BARGAINING VERSUS FIGHTING*

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Abstract

I examine the determinants of conflict and settlement by embedding probabilistic contests in a bargaining framework. Different costly enforcement efforts (e.g., arming, litigation expenditures) induce different disagreement points and Pareto frontiers. After examining the incentives for settlement, I demonstrate how different division rules and bargaining norms have real, economic effects. I then analyze some sources of conflict. I emphasize long-term, strategic considerations by examining an illustrative model and discussing particular historical examples.

Why individuals, organized groups, or states engage in fighting and wars is a central problem for society as well as for the study of society, the social sciences. It is also a problem for the economy and for economics, as conflict and wars take away resources from production, destroy resources, and change the incentives for productive investment and innovation. Jack Hirshleifer spearheaded the study of conflict by the use of models of contests in which agents make costly choices between production and appropriation.[1] The relative levels of appropriative activities, usually interpreted as arms, determine the probability of each side winning in conflict or, sometimes equivalently, the share of the contested prize that each side receives.

Although there is by now much accumulated research on conflict and contests, often no distinction is being made between probabilistic outcomes, in which one side wins and the others lose, and deterministic outcomes whereby each side receives a share of the prize that is contested. In this paper I will systematically examine the conditions that might lead to fighting and those that might lead to settlement under the threat of fighting; in Jack's words, the distinction is between "hot wars" on the one hand and "cold wars" or "armed peace" on the other.[2] In doing so, I will attempt to synthesize previous research within a common framework but also point out some relatively new avenues for understanding when fighting can be expected to occur and when not.

I first describe the basic setting whereby different types of probabilistic contests can be embedded within a bargaining framework. After choosing enforcement efforts (e.g., arming, litigation expenditures), which determine the probabilities of winning and losing for each party, the parties can engage in bargaining and settlement in the shadow of conflict. Because enforcement efforts are costly, in general both the disagreement point and the Pareto frontier faced by bargainers are endogenously determined.

The different incentives to bargain and settle are then reviewed. Destruction and additional costs brought about by conflict, risk aversion, diminishing and decreasing returns, and complementarities in production or consumption provide strong incentives for bargaining and settlement. Where the adversaries end up, however, when they bargain and settle depends on the division rule or the bargaining norm that they subscribe to. Division rules that put more weight on the disagreement (or, threat) point tend to induce greater enforcement costs and thus induce lower levels of utility for all parties. That is, contrary to ordinary bargaining theory in which Pareto frontiers and disagreement points are fixed, different division rules can be Pareto ranked in this setting.

I next turn to an examination of sources of conflict. Using the basic setting established earlier, I first review both well-known and less well-known sources of conflict, including indivisibilities, incomplete information about various aspects of the environment within which the adversaries

operate, and differential beliefs (or, priors) that the adversaries may have. I then examine a much less discussed class of dynamic sources of conflict. Conflict and settlement or "War" and "Armed Peace" can have very different strategic implications for the future. War tends to provide compounding rewards to the winner well into the future, whereas Armed Peace tends to preserve the status quo. It is then possible for War to be preferable by one or both adversaries in such dynamic settings. I Illustrate the point with a particular model and then discuss its empirical relevance with historical examples.

Throughout the paper, the adversaries are considered unitary actors who have the capability of maximizing their own payoff. Conflict and settlement in practice when the adversaries are collectivities can also be determined by the internal politics within each adversary's constituency, but I do not examine this potentially important determinant of conflict and settlement.[3]

THE BASIC SETTING

Throughout the paper I will consider two sides, A and B, competing for a prize that can be either exogenous or endogenous to the choices made by them. The strategic variable at each side's disposal is a level of costly "enforcement effort" e_i $(i = A, B)$, which in the case of literal warfare would stand for levels of arming. The reader though can keep in mind that much of the framework and the analysis can apply to other settings of contests, such as litigation (e.g., Hirshleifer and Osborne, 2001) or lobbying and rent seeking (Tullock, 1980; Nitzan, 1994). Any combination of efforts, (e_A, e_B), leads to probabilities of winning and losing for the two sides. Let $p_i(e_A, e_B)$ denote $i's$ winning probability. We suppose $i's$ winning probability is increasing in $i's$ own effort and decreasing in that of its opponent. One wide class of functional forms, for which $p_A(e_A, e_B) + p_B(e_A, e_B) = 1$, is the following additive form:

$$\begin{aligned} p_A(e_A, e_B) &= \frac{f_A(e_A)}{f_A(e_A) + f_B(e_B)} \\ p_B(e_A, e_B) &= \frac{f_B(e_B)}{f_A(e_A) + f_B(e_B)} \end{aligned} \qquad (1)$$

where $f_A(\cdot)$ and $f_B(\cdot)$ are non-negative, increasing functions and provided $e_A + e_B > 0$.[4] The "ratio" or "Tullock" form, whereby $f_A(e) = f_B(e) = e^m$ $(m > 0)$, has been the workhorse of research on conflict and contests.[5]

Enforcement efforts can be thought of as coming from a resource R_i for each side i, so that $R_i - e_i$ is left to be used for other (presumably, productive) purposes. In the event of fighting or War, the expected payoff of side i could generally be described as follows:

$$\begin{aligned} V_i^W(e_A, e_B) &= p_i(e_A, e_B) H_i(T_h, X_{Ah}(e_A), X_{Bh}(e_B)) \\ &\quad + (1 - p_i(e_A, e_B)) H_i(T_l, X_{Al}(e_A), X_{Bl}(e_B)) \end{aligned} \qquad (2)$$

$H_i(T, X_B, X_B)$ is a non-decreasing function of each argument and could stand for a composition of utility and production functions. T_h and T_l represent exogenous quantities for the winner and loser, respectively, of some resource of economic value that the two sides might be competing over. The $X_{ij}^{'}s$ could represent inputs in a production process, in the event of a win and a loss, that would be in general endogenous to the choices of enforcement efforts.

For the case of simple conflict or rent-seeking under risk neutrality, typically we have $T_h = T > 0$ and $T_l = 0,$ with $X_{Ah}(e_A) = X_{Al}(e_A) = R_A - e_A$, $X_{Bh}(e_B) = X_{Bl}(e_B) = 0$, and

$$H_A(T, X_A, X_B) = T + X_A \qquad (3)$$

and similarly for B.

Another example of an $H_i(\cdot)$ function, in which $X_{ih}(e_i) = R_i - e_i$ and $X_{il}(e_i) = 0$ (for both $i = A, B$) are inputs in a production function:

$$H_A(T, X_A, X_B) = H_B(T, X_A, X_B) = F(X_A, X_B) \qquad (4)$$

In such a case, the winner receives all the output $F(R_A - e_A, R_B - e_B)$ and the loser receives $F(0,0)$ (typically equal to 0).

The payoffs in (1) are those in the event of War. If the two sides were to expect to bargain and settle in the shadow of War, then these would not be the appropriate payoff functions that should determine equilibrium choices of effort. We will analyze both single-period and multi-period dynamic games that involve choices of enforcement effort as well as of fighting or settling. Regardless of the number of periods, however, in each period we will consider games with the following movers:

- 1. The two sides simultaneously choose enforcement efforts (e_A, e_B).
- 2. Each side chooses whether to go to War or to engage in bargaining with the aim of peacefully settling. If either side chooses to go to War, War occurs with the expected payoffs described in (1).
- 3. If both sides choose to bargain, bargaining and settlement may occur. (Depending on how the bargaining game is specified and its conditions, War could still be possible.)

Such a sequence of moves is consistent with, and is meant to typify, the sequence of moves that adversaries tend to make in actual conflictual conditions: arming takes place before bargaining, both as a bargaining tool and as a way of influencing the likelihood of winning if conflict were to take place. In general, we would expect different levels of enforcement efforts if the sides were to expect War and different levels of the same variables if bargaining and settlement were to be expected. And, as we will show in section 3, the equilibrium levels of enforcement can vary widely

with the bargaining game or the bargaining norm (or, solutions) that is expected to take place in stage 3.

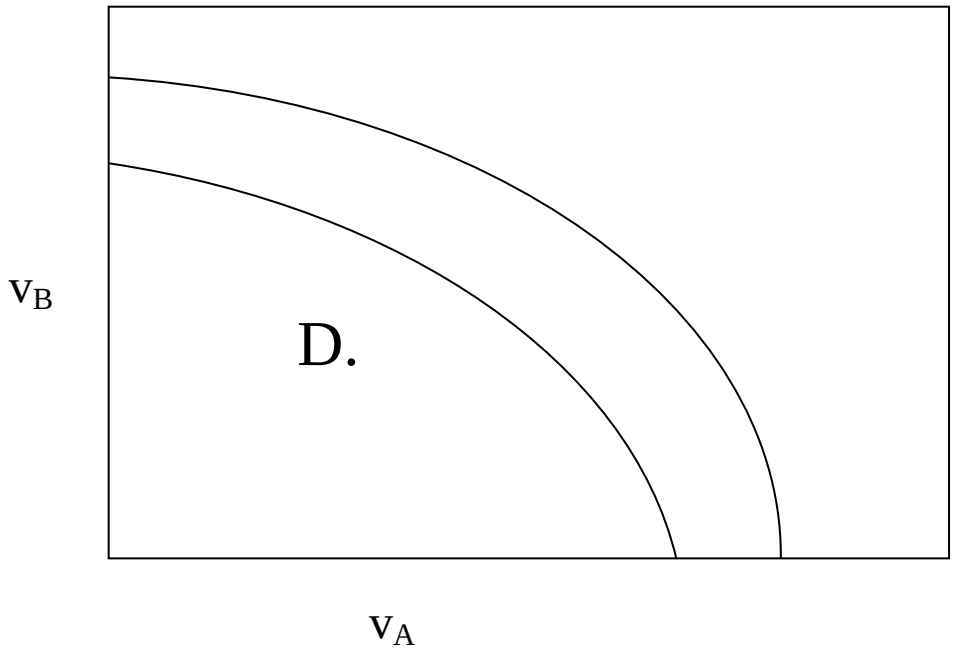

Figure: 1

It should be emphasized that the bargaining settlements that can occur in this setting are *conditional* on the enforcement levels. That is, we maintain that *contracts on enforcement levels are not enforceable.* Therefore, in general, because enforcement efforts are costly, the two sides cannot expect to reach the "Nirvana" unconstrained Pareto-efficient frontier in Figure 1. Instead, given enforcement levels (e_A, e_B) from stage 1, in stage 2 the two sides would face a bargaining game with (2) as the disagreement point (D in Figure 1) and a constrained-efficient frontier as depicted. (In that case, the two sides would always have an incentive to settle.)

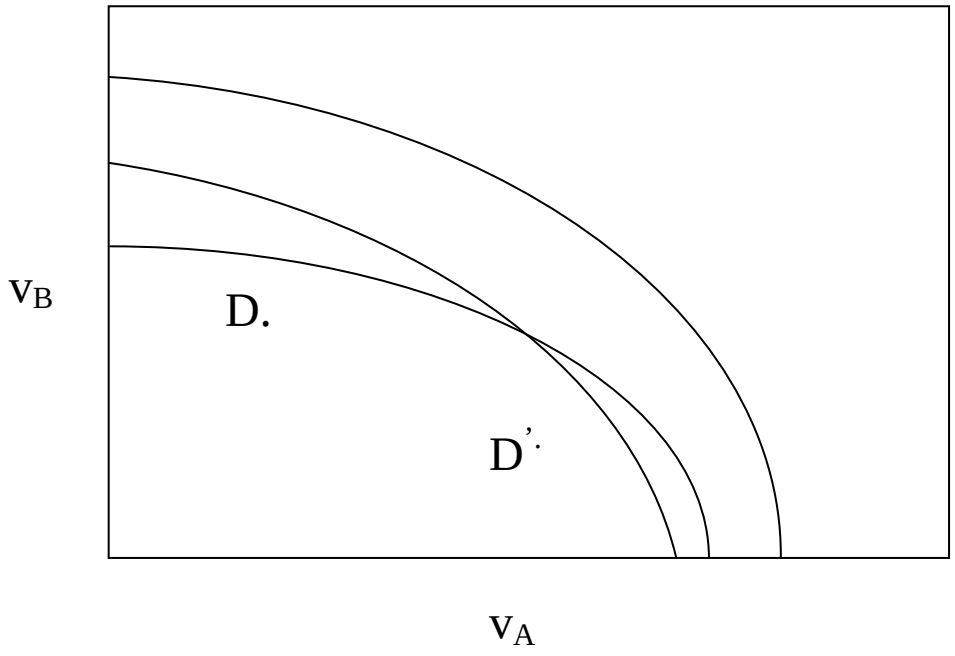

Figure: 2

The disagreement point and the constrained efficient frontier are endogenous themselves. An increase in the effort of side A, as depicted in Figure 2, could shift the disagreement payoff of A in his favor, to the detriment of $B's$ disagreement payoff, and it would shift the whole frontier to the right. That is, with the approach taken here, both the disagreement point – moving from D to D' -- and the Pareto frontier over which the two sides would negotiate shift. Where in that space the two sides end up would depend both on the production, utility, and contest success functions, as well as on the type of game that is expected to be played in stage 3. In other cases, as we shall examine in subsequnets sections, there would be no allocations in stage 2 that could avoid War; that is, the disagreement point could well be above all point of constrained-efficient frontier.

INCENTIVES TO BARGAIN AND SETTLE

Why would two armed adversaries both prefer to settle instead of fighting? That is the question we ask in this section, and for that we consider the behavior of the two sides in stage 2 of the aforementioned sequence of moves. In that stage, the enforcement efforts (e_A, e_B) have been chosen already. To have the possibility of bargaining and settlement, whatever the two sides contest must be divisible enough so that War can be avoided. The question then becomes on whether there are divisions of the contestable items that could yield payoffs for each side that are at least as high as those under War in (2), or that the constrained-efficient frontier is at or above the disagreement point.

As we describe below, there is a variety of economic conditions that would make both sides prefer settlement to War.

Destruction and other costs brought about by war

In addition to the cost of arming, War has other costs: spent ammunition and other war materiel, destruction of physical objects, injury and death.

For specificity, suppose both sides are risk neutral, competing for an exogenous prize of value T, and the valuation function is as in (3). Furthermore, suppose each side i would incur an additional cost $C_i (> 0)$ if they were to go to War and lose.[6] That is, the expected payoff of going to War would be (where $p_i \equiv p_i(e_A, e_B)$):

$$V_i^{Wc} = p_i T + R_i - e_i - (1 - p_i)C_i \qquad (5)$$

Letting β_i denote a share of T, side i would accept any division of T that yields a payoff at at least as high as V_i^{Wc}, or when

$$\beta_i T + R_i - e_i \geq p_i T + R_i - e_i - (1 - p_i)C_i$$

which is equivalent to

$$\beta_i \geq p_i - (1 - p_i)\frac{C_i}{T} \qquad (6)$$

Since the second term of the right-hand-side of this inequality is negative, any division of the prize T in accordance with the winning probabilities (i.e., $\beta_i = p_i$ for both $i = A, B$) would be acceptable to both parties. However, other divisions of the prize would be acceptable to both parties, and the higher are the costs of War relative to the value of the prize (i.e., the higher is the ratio $\frac{C_i}{T}$), the greater is the range of divisions of the prize that would be Pareto superior to War.

Since the range of bargaining alternatives increases with the size of the possible destruction, we could also expect less of a chance of fighting if conditions favor to fighting, that we examine later, were to be present. Thus, the severe cost of nuclear war had at least an effect on the avoidance of such a war thus far, despite other conditions that might have precipitated it.

Risk aversion

When the adversaries are individuals or representatives of larger groups, we might expect at least some of them—and perhaps almost all of them—to dislike risk and uncertainty. In other words, we would expect the participants to be risk averse. Since, as we have modelled it, War is uncertain, risk aversion would be another reason for preferring bargaining and settlement to fighting.

To fix ideas, suppose both sides have as their valuation functions von-Neumann-Morgenstern utility functions $U_i(\cdot)$ and the income of each is linear in the exogenous contested resource T and

in their own resource $R_i - e_i$. Expected utilities under War are then:

$$V_i^{Wu} = p_i U_i(T + R_i - e_i) + (1 - p_i) U_i(R_i - e_i)$$

When each side is strictly risk averse, the $U_i(\cdot)'s$ are strictly concave and the following inequality holds for all $p_i \in (0,1)$:

$$\begin{aligned} U_i(p_i T + R_i - e_i) &= U_i(p_i T + p_i(R_i - e_i) + (1 - p_i)(R_i - e_i)) \\ &> p_i U_i(T + R_i - e_i) + (1 - p_i) U_i(R_i - e_i) = V_i^{Wu} \end{aligned}$$

Note that $U_i(p_i T + R_i - e_i)$ is the (sure) payoff that results from receiving a p_i share of T. We have therefore just shown that the two adversaries strictly prefer to divide the contested resource according to the winning probabilities than engaging in War. Other divisions of T would also be Pareto superior to fighting. How wide such a range is would depend on the particular von-Neumann-Morgenstern utility functions—and importantly on the degree of risk aversion—as well as on the values of the other parameters (T, R_i, and e_i).

Diminishing returns

In much of economics diminishing returns is considered a typical property of production processes. If a contestable resource like land is an input in production with diminishing returns, then fighting can be expected to lead to outcomes that are suboptimal, with the winner having too much of the input and the loser too little relative to an efficient outcome.

Continue to suppose a resource T that is the primary bone of contention between the two adversaries, but now consider it an input in a production process along with the other resource ($R_i - e_i$) each side possesses. That is, we consider a case in which each side produces final output by means of a production function $F(t, X)$ (where X is made out of the other resources of the two sides). The expected payoff under War of side i would then be:

$$V_i^{Wf} = p_i F(T, R_i - e_i) + (1 - p_i) F(0, R_i - e_i)$$

Since diminishing returns is equivalent to $F(t, X)$ being strictly concave in both of its arguments, we have for all $p_i \in (0,1)$:

$$\begin{aligned} & F(p_i T, R_i - e_i) \\ = \; & F(p_i T + (1 - p_i)0, p_i(R_i - e_i) + (1 - p_i)(R_i - e_i)) \\ > \; & p_i F(T, R_i - e_i) + (1 - p_i) F(0, R_i - e_i) = V_i^{Wf} \end{aligned} \tag{7}$$

Again, similarly to the case of risk aversion, $F(p_i T, R_i - e_i)$ is the sure payoff of having a

share p_i of T. Both sides would prefer to divide the contested resource according to the winning probabilities than going to War. A range of other divisions of the resource would also be Pareto superior to War.

Complementarities and efficiency

Production functions like the one we just examined exhibit complementarities.[7] The same is true for utility functions, as $F(t, X)$ could also be interpreted as a utility function. Complementarities, however, between goods that are contested and divided and others that are not imply that overall efficiency is not guaranteed if the division of the contested good does not take into account such complementarities.

Suppose, for example, in the case of the previous subsection that the two sides were to divide T so that A receives a p_A share with the remainder ($p_B = 1 - p_A$) going to B. That is, A would have an endowment of $(p_A T, R_A - e_A)$ and B an endowment of $(p_B T, R_B - e_B)$. Although this allocation is Pareto-superior to War, nothing guarantees that both sides could not become better off by trading some t in exchange for some X. Thus, the two sides could potentially improve on allocations like those indicated in (7) that exploit just diminishing returns. If $F(t, X)$ were homothetic, efficiency would be guaranteed if and only if the ratios of the two inputs were identical (i.e., $\frac{p_A T}{R_A - e_A} = \frac{p_B T}{R_B - e_B}$).[8]

Given that in modern economies goods are highly complementary with other goods, complementarity could be an empirically significant factor in avoiding fighting.

Decreasing returns to scale in production

In all the valuation functions we have used up to this point, we have supposed an exogenous contested resource *T*. Suppose now that the contested is a function of the endogenous inputs, so that $H_i(X_A, X_B) = G(X_A, X_B)$ which is an ordinary production function for which we assume $G(0,0) = 0$. Then, the expected payoff under War would be as follows:

$$V_i^{Wg} = p_i G(R_A - e_A, R_B - e_B) \qquad (8)$$

If $G(X_A, X_B)$ has decreasing returns to scale, for all $p_i \in (0,1)$ by definition we must have:

$$G(p_i(R_A - e_A), p_i(R_B - e_B) > p_i G(R_A - e_A, R_B - e_B) \qquad (9)$$

Or, again, dividing the contested inputs according to the winning probabilities is Pareto superior to fighting it out for the two inputs.

Cumulatively, the sets of economic reasons for which bargaining and settlement dominate fighting is impressive, and one would expect as a result not to have much fighting in practice. Nevertheless, wars and other lower-level forms of conflict, including litigation, have been and

continue to be routine. Perhaps with one exception—that of decreasing returns—bargaining and settlement would be the expected outcome in rich, modern, economies with high complementarities in production and consumption, high costs of conflict, or risk averse attitudes. Yet war overtook high-income countries with a vengeance in the first half of the 20th century. Although we cannot provide much of an argument why specific wars have occurred in this paper, we will examine various reasons for fighting. Before doing so, however, we will briefly touch another issue: that of the enforcement levels when the sides expect to bargain and settle with probability one.

ARMING FOR SETTLEMENT: THE ROLE OF BARGAINING NORMS

Thus far, we have only shown the incentive to bargain and settle, instead of going to War, in stage 2 of the sequence of 3 stages by which we have described a plausible environment of arming, fighting, and settling. Given settings with complete information in which settlement would be part of any subgame perfect equilibrium, how large enforcement efforts would the two adversaries choose in stage 1 of the process? Does the expectation of a negotiated settlement reduce their arming compared to the case of War? Given that there are many possible negotiated settlements and rules of division, which ones would the two sides be expected to use? Are there any rules of division that are better than others and in what sense?

To begin answering such questions, we need to know—and the two sides would need to know and agree upon—a rule of division (or, bargaining solution, or bargaining norm) at stage 3. That is, big parts of the answers to the questions just posed above would depend on how the two sides expect to behave when they finally settle, and we need to specify both a particular model with a valuation function, a rule of division in stage 3, and the resultant payoff functions.

For simplicity and tractability, we consider a variation of the model where settlement is always preferred by the two players because War has additional costs. Here, however, we suppose that the costs of War are proportional to T, instead of additive. In particular, we suppose that if the two sides were to go to War, the winner would only win θT of the contested resource where $\theta \in (0,1)$. Then, the expected payoff under War is the following variation of (5)

$$V_i^{W\theta} = \frac{e_i}{e_A + e_B}\theta T + R_i - e_i \qquad (10)$$

Note that we have specified the well-used contest success function $p_A(e_A, e_B) = \frac{e_A}{e_A + e_B}$.

These expected payoffs only specify what would occur under disagreement (War), which would never occur in equilibrium. The payoffs under "Armed Peace" in stage 3 can be specified as follows:

$$\begin{aligned} V_A^P(e_A, e_B) &= \beta^\gamma(e_A, e_B)T + R_A - e_A \\ V_B^P(e_A, e_B) &= (1-\beta^\gamma(e_A, e_B))T + R_B - e_B \end{aligned} \qquad (11)$$

where by $\beta^\gamma(e_A, e_B)$ we represent a rule of division which, in general, should depend on the enforcement efforts chosen by the two sides. In particular, we consider the following class of rules parametrized by $\gamma(>0)$:

$$\beta^\gamma(e_A, e_B) = \gamma \frac{e_A}{e_A + e_B} + (1-\gamma)\frac{1}{2} \qquad (12)$$

This class of rules includes the following three possibilities:

a. ($\gamma = 0$) When T is divided in half regardless of each side's choice of enforcement effort. This is an example of a rule of division that is independent of the disagreement payoff of each side.

b. ($\gamma = 1$) When T is divided according to the probability of winning ($\frac{e_A}{e_A + e_B}$ for A and $\frac{e_B}{e_A + e_B}$ for B).

c.($\gamma = \theta$) When the insecure income is divided according to any symmetric axiomatic bargaining solution (including the Nash and Kalai-Smorodinsky solutions) where the disagreement payoffs are those under fighting described in (10).[9]

In addition, given risk neutrality, γ can also be interpreted as a (common) prior probability that the two sides might have about the rule of division that will be used in stage 3. That is, the parametrization in (12) allows for uncertainty that the two sides could have about the rule of division that they might use.

The payoffs in (11) along with a division rule in (12) constitute a well-defined game. The Nash equilibrium choices of enforcement efforts, denoted by (e_A^γ, e_B^γ), are the following:

$$e_A^\gamma = e_B^\gamma \equiv e^\gamma = \frac{\gamma}{4}T \qquad (13)$$

The corresponding equilibrium payoffs under Armed Peace are:

$$V_i^P(e_A^\gamma, e_B^\gamma) = \frac{2-\gamma}{4}T + R_i, \quad i = A, B \qquad (14)$$

Note how both enforcement efforts and equilibrium payoffs depend on the rule of division or bargaining norm parameter γ. If the disagreement payoff and enforcement efforts play no role in dividing the surplus ($\gamma = 0$), no enforcement efforts are chosen and payoffs are maximal, with the contested resource simply divided in half. As more weight is given to the disagreement point in bargaining (γ is rising), more resources are expended on enforcement and less income is left for consumption or other purposes.

From the point of view of economic theory, the division rule with $\gamma = \theta$ appears the best justified, as it corresponds to any symmetric bargaining solution. However, when the Pareto frontier in bargaining is strictly concave, different bargaining solutions would yield different enforcement efforts in equilibrium and it is possible that such solutions could even Pareto-ranked under certain conditions. Anbarci, Skaperdas, Syropoulos (2002) have performed such a comparison and found that bargaining solutions that put more weight on disagreement utilities indeed produce more equilibrium enforcement effort and lead to lower equilibrium payoffs.[10] Thus, bargaining norms have been shown to have real effects in more complex economic environments than the one examined here and, if anything, the effects appear to be as strong or stronger than in the simple case with linear Pareto frontiers.

The equilibrium enforcement efforts under War (i.e., with the payoffs in (10)) are identical for the two sides and equal $e^{\theta} = \frac{\theta}{4}T$. Note that these efforts under War are *lower* than the enforcement efforts under Armed Peace whenever $\gamma > \theta$. Moreover, it is even possible for the equilibrium payoff under Armed Peace to be lower than that under War. That occurs whenever $\gamma > 2 - \theta$, which is true only if $\gamma > 1$ and would therefore involve a very high weight on the the disagreement point.

The effect of norms on arming that we have identified here also concerns a recent debate within the field of international relations between "constructivists" and "realists" (or, "neorealists") about the effect of norms. Realists view the world of interaction between states as anarchic where military power is the overwhelming, if not the sole, determinant of success and survival as a state.[11] Constructivists emphasize the role of international social and cultural norms regarding interactions between states, including the role of such norms in bringing about or preventing war (see, e.g., Wendt, 1999). What we have shown is that norms have an important economic role to play even in an anarchic world. Military power cannot determine solely all power since there are typically too many possible agreements that can take place in the shadow of War, and that is for given levels of military power. Different norms about how the mutual gains from not fighting are shared can lead to radically different levels of arming, without essentially changing the relative military power of the adversaries, thus increasing the economic pie of each side in a non-zero sum fashion. Therefore, a constructivist approach, with its emphasis on norms, and a realist approach, based on rational-choice, are not fundamentally incompatible and can be fruitfully combined.

REVIEWING SOME SOURCES OF CONFLICT

Having examined the incentives to bargain and settle in the shadow of War as well as the role of bargaining norms when settlement occurs, we turn to possible reasons that induce fighting. In this section we review a number of causes of fighting that have appeared in different literatures,

using the framework of the first main section of the paper. In the next section we examine some reasons for fighting that emerge in dynamic environments that are empirically important but have not received much attention.

For ease of reference in the remainder of this section, we reproduce the sequence of moves from section 1:

• 1. The two sides simultaneously choose enforcement efforts (e_A, e_B).

• 2. Each side chooses whether to go to War or to engage in bargaining with the aim of peacefully settling. If either side chooses to go to War, War occurs with the expected payoffs described in (1).

•3. If both sides choose to bargain, bargaining and settlement may occur. (Depending on how the bargaining game is specified and its conditions, War could still be possible.)

Advance commitment to fight

One or both adversaries could possibly engage in a burn-the-bridges act (Schelling, 1960) that would eliminate the possibility of negotiation in stages 2 and 3. That could take place in advance of stage 1, by commiting to War, so as to preclude the possible temptation of choosing to settle if the two sides were actually to negotiate in stage 2. There are at least two substantive reasons why such a pre-commitment could occur.

First, it is possible that the ordinary equilibrium payoff under War could be higher than the equilibrium payoff under Armed Peace for at least one side. We have shown such a theoretical possibility in the previous section and it can occur only when the weight of the division rule on the disagreement payoff is abnormally high. Other, more involved, models could share such an attribute, depending on the type of rule of division that is used.

Second, the adversaries could have negative interdependence of payoffs due to emotional dislike or hatred of one another in ways that would differentially favor War over Armed Peace. (Hirshleifer, 1995, discusses in more detail how this could occur.) That is, speaking with the enemy creates additional disutility so that, even in the presence of factors that would otherwise make settlement preferable, commiting to War would be ex ante more preferable to Armed Peace.

Indivisibilities

In the analysis of settlement in the two previous sections, we have assumed that whatever is contested by the two sides is perfectly divisible. If the contested object is imperfectly divisible, then War could ensue because the object could be indivisible for the values that dominate War. If the contested object is completely indivisible, then War would occur because that would be left as the sole feasible alternative.[12]

In a world with money, compensation could be offered by one party to the other in exchange for the contested object even if that were indivisible. For example, Fearon (1995, p.389) states: “Before the age of nationalism, princes bought, sold, and partitioned land. In the nineteenth century the United States purchased the Louisiana territory from France, and Alaska from Russia, and as late as 1898 President McKinley explored the possibility of buying Cuba from Spain in order to avoid a war over it.”

Thus, War can be the outcome of indivisibilities only if (i) money and a substitute does not exist or (ii) there are liquidity constraints that prevent the use of money or substitutes or (iii) if the contested object is not exchangeable for money or other substitutes. (i) and (ii) might have been true often in earlier times when hoarded commodity money—gold and other precious metals—might have been insufficient to buy off intruders and rivals. The uncompromising contestation of the same territory be rival ethnic groups could be considered an example of (iii). However, in the case of ethnic groups it is unclear whose preferences are relevant (or, should be relevant). For different members of the same ethnic group typically have different attitudes towards the importance of particular pieces of territory; for each uncompromising member there could easily be many others who are willing to be compensated in other dimensions for a loss of ancestral land.

Increasing returns

Indivisibility is a limiting case of increasing returns. If the production function $G(X_A, X_B)$ we examined earlier exhibits increasing returns, the inequality in (9) is reversed so that

$$G(p_i(R_A - e_A), p_i(R_B - e_B) < p_i G(R_A - e_A, R_B - e_B)$$

Then, each side would prefer the risk of War to dividing the two inputs according to the winning probabilities, and no other feasible division of the inputs would be possible. Of course, the same result would hold for increasing returns in other types functions; for example, if the function $F(t, X)$, examined earlier, were strictly convex in *t*.

Given that indivisibility is a special case of increasing returns, increasing returns as a possible contributor to fighting is at least as empirically plausible as indivisibilities are. Whole plains and valleys did not have an advantage when they belonged to a single state instead of more not because of indivisibilities but likely more due to the increasing returns brought about by a better unified irrigation and transportation infrastructure.

Risk-seeking preferences

Those who like risk or have risk-seeking preferences, by definition, will take a risk than its expected value. That is, if the function $U_i(\cdot)$ is strictly convex (for risk-seeking preferences) we have:

$$U_i(p_iT + R_i - e_i) = U_i(p_iT + p_i(R_i - e_i) + (1-p_i)(R_i - e_i))$$
$$< p_iU_i(T + R_i - e_i) + (1-p_i)U_i(R_i - e_i) = V_i^{Wu}$$

Therefore, a risk averse side would prefer to fight than divide the contested resource according to the winning probabilities. However, if the other side were sufficiently risk averse, there could still be a division of the contested resource that the risk-seeking side, as well as the risk averse one, would find preferable to War. That is, having just one of the sides being risk-seeking is not sufficient for War to take place. Of course, having both sides being risk-seekers would be sufficient for War.

Risk-seeking behavior is considered far from being typical for humans. There is no presumption, or evidence that I am aware of, that leaders of states who make decisions about war and peace are less risk averse than others. Was Hitler a risk seeker or could his behavior be explained by the many other available hypothesis. Taking into account the seeming absence of evidence on the topic, I would conjecture that risk seeking behavior has not or is not an important cause of conflict.

Incomplete information

By far, the most analyzed and discussed cause of fighting within the rational-choice approach involves different types of incomplete information. Up to this point, we have assumed that both sides have complete information about each others' payoffs, the conflict technology, the strength of one another, as well as of all other pertinent details of the nature of the game. Any uncertainty about any of those aspects of the game would imply incomplete information.

In such a game, the two sides are assumed to have common knowledge of the priors (i.e., common probabilities) regarding that aspect of the game over which there is uncertainty. For example, in stage 2 the two sides might not know one another's true strength (in terms, for example, of the amount of arms the other side have and, therefore, of their winning probabilities). Each side would have a probability distribution over the other side's strength and that probability distribution is known by the other side (and, in turn, that knowledge is known by its opponent, and so on, so as for that knowledge to be common). Under such conditions, one or both sides might choose to fight in stage 2 if they feel they are strong and their opponent also turns out to be stronger that expected, so that War could stochastically emerge as part of a regular equilibrium. (For such models, see Brito and Intriligator, 1985 or Bester and Warneryd, 2006.)

The absence of complete information about relative power has been traditionally considered an empirically important source of conflict (see Fearon, 1995, for an overview). The problem is not just the one discussed, which involves no communication between the two parties, but also when

there is a possibility of communication and signalling one's strength, which sometimes might involve misrepresentation, bluffing, and fighting as a result of such attempts. As Sanchez-Pages (2004) has shown in a sequential setting, some preliminary fighting might take place in order for the opponents to learn about each others' strengths. In such a case, we would not expect a too-prolonged fighting.

Different priors

As we just mentioned above, in traditional games with incomplete information the two sides are supposed to have the same priors regarding any uncertainty about the nature of the game. The reason for this assumption (called sometimes the Harsanyi doctrine) is that if the two sides did not have the same priors but were allowed to communicate their own priors to one another they would eventually learn to agree on a common prior (or, rather, a common posterior—see Samuelson, 2004). However, such a procedure assumes that communication is costless, an assumption that is clearly empirically difficult to satisfy. As a result, we can expect different sides, especially those with different experiences that cannot be easily communicated to one another, would have different priors about the different possibilities about the other side's strength and other characteristics. When the difference in priors is characterized by over-optimism, in the sense that one or both sides think of themselves as stronger than they are objectively and their opponents as weaker than they could objectively be, War could occur.

The sources of conflict we have discussed thus far occur in one-period, timeless settings. The various types of incomplete information that can exist tend to be considered by far the most important, if not sole, source of actual conflicts, even though I know of no systematic studies that have made in-depth comparisons of alternative hypotheses for the causes of particular conflicts. I now turn to a class of potential sources of conflict that has to do with the long-term, differential strategic effects of War and Armed Peace that has not received as much scrutiny as incomplete information but has the potential of being empirically significant.

FORWARD-LOOKING, STRATEGIC SOURCES OF CONFLICT

War does not just determine today's winner. It also changes the strategic positions of the adversaries in the future. The winner can be expected to be stronger in the future and the loser weaker. For example, the winner of a battle or war for territory will not just receive the current income of that territory; it will also be able to use the extra resources of that territory to increase arming in the future, while preventing its adversary from doing so, and therefore gain a strategic advantage well into the future. In another very different context—litigation—going to court, instead of settling out of court, clarifies the property rights of the winner and brings other benefits, including deterring lawsuits that might be filed solely with the intent of extracting settlement payments. Bargaining and settlement, on the other hand, tends not to change the future strategic

positions of the adversaries and maintain the status quo. It is possible, then, for War to be an equilibrium phenomenon in such dynamic settings.

Specifically, when (i) the future strategic implications of War and Armed Peace are very different from one another and (ii) no long-term disarmament contracts are possible,[13] then War could occur even if it brings about destruction (or, in the presence of other factors that induce settlement). We will demonstrate this possibility in a dynamic version of the model of section 3 in which the winner of War receives permanent possession of the contested resource with some it destroyed, whereas Armed Peace induces a division of the resource but entail arming in every period. What is essentially traded off is the long-term destruction that War induces versus the permanent need for arming that Armed Peace necessitates.[14] We will then discuss how this dynamic source of conflict might be distinguishable from incomplete information in particular historical instances of conflict.

War versus armed peace in a dynamic setting

Consider an indefinite horizon setting in which the single-period payoff is as in (10). That is, there is a contested resource T which loses a portion $1-\theta$ of its value if War were to occur. For notational convenience, we assume $R_i = 0$ for both $i = A, B$.[15] In each period, the two sides follow the same sequence of moves we have supposed up to this point: first, they choose enforcement efforts and then make choices between War and Armed Peace. If, however, they were to engage in War, its outcome would be permanent, in the sense that the winner would capture the contested resource thereafter, although in each period he would only receive a fraction of its benefit (θT). War, then, has a cost that is borne by the winner forever. Nevertheless, since War decides the winner once for all, there would be no enforcement efforts in future periods. By contrast, Armed Peace involves a division of the contested resource in each period without any loss of the contested resource, but it can be expected to typically involve some arming so as to better each side's bargaining position. Thus, whether War or Armed Peace prevails largely depends on the costs of War versus the extra enforcement effort that is chosen under Armed Peace.

We examine each of the two possibilities, War and Armed Peace, separately first. Under War, letting $\delta \in (0,1)$ denote the identical discount factor for the two sides, the expected payoff of side i is the following:

$$\begin{aligned} \pi_i^w(e_A, e_B) &= \frac{e_i}{e_A + e_B} \Sigma_{t=0}^{\infty} \delta^t \theta T - e_i \\ &= \frac{e_i}{e_A + e_B} \frac{\theta T}{1-\delta} - e_i \end{aligned} \qquad (15)$$

The equilibrium choices of effort are identical and equal:

$$e^w = \frac{\theta T}{4(1-\delta)} \qquad (16)$$

The equilibrium expected payoff of both sides then becomes:

$$\pi_i^w(e^w, e^w) = \frac{\theta T}{4(1-\delta)} \qquad (17)$$

To examine the case of Armed Peace, we first need to specify a division rule for stage 3 of each period that two sides negotiate. As we have seen in section 3, there are many such rules that could be adopted with different rules yielding potentially different equilibrium efforts and payoffs. Since both sides are risk neutral, all symmetric bargaining solutions prescribed the same rule of division and I will use that rule here. The qualitative findings that are reported below, however, do not depend on that rule. Let $\pi_i^{p-}(e_A, e_B)$ the continuation peace payoff of side i in a particular period (time subscripts are suppressed for notational clarity); that payoff depends on the choice of enforcement efforts, (e_A, e_B), as it affects the probabilities of winning and losing but the cost of the effort of each side is considered sunk and not included in $\pi_i^{p-}(e_A, e_B)$. Also, let $\pi_i^{w-}(e_A, e_B)$ denote the continuation War payoff of side, which is the disagreement payoff in this case. This payoff also does not include each side's cost of enforcement effort (which in general would differ from that in (15); the payoff would in fact equal $\frac{e_i}{e_A + e_B}\frac{\theta T}{1-\delta}$). Then, the symmetric rule prescribes equal division of the surplus, or that:

$$\pi_A^{p-}(e_A, e_B) - \pi_A^{w-}(e_A, e_B) = \pi_B^{p-}(e_A, e_B) - \pi_B^{w-}(e_A, e_B) \qquad (18)$$

We next need to specify the continuation peace payoffs $\pi_A^{p-}(e_A, e_B)$. Because we employ the notion of Markov perfect equilibrium, we suppose that, under Armed Peace, the two sides will choose in all future periods a particular combination of such equilibrium efforts, denoted by (e_A^p, e_B^p), and choose current period efforts optimally given these future efforts. Associated with these future efforts would be a division of the contested resource, whose share for A we denote by β^p, with the share of B thus being $1-\beta^p$. Then, for a current-period share of A denoted by β (which can in general be different from β^p) the continuation Armed peace payoff for side A is the following:

$$\begin{aligned} \pi_A^{p-}(e_A, e_B) &= \beta T + \Sigma_{t=0}^{\infty}\delta^t(\beta^p T - e_A^p) \\ &= \beta T + \frac{\delta(\beta^p T - e_A^p)}{1-\delta} \end{aligned}$$

Similarly for side B we have:

$$\pi_B^{p-}(e_A,e_B) = (1-\beta)T + \Sigma_{t=0}^{\infty}\delta^t((1-\beta^p)T - e_B^p)$$
$$= (1-\beta)T + \frac{\delta((1-\beta^p)T - e_B^p)}{1-\delta}$$

Using these two expressions in (18) along with the continuation War payoffs for each side (equal to $\frac{e_i}{e_A+e_B}\frac{\theta T}{1-\delta}$), we can find the rule of division as a function of efforts and the other parameters:

$$\beta^*(e_A,e_B) = \frac{e_i}{e_A+e_B}\frac{\theta}{1-\delta} + \frac{1}{2}(1-\frac{\theta}{1-\delta}) + \frac{\delta}{1-\delta}\frac{(1-2\beta^p + e_A^p - e_B^p)}{2T}$$

The only part of β^* that depends on efforts is the first component, with the rest of the component not influencing the choice of equilibrium effort. That first component includes the probability of winning multiplied by a factor $\frac{\theta}{1-\delta}$, which represents the discounted value of the non-destruction share θ.[16] That is, the rule of division derived is rather sensitive to discounting of the future, with greater sensitivity when the future is highly valued. The reason for this characteristic is that the rule of division (see (18)) is sensitive to the disagreement payoff, which in turns depend on the expected future discounted payoff under War. In addition, note that we should eventually have $\beta^*(e_A^p,e_B^p) = \beta^p$. With all this preparation, we are now ready to specify the relevant payoffs under Armed Peace:

$$\pi_A^p(e_A,e_B) = \beta^*(e_A,e_B)T - e_A + \frac{\delta(\beta^p T - e_A^p)}{1-\delta}$$
$$\pi_B^p(e_A,e_B) = (1-\beta^*(e_A,e_B))T - e_B + \frac{\delta((1-\beta^p)T - e_B^p)}{1-\delta}$$

Then, we can calculate that the Markov perfect equilibrium choices of effort are identical (and actually equal to those in (16)):

$$e_A^p = e_B^p \equiv e^p = \frac{\theta T}{4(1-\delta)} \qquad (19)$$

Both the probability of winning and the equilibrium share under Armed Peace (β^p) equal $\frac{1}{2}$. Most significantly, note that these equilibrium efforts involve a cost that is one quarter of the total discounted benefits of using the contested resource, taking account of the shrinkage that would

occur in the event of War. With a high enough discount factor (high δ) and a low enough destruction induced by War (high θ), the total surplus for one period could be lower than the total expenditures on enforcement for its peaceful division in (19); such an outcome occurs when $T < \frac{\theta T}{2(1-\delta)}$, or when

$$\theta > 2(1-\delta) \qquad (20)$$

In such a case the equilibrium payoff under Armed Peace would be *negative*, not just lower than the expected payoff under War in (17). Both sides, as will be shown below, would prefer to fight it out in stage when (20) is satisfied, although the range of parameters for which such an outcome would occur is wider than that suggested by (20).

To determine whether War or Armed Peace takes place, consider stage 2 for the choice of enforcement efforts in either (15) or (19) (since both equal $\frac{\theta T}{4(1-\delta)}$). Since these efforts are sunk, we need to compare the continuation payoffs under Armed Peace versus those under War. Since, given the enforcement efforts, these payoffs are symmetric, the comparison is the same for both sides. In particular, the continuation payoff under Armed Peace is

$$\begin{aligned} \pi_i^{p-}(e^p, e^p) &= \frac{T}{2} + \frac{\delta}{1-\delta}\left(\frac{T}{2} - \frac{\theta T}{4(1-\delta)}\right) \\ &= \frac{2(1-\delta)-\delta\theta}{4(1-\delta)^2} T \end{aligned}$$

whereas the expected continuation payoff under War is

$$\pi_i^{w-}(e^p, e^p) = \frac{\theta}{2(1-\delta)} T$$

Therefore, War will occur if and only[17]

$$\frac{2(1-\delta)-\delta\theta}{4(1-\delta)^2} T < \frac{\theta}{2(1-\delta)} T$$

which reduces to

$$\frac{\theta}{1-\theta} > \frac{2(1-\delta)}{\delta} \qquad (21)$$

Thus when destruction when War occurs is not too high (θ is high enough) and the discount factor δ is high enough, War occurs.[18] A higher discount factor, by making the future more important, induces higher enforcement costs that need to be paid in every period in order to

maintain each side's bargaining position. These costs then have to be compared to the cost of War, which involves some permanent loss of the value of the contested resource. This comparison of the two types of costs does not depend on the particular structure we have assumed here or on winner-take-all nature of War.[19] I close the presentation of this illustrative model, with some observations regarding the effects of long-term, strategic concerns as a source of conflict by incorporating ideas and findings from other related research:

• War can have very different strategic implications than Armed Peace has, in ways that in the absence of long-term contracting on arming, War could well be the equilibrium outcome despite its costs.

• One factor in inducing War is that, in order to maintain a proper bargaining position, Armed Peace can be very expensive in terms of the resources that it requires for arming.

• Low destruction and other costs of War (as well as relatively unimportant other incentives for Armed Peace) increase the likelihood of War.

• High importance attached to future payoffs also tend to induce War.

This last observation is opposite to that predicted by folk-theorem arguments, according to which a higher importance attached to the future (i.e., higher discount factors) tends to induce more cooperative behavior. It should be emphasized that folk-theorem arguments do not predict the necessity of cooperation but only its possibility, among many possibilities. In settings with high levels of distrust, like the ones envisaged in our setting, where long-term explicit disarmament contracts are difficult or impossible to enforce, the implementation of supergame strategies requires a measure of trust on adversaries that I think would be difficult to maintain. Folk-theorem arguments and supergame strategies would be more appropriate for settings in which parties already have developed methods of communication and levels of trust so that the contemplated, highly contingent supergame strategies would continue to be followed in the future.

Is the shadow of the future empirically relevant?

There is little doubt that various forms of incomplete information as well as disagreement about the nature of the game (in the sense of having different priors) that potential adversaries play are relevant in explaining the break-up of many conflicts. For example, there is no doubt that there was much confusion that European states and their leaders had about what was happening in the summer of 1914 that led to World War I. (See Ch. 2 in Joll, 1992, or Ch. 3 in Keegan, 2000.) Especially because the lead times from initial mobilization to actual readiness were large, and in the intervening time each country was very vulnerable to attack, it was easy to make the decision for initial mobilization—and lead others to do the same and, therefore, to war—with very limited information about other states' predispositions.[20] But was World War I just a calculated mistake

based on incomplete information?

It would be fruitless to argue here that Germany or France were determined to go to war, each for their own reasons; the former in order to loosen the perceived stranglehold of the other established empires on its own imperial ambitions, the latter in order to gain back Alsace and Lorraine as well as for defending its own empire. What is perhaps easier to argue that incomplete information is not the whole story, is to consider that there was no peace after it became obvious to almost everyone that trench warfare brought stalemate and not quick victory. With trench warfare much of the initial incomplete information dissipated, the costs of the war continuing were horrendous with not much end in sight and yet war continued. Reasonably, it could be argued that each side saw the chance of eventual dominance well into the future as the carrot that kept the war going.

Even more compelling for the arguments made in this section was the endgame of World War II. Why didn't the United States settle for the advantageous peace that Japan was bidding for? Why did the Soviet Union push so hard, and at such cost, in the Eastern front? Why were the Western allies rushing in the Western front? Certainly it could not be because they were not aware of Japan's or Germany's strength or the other way around. The allies were all looking into the future. They wanted the Axis powers crushed without the possibility of even a remote comeback, as it happened with Germany after World War I. They were also eyeing one another, jockeying for position in the post-war period - the Cold War had effectively started considerably before the end of the actual hot war.

Since the Second World War, civil wars have been much more common than interstate wars. With an average duration of over seven years (Collier et. al., 2003), by that time both incomplete information and the costs of war become apparent. Similarly, civil wars within Northern Italian city-states in late medieval times often lasted for decades with tremendous costs to the participants (see, for the case of Genoa, Greif, 1998). Before attributing all such conflicts to irrationality, obstinacy, or deep hatred, the gamble on gaining long-term advantage over opponents again appears as at least another, complementary to others, explanation of the many civil wars that have occurred.

Non-military types of conflict are also subject to the similar logic. Litigants go to court, instead of pursuing out-of-court settlements, not just because of incomplete information (or for the other static sources of conflict that we examined in the previous section). They seek once-and-for all resolutions of their disputes as the winner can expect to have a firmer grasp over what is under dispute well into the future. Unions strike and firms can engage in lockouts frequently because the eventual outcome can be expected to establish a "pattern" for the rest of the industry or even the country. There is little theoretical or empirical work that takes account of these dynamic aspects of conflict and settlement and, in the least, they deserve more scrutiny than they have hitherto

received.

CONCLUDING REMARKS

It is very rare that any particular economic, social, or historical event can have a single explanation. It would be surprising that if particular wars or periods of peace could be due to just a single factor. There are pros and cons for different views and the evidence is often inconclusive so as to never convince all informed researchers. For example, the seeming economic interdependence of the first era of globalization before 1914 made war unthinkable for many observers at the time, as they perceived the benefits of settlement definitively higher than those of war. Yet war occurred with a vengeance and, at least initially, with enthusiasm. Was it the slow information transmission or the lack of it that caused that war? Was it irrationality and blind nationalism? Or, were long-term calculations involved, with irrationality and blind nationalism possibly strategically manipulated and used as smokescreens? Besides the evidence, its weighing much depends on how we view the same evidence with the theoretical framework we use. With such thoughts in mind, I have tried to systematically present some main determinants of conflict and settlement using the contest approach that Jack Hirshleifer introduced and developed for the study of conflict. I have put some more emphasis than is customary on long-term, strategic effects, of course not because I believe they are the sole explanation of conflict but because of the received overemphasis of incomplete information as being so.

• I would like to thank Vimal Kumar and Marty McGuire for their help.

FOOTNOTES

[1] The first paper on the topic was Hirhsleifer (1988). Hirshleifer (1995) provides and overview, including a discussion of the factors that contribute to conflict and settlement.

[2] Jack used these terms in personal communications. To my knowledge, he did not use these words in print.

[3] Garfinkel (1994) and Hess and Orphanides (1995) are two pioneering studies that examine, respectively, positive and negative aspect of internal politics with regard to conflict.

[4] When $e_A = e_B = 0,$ if $f_A(0) = f_B(0) = 0$, the probabilities of winning for the two sides equal some constants k and $1-k$.

[5] Hirsheifer (1989) analyzes the properties of this and another well-known functional form (where $f_i(e) = \exp ke$; $k > 0$). For an overview of contest success functions, see section 2 of Garfinkel and Skaperdas (2006).

[6] If the winner were to pay a cost as well, the effect of destruction as a contributor to settlement would be stronger. There are of course other ways to model costs, without changing the basic finding that bargaining and settlement are preferable to War. In fact, in sections 3 and 5 we examine a variation in which the costs of War are proportional to T.

[7] In this particular case, complementarity is implied by a positive cross-partial derivative.

[8] Skaperdas and Syropoulos (2002) have examined whether concentrating on the larger bargaining set is actually *ex ante* efficient or not, and found that it is not in general. The reason is that the larger set could encourage too many enforcement costs in equilibirum so as to counteract the ordinary allocative efficency.

[9] All symmetric axiomatic solutions yield the same outcome because the Pareto frontier is linear in this case. Furthermore, this solution would also be the limiting outcome of alternating-offers (Rubinstein) noncooperative games with symmetric costs (see, for example, Osborne and Rubinstein, 1990; Muthoo, 1999).

[10] The solutions that are compared are parametrized by their relative weights that they put on the diagreement and "utopia" points. This approach allowed for the comparison of bargaining solutions like the Kalai-Smorodinsky, Equal Sacrifice, and Equal division. Because this last solution puts all its weight on the disagreement point, it performs the worst, whereas the Equal Sacrifice solution, as it puts all its weight on the utopia point, it performs best. The Nash bargaining solution has a different structure and could not be compared to these solutions. However, in simulations it performed similarly to the Kalai-Smorodinsky solution.

[11] See Waltz (1979) for a defining text or Mearsheimer (2001) for the version of "offensive" realism.

[12] Hirshleifer, Boldrin, and Levine (2005) examine the role of indivisibilities in more detail than I do here.

[13] Sometimes, this second conditions is referred to as an inability to *commit* (see Fearon, 1995).

[14] McBride and Skaperdas (2006) examine a similar infinite-horizon model, in which War has costs only in the current period, whereas in the model below War has costs over the whole horizon, leading to somewhat different comparative statics. McBride and Skaperdas (2006) also have analyzed the case of multiple battles when arming (enforcement costs) are exogenous. In addition to Fearon (1995), who first discussed the dynamic sources of conflict we examine here include a number of other recent papers. Garfinkel and Skaperdas (2000) analyzed a finite-horizon model and Powell (2004) identified some of the possible sources of conflict in an infinite horizon setting. Robson and Skaperdas (2002) showed how litigants could go to court as a way of clarifying property rights. Hirshleifer et al (2005) also showed the possibility of conflict in an infinite horizon model when the payoff functions have particular forms of time dependence. Bester and Konrad (2004, 2005) demonstrated how large asymmetries in power or expectations of future equality can induce warfare

[15] There is no loss in generality for this assumption as long as there are no liquidity constraints and each side can exert the (interior) equilibirum effort.

[16] Essentially, fitting this rule of division to that in (12), we have $\gamma = \frac{\theta}{1-\delta}$.

[17] We can assume that when the two quantities are equal, Armed Peace is chosen by convention.

[18] As mentioned abover, tt can be confirmed that (21) is implied by (20). That is, rather obviously, when the payoff under Armed Peace is negative, War is necessarily chosen in stage 2.

- [19] Fearon (1995) and Powell (2004) have discussed and analyzed the broader issues, especially relative to the political science literature. McBride and Skaperdas (2006) examine the case in which it takes more that one battle to win the war, but when enforcement costs are exogenous.

[20] It shoud be note, though, that temporary offense-dominance that early mobiization provided, could lead to what is called pre-emptive war, and which can be considered one of thedynamic sources of conflict that we examine in this section.

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