existence of the veto threat can sometimes induce the receiver to use what information he has less effectively (from his point of view) than would otherwise be the case.

An interesting extension of the model would be to allow the expert to communicate privately with the receiver and the vetoer. This complicates the analysis considerably: in particular, if the receiver is less well informed than the vetoer, he is no longer able to predict when a veto will be forthcoming. Similarly, for certain applications it may be appropriate to assume that the vetoer (or the receiver) has private information not acquired from the sender. For example, in the United States, in matters of legislation concerning the federal budget, presidents receive detailed information from the Office of Management and Budget (OMB), and are thus better informed than Congress about the likely impact of particular policies. We also hope to extend our analysis of expert advice with multiple decision makers to alternative bargaining procedures. This would allow us to investigate inter- and intra-cameral bargaining in the United States, as well as other bicameral systems where power is shared more equally between the two chambers.

Finally, we would like to reexamine the issues raised by the presence of multiple decision makers from a mechanism design perspective. In the classic cheap talk approach to communication, the decision maker (receiver) effectively has no commitment power. In contrast, the mechanism design approach, initiated by Holmström [12] and analyzed by Melumad and Shibano [15] in the context of the Crawford and Sobel framework, assumes that the decision maker can commit *ex ante* to a mechanism which stipulates what actions will be taken in response to various messages from the expert. Baron [2] has argued that this is the appropriate framework to use when studying the relationship between legislators and informational committees.

A Proofs

Proof of Proposition 1 Proposition 1 provides a comparison of the informativeness of equilibria with and without veto. We start by characterizing the equilibria in each case.

Communication equilibrium without veto. The properties of a communication equilibrium without veto are well understood. Crawford and Sobel [4] prove that every such equilibrium is partitional in nature, divided up the state space into a finite number of intervals $[0, \theta_1), [\theta_1, \theta_2), \ldots, [\theta_{n-1}, 1]$; in each interval i the Sender sends the same message m_i, informing the Receiver that $\theta \in [\theta_{i-1}, \theta_i)$, and the Receiver responds optimally by choosing action $a_i = \frac{\theta_{i-1}+\theta_i}{2}$. The boundary points between the intervals must satisfy the following difference equations:

$$\theta_{i+1} - \theta_i = \theta_i - \theta_{i-1} + 4y_S.$$

These difference equations are derived from a family of indifference conditions, which state that Sender types on the boundary between two intervals must be indifferent between the actions chosen in the lower and in the higher intervals. Crawford and Sobel prove that there is an upper bound on the number of intervals possible in any equilibrium. This bound is given by

$$\left\lfloor -\frac{1}{2} + \frac{1}{2}\sqrt{\left(1 + \frac{2}{y_S}\right)} \right\rfloor,$$

where $\lfloor z \rfloor$ denotes the smallest integer greater than or equal to z. Our focus is on the most informative equilibrium: this is the equilibrium with the largest number of intervals.

Communication equilibrium with veto. Our characterization of the communication equilibrium with veto proceeds in two stages. We start by showing that the equilibrium must be partitional, as before. Then we demonstrate that the (most informative) partition divides the state space the same or less evenly than in the absence of the veto threat, so that the equilibrium is no more informative than before (example 1 in the main text show that it may be strictly less so).

The communication equilibrium with veto is partitional. First we show that only a finite number of different actions result in any equilibrium. Fix some equilibrium. Let $D(\overline{a})$ be the set of messages sent by the Sender that would result in action $\overline{a}$ (note that $\overline{a}$ could be the action actually chosen by the receiver as long as it is not vetoed, or it could be the *status quo* action a_0 if the Receiver chooses some alternative action and the Vetoer exercises his veto). Formally, $D(\overline{a}) \equiv \{m : a(m) = \overline{a} \text{ and } a(m, b(m) = \textit{approve})\}$ for $\overline{a} \neq a_0$, and $D(a_0) = m : \{a(m) = a_0 \text{ or } a(m, a(m)) = \textit{veto}\}$. We say that an action $\overline{a}$ is *induced by* an Sender type $\overline{\theta}$ if $m(\overline{\theta}) \in D(\overline{a})$. Notice that if A is the set of all actions induced in equilibrium (by any Sender type), then if Sender type $\overline{\theta}$ induces action $\overline{a}$ we must have $U_S(\overline{a}, \overline{\theta}, y_S) = \max_{a \in A} U_S(a, \overline{\theta}, y_S)$. (We assume without loss of generality that the Receiver takes actions in A even for values of m not in the support of $m(\theta)$). For all $\theta \in [0, 1]$, let

$a_S(\theta)$ denote the preferred action of the Sender, i.e.,

$$a_S(\theta) \equiv \arg\max_a U_S(a,\theta,y_S) = \theta + y_S.$$

Next, let $a_R(E[\theta])$ denote the preferred action of the Receiver given the constraints imposed by the veto, assuming that the Receiver and the Vetoer have the same expectation of θ. It is more complex to characterize $a_R(E[\theta])$:

$$a_R(E[\theta]) = \begin{cases} E[\theta] & \text{for } E[\theta] \leqslant a_0 \text{ or } E[\theta] \geqslant a_0 + 2y_V \\ a_0 & \text{for } a_0 < E[\theta] \leqslant a_0 - y_V \\ 2E[\theta] + 2y_V - a_0 & \text{for } a_0 - y_V < E[\theta] < a_0 - 2y_V \end{cases}$$

(The source of the computations can be found in section 3.4.1; see also figure 1.) Notice that $a_R(\cdot)$ is weakly monotonic increasing.

We now show that, for some $\varepsilon > 0$, if a^i and a^j are two actions induced in equilibrium, then $|a^i - a^j| \geqslant \epsilon$; furthermore, the number of actions induced in equilibrium is finite. Without loss of generality, suppose $a^i < a^j$. Since a Sender type who induces a^j(or a^i) thereby reveals a weak preference for that action over a^i(or a^j), by continuity there exists a $\overline{\theta} \in [0,1]$, such that $U_S(a^i,\overline{\theta},y_S) = U_S(a^j,\overline{\theta},y_S)$. Since $\frac{\partial^2 U_S}{\partial a^2} < 0$ and $\frac{\partial^2 U_S}{\partial a \partial \theta} > 0$, the following conditions hold:

(1) $a^i < a_S(\overline{\theta}) < a^j$,

(2) a^i is not induced by any Sender type $\theta > \overline{\theta}$, and

(3) a^j is not induced by any Sender type $\theta < \overline{\theta}$.

When a^i in induced, then, the Receiver and the Vetoer know that $\theta \leqslant \overline{\theta}$, and so $E[\theta] \leqslant \overline{\theta}$; it follows that $a_R(E[\theta]) = a^i$ for some $E[\theta] \leqslant \overline{\theta}$, giving us $a^i \leq a_R(\overline{\theta})$ since $\frac{\partial^2 U_R}{\partial a \partial \theta} > 0$. By similar reasoning, $a_R(\overline{\theta}) \leq a^j$, so we have:

(4) $a^i \leq a_R(\overline{\theta}) \leq a^j$.

However, since $a_R(\theta) \neq a_S(\theta)$ for all $\theta \in [0,1]$, there exists an $\epsilon > 0$ such that $|a_R(\theta) - a_S(\theta)| \geqslant \epsilon$ for all $\theta \in [0,1]$. It follows from (1) and (4) that $|a^i - a^j| \geqslant \epsilon$. Since the set of actions induced in equilibrium is bounded by $a_R(0)$ and $a_R(1)$ (because $\frac{\partial^2 U_R}{\partial a \partial \theta} > 0$), this completes the proof.

We have shown that only a finite number of actions can be induced in equilibrium. Denote these actions $a_1, a_2, \ldots, a_n$, with $a_i > a_{i-1}$. Each Sender type $\overline{\theta}$ will choose its preferred action from this set. The Sender types can therefore be partitioned into N intervals $[0,\theta_1), [\theta_1,\theta_2), \ldots, [\theta_{n-1},1]$, with action a_i preferred by all types $\theta \in [\theta_{i-1},\theta_i)$; therefore all these types must send (one of) the message(s) which induces a_i. For a_i actually to result, we need in addition that $a_R(E[\theta]) = a_i$ when $E[\theta] = \frac{\theta_{i-1}+\theta_1}{2}$.

The communication equilibrium with veto is no more informative than the communication equilibrium without veto. Now that we know which actions will be chosen in each step of the equilibrium partition, we must verify that the Sender types are indeed choosing optimally. It suffices to check that the Sender types on the boundary between each interval are indifferent between the actions induced in the two adjacent intervals. The general form of this family of indifference conditions is:

$$\frac{a_{i-1}+a_i}{2} = \theta_i + y_S.$$

Substituting in the values $a_{i-1} = a_R(\frac{\theta_{i-1}+\theta_{i-2}}{2})$ and $a_i = a_R(\frac{\theta_i+\theta_{i-1}}{2})$ gives us a difference equation describing that *length* of each interval in terms of the length of the previous interval. (The main result will follow from the fact that the intervals grow at least as quickly in the equilibrium with veto as in the equilibrium without veto; hence the former equilibrium partition is less evenly spaced.) The indifference condition that must be satisfied by two consecutive intervals depends on where $E[\theta]$ (the midpoint of each interval) lies, since the value of $a_R(E[\theta])$ depends on in which region of the state space $E[\theta]$ falls. We consider 7 exhaustive possibilities.

(1) $\frac{\theta_{i-1}+\theta_i}{2} \notin (a_0, a_0 - 2y_V)$ and $\frac{\theta_i+\theta_{i+1}}{2} \notin (a_0, a_0 - 2y_V)$

$$\theta_{i+1} - \theta_i = \theta_i - \theta_{i-1} + 4y_S$$

(2) $\frac{\theta_{i-1}+\theta_i}{2} \leqslant a_0$ and $\frac{\theta_i+\theta_{i+1}}{2} \in (a_0, a_0 - y_V]$

$$\begin{aligned}
\frac{\frac{\theta_{i-1}+\theta_i}{2} + a_0}{2} &= \theta_i + y_S \\
\Rightarrow \theta_{i-1} + \theta_i + 2a_0 &= 4\theta_i + 4y_S \\
\Rightarrow 2a_0 - 2\theta_i &= \theta_i - \theta_{i-1} + 4y_S \\
\text{Since } \frac{\theta_i + \theta_{i+1}}{2} &> a_0, \text{ this gives us:} \\
\theta_{i+1} - \theta_i &> \theta_i - \theta_{i-1} + 4y_S
\end{aligned}$$

(3) $\frac{\theta_{i-1}+\theta_i}{2} \leqslant a_0$ and $\frac{\theta_i+\theta_{i+1}}{2} \in (a_0 - y_V, a_0 - 2y_V)$

$$\begin{aligned}
\frac{\frac{\theta_{i-1}+\theta_i}{2} + 2\left(\frac{\theta_i+\theta_{i+1}}{2} + y_V\right) - a_0}{2} &= \theta_i + y_S \\
\Rightarrow \theta_{i-1} + \theta_i + 2\left(\theta_i + \theta_{i+1}\right) + 4y_V - 2a_0 &= 4\theta_i + 4y_S \\
\Rightarrow 2\theta_{i+1} + 4y_V - 2a_0 &= \theta_i - \theta_{i-1} + 4y_S \\
\Rightarrow (\theta_{i+1} - \theta_i) + (\theta_i + \theta_{i+1}) - 2a_0 + 4y_V &= \theta_i - \theta_{i-1} + 4y_S \\
\text{Since } \frac{\theta_i + \theta_{i+1}}{2} &> a_0, \text{ this gives us:} \\
\theta_{i+1} - \theta_i &> \theta_i - \theta_{i-1} + 4y_S
\end{aligned}$$

(4) $\frac{\theta_{i-1}+\theta_i}{2} \in (a_0, a_0 - y_V]$ and $\frac{\theta_i+\theta_{i+1}}{2} \in (a_0 - y_V, a_0 - 2y_V)$

$$\begin{aligned}
\frac{a_0 + 2\left(\frac{\theta_{i-1}+\theta_i}{2} + y_V\right) - a_0}{2} &= \theta_i + y_S \\
\Rightarrow 2a_0 + 2\left(\theta_i + \theta_{i+1}\right) + 4y_V - 2a_0 &= 4\theta_i + 4y_S \\
\Rightarrow 2\theta_{i+1} - \theta_i + 4y_V &= \theta_i + 4y_S \\
\Rightarrow (\theta_{i+1} - \theta_i) + \theta_{i+1} - \theta_{i-1} + 4y_V &= \theta_i - \theta_{i-1} + 4y_S \\
\text{Notice that } \frac{\theta_i + \theta_{i+1}}{2} - \frac{\theta_{i-1} + \theta_i}{2} &< 2y_V, \text{ so } \theta_{i+1} - \theta_{i-1} < 4y_V \\
\Rightarrow \theta_{i+1} - \theta_i &> \theta_i - \theta_{i-1} + 4y_S
\end{aligned}$$

(5) $\frac{\theta_{i-1}+\theta_i}{2} \in (a_0, a_0 - y_V]$ and $\frac{\theta_i+\theta_{i+1}}{2} \geqslant a_0 - 2y_V$

$$\begin{aligned}
\frac{a_0 + \frac{\theta_i+\theta_{i+1}}{2}}{2} &= \theta_i + y_S \\
\Rightarrow 2a_0 + \theta_i + \theta_{i+1} &= 4\theta_i + 4y_S \\
\Rightarrow \theta_{i+1} - \theta_i &= 2\theta_i - 2a_0 + 4y_S \\
\text{Since } \frac{\theta_i + \theta_{i+1}}{2} &> a_0, \text{ this gives us:} \\
\Rightarrow \theta_{i+1} - \theta_i &> \theta_i - \theta_{i-1} + 4y_S
\end{aligned}$$

(6) $\frac{\theta_{i-1}+\theta_i}{2} \in (a_0 - y_V, a_0 - 2y_V)$ and $\frac{\theta_i+\theta_{i+1}}{2} \in (a_0 - y_V, a_0 - 2y_V)$:

$$\begin{aligned}
\frac{2\left(\frac{\theta_{i-1}+\theta_i}{2}+y_V\right)-a_0+2\left(\frac{\theta_i+\theta_{i+1}}{2}+y_V\right)-a_0}{2} &= \theta_i + y_S \\
\Rightarrow 2(\theta_{i-1}+\theta_i)+2(\theta_i+\theta_{i+1})+8y_V-4a_0 &= 4\theta_i+4y_S \\
\Rightarrow (\theta_{i+1}-\theta_i)+2\theta_i+\theta_{i-1}+\theta_{i+1}+8y_V-4a_0 &= \theta_i-\theta_{i-1}+4y_S \\
\Rightarrow (\theta_{i+1}-\theta_i)+(\theta_{i-1}+\theta_i)+4y_V-2a_0+(\theta_i+\theta_{i+1})+4y_V-2a_0 &= \theta_i-\theta_{i-1}+4y_S \\
\text{Notice that } \frac{\theta_i+\theta_{i+1}}{2} < a_0-2y_V \text{ and } \frac{\theta_i+\theta_{i+1}}{2} &< a_0-2y_V \\
\Rightarrow \theta_{i+1}-\theta_i &> \theta_i-\theta_{i-1}+4y_S
\end{aligned}$$

(7) $\frac{\theta_{i-1}+\theta_i}{2} \in (a_0 - y_V, a_0 - 2y_V)$ and $\frac{\theta_i+\theta_{i+1}}{2} \geqslant a_0 - 2y_V$:

$$\begin{aligned}
\frac{2\left(\frac{\theta_{i-1}+\theta_i}{2}+y_V\right)-a_0+\frac{\theta_i+\theta_{i+1}}{2}}{2} &= \theta_i + y_S \\
\Rightarrow 2(\theta_{i-1}+\theta_i)+\theta_i+\theta_{i+1}+4y_V-2a_0 &= 4\theta_i+4y_S \\
\Rightarrow (\theta_{i+1}-\theta_i)+\theta_{i-1}+\theta_i+4y_V-2a_0 &= \theta_i-\theta_{i-1}+4y_S \\
\text{Notice that } \frac{\theta_{i-1}+\theta_i}{2} &< a_0-2y_V \\
\Rightarrow \theta_{i+1}-\theta_i &> \theta_i-\theta_{i-1}+4y_S
\end{aligned}$$

Any partition of the space which satisfies these conditions describes an equilibrium of the game: the conditions themselves imply that the Sender is maximizing expected utility given the actions which will result, and the actions have been chosen in such a way than neither Receiver nor Vetoer can gain by deviating from their specified strategies.

Recall that the communication equilibrium with veto is the *most informative* equilibrium which satisfies these conditions. To prove Proposition 1, we must show that this equilibrium is no more informative that the communication (i.e. most informative) equilibrium without veto. Suppose that the two equilibria are characterized by the following partitions:

$$\begin{aligned}
\text{communication equilibrium without veto:} \quad & \mathcal{P} = \{[0,\theta_1), [\theta_1,\theta_2), \ldots, [\theta_{n-1,}1]\} \\
\text{communication equilibrium with veto:} \quad & \mathcal{P}' = \left\{[0,\theta'_1), [\theta'_1,\theta'_2), \ldots, \left[\theta'_{m-1,}1\right]\right\}
\end{aligned}$$

Notice that $m \leqslant n$: since the communication equilibrium without veto contains the maximum number of intervals consistent with the relevant difference equation ($\theta_{i+1} - \theta_i = \theta_i - \theta_{i-1} + 4y_S$, $\theta_0 = 0$, $\theta_n = 1$), and the intervals grow at least as quickly with as without the veto, the number of intervals possible in the communication equilibrium with veto must the same or lower.

Recall that for a given partition, informativeness is defined as the variance of the outcome y when bills are chosen to minimize this variance, i.e. $a_i = \frac{\theta_{i-1}+\theta_i}{2}$ for all i (so each action is the midpoint of its respective interval). Letting $l_1, l_2, \ldots, l_n$ and $l'_1, l'_2, \ldots, l'_n$ denote the lengths of the intervals in the non-veto case and the veto case respectively[10], we have

$$\begin{aligned} \text{informativeness}\left(\mathcal{P}\right) = I\left(\mathcal{P}\right) = & -\int_0^{\theta_1}\left(\frac{\theta_1}{2}-\theta\right)^2 d\theta - \int_{\theta_1}^{\theta_2}\left(\frac{\theta_1+\theta_2}{2}-\theta\right)^2 d\theta - \cdots \\ & -\int_{\theta_{n-1}}^{1}\left(\frac{\theta_{n-1}+1}{2}-\theta\right)^2 d\theta \\ = & -\frac{1}{12}\left(l_1^3+l_2^3+\cdots+l_n^3\right) \end{aligned}$$

and $I\left(\mathcal{P}'\right) = -\frac{1}{12}\left(l_1'^3+l_2'^3+\cdots+l_n'^3\right)$.

Next, observe that the l_i's and the l'_i's must satisfy the following inequalities:

$$\begin{array}{lll} l_1 & \leqslant & 4y_S \qquad l'_1 > 0 \\ l_2 & \leqslant & 8y_S \qquad l'_2 > 4y_S \\ l_3 & \leqslant & 12y_S \qquad l'_3 > 8y_S \\ & \vdots & \qquad\qquad \vdots \end{array}$$

The first inequality, $l_1 \leqslant 4y_S$, follows from the fact that the communication equilibrium without veto is the *most* informative equilibrium, and the rest follow from the difference equations. Combining the inequalities, we obtain

$$l'_i > l_j \text{ for all } i = 2, \ldots, m \text{ and } j < i.$$

We use this result to prove the following lemma:

Lemma 1 *For all* $i = 1, \ldots n-1$ *and* $j = 1, \ldots, m-1$, *if* $\theta_i < \theta'_j$ *then* $\theta_{i+1} < \theta'_{j+1}$.

Proof Consider two cases:

(a) $i < j$. Since $i < j$, we know that $\theta'_{j+1} - \theta_j = l'_j > l_i = \theta_{i+1} - \theta_i$. It follows immediately that if $\theta_i < \theta'_j$, then $\theta_{i+1} < \theta'_{j+1}$.

(b) $i \geqslant j$. Assume that $\theta_i < \theta'_j$ and $\theta_{i+1} \geqslant \theta'_{j+1}$. Then $l_{i+1} > l'_{j+1}$, and it follows from the difference equations that $l_{i+1-k} > l'_{j+1-k}$ for $k = 0, \ldots, j$. Thus we have

$$\theta_i = \sum_{k=1}^{i} l_k = \sum_{k=1}^{j} l_k + \sum_{k=j+1}^{i} l_k > \sum_{k=1}^{j} l'_k = \theta'_j,$$

[10] i.e. $l_i = \theta_i - \theta_{i-1}$ and $l'_j = \theta_j - \theta_{j-1}$, for $i = 1, \ldots, n$ and $j = 1, \ldots, m$.

contradicting the initial assumption. It follows that if $\theta_i < \theta'_j$, then $\theta_{i+1} < \theta'_{j+1}$. ■

We now show how the non-veto partition, $\mathcal{P}$, can be transformed into the veto partition, $\mathcal{P}'$, by a sequence of steps, each of which reduces its informativeness. This proves Proposition 1. For the first step, we take the meet (finest common coarsening) of the two partitions, $\mathcal{P} \wedge \mathcal{P}'$. Note that this is the partition of $[0,1]$ defined by the common boundary points of $\mathcal{P}$ and $\mathcal{P}'$. We can use the partition $\mathcal{P}$ to divide up each element of $\mathcal{P} \wedge \mathcal{P}'$, giving us a number of sub-partitions, $\mathcal{P}^{11}, \ldots, \mathcal{P}^{1k}$. Because the lengths of each element of $\mathcal{P}$ (when ordered in the obvious way) are increasing (i.e. $l_1 < l_2 < \cdots$), the same is true of the lengths of each element of every sub-partition $\mathcal{P}^{1i}$. Next, we take each sub-partition, $\mathcal{P}^{1i} = \{[\theta_a, \theta_{a+1}), [\theta_{a+1}, \theta_{a+2}), \ldots, [\theta_{b-1}, \theta_b)\}$, and construct a new (sub-)partition $\mathcal{P}_{1i}$ as follows:

$$\mathcal{P}_{1i} = \{[\theta_a, \theta_{a+1} - x), [\theta_{a+1} - x, \theta_{a+2} - x), \ldots, [\theta_{b-1} - x, \theta_b)\},$$

for the smallest x such that $\theta_c - x = \theta'_d$ for some θ_c, θ'_d (if $\mathcal{P}^{1i}$ is a singleton, we set $\mathcal{P}_{1i} = \mathcal{P}^{1i}$). Intuitively, we construct $\mathcal{P}_{1i}$ by shifting all of the interior boundary points of $\mathcal{P}^{1i}$ to the left until one of them coincides with a boundary point of $\mathcal{P}'$. Clearly, this preserves the property that the lengths of the (ordered) elements of the sub-partition are increasing: the first element shrinks (possibly to nothing), the interior elements remain the same size, and the final element grows. Finally, we recombine all the sub-partitions, to form a new partition $\mathcal{P}_1 = \mathcal{P}_{11} \cap \ldots \cap \mathcal{P}_{1k}$. Clearly, $I(\mathcal{P}_1) \leqslant I(\mathcal{P})$, since we have taken length from the shortest element of each sub-partition, and added it to the longest element.

We now repeat the process, constructing a partition $\mathcal{P}_2$. First we use $\mathcal{P}_1$ to partition each element of $\mathcal{P}_1 \wedge \mathcal{P}'$ into a number of sub-partitions $\mathcal{P}_{21}, \ldots, \mathcal{P}_{2k'}$. Recall that each sub-partition $\mathcal{P}_{1i}$ consists of elements of increasing length. The same must therefore be true of each of these new sub-partitions, since $\mathcal{P}^{2j} \subseteq \mathcal{P}_{1i}$ for some i, by construction. We construct the $\mathcal{P}_{2j}$'s from the $\mathcal{P}^{2j}$'s in the same way as before, shifting all the interior boundary points to the left until one of them coincides with a boundary point in $\mathcal{P}'$. Finally, let $\mathcal{P}_2 = \mathcal{P}_{21} \cap \ldots \cap \mathcal{P}_{2k'}$. By the same reasoning as before, we have $I(\mathcal{P}_2) \leqslant I(\mathcal{P}_1)$.

Repeating the process, we will eventually obtain some $\mathcal{P}_z = \mathcal{P}'$. To see this, observe that (i) each boundary point in the original partition $\mathcal{P}$ will eventually be matched up with a boundary point of $\mathcal{P}'$, and (ii) each boundary point in $\mathcal{P}'$ will eventually be matched up with (at least) one boundary point in $\mathcal{P}$, specifically the boundary point that coincides with it or lies between it and its right-side neighbor $\mathcal{P}'$ (lemma 1 guarantees that such a boundary point exists). Combining all the inequalities, we have $I(\mathcal{P}) \geqslant I(\mathcal{P}')$, as required. ■

Figure 6 below illustrates the final step of this proof.

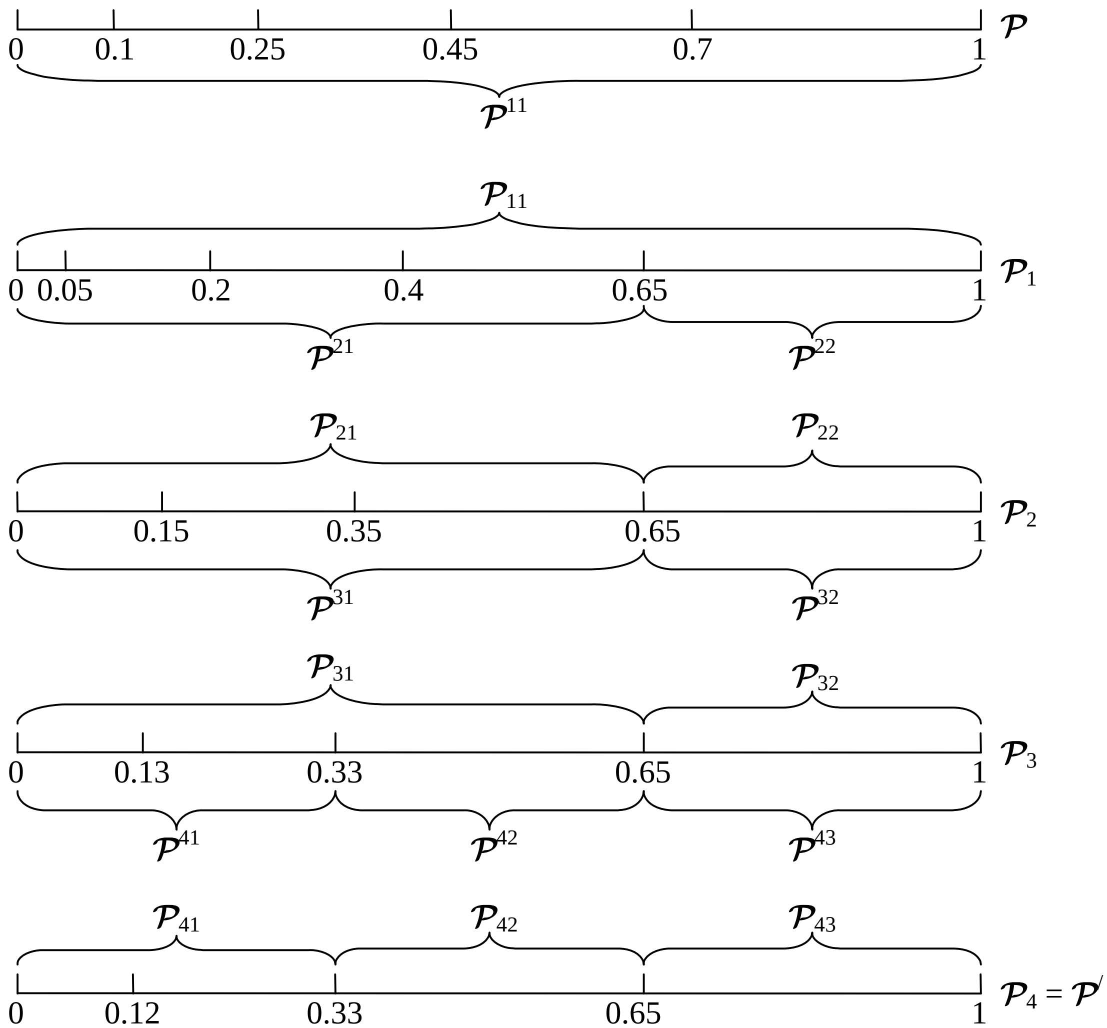

Figure 6: Illustration of proof of Proposition 1

Proof of Proposition 2 Just as Proposition 1, Proposition 2 provides a comparison of the informativeness of equilibria with and without veto. We start by characterizing the equilibria in each case.

Communication equilibrium without veto. The properties of a communication equilibrium without veto are exactly as described in Proposition 1.

Communication equilibrium with veto. We follow the same two stages as in the proof of Proposition 1. First, we show that the equilibrium must be partitional, and then we demonstrate that there is an equilibrium partition with veto that divides the state space at least as evenly as in the absence of the veto threat, so that the equilibrium is at least as informative than before (example 2 in the main text shows that it may be strictly more so). This suffices to prove the Proposition, since if this equilibrium partition does not characterize the communication equilibrium with veto, then by definition there must be an *even more* informative partition which does.

The communication equilibrium with veto is partitional. The proof that only a finite number of different actions can result in any equilibrium follows the same steps as in Proposition 1, which we do not repeat here. Note that the preferred action of the receiver, $a_R(E[\theta])$ given the constraints imposed by the veto, is given by the following function:

$$a_R(E[\theta]) = \begin{cases} E[\theta] & \text{for } E[\theta] \leqslant a_0 - 2y_V \text{ or } E[\theta] \geqslant a_0 \\ a_0 & \text{for } a_0 - y_V < E[\theta] \leqslant a_0 \\ 2E[\theta] + 2y_V - a_0 & \text{for } a_0 - 2y_V < E[\theta] < a_0 - y_R \end{cases}$$

Also, just as in Proposition 1, the indifference condition that must be satisfied by two consecutive intervals depends on where $E[\theta]$ (the midpoint of each interval) lies: since the value of $b_l(E[\theta])$ depends on in which region of the state space $E[\theta]$ falls. We consider 6 exhaustive possibilities.[11]

(1) $\frac{\theta_{i-1}+\theta_i}{2} \notin (a_0 - 2y_V, a_0)$ and $\frac{\theta_i+\theta_{i+1}}{2} \notin (a_0 - 2y_V, a_0)$

$$\theta_{i+1} - \theta_i = \theta_i - \theta_{i-1} + 4y_S$$

(2) $\frac{\theta_{i-1}+\theta_i}{2} \leqslant a_0 - 2y_V$ and $\frac{\theta_i+\theta_{i+1}}{2} \in (a_0 - 2y_V, a_0 - y_V)$

$$\begin{aligned} \frac{\frac{\theta_{i-1}+\theta_i}{2} + 2\left(\frac{\theta_i+\theta_{i+1}}{2} + y_V\right) - a_0}{2} &= \theta_i + y_S \\ \Rightarrow \theta_{i-1} + \theta_i + 2(\theta_i + \theta_{i+1}) + 4y_V - 2a_0 &= 4\theta_i + 4y_S \\ \Rightarrow 2\theta_{i+1} + 4y_V - 2a_0 &= \theta_i - \theta_{i-1} + 4y_S \\ \Rightarrow (\theta_{i+1} - \theta_i) + (\theta_i + \theta_{i+1}) - 2a_0 + 4y_V &= \theta_i - \theta_{i-1} + 4y_S \\ \text{Since } \frac{\theta_i + \theta_{i+1}}{2} &< a_0 - 2y_V, \text{ this gives us:} \\ (\theta_{i+1} - \theta_i) + (\theta_i + \theta_{i+1}) - 2(\frac{\theta_i + \theta_{i+1}}{2}) &< \theta_i - \theta_{i-1} + 4y_S \\ \theta_{i+1} - \theta_i &< \theta_i - \theta_{i-1} + 4y_S \end{aligned}$$

[11] One of the cases considered in the proof of theorem 1 above does not need to be considered here, since the minimum distance between the midpoints of any two intervals is greater than $2y_S > 2y_V$.

(3) $\frac{\theta_{i-1}+\theta_i}{2} \leqslant a_0 - 2y_V$ and $\frac{\theta_i+\theta_{i+1}}{2} \in [a_0 - y_V, a_0)$

$$\begin{aligned}
\frac{\frac{\theta_{i-1}+\theta_i}{2} + a_0}{2} &= \theta_i + y_S \\
\Rightarrow \theta_{i-1} + \theta_i + 2a_0 &= 4\theta_i + 4y_S \\
\Rightarrow 2a_0 - 2\theta_i &= \theta_i - \theta_{i-1} + 4y_S \\
\text{Since } \frac{\theta_i + \theta_{i+1}}{2} &< a_0, \text{ this gives us:} \\
\theta_{i+1} &< \theta_i - \theta_{i-1} + 4y_S \Rightarrow \theta_{i+1} - \theta_i < \theta_i - \theta_{i-1} + 4y_S
\end{aligned}$$

(4) $\frac{\theta_{i-1}+\theta_i}{2} \in (a_0 - 2y_V, a_0 - y_V]$ and $\frac{\theta_i+\theta_{i+1}}{2} \in (a_0 - y_V, a_0)$

$$\begin{aligned}
\frac{2\left(\frac{\theta_{i-1}+\theta_i}{2} + y_V\right) - a_0 + a_0}{2} &= \theta_i + y_S \\
\Rightarrow 2\left(\theta_{i-1} + \theta_i\right) + 4y_V &= 4\theta_i + 4y_S \\
\Rightarrow \left(\theta_{i+1} - \theta_i\right) - \left(\theta_{i+1} - \theta_{i-1}\right) + 4y_V &= \theta_i - \theta_{i-1} + 4y_S \\
\text{Notice that } \frac{\theta_i + \theta_{i+1}}{2} - \frac{\theta_{i-1} + \theta_i}{2} &< 2y_V, \text{ so } \theta_{i+1} - \theta_{i-1} < 4y_V \\
\Rightarrow \theta_{i+1} - \theta_i &< \theta_i - \theta_{i-1} + 4y_S
\end{aligned}$$

(5) $\frac{\theta_{i-1}+\theta_i}{2} \in (a_0 - 2y_V, a_0 - y_V)$ and $\frac{\theta_i+\theta_{i+1}}{2} \geqslant a_0$:

$$\begin{aligned}
\frac{2\left(\frac{\theta_{i-1}+\theta_i}{2} + y_V\right) - a_0 + \frac{\theta_i+\theta_{i+1}}{2}}{2} &= \theta_i + y_S \\
\Rightarrow 2\left(\theta_{i-1} + \theta_i\right) + \theta_i + \theta_{i+1} + 4y_V - 2a_0 &= 4\theta_i + 4y_S \\
\Rightarrow \left(\theta_{i+1} - \theta_i\right) + \theta_{i-1} + \theta_i + 4y_V - 2a_0 &= \theta_i - \theta_{i-1} + 4y_S \\
\text{Notice that } \frac{\theta_{i-1} + \theta_i}{2} &> a_0 - 2y_V \\
\Rightarrow \theta_{i+1} - \theta_i &< \theta_i - \theta_{i-1} + 4y_S
\end{aligned}$$

(6) $\frac{\theta_{i-1}+\theta_i}{2} \in (a_0 - y_V, a_0)$ and $\frac{\theta_i+\theta_{i+1}}{2} \geqslant a_0$

$$\begin{aligned}
\frac{a_0 + \frac{\theta_i+\theta_{i+1}}{2}}{2} &= \theta_i + y_S \\
\Rightarrow 2a_0 + \theta_i + \theta_{i+1} &= 4\theta_i + 4y_S \\
\Rightarrow \theta_{i+1} - \theta_i &= 2\theta_i - 2a_0 + 4y_S \\
\text{Since } \frac{\theta_i + \theta_{i-1}}{2} &< a_0, \text{ this gives us:} \\
\Rightarrow \theta_{i+1} - \theta_i &< \theta_i - \theta_{i-1} + 4y_S
\end{aligned}$$

Suppose that the communication equilibrium without veto is given by $\mathcal{P} = \{[0,\theta_1), [\theta_1,\theta_2), \ldots, [\theta_{n-1,}1]\}$. We shall show that there is an n-step equilibrium partition with veto which is at least as informative as $\mathcal{P}$. First consider the following (set-valued) function $f\left(\theta'_{i-1},\theta'_i\right)$, which gives us the value of the $i+1$st boundary point of the veto partition as a function of the preceding two.

$$
\begin{aligned}
f\left(\theta'_{i-1},\theta'_i\right) &= 2\theta'_i - \theta'_{i-1} + 4y_S \text{ when } 3\theta'_i - \theta'_{i-1} \leqslant 2a_0 - 4y_V - 4y_S \\
f\left(\theta'_{i-1},\theta'_i\right) &= \frac{\theta'_i - \theta'_{i-1}}{2} + a_0 + 2y_S - 2y_V \text{ when } 2a_0 - 4y_V - 4y_S < 3\theta'_i - \theta'_{i-1} < 2a_0 - 4y_S \\
f\left(\theta'_{i-1},\theta'_i\right) &= \left[2a_0 - 2y_V - \theta'_i, 2a_0 - \theta'_i\right] \text{ when } 3\theta'_i - \theta'_{i-1} = 2a_0 - 4y_S \\
f\left(\theta'_{i-1},\theta'_i\right) &= 2\theta'_i - \theta'_{i-1} + 4y_S \text{ when } 3\theta'_i - \theta'_{i-1} > 2a_0 - 4y_S \text{ and } \theta'_i + \theta'_{i-1} \leqslant 2a_0 - 4y_V \\
f\left(\theta'_{i-1},\theta'_i\right) &= \theta'_i - 2\theta'_{i-1} + 2a_0 + 4y_S - 4y_V \text{ when } 2a_0 - 4y_V < \theta'_i + \theta'_{i-1} \leqslant 2a_0 - 2y_V \\
f\left(\theta'_{i-1},\theta'_i\right) &= 3\theta'_i - 2a_0 + 4y_S \text{ when } 2a_0 - 2y_V < \theta'_i + \theta'_{i-1} < 2a_0 \\
f\left(\theta'_{i-1},\theta'_i\right) &= 2\theta'_i - \theta'_{i-1} + 4y_S \text{ when } \theta'_i + \theta'_{i-1} \geqslant 2a_0
\end{aligned}
$$

It is easy to check that the value of θ'_{i+1} is such that the relevant indifference equation above is satisfied. From the function f, we can construct a sequence of functions $g_1, g_2, \ldots, g_n$ which give us the possible equilibrium values of the ith (interior) boundary point as a function of the first, θ'_1. g_i is defined inductively as follows:

$$
\begin{aligned}
g_1\left(\theta'_1\right) &= \theta'_1 \\
g_2\left(\theta'_1\right) &= f\left(0,\theta'_1\right) \\
g_i\left(\theta'_1\right) &= f\left(g_{i-1}\left(\theta'_1\right), g_{i-2}\left(\theta'_1\right)\right) \text{ for } i = 3,\ldots,n
\end{aligned}
$$

Notice that the graph of each g_i consists of connected, linear elements, $g_n(\theta_1) \leqslant 1$, and $g_n(1) \geqslant 1$. It follows that, for some $\theta'_1 \in [\theta_1, 1]$, we have $1 \in g_n\left(\theta'_1\right)$; furthermore, there is a sequence $0, \theta'_1, \ldots, \theta'_{n-1}, 1$ such that $\theta'_i \in g_i\left(\theta'_1\right)$. By construction, this sequence describes an equilibrium partition with veto: $\mathcal{P}' = \left\{[0,\theta'_1), [\theta'_1,\theta'_2), \ldots, \left[\theta'_{n-1,}1\right]\right\}$. Finally, observe that the lengths $l'_1, \ldots, l'_n$ of the intervals of $\mathcal{P}'$ are increasing, and that $\mathcal{P}$ and $\mathcal{P}'$ satisfy the opposite of Lemma 1 (i.e. for all $i = 1,\ldots,n$ and $j = 1,\ldots,n$, if $\theta'_i < \theta_j$ then $\theta'_{i+1} < \theta_{j+1}$). The same steps as in the final stage of the proof of Proposition 1 can thus be applied to prove that the communication equilibrium with veto is at least as informative as the communication equilibrium without veto.■

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