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Conflict and Compromise in Hard Times*

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Abstract

Insiders often have better information about an organization's resources than outsiders do, and this informational asymmetry may lead to inefficient conflict over the distribution of those resources. This paper formalizes this conflict as a signaling game in which an incumbent government and an opposing faction vie for control of the state and the accompanying spoils. To avoid a challenge, the government must buy the opposition off by offering a share of the pie which the opposition can accept or reject by fighting. The size of the pie is private information. The government knows how large it is, but the opposition only has a rough idea (e.g., oil prices are high or low). The unique perfect Bayesian equilibrium satisfying a common refinement is fully separating but inefficient with the probability of breakdown increasing as times become harder. The paper generalizes the government-opposition game to a larger class of "coercive" signaling game which exhibit the same equilibrium behavior and include models of war and litigation.

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Conflict and Compromise in Hard Times

Those inside and, especially, those controlling an organization – be it a firm, committee, ministry, or the state – often have better information about the organization’s resources and activities than outsiders do. For instance, the government usually knows more than the opposition does about the revenues of state-controlled companies, and management typically knows more than shareholders about the firm’s surplus. Although less well informed about the size of the “pie” than insiders, outsiders frequently can challenge the insiders for control of the organization and the accompanying spoils. This threat gives the insiders an incentive to try to buy off or co-opt the outsiders.

A vexing strategic problem hampers the insiders’ efforts to buy the outsider off. If the outsiders also knew the size of the pie, they would accept a low offer when times are hard and the pie is small because the payoff to fighting and, if victorious, capturing the surviving spoils is also small. But always accepting lower offers cannot be equilibrium behavior when the size of the pie is uncertain. If the outsiders always agree when offered little, nothing deters the insiders from low-balling the outsiders, i.e., offering a small amount when the pie is large. To prevent this, the outsiders must reject low offers and bargaining breaks down in inefficient fighting with positive probability. Thus, the informational asymmetry may lead to costly, inefficient conflict between insiders and outsiders over the allocation of the organization’s resources.

We formalize this general problem as a signaling game between the insiders and outsiders and addresses two central questions. First, under what circumstances is inefficient distributive conflict – fighting – more likely? Of particular interest is how the probability of fighting varies with the outsider’s limited information about the size of the pie. Do hard times make for more fighting? Second, under what circumstances will those in power move towards a more transparent regime that, while eroding their informational advantage, eliminates inefficient conflict?

The main example throughout the paper is that of an incumbent government and an opposition faction vying for control of the state and the spoils that come with it. The

government knows the size of the pie while the opposition only has a rough idea about its size. The opposition knows, for example, whether times are “good” or “bad” (e.g., oil prices are high or low, the economy is booming or in recession) and therefore whether the pie is on average large or small. But the opposing faction is unsure of precisely how large the spoils are in good times or how small they are in bad times. In resource-rich, developing countries, for example, the government frequently has private information about the revenues those resources bring. This lack of transparency is believed to facilitate corruption, make conflict more likely, and has led to international efforts to promote greater transparency.¹

Formally, the government-opposition model is a standard signaling game with a continuum of types and actions. As is commonly the case with such games, multiple equilibria exist. However, only one of these equilibria is supported by “reasonable” off-the-equilibrium-path beliefs satisfying a common equilibrium refinement (Cho and Kreps’ (1987) condition D1). This equilibrium is fully separating with the government’s offer strictly increasing in the spoils. The larger the pie, the more the government offers. Because pies of different sizes lead to different offers, the opposition knows how much there is to be divided as well as its payoff to fighting as soon as it receives an offer. Nevertheless, the opposing faction, although now certain of the size of the pie, fights with positive probability. The smaller the offer, the more likely the opposition is to fight.

The equilibrium has an interesting empirical implication. Bargaining between the government and the opposing faction is more likely to break down during hard times. That is, the equilibrium probability of fighting if times are hard is larger than if times are good. This is in keeping with econometric work on civil war which generally finds that poor economic conditions – hard times – make conflict more likely (e.g., Collier and Hoeffler 1998; Fearon and Laitin 2003; Miguel, Satyanath, and Sergenti 2004).

The relation between the strength of the opposition and the probability of fighting in

¹ An example of the latter is the Extractive Industries Transparency Initiative, see *The Economist* 2005, DFID a, nd.; DFID b, nd. On the link between the lack of transparency about government revenues stemming from natural resources and conflict, see Swanson, Oldgard and Lunde (2003).

the model also resonates with Fearon and Laitin's (2003) explanation for the negative relation between income and conflict. They argue that wealthier countries have better repressive capabilities and as a result less insurgency. Low income therefore proxies for weak government and weak government leads to more conflict. In the model, the stronger the opposition or equivalently the weaker the government, the higher the probability of fighting.

One can make reasonable informal arguments for why a stronger opposition may imply both higher and lower probabilities of conflict. For instance, a stronger opposition is more willing to fight, and this should tend to increase the chances that conflict occurs. But at the same time a stronger opposition will increase the willingness of the government to appease that opposition, reducing the chances that conflict occurs. The formal model in this paper clarifies why harder times, a stronger opposition, and lower costs of fighting all make fighting unambiguously more likely for the same basic reason. They aggravate the strategic tension between government and opposition by raising the value of the government's private information relative to the cost of fighting.

The paper then generalizes the model in two ways. Because the government's offer leaves the opposition indifferent between fighting and accepting, the government suffers all of the efficiency losses if the opposition fights. That is, the government pays all of the costs arising from its having private information about the size of the pie. The government therefore has an incentive to share its information with the opposition. Why then does it not adopt more transparent institutions or decision-making procedures which reveal its private information to the opposition? We consider the case in which the only way to credibly share private information with the opposition is to bring the latter into the government through a power-sharing agreement. For instance, opposition members may have to be brought into parliament, onto the boards of state-controlled corporations, or given control of important ministries or parts of the military. However, bringing the opposition into the government also makes it more powerful, i.e., increases the chances it will prevail in the event that government and opposition fight.

This shift in the distribution of power creates a commitment problem. If the opposition

could commit to not using its greater power to secure more of the spoils, the government would want to reveal the size of the spoils to the opposition. But the opposition's inability to commit to this creates a trade off between an informational and a commitment problem for the government. The former swamps the latter if the shift in power brought by power sharing is sufficiently small and if times are bad enough. In these circumstances, the government focuses on the information problem which it solves by sharing power with the opposition.

The second generalization shows that the government-opposition game is but one of a larger class of "coercive" signaling models in which D1 implies uniqueness and separation. That the types separate leads directly to an explicit characterization of the equilibrium strategies of any game in this class. The conditions defining this class of games are also quite simple, and checking to see if a signaling game satisfies them is very easy. The set of coercive signaling games includes models of war closely related to the one Fearon (1995) studies, and it includes models of litigation (e.g., Reinganum and Wilde 1986).

The Model and Equilibria

In order to prevent a challenge, the government must buy off or co-opt an opposing faction. To this end, the government begins the game knowing π , the size of the pie to be divided, and makes an offer $y \geq 0$ to the opposition that can accept the offer or fight. Accepting ends the game with the government and opposition receiving $\pi - y$ and y respectively.² Fighting destroys a fraction $1 - \sigma$ of the pie, while a fraction σ survives. If the opposing faction wins, which it does with probability p , it gets the surviving spoils; if the government wins it keeps the spoils. Thus, the payoffs to fighting for the government and opposition are $(1 - p)\sigma\pi$ and $p\sigma\pi$, respectively.

To formalize the informational asymmetry, let $\pi = c + r$ where r has mean 0 and is distributed over $[\underline{r}, \bar{r}]$ according to H which has a continuous and strictly positive

² Strictly speaking, the government could offer more than there is to be divided ($y > \pi$) in which case the payoffs would be $\pi - \min\{y, \pi\}$ and $\min\{y, \pi\}$. However, these offers are strictly dominated and will never be made, so we simplify the notation by taking the payoffs to be $\pi - y$ and y and $y \leq \pi$.

density h over (\underline{r}, \bar{r}) . The government knows c and r , but the rebels only observe c . The parameter c measures the general climate of the times. The larger c , the larger π is and the larger the rebels expect it to be (i.e., the larger $\int_{\underline{r}}^{\bar{r}} \pi dH = c + \int_{\underline{r}}^{\bar{r}} r dH$ is).

A pure-strategy for the government specifies the government's offer as a function of its private information about the spoils: $y : [\underline{r}, \bar{r}] \rightarrow [0, \bar{\pi}]$ where $\bar{\pi} = c + \bar{r}$.³ A strategy for the opposing faction defines the probability that the opposition accepts as a function of the government's offer: $\alpha : [0, \bar{\pi}] \rightarrow [0, 1]$. As for what the opposition believes about the size of the spoils after receiving an offer, let Δ be the set of distributions over $[\underline{r}, \bar{r}]$ and let $\mu(x) \in \Delta$ for all $x \in [0, \bar{\pi}]$ denote the opposition's beliefs following an offer of x . Finally, a perfect Bayesian equilibrium (PBE) is a strategy profile (y, α) and beliefs μ such that the government can never profitably deviate from offering $y(\pi)$ given the opposition's strategy $\alpha(x)$; $\alpha(x)$ is a best reply to x given $\mu(r|x)$; and μ is derived from H and y via Bayes' rule.⁴

The game has infinitely many PBEs. In some, the government pools on a specific offer, i.e., the government makes the same offer regardless of the size of the pie. In other semi-separating equilibria, the government's offer varies with the spoils but does not fully reveal the exact size of the pie. In these equilibria, there are a set of cutpoints $\underline{\pi} = k_0 < k_1 < \dots < k_N = \bar{\pi}$ and a set of ever more favorable offers $p\sigma\underline{\pi} \leq y_1 < \dots < y_N \leq p\sigma\bar{\pi}$ such that the government proposes y_j if $\pi \in (k_{j-1}, k_j)$. And, there is a fully separating equilibrium in which the government's offer is strictly increasing in the size of the pie.

³ In our exposition we only consider strategy profiles and equilibria in which the government plays a pure strategy. Our focus will be on equilibria that survive D1, and there is no equilibrium surviving this criterion that features mixing on the government's side. A proof is available from the authors upon request.

⁴ Because the parameter c is common knowledge, we abuse the notation slightly by taking y to be a function of π in order to simplify the exposition. Defining PBE's with a continuum of types raises a number of technical issues. For example, no offer is made with positive probability in a separating equilibrium. Bayes' rule therefore places no restriction on the opposition's beliefs following any offer. It suffices for the present analysis to assume that if the nonempty set of types offering z has zero measure, then the support of the opposition's beliefs following z is contained in the closure of the set $\{\pi : y(\pi) = z\}$. See Ramey (1996) for a definition of a sequential or perfect Bayesian equilibrium with a continuum of types.

Incentive compatibility ensures that the equilibrium offers are weakly increasing in the spoils and that larger equilibrium offers are generally more likely to be accepted than smaller offers. More formally:

LEMMA 1: *Let $(y, \alpha; \mu)$ be a PBE with $y' = y(\pi')$, $y'' = y(\pi'')$, and $\pi' < \pi''$. Then:*

- (i) $\alpha(y'') \geq \alpha(y')$;
- (ii) *if $\alpha(y') > 0$, then $y'' \geq y'$;*
- (iii) *if $\alpha(y'') > 0$ or $\alpha(y') > 0$ and if $y'' > y'$, then $\alpha(y'') > \alpha(y')$.*

Proof: See the proof of Lemma 1A in the Appendix.

Although there is a surfeit of equilibria, only the separating equilibrium is predicated on reasonable out-of-equilibrium beliefs in the sense that they satisfy Cho and Kreps' (1987) condition D1. Roughly, D1 requires the opposition to discount the possibility of facing type η after an out-of-equilibrium offer z if another type η' would want to deviate to z whenever η did and there are still other circumstances in which η' would want to play z and η would not.

The out-of-equilibrium-beliefs satisfying D1 turn out to be very simple. Suppose as illustrated in Figure 1 that no type offers z , i.e., there is no π for which $z = y(\pi)$ where $y(\pi)$ are the government's equilibrium proposals. (Lemma 1(ii) ensures that y is nondecreasing.) Assume further that z is larger than some equilibrium offer that is accepted with positive probability: $z > y(\pi)$ and $\alpha(y(\pi)) > 0$ for some π . Then D1 implies that the opposition believes that it is facing the type $\hat{\pi}$ at which the government's equilibrium offers "jump" over z .

More formally, let π^+ be the lowest type whose offer is accepted with positive probability in the PBE $(y(\pi), \alpha(x); \mu)$: $\pi^+ \equiv \inf\{\pi : \alpha(y(\pi)) > 0\}$. Then,

LEMMA 2: *Take $(y(\pi), \alpha(x); \mu)$ to be a PBE satisfying D1. Assume further that z is an out-of-equilibrium offer, i.e., $z \notin \{y(\pi) : \pi \in [\underline{\pi}, \bar{\pi}]\}$, such that $p\sigma\bar{\pi} > z > y(\pi)$ for some $\pi > \pi^+$. Then the opposition believes that it is facing $\hat{\pi}$ with probability one where $\hat{\pi} \equiv \sup\{\pi : y(\pi) \leq z\} = \inf\{\pi : y(\pi) \geq z\}$.*

Proof: See the proof of Lemma 2A in the Appendix.

It follows that all $\pi > \pi^+$ make distinct offers in any PBE satisfying D1. To sketch the intuition, assume the contrary. Then as depicted in Figure 1, there must be two types π' and π'' such that $\pi^+ < \pi' < \pi''$ and π' and π'' make the same offer \hat{y} . Let $\hat{\pi} = \inf\{\pi : \hat{y} =$

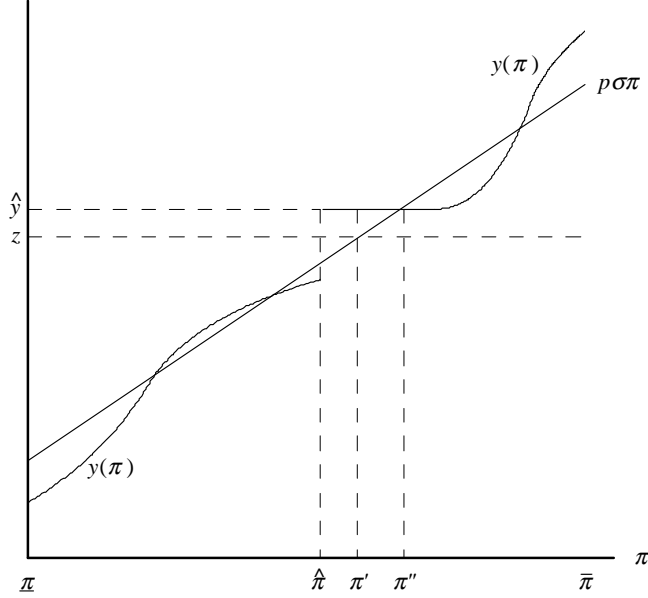


Figure 1: The government's offers.

$y(\pi)$. Observe first that $\hat{y} > p\sigma\hat{\pi}$. Because $y(\pi)$ is nondecreasing, all $\pi \in [\pi', \pi'']$ propose \hat{y} . This interval has positive measure, and therefore the opposition's payoff to fighting must be strictly larger than its payoff to fighting type $\hat{\pi}$. That is, $\int_{\{\pi: \hat{y}=y(\pi)\}} p\sigma\pi d\hat{H}(\pi) > p\sigma\hat{\pi}$ where \hat{H} is the posterior of H given \hat{y} . Moreover, Lemma 1 guarantees $\alpha(y(\pi)) > 0$ for all $\pi > \pi^+$. Hence the opposition accepts \hat{y} with positive probability and consequently must weakly prefer \hat{y} to fighting. This leaves $\hat{y} \geq \int_{\{\pi: y^*=y(\pi)\}} p\sigma\pi d\hat{H}(\pi) > p\sigma\hat{\pi}$.

Now consider any offer z in the gap between $p\sigma\hat{\pi}$ and \hat{y} . If the challenger strictly prefers accepting z to fighting, then $\alpha(z) = 1$ and a contradiction results as those offering \hat{y} could profitably deviate to the lower offer z . To see that the opposing faction does prefer accepting z , suppose first that z is an equilibrium proposal, i.e., $y(\pi) = z$ for some π . Because y is nondecreasing and $z < \hat{y}$, the opposition believes that π is bounded above by $\hat{\pi}$ after being offered z as $\sup\{\pi : y(\pi) = z\} \leq \inf\{\pi : y(\pi) \geq z\} = \hat{\pi}$. Hence, the opposing faction's payoff to fighting is bounded above by $p\sigma\hat{\pi}$ which is strictly less than z . If alternatively z is an out-of-equilibrium offer, then Lemma 2 ensures that the opposition believes that it is facing $\sup\{\pi : y(\pi) \leq z\} = \hat{\pi}$ after z . The opposing faction's

expected payoff to fighting is therefore $p\sigma\hat{\pi}$ and again strictly less than z . Formally,

LEMMA 3: *Let $(y(\pi), \alpha(x); \mu)$ be a PBE satisfying condition D1 with $\pi^+ \equiv \inf \{\pi : \alpha(y(\pi)) > 0\}$. Then all $\pi > \pi^+$ separate: $y(\pi') < y(\pi'')$ whenever $\pi^+ < \pi' < \pi''$.*

Proof: See the proof of Lemma 3A in the Appendix.

The remainder of this section characterizes the unique equilibrium strategies in any PBE satisfying D1.⁵ Lemma 1 guarantees that $y(\pi)$ is accepted with positive probability for any $\pi > \pi^+$. That lemma also implies that $y(\pi)$ is weakly increasing in any PBE and therefore strictly increasing for $\pi \geq \pi^+$ because all $\pi > \pi^+$ separate. Again from Lemma 1, that $y(\pi) < y(\pi')$ for $\pi^+ \leq \pi < \pi'$ means that $\alpha(y)$ is strictly increasing. Hence, $0 < \alpha(y(\pi)) < \alpha(y(\bar{\pi})) \leq 1$ for $\pi > \pi^+$.

That $\alpha(y) \in (0, 1)$ implies that the opposition is mixing between fighting and accepting and is, therefore, indifferent between these alternatives. Consequently, the government must be offering the opposing faction its certainty equivalent of fighting: $y(\pi) = p\sigma\pi$ for $\pi^+ < \pi < \bar{\pi}$.⁶

As for the probability of acceptance, let $y = p\sigma\pi$ and $\hat{y} = p\sigma\hat{\pi}$ with $\pi^+ < \pi < \hat{\pi}$. Because no type can profitably deviate,

$$\begin{aligned} \alpha(y)(\pi - y) + (1 - \alpha(y))(1 - p)\sigma\pi &\geq \alpha(\hat{y})(\pi - \hat{y}) + (1 - \alpha(\hat{y}))(1 - p)\sigma\pi \\ \alpha(\hat{y})(\hat{\pi} - \hat{y}) + (1 - \alpha(\hat{y}))(1 - p)\sigma\hat{\pi} &\geq \alpha(y)(\hat{\pi} - y) + (1 - \alpha(y))(1 - p)\sigma\hat{\pi}. \end{aligned}$$

Rewriting these inequalities and using the expressions for the government's offers to eliminate π and $\hat{\pi}$ gives,

$$\frac{\alpha(\hat{y})p\sigma}{y(1 - \sigma)} \geq \frac{\alpha(\hat{y}) - \alpha(y)}{\hat{y} - y} \geq \frac{\alpha(y)p\sigma}{\hat{y}(1 - \sigma)}.$$

⁵ The equilibrium strategies are unique in any equilibrium satisfying D1. But a multiplicity of equilibrium beliefs satisfy D1, because this condition does not pin down the opposition's beliefs if the offer is below $p\sigma\underline{\pi}$ or above $p\sigma\bar{\pi}$. The opposition in both cases has a unique best-response to the offer regardless of what it believes about the government, namely accept if $x < p\sigma\underline{\pi}$ and fight if $x > p\sigma\bar{\pi}$. This deprives D1 of any power to eliminate any types.

⁶ It is straightforward to show $y(\bar{\pi}) = p\sigma\bar{\pi}$ given $y(\pi) = p\sigma\pi$ for $\pi \in (\pi^+, \bar{\pi})$.

Letting \hat{y} go to y then yields,

$$\frac{\alpha'(y)}{\alpha(y)} = \frac{p\sigma}{y(1-\sigma)}. \quad (1)$$

Solving this differential equation with the boundary condition $\alpha(p\sigma\bar{\pi}) = 1$ leads to $\alpha(y) = [y/(p\sigma\bar{\pi})]^{\sigma p/(1-\sigma)}$.⁷ The Appendix shows that $\pi^+ = \underline{\pi}$ and hence $\alpha(y) = [y/(p\sigma\bar{\pi})]^{\sigma p/(1-\sigma)}$ for all $\pi \geq \underline{\pi}$. This leaves:

PROPOSITION 1: *The unique equilibrium strategies in any PBE satisfying D1 are $y(\pi) = p\sigma\pi$ and $\alpha(y) = 0$ if $y < p\sigma\underline{\pi}$, $\alpha(y) = [y/(p\sigma\bar{\pi})]^{\sigma p/(1-\sigma)}$ if $p\sigma\underline{\pi} \leq y \leq p\sigma\bar{\pi}$, and $\alpha(y) = 1$ if $y \geq p\sigma\bar{\pi}$.*

Proof: See the proof of Proposition 5 in the Appendix.

In words, in the unique PBE that satisfying D1 the government offers the opposition exactly the latter's certainty equivalent for fighting given the prevailing state of nature. The opposition is sure to accept the offer associated with the largest possible pie ($\alpha(p\sigma\bar{\pi}) = 1$) but fights if offered anything less. The lower the offer, the more likely the opposition is to fight.

Fighting in Hard and Uncertain Times

Empirical evidence indicates that hard times make civil war and political conflict in general more likely. There is a strong negative relation between income and the likelihood of civil war (e.g., Collier and Hoeffler 2004; Fearon and Laitin 2003; Miguel, Satyanath, and Sergenti 2004). Low income also makes coups more likely (Londregan and Poole 1990), and recessionary crises tend to undermine democratic regimes (Gasiorowski 1995).

Hard times make conflict more likely in the model as do a stronger opposition and lower costs of fighting. Proposition 2 formalizes the comparative statics of the equilibrium described in Proposition 1.

PROPOSITION 2: *Hard times (low expected income c), a strong opposition (high p) and less destructive conflict (higher σ) make fighting more likely.*

Proof: Recalling that $\pi = c + r$ with r distributed according to H over $[\underline{r}, \bar{r}]$, the proba-

⁷ If $\alpha(p\sigma\bar{\pi}) < 1$, then $\bar{\pi}$ could profitably deviate by offering slightly more than $p\sigma\bar{\pi}$ which would be accepted for sure.

bility of fighting given the climate of the times is,

$$F = \int_{\underline{r}}^{\bar{r}} \left[1 - \left(\frac{c+r}{c+\bar{r}} \right)^{\frac{p\sigma}{1-\sigma}} \right] dH(r).$$

The integrand $I = 1 - [(c+r)/(c+\bar{r})]^{p\sigma/(1-\sigma)}$ is decreasing in c , so $\partial I/\partial c < 0$. Bad times (lower values of c) therefore make fighting more likely ($\partial F/\partial c < 0$). The integrand is also decreasing in both p and σ . So a stronger opposition makes for more fighting ($\partial F/\partial p > 0$) while lower costs as related to a higher fraction σ surviving conflict lead to more fighting ($\partial F/\partial \sigma > 0$). ■

Two comments about the comparative statics are in order. The first centers on the interpretation of “hard times” as a low value of c rather than a low realization of r ; we must consider which interpretation seems more appropriate when linking the analysis to the empirical finding of a negative relation between income and fighting. The second remark provides some intuition for the comparative static results.

One might think of hard times as a negative value of r which makes the realized pie $\pi = c + r$ smaller than its average value of c . Incentive compatibility then implies via Lemma 1 that the probability of acceptance is weakly increasing in r . Thus hard times in the sense of a low r makes fighting weakly more likely. Moreover, this relation holds in every PBE because it is derived from incentive compatibility conditions that all PBE must satisfy. By contrast, the fact that hard times in the sense of a low c makes conflict more likely only holds (or at least has only been shown to hold) in the particular equilibrium described in Proposition 1.

Why focus on the comparative statics involving c rather than the more general results for r ? The reason is that the former are more in keeping with the econometric evidence linking hard times to political conflict. In these studies, most of which involve cross-country regressions, both the government and opposition know that the country is poor or rich. Government and opposition also know whether the state is strong, or weak and generally lacking in repressive capabilities. These conditions are common knowledge at the outset and define the strategic arena in which the interaction between the government and opposition plays out.

In the model, the climate of the times c is part of the backdrop; it is common knowledge when play begins. If c is low, both sides know that times are hard when they try to divide what spoils there are. If, by contrast, hard times were defined as a low r , then the general conditions would not be part of the backdrop. Both sides would not know whether times were good or bad. Thus although they are less general than the incentive compatibility results on r , the comparative statics on c in a specific equilibrium are of interest because they provide a more natural formal referent for the empirical findings.

The second remark offers some intuition for the comparative statics summarized in Proposition 2. Formal work in international relations theory shows that the relation between the distribution of power and the probability of fighting is ambiguous in general because of two competing pressures. As an actor gets weaker, it is more likely to accept any given offer and this tends to make fighting less likely. But the as the other actor gets stronger, it demands more, and this tends to increase the probability of fighting. These opposing factors exactly cancel each other out in Fearon's (1995) model of war. But this is not a general result. Powell (1996), for example, finds that the probability of fighting increases as the distribution of power diverges from the distribution of benefits.⁸

In the government-opposition model analyzed here, the probability of fighting unambiguously goes down as the opposition weakens (p falls). Indeed, the probability that the opposition will accept the government's offer, $[(c+r)/(c+\bar{r})]^{p\sigma/(1-\sigma)}$, goes to one as p goes to zero regardless of the value of r . The reason for this is rooted in the strategic tension at the heart of the model. When the opposition is nearly harmless the government need only pay a very small amount to keep the opposition from fighting. (In the limit when $p = 0$, the government's offer of the opposition's certainty equivalent $p\sigma\pi$ is zero regardless of the state of nature.) Thus, when p is very low, the government faces a very small temptation to low-ball the opposition. After all, being sure of buying the opposition off by offering $p\sigma\bar{\pi}$ is nearly costless when p is small. That means that the opposition need not threaten with high fighting probabilities to prevent the government

⁸ See Powell (1999, 104-110) and Wagner (1994) on the relation between the distribution of power and the probability of war.

from making low offers. Thus, a weak opposition goes hand in hand with low chances of conflict.

More generally, better times, a weaker opposition, and higher costs of fighting make fighting less likely for the same fundamental reason. They reduce the value of the government's private information relative to the cost of fighting. The government can always buy peace by offering $p\sigma\bar{\pi}$ which the opposing faction accepts for sure and leaves the government with a payoff of $\pi - p\sigma\bar{\pi}$. The best that the government could possibly hope for given its informational advantage is that the opposition would assume the worst, i.e., $\pi = \underline{\pi}$, and accept $p\sigma\underline{\pi}$ which would leave the government with $\pi - p\sigma\underline{\pi}$. The difference between these two payoffs is an upper bound on the value of the government's private information. Relative to the cost of fighting $(1 - \sigma)\pi$, the value of the government's private information is,

$$\begin{aligned} V &= \frac{[\pi - p\sigma\bar{\pi}] - [\pi - p\sigma\underline{\pi}]}{(1 - \sigma)\pi} \\ &= \frac{p\sigma(\bar{r} - \underline{r})}{(1 - \sigma)(c + r)}. \end{aligned}$$

The value of the government's information therefore decreases as times improve (c increases), the opposition weakens (p falls), or the costs of fighting rise (σ falls): $\partial V/\partial c < 0$, $\partial V/\partial p > 0$, and $\partial V/\partial \sigma > 0$. In the limit as times become very good (c goes to infinity), the opposition becomes no more than a nuisance (p goes to zero), fighting becomes costless (σ goes to one), the value of the government's private information relative to the cost of fighting goes to zero. Trying to exploit its private information now becomes too costly, and the probability of fighting goes down.

Turning to the role of uncertainty, assume that the distribution of benefits is $\pi = c + s$ where s is distributed over $[\underline{s}, \bar{s}]$ according to the cumulative distribution H . Assume further that the spoils when distributed according to H are more uncertain than when distributed according to G in the sense that G second-order stochastically dominates H .⁹

⁹ See Mas-Collel, Whinston and Green 1995, 197-99) on second-order stochastic dominance.

Then,

PROPOSITION 3: (a) *If the opposition is sufficiently weak (i.e. if $p \leq (1 - \sigma)/\sigma$) and the distribution of spoils H is more uncertain than G in the sense that G second-order stochastically dominates H , then the probability of conflict is weakly higher with the more uncertain spoils H than with G .*

(b) *Suppose that the distributions of the spoils G and H are uniform and H is more uncertain in the sense that G second-order stochastically dominates H . Then the probability of conflict is higher with the more uncertain spoils H than with G regardless of the strength of the opposition.*

Proof: See Appendix.

If $p \leq (1 - \sigma)/\sigma$, then the integrand $1 - [(c + r)/(c + \bar{r})]^{p\sigma/(1-\sigma)}$ is convex in r . So the probability of fighting F is weakly larger when the spoils are distributed according to the more uncertain H . If, however, the opposition is sufficiently strong ($p > (1 - \sigma)/\sigma$), the integrand is concave in r , and the effects of an increase in uncertainty are ambiguous in general because of two competing pressures.

Note that the integrand in F , $1 - [(c + r)/(c + \bar{r})]^{p\sigma/(1-\sigma)}$, depends on the upper end of the support of the distribution of spoils, \bar{r} . Thus calculating the probability of fighting with respect to the more uncertain distribution H affects the probability of fighting directly through the change in the distribution and indirectly through the integrand. These two effects work in opposite directions when $p > (1 - \sigma)/\sigma$.

To illustrate these competing effects, suppose that the support of distributions of the spoils remains unchanged so that $\bar{s} = \bar{r}$. Then the concavity of the integrand implies that the probability of fighting decreases as the uncertainty increases. But suppose that the supports of H and G differ with $\bar{s} > \bar{r}$.¹⁰ Then the integrand increases when the spoils are distributed according to H rather than G , i.e., $1 - [(c + r)/(c + \bar{s})]^{p\sigma/(1-\sigma)} > 1 - [(c + r)/(c + \bar{r})]^{p\sigma/(1-\sigma)}$. This upward shift in the support tends to increase the probability of fighting for the more uncertain H .

If G and H are uniform, second-order stochastic dominance implies $\bar{s} > \bar{r}$, the upward-support effect swamps the concavity effect, and the probability of fighting is unambiguously increasing in uncertainty. Assuming the distribution of spoils to be uniformly

¹⁰ That H is second-order stochastically dominated by G implies $\bar{s} \geq \bar{r}$.

distributed over $[-\bar{r}, \bar{r}]$ and solving for the probability of fighting gives,

$$F = 1 - \frac{(1 - \sigma)(c + \bar{r})}{2\bar{r}[1 - \sigma(1 - p)]} \left[1 - \left(\frac{c - \bar{r}}{c + \bar{r}} \right)^{\frac{1 - \sigma(1 - p)}{1 - \sigma}} \right].$$

Differentiation then shows that F is increasing in \bar{r} (see the proof of Proposition 2 in the Appendix).

The uniform-distribution case also suggests why better times make for less fighting (i.e., why $\partial F/\partial c < 0$). As c increases the *relative* uncertainty surrounding the spoils decreases. More formally, for a fixed distribution G , the relative uncertainty surrounding the spoils as measured by the volatility of the spoils is $v = \sqrt{\text{var}(r)}/c$ decreases as c increases. Rewriting the expression for F in terms of the volatility of the spoils, which in the case of a uniform distribution reduces to $v = \bar{r}/(c\sqrt{3})$, gives,

$$F = 1 - \frac{(1 - \sigma)(1 + v\sqrt{3})}{2v\sqrt{3}[1 - \sigma(1 - p)]} \left[1 - \left(\frac{1 - v\sqrt{3}}{1 + v\sqrt{3}} \right)^{\frac{1 - \sigma(1 - p)}{1 - \sigma}} \right].$$

Thus, the climate of the times affects the probability of fighting solely through the relative uncertainty surrounding the spoils. This indicates that bad times make fighting more likely because the relative uncertainty surrounding the spoils is larger in bad times. (We return to the issue of relative uncertainty below after generalizing the analysis to a larger set of coercive signaling models.)

Power Sharing: Why Not Reveal the Size of the Pie?

The opposition fights because it has to deter the government from bluffing, i.e., making low offers when the spoils are relatively large. Suppose, however, that there were some way the government could reveal the size of the pie to the opposing faction that was not vulnerable to bluffing or misrepresentation. Then the government would reveal the spoils in this way because it would increase the government's payoff. If, more specifically, the government verifiably reveals the size of the pie to the opposing faction before offering that faction its certainty equivalent $p\sigma\pi$, the opposition would accept this offer for sure rather

than with probability $\alpha(p\sigma\pi) = (\pi/\bar{\pi})^{p\sigma/(1-\sigma)} < 1$.¹¹ As a result, verifiably revealing the spoils raises the government's payoff from $\alpha(p\sigma\pi)(\pi - p\sigma\pi) + [1 - \alpha(p\sigma\pi)](1 - p)\sigma\pi = \pi(1 - p\sigma) - [1 - \alpha(p\sigma\pi)]\pi(1 - \sigma)$ to $\pi(1 - p\sigma)$. Why, then, does the government not verifiably reveal its private information?

One answer may be that there is simply no way to do so that is not vulnerable to bluffing. Suppose alternatively that the government cannot credibly commit to transparent institutions and decision-making procedures which would reveal the size of the pie to outsiders, but the government can reveal the size of the pie to the opposition by bringing it inside – possibly through some sort of power-sharing arrangement. However, revealing information in this way is costly. In particular, giving opposition elements positions of influence also shifts the distribution of power in the opposition's favor by increasing the probability it prevails from p to $p + \Delta$.

This shift introduces a commitment problem alongside the original informational problem. If the opposition could commit to accepting $p\sigma\pi$ and to not exploiting its enhanced bargaining power, then the government would reveal the spoils, the opposing faction would accept the government's offer, and there would be no fighting. But the opposition cannot commit to this and will fight if offered anything less than $(p + \Delta)\sigma\pi$. Thus, verifiably revealing the spoils to the opposition also raises the cost of buying it off from $p\sigma\pi$ to $(p + \Delta)\sigma\pi$. If this cost is too large, the commitment problem swamps the informational problem, and the government foregoes the opportunity to reveal the spoils.

The shifting distribution of power along with the inability to commit create a trade off between the efficiency gains and distributive costs for the government. Sharing power solves the inefficiency problem the benefits of which accrue to the government. But sharing power also affects the distribution of the spoils as the now more powerful opposition

¹¹ Although the opposition is indifferent between accepting its certainty equivalent and fighting, it accepts for sure for the same reason that it is sure to accept this offer in a complete-information, take-it-or-leave-it-offer game. If the government has verifiably revealed the spoils to be π , then the opposition accepts any $z > p\sigma\pi$ with probability one as it is sure to do strictly better by accepting than by fighting. But if in turn it does not accept $z = p\sigma\pi$ for sure, then the government has no best reply to the opposing faction's strategy, and this strategy cannot be part of an equilibrium.

can claim a larger fraction of the pie. If the distributive costs to the government are too high, it will prefer the larger share of the (in expectation) smaller pie to the smaller share of the larger pie.¹² The government foregoes the opportunity to resolve the inefficiency.

To formalize these issues, assume that the government can reveal the spoils to the opposition by sharing power or it can make an offer to the opposing faction. If the government shares power, the game ends with payoffs $\pi - (p + \Delta)\sigma\pi$ and $(p + \Delta)\sigma\pi$ for the government and opposition respectively. (These are the payoffs that would result if the size of the pie were known to both at the outset of the game.) If the government makes an offer rather than sharing power with the opposition, the game proceeds as before. Then,

PROPOSITION 4: *If times are bad enough and the shift in power is small enough, i.e., if $\pi < \bar{\pi} [(1 - \sigma - \Delta\sigma)/(1 - \sigma)]^{(1-\sigma)/(p\sigma)}$, then the government shares power in equilibrium.*

Proof: The payoff from sharing power and thereby avoiding any risk of fighting is $\pi[1 - (p + \Delta)\sigma]$ while the expected payoff from playing the game with private information is $\alpha(p\sigma\pi)\pi(1 - p\sigma) + [1 - \alpha(p\sigma\pi)](1 - p)\sigma\pi$ where $\alpha(p\sigma\pi) = (\pi/\bar{\pi})^{p\sigma/(1-\sigma)}$. Algebra demonstrates that former payoff is larger than the latter if and only if the condition stated in the proposition holds. ■

The probability that the government shares power is $\Pr\{\pi < \bar{\pi} [(1 - \sigma - \Delta\sigma)/(1 - \sigma)]^{(1-\sigma)/(p\sigma)}\} = G(\bar{\pi} [(1 - \sigma - \Delta\sigma)/(1 - \sigma)]^{(1-\sigma)/(p\sigma)})$. This probability increases as the opposition becomes stronger. Hence, governments are more likely to share power when the opposition is stronger.

A More General Model

The preceding discussion focused on an incumbent government and an opposition group vying for control of the state. But the model analyzed above is just one member of a simple class of “coercive” signaling models that exhibit the same broad equilibrium behavior: The unique equilibrium satisfying D1 is separating and simple to characterize. This section describes this class of games, characterizes their equilibria, and briefly discusses

¹² The “smaller” pie is $\alpha(p\sigma\pi)(\pi - p\sigma\pi) + [1 - \alpha(p\sigma\pi)](1 - p)\sigma\pi = [(1 - p)\sigma + \alpha(1 - \sigma)]\pi$.

three other members of this class: a model of war, a model of litigation, and a modified version of the government-opposition model analyzed above. The latter reinforces the point that harder times make for more fighting by creating relatively more uncertainty.

Let Γ be the class of signaling games in which the sender (player 1) knows t which defines the situation facing the actors. The receiver believes t is distributed according to H which has a continuous and strictly positive density over (\underline{t}, \bar{t}) . In the example above, t was the size of the spoils. The sender then proposes a division x of the spoils $s(t)$ as illustrated in Figure 2 where $x \leq s(\bar{t}) - w_1(\bar{t})$.¹³ The receiver (player 2) can accept this offer or try to impose a settlement through the costly use of some form of power. Accepting ends the game in payoffs $s(t) - x$ and x for 1 and 2, respectively. Fighting ends the game in an inefficient outcome with payoffs $w_1(t)$ and $w_2(t)$ where s , w_1 , and w_2 are assumed to be continuously differentiable.

These functions satisfy three additional conditions: Fighting is inefficient, i.e., $w_1(t) + w_2(t) < s(t)$ for all $t \in [\underline{t}, \bar{t}]$. The receiver's payoff to fighting is increasing in t , $w_2'(t) > 0$. And, the difference between the spoils and the sender's payoff to fighting is increasing, $s'(t) - w_1'(t) > 0$.¹⁴

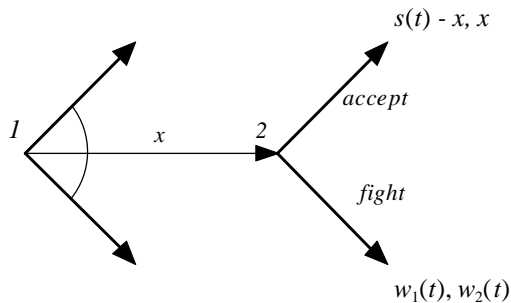


Figure 2: A general signaling game.

DEFINITION 1: A signaling game γ is coercive if: (i) $s(t)$, $w_1(t)$, and $w_2(t)$ continuously differentiable; (ii) $s'(t) - w_1'(t) > 0$ and $w_2'(t) > 0$; and (iii) $w_1(t) + w_2(t) < s(t)$ for all

¹³ This restriction on x simplifies the notation and parallels the restriction in footnote 2, but it is not essential.

¹⁴ Alternatively, we could denote the types by $w_2 \in [\underline{w}_2, \bar{w}_2]$ and assume $d[s(w_2) - w_1(w_2)]/dw_2 > 0$.

$t \in [\underline{t}, \bar{t}]$.

Although the setting is more general, the receiver faces the same dilemma in any coercive signaling game as the opposition does in the example above. If the value of t were common knowledge and the receiver was weak (t is small), the receiver's expected payoff to fighting would be low and it would accept a low offer. But if the receiver is unsure of t and hence $w_2(t)$, it needs to deter the sender from making low offers when t is high. To do this, the receiver must reject offers less than $w_2(\bar{t})$ with positive probability. The probability of fighting and the corresponding probability of acceptance are given by the solution to a differential equation analogous to (1) above. More precisely,

PROPOSITION 5: *Let γ be a coercive signaling game. Then PBEs satisfying D1 exist and the unique strategies in them are:¹⁵ $y(t) = w_2(t)$ for all $t \in [\underline{t}, \bar{t}]$; $\alpha(x) = 0$ if $x < w_2(\underline{t})$; $\alpha(x) = 1$ if $x > w_2(\bar{t})$; and*

$$\int d \ln \alpha(x) = \int \frac{w_2'(\tau) d\tau}{s(\tau) - w_1(\tau) - w_2(\tau)}$$

for $w_2(\underline{t}) \leq x \leq w_2(\bar{t})$. This expression along with the boundary condition $\alpha(w_2(\bar{t})) = 1$ gives

$$\alpha(x) = \exp \left[- \int_{w_2^{-1}(x)}^{\bar{t}} \frac{w_2'(\tau) d\tau}{s(\tau) - w_1(\tau) - w_2(\tau)} \right]. \quad (2)$$

Proof: See the appendix.

Three examples illustrate the proposition.

War: The first example is a model of war and related to that in Fearon (1995). Suppose two states, S_1 and S_2 , are bargaining about revising the territorial status quo. S_1 makes a take-it-or-leave-it offer $x \in [0, 1]$ to S_2 who can accept or reject by fighting. Accepting ends the game with payoffs $1 - x$ and x for S_1 and S_2 . Fighting destroys a fraction $1 - \sigma$ of the value of the territory with the winner taking what is left. The payoffs to fighting are therefore $(1 - p)\sigma$ and $p\sigma$ for S_1 and S_2 where p is the probability that S_2 prevails. However, the distribution of power p is uncertain. In particular, $p = \hat{p} + \varepsilon$ where ε is

¹⁵ D1 does not pin down ϱ 's beliefs if $x < w_2(\underline{t})$ or $x > w_2(\bar{t})$. In both cases, ϱ has a unique best response regardless of its beliefs, namely, fight if $x < w_2(\underline{t})$ and accept if $x > w_2(\bar{t})$. This deprives D1 of any power to eliminate any types.

distributed over $[\underline{\varepsilon}, \bar{\varepsilon}]$ according to G with mean zero. S_1 begins the game knowing the balance of power, i.e., S_1 knows ε , but S_2 does not.

This formulation closely parallels Fearon's (1995) basic model with two exceptions. First and most importantly, the informed state makes the offer here whereas the uninformed state makes the offer in Fearon's game. Second, the uninformed party is uncertain about the distribution of power here and not about the rival's cost of fighting as in Fearon's formulation. This means that, in the terminology of game theory, the present model entails correlated values whereas Fearon's set up and much of the existing work in international relations entails independent private values.

To deter S_1 from making low offers when S_2 is strong (ε is large), S_2 fights with positive probability in response to all $x < (\hat{p} + \bar{\varepsilon})\sigma$. To determine the corresponding probability of acceptance, take $s(\varepsilon) = 1$, $w_1(\varepsilon) = [1 - (\hat{p} + \varepsilon)]\sigma$, $w_2(\varepsilon) = (\hat{p} + \varepsilon)\sigma$. It follows that $w'_2 = \sigma$, $s(\varepsilon) - w_1(\varepsilon) - w_2(\varepsilon) = 1 - \sigma$, $w_2^{-1}(y) = y/\sigma - \hat{p}$, and, by Proposition 5, $y(\varepsilon) = (\hat{p} + \varepsilon)\sigma$ with $\alpha(y) = \exp \left[- \int_{y/\sigma - \hat{p}}^{\bar{\varepsilon}} [\sigma/(1 - \sigma)] d\varepsilon \right] = e^{[y - y(\bar{\varepsilon})]/\sigma}$.

Litigation: The second example is Reinganum and Wilde's (1986) model of litigation.¹⁶ A plaintiff, P , has private information about the damages it has suffered and makes a settlement offer of x to the defendant D . The defendant is unsure of d but believes it to be distributed over $[\underline{d}, \bar{d}]$ according to the strictly increasing distribution $G(d)$. The defendant can accept the demand or fight by going to court.

If the defendant proposes x and the plaintiff agrees, the game ends with payoffs $-x$ and x for P and D , respectively. If D refuses x , and the case goes to court, the court finds in favor of the plaintiff with probability π and awards td to her. Litigation costs the plaintiff c_P and the defendant c_D , and the parameters π , t , c_P , and c_D are common knowledge. The payoffs to going to court are therefore $\pi td - c_P$ for the plaintiff and $-\pi td - c_D$ for the defendant.

Unsure of the actual damages, the defendant must deter large demands when the

¹⁶ Models of litigation and war are closely related. In each, one actor threatens to use force – legal or military – to impose a settlement. But the use of force is costly and the resulting outcome is *ex post* inefficient. See Powell (1999, 216-19) for a discussion of the parallel between models of litigation and war.

actual damages are small. To appeal to Proposition 5, let $s(d) = 0$, $w_1(d) = \pi t d - c_P$, and $w_2(d) = -\pi t d - c_D$. Because $w'_2 = -\pi t < 0$, redefine the type-space via $\phi = \bar{d} - d \in [\underline{\phi}, \bar{\phi}] = [0, \bar{d} - \underline{d}]$ where ϕ is the difference between the actual damages and the worst-case damages. Larger ϕ therefore mean higher payoffs for the defendant. Now define $\hat{w}_2(\phi) \equiv w_2(d) = -\pi t(\bar{d} - \phi) - c_D$, $\hat{w}_1(\phi) \equiv w_1(d) = \pi t(\bar{d} - \phi) - c_P$, $\hat{s}(\phi) = s(d) = 0$, and observe $\hat{w}'_2 = \pi t > 0$ and $\hat{s}'(\phi) - \hat{w}'_1(\phi) \equiv \pi t > 0$. Proposition 5 then implies that the plaintiff demands $y = w_2(d) = \hat{w}_2(\phi)$ and the probability of acceptance satisfies

$$\int d \ln \alpha(x) = \int \frac{\pi t d \tau}{c_P + c_D}.$$

Hence the probability that a case goes to court is

$$1 - \alpha(x) = 1 - \exp \left[-\frac{\pi t(\bar{\phi} - \phi)}{c_P + c_D} \right] = 1 - \exp \left[-\frac{\pi t(d - \underline{d})}{c_P + c_D} \right],$$

which is what Reinganum and Wilde (1986, 562) report.

Multiplicative uncertainty: The third example shows that the insights derived above about the effects of uncertainty extend to government-opposition games where uncertainty affects the value of resources multiplicatively. This example reinforces the point that changes in the climate of the times affect the probability of fighting through the effects those changes have on the relative uncertainty about the spoils. Suppose that the uncertainty enters multiplicatively rather than additively in the government-opposition game, i.e., $\pi = c\theta$ where θ is distributed over $[\underline{\theta}, \bar{\theta}]$ according to H which has a strictly positive density over $(\underline{\theta}, \bar{\theta})$ and a mean of one. The relative uncertainty surrounding the spoils in this formulation is independent of c as $v = \sqrt{\text{var}(\pi)}/c = \sqrt{\text{var}(\theta)}$. In keeping with this, the probability of fighting is independent of c . To apply Proposition 5, let $s(\theta) = c\theta$, $w_1(\theta) = (1 - p)\sigma c\theta$, $w_2(\theta) = p\sigma c\theta$. Then

$$\alpha(x) = \exp \left[-\int_{x/(p\sigma c)}^{\bar{\theta}} \frac{p\sigma c d \theta}{c(1 - \sigma)\theta} \right] = \left(\frac{x}{\bar{x}} \right)^{\frac{p\sigma}{1 - \sigma}}.$$

This implies that the probability of fighting is,

$$F = 1 - \int_{\underline{\theta}}^{\bar{\theta}} \left(\frac{\theta}{\bar{\theta}} \right)^{\frac{p\sigma}{1-\sigma}} dH,$$

which depends on the distribution H but not on c .

The results summarized in Proposition 5 are closely related to previous work on D1 in signaling games. Cho and Sobel (1990) show that D1 implies uniqueness and separation in monotonic signaling games with finitely many types.¹⁷ Ramey (1996) extends Cho and Sobel's analysis to signaling games with a continuum of types, the sender's and receiver's strategies are elements of \mathbb{R}^n and \mathbb{R} respectively, and the game satisfies a more general monotonicity condition. (Mailath 1987 also analyses separating equilibria in signaling games with a continuum of types.) Cho and Sobel (1990) observe that D1 implies uniqueness and separation in many models that are non-monotonic (e.g., Reinganum and Wilde 1986), and in which the sender's action space is a closed interval, and the receiver has two responses (e.g., accept or fight). The results derived above complement those analyses by identifying a set of continuous-type, non monotonic, signaling games which is easier to characterize than Cho and Sobel's set and in which D1 implies uniqueness and separation.

Conclusion

In many situations, an actor has private information about the resources it controls and needs to buy off or co-opt potential challengers; these challengers, although less well informed about the resources, can fight for and possibly gain control of them. For instance, an incumbent government is likely to know more about the spoils that come with controlling the state than is an opposing, out-of-power faction. This informational asymmetry creates a vexing strategic problem for the government and the opposing faction vying for control of the state. Because fighting is costly, the government prefers to buy

¹⁷ Roughly, a signaling game is monotonic if whenever one type prefers the receiver to take action a rather than a' following a given signal, then all types prefer a to a' . In addition to monotonicity, several other conditions are needed. See Cho and Sobel's Proposition 4.5 (1990, 399).

off or co-opt the potential challenger by offering to share some of the spoils. But even if the opposing faction would be willing to accept a lower offer if the spoils were known to be small (and therefore the value of winning control of the state was less), the opposition cannot simply accept low offers when it is uncertain of the spoils. If it did, there would be nothing to deter the government from making low offers when the spoils are large. To discourage these low-ball offers, the opposing faction rejects all low offers with positive probability and the bargaining breaks down in costly fighting.

This dilemma leads to very simple equilibrium behavior when the interaction is modeled as a signaling game. The unique perfect Bayesian equilibrium satisfying Cho and Kreps' (1987) D1 restriction on beliefs is fully separating with the government offering the opposing faction the latter's certainty equivalent of fighting. The larger the realized spoils, the more the government offers and the higher the probability that the opposition accepts the proposal.

Formalizing the interaction between informed insiders and less well informed outsiders as a signaling game highlights and helps to answer two important questions. First, what makes conflict more likely? Do more (in expectation) resources, more destructive conflict technologies, or a stronger opposition make for more conflict? One might have supposed, for example, that a stronger opposition would have led to less conflict because the government will be more willing to offer more in order to buy it off. The formal analysis shows this is not the case. Harder times, a stronger opposition, and lower costs to fighting all make fighting more likely for the same fundamental reason. They lower the value of the government's private information relative to the cost of fighting.

The effects of uncertainty on the probability of fighting depends on the strength of the opposition. If the opposition is weak enough, more uncertainty leads to more conflict. When the spoils are uniformly distributed, higher uncertainty also leads to more fighting regardless of the strength of the opposition. However, what really matters for the likelihood of conflict is uncertainty relative to the expected size of the spoils. More relative uncertainty increases the potential for opportunistic behavior on the side of government and this increases the probability of fighting.

The second question centers on the government's incentive to solve the information problem efficiently. Because the government's equilibrium offer leaves the opposition indifferent between accepting and fighting, the government bears all of the inefficiency cost of fighting and therefore would like to reveal the spoils to the opposition if that were possible and costless. Sometimes, however, the only bluff-proof way to reveal the size of the pie to outsiders may be to bring them inside. The government may only be able to reveal the spoils to the opposition by giving members of the opposing faction influential positions in the government. This, however, may make the opposition more powerful and thereby create a commitment problem. If the opposition could commit to not exploiting its more powerful position, the government would reveal the information to the opposition by bringing it into the government. But if the opposition cannot commit, the government faces both an information and commitment problem. The former dominates the latter and the government shares power with the opposition when the efficiency gains which the government alone captures are large enough relative to the distributive shift induced by the change in the distribution of power. This occurs if the shift in power towards the opposition is sufficiently small and times are bad enough.

Finally, the government-opposition signaling game can be seen as one example from a larger class of coercive signaling models in which D1 implies uniqueness and separation. Separation can then be used to derive the equilibrium explicitly. This class includes models of war and litigation.

Appendix

The government-opposition game is an element of the more general set of coercive signaling models. We therefore prove Lemmas 1-3 and Proposition 1 by proving the claims for any coercive signaling game.

Incentive compatibility ensures that the equilibrium offers are weakly increasing in the spoils and that larger equilibrium offers are generally more likely to be accepted than smaller offers. More formally:

LEMMA 1A: *Let $(y(t), \alpha(x); \mu(x))$ be a PBE of a $\gamma \in \Gamma$ with $y' = y(t')$, $y'' = y(t'')$, and $t' < t''$. Then:*

- (i) $\alpha(y'') \geq \alpha(y')$;
- (ii) if $\alpha(y') > 0$, then $y'' \geq y'$;
- (iii) if $\alpha(y'') > 0$ or $\alpha(y') > 0$ and if $y'' > y'$, then $\alpha(y'') > \alpha(y')$.

Proof: Incentive compatibility implies,

$$\begin{aligned} \alpha(y')(s(t') - y') + (1 - \alpha(y')) w_1(t') & \tag{A1} \\ & \geq \alpha(y'')(s(t') - y'') + (1 - \alpha(y'')) w_1(t'), \end{aligned}$$

and

$$\begin{aligned} \alpha(y'')(s(t'') - y'') + (1 - \alpha(y'')) w_1(t'') & \tag{A2} \\ & \geq \alpha(y')(s(t'') - y') + (1 - \alpha(y')) w_1(t''). \end{aligned}$$

To establish (i) subtract (A1) from (A2) to obtain $[\alpha(y'') - \alpha(y')][s(t'') - w_1(t'') - (s(t') - w_1(t'))] \geq 0$. That $s(t) - w_1(t)$ is increasing in t then leaves $\alpha(y'') \geq \alpha(y')$.

For (ii), assume $\alpha(y') > 0$ and rewrite (A1) to obtain $\alpha(y'')(y'' - y') \geq [\alpha(y'') - \alpha(y')][s(t') - y' - w_1(t')]$. Because y' is accepted with positive probability, it must bring the sender t' as least as much as it would get by fighting (otherwise the offer would not be made). So, $s(t') - y' \geq w_1(t')$. This along with part (i) implies $[\alpha(y'') - \alpha(y')][s(t') - y' - w_1(t')] \geq 0$. Part (i) also ensures that $\alpha(y'') \geq \alpha(y') > 0$ which leaves $y'' \geq y'$.

As for (iii), again take $\alpha(y') > 0$ and $y'' > y'$. Rewriting (A2) gives $\alpha(y')(y'' - y') \leq [\alpha(y'') - \alpha(y')][s(t'') - y'' - w_1(t'')]$. The left side of this inequality is positive. And, $\alpha(y') > 0$ implies $\alpha(y'') > 0$ from (i). Because y'' is accepted with positive probability, agreeing to y'' must bring t'' as least as much as it would get by fighting. So, $s(t'') - y'' \geq w_1(t'')$. Hence, $\alpha(y'') > \alpha(y')$.

Now suppose $\alpha(y'') > 0$. If $\alpha(y') = 0$, there is nothing to show. If $\alpha(y') > 0$, the previous argument ensures $\alpha(y'') > \alpha(y')$. ■

LEMMA 2A: *Take $(y(t), \alpha(x); \mu(x))$ to be a PBE satisfying D1. Assume further that z is an out-of-equilibrium offer, i.e., $z \notin \{y(t) : t \in [\underline{t}, \bar{t}]\}$ such that $w_2(\bar{t}) > z > y(\tau)$ for some $\tau > t^+ \equiv \inf\{t : \alpha(y(t)) > 0\}$. Then the receiver believes that it is facing \hat{t} with probability one where $\hat{t} \equiv \sup\{t : y(t) < z\} = \inf\{t : y(t) \geq z\}$.*

Proof: The set of strategies that are mixed best responses to z given some set of beliefs is simply $\alpha \in [0, 1]$ as any α is a best reply to z if the opposition believes $t = w_2^{-1}(z)$. Moreover, deviating to z from $y(t)$ given α is weakly profitable if,

$$\alpha(z)[s(t) - z] + (1 - \alpha)w_1(t) \geq \alpha(y(t))[s(t) - y(t)] + [1 - \alpha(y(t))]w_1(t)$$

$$\alpha \geq \alpha^*(t) \equiv \alpha(y(t)) \left(\frac{s(t) - w_1(t) - y(t)}{s(t) - w_1(t) - z} \right),$$

as long as $s(t) - w_1(t) - z > 0$. Hence, the set of strategies α for which deviating from $y(t)$ are strictly and weakly profitable are, respectively, $D(z, t) \equiv (\alpha^*(t), 1]$ and $D^0(z, t) \equiv [\alpha^*(t), 1]$.

There are now two cases to be considered. Assume, first, that $t^+ < t < t'$ and $y = y(t) > z$. Because $t > t^+$, $\alpha(y(t)) > 0$ and, consequently, $0 \leq s(t) - y(t) - w_1(t) < s(t) - z - w_1(t)$. It follows that,

$$1 - \frac{y - z}{s(t') - w_1(t') - z} > 1 - \frac{y - z}{s(t) - w_1(t) - z}$$

$$\alpha(y) \left[\frac{s(t') - w_1(t') - y}{s(t') - w_1(t') - z} \right] > \alpha(y) \left[\frac{s(t) - w_1(t) - y}{s(t) - w_1(t) - z} \right].$$

Incentive compatibility implies $\alpha(y')[s(t') - w_1(t') - y'] \geq \alpha(y)[s(t') - w_1(t') - y]$ which

leaves,

$$\alpha(y') \left[\frac{s(t') - w_1(t') - y'}{s(t') - w_1(t') - z} \right] > \alpha(y) \left[\frac{s(t) - w_1(t) - y}{s(t) - w_1(t) - z} \right]$$

$$\alpha^*(t') > \alpha^*(t).$$

Hence, $D^0(z, t) \subset D(z, t')$, and D1 eliminates t' along with all $t > \inf\{t : y(t) > z\}$.

Now suppose $t^+ < t < t'$ and $y(t') < z$. Then repeating the argument above shows that D1 eliminates t . It follows that D1 eliminates all t such that $t^+ < t < \sup\{t : y(t) < z\}$. If $\alpha(y(t^+)) > 0$, the same argument eliminates t^+ . So suppose $\alpha(t^+) = 0$, and consider any $t \leq t^+$. This type cannot profitably deviate to y' , so $w_1(t) \geq \alpha(y(t'))[s(t) - y'] + [1 - \alpha(y')]w_1(t)$. This implies $w_1(t) \geq s(t) - y' > s(t) - z$. Consequently, no $\alpha > 0$ can rationalize t 's deviation to z and $D^0(t, z) = \{0\} \subset D(t', z)$. D1 therefore eliminates all $t \leq t^+$. ■

LEMMA 3A: *Let $(y(t), \alpha(x); \mu)$ be a PBE satisfying condition D1 with $t^+ \equiv \inf\{t : \alpha(y(t)) > 0\}$. Then all $t > t^+$ separate: $y(t') < y(t'')$ whenever $t^+ < t' < t''$.*

Proof: Arguing by contradiction, there must be two types t' and t'' such that $t^+ < t' < t''$ and t' and t'' make the same offer \hat{y} . Let $\hat{t} = \inf\{t : \hat{y} = y(t)\}$. It follows that $\hat{y} > w_2(\hat{t})$. To see this, note that because $y(t)$ is nondecreasing, all $t \in [t', t'']$ propose \hat{y} . This interval has positive measure, and therefore player 2's payoff to fighting must be strictly larger than the payoff to fighting the lowest type. Formally, $\int_{\{t: \hat{y}=y(t)\}} w_2(t) d\hat{H}(t) > \int_{\{t: \hat{y}=y(t)\}} w_2(\hat{t}) d\hat{H}(t) = w_2(\hat{t})$ where \hat{H} is the posterior of H given \hat{y} . Lemma 1 guarantees $\alpha(y(t)) > 0$ for all $t > t^+$. Thus, the opposition accepts \hat{y} with positive probability which leaves $\hat{y} \geq \int_{\{t: \hat{y}=y(t)\}} w_2(t) d\hat{H}(t) > w_2(\hat{t})$.

Now consider any offer of slightly less than \hat{y} , i.e., some $z \in (\hat{y} - \varepsilon, \hat{y})$ for an ε small enough to ensure $z > w_2(\hat{t})$. If the opposition strictly prefers accepting z to fighting, then $\alpha(z) = 1$ and a contradiction results as those offering \hat{y} could profitably deviate to the lower offer z . To see that the opposition does prefer accepting z , suppose that z is an equilibrium proposal, i.e., $y(t) = z$ for some t . Because y is nondecreasing and $z < \hat{y}$.

The opposing faction therefore believes that t is bounded above by \hat{t} after being offered z since $\sup\{t : z = y(t)\} \leq \inf\{t : y(t) \geq \hat{y}\} = \hat{t}$. Hence, the opposition's payoff to fighting is bounded above by $p\sigma\hat{t}$ which is strictly less than z . If z is an out-of-equilibrium offer, then the argument in the second case in the proof of Lemma 2 implies that the opposition believes it is facing $\sup\{t : y(t) \leq z\} \leq \hat{t}$ after z . The opposing faction's expected payoff to fighting is therefore $w_2(\hat{t})$ and again strictly less than z . ■

Proof of Proposition 3: (a) Given $p \leq (1-\sigma)/\sigma$, the integrand in the expression for the probability of acceptance $A = 1 - F = \int_{\underline{r}}^{\bar{r}} [(c+r)/(c+\bar{r})]^{p\sigma/(1-\sigma)} dH$ is concave. Second-order stochastic dominance then implies,

$$\begin{aligned} \int_{\underline{r}}^{\bar{r}} \left(\frac{c+r}{c+\bar{r}} \right)^{\frac{p\sigma}{1-\sigma}} dH &\geq \int \left(\frac{c+s}{c+\bar{r}} \right)^{\frac{p\sigma}{1-\sigma}} dG \\ &\geq \left(\frac{c+\bar{r}}{c+\bar{s}} \right)^{\frac{p\sigma}{1-\sigma}} \int \left(\frac{c+s}{c+\bar{r}} \right)^{\frac{p\sigma}{1-\sigma}} dG = \int \left(\frac{c+s}{c+\bar{s}} \right)^{\frac{p\sigma}{1-\sigma}} dG, \end{aligned}$$

where the final inequality is strict whenever $\bar{s} > \bar{r}$. (Second-order stochastic dominance implies $\bar{s} \geq \bar{r}$.)

(b) Uniform case: Suppose that the distribution of spoils is distributed uniformly over $[-\bar{r}, \bar{r}]$. With a uniform distribution, a (mean preserving) increase in the uncertainty of the spoils is equivalent to an increase in \bar{s} . Solving for the probability of fighting gives,

$$F = 1 - \frac{(1-\sigma)(c+\bar{r})}{2\bar{r}[1-\sigma(1-p)]} \left[1 - \left(\frac{c-\bar{r}}{c+\bar{r}} \right)^{\frac{1-\sigma(1-p)}{1-\sigma}} \right]. \quad (3)$$

We now show $\partial F/\partial \bar{r} > 0$. Letting $A = 1 - F$ be the probability of acceptance, then $A = (1-\sigma)/[2(1-\sigma(1-p))\Lambda]$ where $\Lambda \equiv (z+1) \left[1 - [(z-1)/(z+1)]^{p\sigma/(1-\sigma)+1} \right]$ and $z \equiv c/\bar{r}$. Differentiation gives,

$$\frac{\partial \Lambda}{\partial z} = 1 - \left(\frac{z-1}{z+1} \right)^{\frac{1-\sigma(1-p)}{1-\sigma}} \left[1 - \frac{2[1-\sigma(1-p)]}{p\sigma(z-1)} \right],$$

where the difference $z-1$ is greater than zero because $c-\bar{r} > 0$. If the factor in brackets on the right side of the previous expression is negative, then $\partial \Lambda/\partial z > 0$ which leaves $\partial F/\partial \bar{r} = -\partial A/\partial \bar{r} = -(1-\sigma)/[2(1-\sigma(1-p))(\partial \Lambda/\partial z)(\partial z/\partial \bar{r})] > 0$. If the factor in

brackets is nonnegative, then the question arises whether $\partial\Lambda/\partial z$ can be positive. Note it must be, because $[(z-1)/(z+1)]^{\frac{1-\sigma(1-p)}{1-\sigma}} < 1$ and $[1-2[1-\sigma(1-p)]]/[p\sigma(z-1)] < 1$. Hence, $\partial\Lambda/\partial z > 0$ in this case as well and, consequently, $\partial F/\partial\bar{r} > 0$. ■

Proof of Proposition 5: Let $(y(t), \alpha(x), \mu(t))$ be a PBE of $\gamma \in \Gamma$ satisfying D1 and recall that $t^+ = \inf\{t : \alpha(y(t)) > 0\}$. The first step in the proof shows $y(t) = w_2(t)$ for all $t \in (t^+, \bar{t}]$. The second step is to demonstrate that $\alpha(x)$ is continuous at any $x \in (w_2(t^+), w_2(\bar{t}))$. This and the incentive compatibility conditions will imply that α' is well-defined at x and that $\alpha(x)$ is given by equation (2) for all $x \in (w_2(t^+), w_2(\bar{t}))$. The third step establishes that $t^+ = \bar{t}$. It follows that $y(t) = w_2(t)$ for all t . Finally we verify that $y(t)$ and $\alpha(x)$ are equilibrium strategies and therefore that equilibria satisfying D1 exist.

Lemma 3A implies $t > t^+$ separate. Lemma 1A then implies that $y(t)$ and $\alpha(y(t))$ are strictly increasing in t for $t > t^+$. This leaves $0 < \alpha(y(t)) < \alpha(y(\bar{t})) \leq 1$. That $\mathcal{2}$ is mixing in response to $y(t)$ implies $\mathcal{2}$ is indifferent between accepting and fighting. Hence, $y(t) = w_2(t)$ for all $t \in (t^+, \bar{t})$ and $y(\bar{t}) \geq w_2(\bar{t})$.

The receiver is sure to accept any $x > w_2(\bar{t})$ as the payoff to fighting is bounded above by $w_2(\bar{t})$. Hence, $\alpha(x) = 1$ for all $x > w_2(\bar{t})$, and it follows that \bar{t} 's offer satisfies $y(\bar{t}) = w_2(\bar{t})$ (otherwise \bar{t} could reduce its offer towards $w_2(\bar{t})$ and still have it accepted for sure). Also, $\alpha(y(\bar{t})) = 1$; otherwise \bar{t} could profitably deviate to some x larger than $w_2(\bar{t})$ but sufficiently close to it.

To see that $\alpha(x)$ is continuous at any $x \in (w_2(t^+), w_2(\bar{t}))$, let $y = w_2(t)$ and $y' = w_2(t')$ for $t^+ < t < t'$. The incentive compatibility conditions imply,

$$\alpha(y)[s(t) - y] + [1 - \alpha(y)]w_1(t) \geq \alpha(y')[s(t) - y'] + [1 - \alpha(y')]w_1(t)$$

$$\alpha(y')[s(t') - y'] + [1 - \alpha(y')]w_1(t') \geq \alpha(y)[s(t') - y] + [1 - \alpha(y)]w_1(t'),$$

Rewriting these conditions gives,

$$\frac{\alpha(y)(y' - y)}{s(t) - y - w_1(t)} \geq \alpha(y') - \alpha(y) \geq \frac{\alpha(y')(y' - y)}{s(t') - y' - w_1(t')}.$$

The bounds on $\alpha(y') - \alpha(y)$ go to zero as y' goes to y , thereby ensuring that α is continuous.

Dividing the previous expression by $y' - y$, letting y' go to y , and using $\lim_{y' \rightarrow y} \alpha(y') = \alpha(y)$ yields,

$$\frac{\alpha(y)}{s(t) - y - w_1(t)} \geq \alpha'(y) \geq \frac{\alpha(y)}{s(t) - y - w_1(t)}.$$

Hence,

$$\frac{\alpha'(y)}{\alpha(y)} = \frac{1}{s(t) - y - w_1(t)}$$

for all $y \in (w_2(t^+), w_2(\bar{t})]$. Recalling that $y(t) = w_2(t)$ and using the boundary condition $\alpha(y(\bar{t})) = 1$ we get,

$$\begin{aligned} \frac{d \ln \alpha(w_2(t))}{dt} &= \frac{w_2'(t)}{s(t) - w_1(t) - w_2(t)} \\ \alpha(y) &= \exp \left[- \int_{w_2^{-1}(y)}^{\bar{t}} \frac{w_2'(t) dt}{s(t) - w_1(t) - w_2(t)} \right] \end{aligned} \quad (\text{A3})$$

for $y \in (w_2(t^+), w_2(\bar{t})]$.

To demonstrate that $t^+ = \underline{t}$, assume the contrary, i.e., that $t^+ > \underline{t}$, and take $\varepsilon > 0$ so that $s(t^+) - w_1(t^+) - w_2(t^+) - \varepsilon > 0$. Then some $t < t^+$ would have an incentive to deviate $z = w_2(t^+) + \varepsilon$ and this contradiction implies $t^+ = \underline{t}$. Deviation is profitable if $w_1(t) < \alpha(z)[s(t) - z] + [1 - \alpha(z)]w_1(t)$ where $\alpha(y(t)) = 0$ because $t < t^+$. Hence, offering z is profitable if $0 < \alpha(z)[s(t) - w_1(t) - w_2(t^+) - \varepsilon]$. Equation A3 ensures $\alpha(z) > 0$ and taking t close enough to t^+ guarantees that the second factor is positive. Hence, $t^+ = \underline{t}$. An immediate consequence of this is that $\alpha(\underline{t})$ is also defined by A3 above. Were α to be discontinuous at \underline{t} , some type in the neighborhood of \underline{t} could profitably deviate.

In sum, if a PBE satisfying D1 exists, the equilibrium strategies must be defined by $y(t) = w_2(t)$ and equation A3. To show that these actually are equilibrium strategies, observe trivially at $\alpha(y)$ is a best reply for 2 to a separating offer that leaves it indifferent between accepting and fighting.

To see that $y(t) = w_2(t)$ is a best reply to $\alpha(x)$, differentiate t 's payoff to offering x ,

$$U(x|t) = \alpha(x)[s(t) - x] + [1 - \alpha(x)]w_1(t)$$

$$U'(x|t) = \alpha'(x)[s(t) - x - w_1(t)] - \alpha(x)$$

$$\text{sgn}[U'(x|t)] = \text{sgn} \left[\frac{\alpha'(x)}{\alpha(x)} [s(t) - x - w_1(t)] - 1 \right].$$

Differentiating A3 gives,

$$\frac{\alpha'(x)}{\alpha(x)} = \frac{1}{s(w_2^{-1}(x)) - w_1(w_2^{-1}(x)) - x},$$

which leaves $\text{sgn}[U'(x|t)] = \text{sgn} [s(t) - w_1(t) - (s(w_2^{-1}(x)) - w_1(w_2^{-1}(x)))]$. But $s(w_2^{-1}(x)) - w_1(w_2^{-1}(x))$ is strictly increasing in x . Hence, $t = w_2^{-1}(x) \Leftrightarrow x = w_2(t)$ uniquely satisfies the first and second order conditions and therefore is the unique best response to α . ■

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