The Rationalist Puzzle of War

Quality and Quantity

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Abstract

Current rationalist explanations of war have been influenced by the treatment of war as a bargaining problem. This treatment introduces what is termed the 'puzzle of war'. The puzzle of war depends on the proposition that the exogenous costs of war guarantee the existence of an ex ante bargaining range of mutually acceptable peaceful outcomes that are preferable to war. This paper examines how this puzzle has been constructed and justified in order to support this proposition. Two conclusions are reached: the costs of war are neither necessary for the existence of a peaceful settlement when an allocation or division is exogenous, nor are the costs of war sufficient for the existence of a bargaining range, when equilibrium is endogenous.

Introduction

Recent literature on the dynamics of war written from a rationalist perspective poses a distinctive puzzle about war. The puzzle is this: Why would states choose war when war is inefficient, that is, when war is costly? In the work of Fearon in particular, the puzzle was developed further: As long as war is costly, a peaceful settlement always exists (Fearon 1995). This sharpens the puzzle: If peaceful settlements always exist, why is one of them not chosen by states in equilibrium?

The theoretical motivation in the puzzle of war for introducing the costs of war is to secure the existence of this 'bargaining range' of peaceful settlements via an exogenous variable. The inefficiency of war ex post is expected to guarantee the existence of an ex ante bargaining range that includes all settlements mutually preferred to war. Thus the puzzle of war is constructed so as to give prior existence to the bargaining range, prior to and independent of

strategic interaction among players. The existence of the bargaining range is fixed by the costs of war.

The Standard Model of the Puzzle of War

While there are several related ways to set out the puzzle, the following represents the standard model of the puzzle of war:

Two risk-neutral states, S and D, dispute the distribution of an infinitely divisible good whose size is normalized to 1. They can either agree to divide it peacefully or fight over it. War is a winner-take-all costly lottery: D wins with probability p ε (0,1), S wins with probability 1-p. and both suffer costs, C_s, C_d >0. The expected payoffs from war are p-C_d for D and 1-p-C_s for S. Since they sum up to less than the total size of the benefit, there always exists a range of settlements, B = [p- C_d, p+ C_s], that both sides prefer to war. A fully rationalist account of war must explain why the two sides fail to reach an agreement when the existence of this range is common knowledge.[1]

The puzzle is at the heart of the bargaining theory of war[2]. This paper examines how this puzzle has been constructed and it pays particular attention to how the costs of war are introduced and used to set out the bargaining theory of war. In both theory and puzzle, the costs of war matter in a specific way. These costs guarantee the existence of a bargaining range.

It will be argued that the puzzle of war is incompletely specified, and a correction will be proposed. The intuition is that the construction of the puzzle of war contains an equivocation about the costs of war that should be addressed. The correction is motivated by the following two observations. [1] A settlement mutually preferred to war can be supported without invoking the costs of war or the credibility of commitments. This shows that the costs of war are not a necessary condition for the existence of a mutually preferred settlement. However, the equilibrium induced by such a settlement is not, strictly speaking, endogenous. Instead 'equilibrium' is exogenous and is in effect induced by 'Nature' rather than by strategic interaction. [2] When equilibrium is endogenous, the costs of war are not sufficient to support the

existence of a bargaining range. The costs of war are sufficient only if mutually preferred settlements are inherently enforceable. However, as will be argued in a later section, these settlements do not have properties that make them intrinsically enforceable.

Together, these two observations imply that the costs of war are neither necessary for the existence of a peaceful settlement nor sufficient for the existence of a bargaining range, whether an allocation is exogenous or equilibrium is endogenous. Thus the correction will have two different parts. These corrections, particularly the second part, are of interest because of the importance of the puzzle of war in contemporary international security studies.

The paper proceeds in two sections. In the first section, I show how the existence of a mutually acceptable solution to the problem of division – the division and allocation between adversaries of some asset or resource -- can be supported without depending on the costs of war or enforceable commitment. In the second section, I discuss whether the costs of war are sufficient to support the existence of the bargaining range and conclude that they are not. The concluding section considers whether, in light of these problems, the puzzle of war is an appropriate standard by which to judge theory and research on bargaining and war, such that bargaining models that do not build in the puzzle of war are judged to be inferior.

Invulnerable Allocations Without War Costs or Enforceable Commitments

It is possible to construct a solution to the division problem that yields an invulnerable peaceful allocation without depending on either the costs of war or the enforceability of this allocation. This solution is non-trivial for two reasons. First of all, it can be used to show that the costs of war are not a necessary condition on the existence of a peaceful allocation. Second, this solution actually appears as a component of the puzzle of war.

In this construction below, strictly speaking, there is no bargaining range, and this makes the costs of war moot. Moreover, the allocation implied by the invulnerability of the peaceful allocation is not endogenous. The allocation, instead, is exogenously determined by the distribution of power. This is enough to show that the costs of war are not necessary for the specification of a peaceful division.

This argument is developed by reworking the argument about the existence of the 'true probability', TP, of winning a war, should war occur. TP is introduced in the puzzle of war as an assumption that is required for the existence of an ex ante bargaining range (Fearon, 1995: 388). If actors are rational, "they should know that there can be only one true probability that one or the other will prevail." The existence of TP is common knowledge among the players. The true probability of war is presented as a "substantive assumption" that, by implication, is relatively easy to satisfy. TP is treated in this paper, however, as a formal condition rather than as a substantive assumption and, under this treatment, TP does not support the existence of a common bargaining range, as claimed. Instead, TP supports the existence of a peaceful allocation, unsupported by an ex ante bargaining range.

This reconstruction does no violence to the meaning of the true probability of war. Rather, it draws out an implication of the meaning of the puzzle: If true probability is common knowledge, there should exist an invulnerable peaceful allocation or division that is determined exogenously. What the reconstruction provides is an argument about how this division is determined, when true probability is assumed.

True probability is essentially a restatement of the division problem itself that motivates an interest in bargaining. That is, true probability is simply 'x' in the division on the unit interval, [x, 1-x], where 'x' represents an allocation after division. The interval along which x is located

represents the distribution of power; hence the division of the issue is an objective function of power. This is consistent with the prevailing tendency in the rationalist literature on the puzzle of war to work with a simple representation of the type of player – players are either strong or weak. Then, when the distribution of power along a unit interval is [Φ, 1-Φ], the division (x) is [x_Φ, 1-x_Φ] and x is a function of, and is determined by Φ.[3]

This TP represents how the spoils would be divided between the players after war, in the hypothetical event of war. The counterfactual in question is a causal rather than an epistemic counterfactual, and it rests on a hypothetical causal inference: If there were to be a war, spoils would be divided in this way. But the cause of the division of the spoils in the event of war is not really war per se but simply the types of the players or, as I argue below, the identity between power and division. In effect, this is why and how the spoils could be divided without war.

The good or resource in question can be divided without war and the resulting allocation or division is determined by the distribution of power, which is, in effect, to distinguish players by their types. I note that introducing the concept of type (and the move by Nature) is consistent with the puzzle of war. The construction of the puzzle of war, and the bargaining theory of war with which it is associated, draws on the economics of information and, in particular, the work of Harsanyi (1982 [1967-1968]). [4] The most consistent way to treat this process of selection is to consider it as a process of exogenous assignment by Nature with no self-selection. Since types are exogenously assigned, it then follows that power itself is exogenous.

The division is fixed without war by the commonly known identity between power and division. Embedded in this identity as well is an implicit theory of war. Again, drawing on the language of much of this literature, strong types defeat weaker types. The outcome of war is determined according to which player is stronger. This is, however, merely a restatement of the

earlier argument about the distribution of power. Division is determined by the distribution of power, and the distribution of power or, equivalently, the assignment of types, is exogenous. There is no ex ante bargaining range, strictly speaking, and the costs of war therefore are irrelevant.

The common knowledge that is implied is not common knowledge of a bargaining range. Rather, it is common knowledge of the identity between power and division. What is meant is that the two sides know how the war will unfold. They have converged on the truth: This is how war would unfold, and some resource or good would be divided, if war were to occur. If we give propositional content to this knowledge and call that content γ, common knowledge of γ thus implies that no one believes $\neg\gamma$, and common knowledge of γ implies that γ is true (Stalnaker 1999).[5]

Common knowledge, whether of TP, as in the original construction of the puzzle of war, or of the identity between power and division in this reconstruction, is a stronger condition than common belief. Knowledge implies truth and belief does not, since beliefs might be false. Under common belief, one cannot inductively infer that the future will be like the past, that is that a belief held in common at the start of the game will continue to be commonly believed in the future, without begging the question, in effect without inserting an ad hoc premise that the future will be like the past (which thus begs the question of forward induction). This is part of the rationale for introducing common knowledge.[6]

For the purposes of this reconstruction of true probability, imagine a complete information game among players who share a theory of war [TW] that specifies the relevant exogenous variables and which specifies the functional form which links these variables to war outcomes. In this illustration, a simple theory of war shared by the parties, with substantive

content, is specified, but a different theory could be put in its place and do the requisite work, as long as this other theory is stipulated to be true independent of belief. In effect, in proceeding in this way, we cash out the identity between the distribution of power and division, introduced earlier, by operationalizing power. Players share common knowledge of this TW. The truth of TW is guaranteed by this presumption of common *knowledge*. If players believed other than TW, they would be holding false beliefs.

Outcomes of war in the hypothetical event of war, and hence allocations or division without war, are determined by the distribution of power. We will stipulate that the distribution of power, and thus the division of the asset or resource, is determined by level of armaments. This is just one way to cash out the identity that defines true probability in the above discussion. We presume that this identity is common knowledge given that, on this reconstruction of the puzzle of war, the identity is implied by the true probability of war. Common knowledge of this identity (or, equivalently, of TW) thus can replace common knowledge of the existence of true probability.

If this simple theory of war, TW, is true and commonly believed (ie. common knowledge), it is impervious to challenge and to conjecture. No player who knows what is true in this 'analogue world', and true independent of belief, would bother to conjecture, for example, that there are substitutes for armament levels, or that resolve could change war outcomes since, by assumption, outcomes are never determined by anything other than armaments and the player knows this. In the fixed structure of this world, the future is like the past and the present is impervious to challenge and manipulation. Outcomes – allocations or the division of some resource or asset – can only change as a consequence of exogenous changes in the distribution of power or, equivalently, the types of players.

Inductive generalizations within this analogue world then should be robust because they would be produced from data that are treated as generated by exogenous selection, and include only variables that are outside the purposive reach of humans. Otherwise, the generalization will be dynamically unstable. As the generalization becomes known to players, they can manipulate those variables within their purposive reach, and generally choose and act in ways that challenge, test and potentially modify or invalidate the inductive generalization.

The discussion in this section supports this correction to the puzzle of war, as it was introduced earlier: The costs of war are not a necessary condition on the existence of an invulnerable peaceful division when the equilibrium associated with division is an exogenous equilibrium. This correction has been justified via a reworking of the meaning of the true probability of war and by drawing out the full implications of this true probability, which is a component of the original construction of the puzzle of war, and by drawing out the full implications of the exogenous assignment of types, which is a central part of the treatment of incomplete information in the economics of information that underpin the puzzle of war.

The discussion above shows that common knowledge of the true probability of war under conditions of complete information implies that equilibrium is exogenous. The allocation or division of some asset or resource is fixed by the exogenous assignment of types. Effectively, common knowledge of (true) probability implies the existence of a peaceful allocation or division, and this division is supported by a distribution of power that is common knowledge, not by the costs of war. These costs thus are not necessary to support the existence of a peaceful allocation. In the next section, the second part of the proposed correction is considered: whether the costs of war are sufficient to support the existence of a bargaining range when equilibrium is endogenous.

Endogenous Equilibrium and the Sufficiency of the Costs of War

The main elements of this part of the argument can be summarized: [1] The puzzle of war is an exercise in the comparative statics of alternative outcomes. Rivals can fight and then share, or they can share without fighting (Langlois and Langlois, 2006: 646). However, the dynamic problems of enforcement and commitment run deeper than the puzzle of war allows or recognizes. [2] The costs of war are not a sufficient condition on the existence of the bargaining range. The existence of the bargaining range is conditioned on a further feature, independent of the costs of war. That feature is related to enforceable commitment. All peaceful settlements in the bargaining range are enforceable. This is the condition that supports the proposition that the costs of war guarantee the existence of the bargaining range. [3] The bargaining range is located conventionally on the unit interval that is used to normalize the division problem that motivates the bargaining theory of war. Outcomes in the bargaining range are distinguished conventionally from outcomes on the unit interval that are not in the bargaining range: Outcomes in the bargaining range are mutually preferred to war and they are enforceable. These properties of outcomes-- mutually preferred and enforceable – are expected to be closely related. Outcomes in the bargaining range are preferable to war because they are enforceable.

However, mutually preferable outcomes need not be guaranteed or enforceable. The game structure of the prisoners' dilemma illustrates the possibility of mutually preferred outcomes of strategic interaction that are not self-enforcing. Cooperation is mutually preferred to the outcome associated with mutual defection but is not enforceable. If we introduce exogenous costs, such that the endogenous incentives to defect from the cooperative outcome must be discounted against these costs, then the mutually preferred outcome can be made to be enforceable for example, by introducing a third party who monitors and punishes acts of defection. Then, under

some conditions, connected to the expectations of players and the expected value of defection, once the latter is discounted by the probability of detection of defection and punishment by the third party, the mutually preferred outcome will be the equilibrium, rather than the outcome associated with mutual defection.

This illustration is not meant as a direct analogy. The prisoners' dilemma, for example, has more structure than does the general bargaining problem. Nevertheless, there can be mutually preferred outcomes that are not enforceable, except under special assumptions. Exogenous costs of war may be said to guarantee the existence of mutually preferred outcomes but these costs, on their own, do not guarantee that such outcomes are enforceable. The illustration above helps to recognize this distinction.

Thus, the problem goes somewhat deeper. There is no intrinsic feature of a mutually preferred outcome that makes that outcome enforceable. Without introducing some other kind of restriction independent of the costs of war, therefore, there may be no mutually preferred outcome that is enforceable. [4] There is nothing in the costs of war that can tell us which (if any) of the outcomes mutually preferred to war are guaranteed enforceable, and these are the outcomes that comprise the bargaining range. The costs of war therefore are not sufficient to support the existence of the bargaining range. [5] A potential problem of coherence for the puzzle of war and the bargaining theory of war thus is raised, since puzzle and theory, as these have been constructed and presented, depend on the costs of war supporting the existence of the bargaining range.

A second correction to the puzzle of war then would take this preliminary form: The costs of war support the existence of mutually preferred settlements, but do not support the existence of the bargaining range, since the latter also requires that mutually preferred settlements are

enforceable.

An enforceable peaceful settlement is one in which players believe with subjective certainty that they will receive their share of a peaceful settlement. By construction in the puzzle of war, the player's expected payoff in war is a function of the probability of winning [$0<P<1$], discounted by the costs of war. If players do not believe with certainty what they are guaranteed in a peaceful settlement, or do not believe with certainty that they will receive what they have been 'guaranteed', such that their expected probability of their share of a peaceful settlement is less than 1, then the inequality typically used to establish the existence of the bargaining range via the costs of war is moot. Given this inequality (1) $P-C<Z$, where P is the probability of winning a war, C is the cost of fighting the war, and Z is the share of a peaceful settlement, then there will be cases in which (2) $P-C>p(Z)$, when $p(Z)<1$. It is not simply the costs of war that matter for the existence of the bargaining range but the subjective certainty of one's share of a peaceful settlement.

This is the basic inequality since the payoff from a peaceful settlement for the other actor is simply its complement. If the share for actor A of a peaceful settlement is Z, the share of a peaceful settlement for actor B is 1-Z. The two inequalities, more fully stated, are (3) $Z_a>P_a-C_a$ and the inequality for B is (4) $(1-Z_a)>P_b-C_b$, where $P_b=1-P_a$. Then Z_a must satisfy two conditions: $Z_a>P_a-C_a$, as in (3) and (4) simplified to: $Z_a<P_a+C_b$. Inequalities (3) and (4) yield a complex inequality (5) $P_a-C_a<Z<P_a+C_b$ or $P_a+C_b>P_a-C_a$ which is satisfied, since ($C_a,C_b>0$).

When $pZ\neq1$, (5) is not routinely satisfied or supported. The difficulty, when Z_a is not certain (ie. when $0<p(Z_a)<1$), is that the positive value of the costs of war ($C_a,C_b>0$) have indeterminate consequences. The consequences now depend on 'p' and p is not an exogenous probability. The indeterminacy is removed when the settlement is exogenously secured (p=1).

Note that this indeterminacy holds even when the probabilities of victory in war by A and B sum to 1, (which appears to be the condition of true probability).

Introducing this epistemic probability of enforcement raises a further difficulty. The correction introduced above allows that the costs of war support the existence of mutually preferred settlements. However, given p [p<1] and (2), these settlements might be said to exist only if they are enforceable. There are some settlements whose existence as a mutually preferred settlement thus depends on the value of p. Some settlements might not exist as a mutually preferred settlement because p is too small to guarantee that the expected value of these settlements is greater than the expected value of war. The costs of war do not then support the existence of mutually preferable settlements for these values of p. The costs of war only unequivocally support mutually preferred settlements when p=1. When p<1, the existence of mutually preferred settlements is conditioned on values of P, C and Z. Under some values of {P,C,Z}, inequality (1) does not hold.

Thus the puzzle of war assigns a probability of enforcement of 1 to the player's share of a peaceful settlement, but this assignment is assumed rather than supported in the construction of the puzzle of war.[7] This is the epistemic equivalent of the problem of coherence identified above in this section, and identifying it increases confidence in the line of argument being developed, and in the proposed correction to the puzzle of war introduced in this section.

The difficulty that has been identified here is the failure to justify why players are subjectively certain that peaceful settlements will be respected. The common assumption is that settlements are self-enforcing (Schultz, 2010: 282-283). The condition of full information reveals the existence of peaceful settlements that are superior to costly conflict, and neither player has an incentive to defect from a settlement, once reached.

However, players continue to be interest-seeking actors with the capacity to seek private advantage; they continue to have a strategic interest in dissembling and misrepresentation. This means that much will depend on how expansively we want to understand the condition of full information, and how we want to understand the relationship of these settlements to time.

Given that this capacity to seek private advantage and strategic incentives to dissemble and misrepresent are inherent to the bargaining problem and are characteristic of both players, the stability of these settlements must also assume perfect monitoring of each player by the other. Otherwise, if monitoring is imperfect, there can be opportunities to surprise the other player, which constitutes cheating -- a deviation (or defection) from the settlement. Then the question is whether we should argue that the problem of monitoring should simply be folded into the condition of full information, such that satisfying this condition simultaneously solves the problem of monitoring. This would mean that full information implies that monitoring is perfect.

The latter is an expansive understanding of the condition of full information. Under a more narrow understanding of this condition, the problem of monitoring should be set out separately as an independent condition that must be satisfied if the costs of war are going to be said to guarantee the existence of the bargaining range. This, therefore, is another way of making the general point that the costs of war are not sufficient to fix the existence of the bargaining range.

This argument now raises the question of the relationship of these settlements to time. It might be proposed, for example, that this argument is implicitly dynamic by virtue of its introduction of the problem of monitoring, and therefore is not an appropriate challenge or objection. It violates the assumed setup (noted earlier) that the puzzle of war is an exercise in comparative statics.

However, the argument has shown the implausibility of the treatment of the range of peaceful settlements as inherently invulnerable to challenge. They are immediately vulnerable to the consequences of strategic incentives, unless we specify a series of special assumptions that guarantee not only full information but perfect monitoring. Their existence in time seems to be vanishingly short without special conditions.

The situation that this setup assumes has been immunized from standard problems of strategic interaction. To truly immunize these situations and ensure that problems of strategic incentives cannot arise, we would need to 'strategy-proof' them, essentially by removing strategic interaction altogether. We would need to specify that outcomes (such as an allocation or division) are not endogenous equilibrium but are fixed exogenously, as we did in the first section of this paper. But, as that section shows, the existence of such allocations need not depend on the costs of war.

As noted, the puzzle of war is motivated by the division problem: There is a good or issue in dispute between parties and this good is continuous and divisible. War is an outside option in this game of division, and is represented as a costly lottery. A set of negotiated settlements that both sides prefer to war then must exist. That is, there exists a range of peaceful outcomes that makes both sides strictly better off than the war option.

Given the existence of this ex ante bargaining range, why might states fail to locate or to agree on an outcome in it, thus avoiding the costs of war? The mechanisms are now familiar. One mechanism is information failure -- information asymmetries between the actors that result in war. Information revelation would work to reveal the existence of settlements that fall within the bargaining range. Another mechanism emerges when actors cannot make credible commitments

in the present about their future behaviour and war occurs in the present. The puzzle of war has been invoked whether the mechanism is information or commitment.

Complete information removes the immediate capacity to dissemble, but it is not sufficient to solve the problem of commitment.[8] A condition of complete information in some initial period cannot guarantee complete information in some later period, given the assumptions that motivate the bargaining problem that underlies the division problem, unless complete or full information removes not just the incentive in seeking private advantage but, more deeply, the interest in private advantage. Both parties continue to seek advantage. For example, even if they were to come to an agreement in some initial period not to seek or create private advantage in the future, including private information that then could be exploited in bargaining, that agreement would be immediately vulnerable to the problem of commitment, even if there is an equilibrium over payoffs in this initial period under the condition of full or complete information.

In light of this dimension of the question of commitment, a further objection that supports the proposed correction is now presented, using a form of propositional logic.

Primitives:

Definition: A self-enforcing equilibrium is an equilibrium reached by agreement among the players from which no player has an incentive to deviate.[9]

Major Premise: Complete information is not sufficient to solve the problem of credible commitment.

Minor Premise 1: The cost of war is an exogenous variable. Elaboration: The cost of war is an undeniable feature of any possible world in which war is an option and is an invariant feature

across counterfactual worlds. The proposition that war has costs is a true proposition in all possible worlds in which war is an option.

Minor Premise 2: The bargaining range is set either (a) by an exogenous variable, or (b) is endogenous to choice.

Propositions

(1) Proposition: A self-enforcing equilibrium is invulnerable to the problem of credible commitment. This follows from the definition above of a self-enforcing equilibrium.

(2) Proposition: Complete information is not sufficient for the existence of a self-enforcing equilibrium. Suppose the contrary: Complete information is sufficient for the existence of a self-enforcing equilibrium. But from (1) above, then it would follow that complete information would be sufficient to solve the problem of credible commitment which would deny the major premise taken from the literature on the puzzle of war.

(3) Proposition: The costs of war do not entail that any negotiated settlement in the bargaining range is a self-enforcing equilibrium. Suppose the contrary to the proposition: The costs of war entail that there exists a negotiated settlement in the bargaining range that is a self-enforcing equilibrium. If this contrary proposition is true, complete information would rule out war in equilibrium. But the problem of credible commitment is separately specified in the puzzle of war because complete information is not sufficient to rule out the problem of commitment. It

follows that the costs of war do not entail that any negotiated settlement in the bargaining range is a self-enforcing equilibrium.

(4) Proposition: The costs of war do not entail that there exists a self-enforcing equilibrium outside of the bargaining range. It would be bizarre if the costs of war did entail such an equilibrium, but this proposition is needed for (5) below.

(5) From the argument in (3) and the Proposition in (4), it follows that: The costs of war do not guarantee the existence of a self-enforcing equilibrium inside the bargaining range or the existence of a self-enforcing equilibrium outside the bargaining range.

(6) Normalize the interval to 1. Call those equilibria in the bargaining range "EBR". The complement of EBR is 1-EBR. Proposition: The costs of war do not distinguish the bargaining range, EBR, from its complement [1-EBR]. Suppose the contrary. Suppose that the costs of war separate the bargaining range from its complement. Then the costs of war would guarantee the existence of a self-enforcing equilibrium. But, from the argument in (3), the costs of war do not guarantee the existence of a self-enforcing equilibrium in the bargaining range. From (4), the costs of war do not guarantee the existence of a self-enforcing equilibrium outside the bargaining range. Then it follows that the costs of war do not distinguish EBR from 1-EBR.

(7) Proposition: If the costs of war do not distinguish EBR from 1-EBR, then the bargaining range is endogenous to choice. From the argument in (6), the antecedent condition in this proposition is true. Given the truth of the antecedent

and given Minor Premise 1 and Minor Premise 2, either an exogenous variable other than the costs of war sets the bargaining range or the bargaining range is endogenous to choice. The puzzle of war does not specify any other exogenous variable. In the absence of a proof that there is another exogenous variable that sets the bargaining range, it follows that the bargaining range is endogenous to choice. Then it follows: If the costs of war do not distinguish EBR from 1-EBR, the bargaining range is endogenous to choice.

(8) Proposition: If the bargaining range is endogenous to choice, then the bargaining range is not set by the exogenous costs of war.

(9) The costs of war do not guarantee the existence of a bargaining range, defined as those settlements that are both mutually preferable to war and invulnerable to problems of enforceability.

The central propositions in this exercise are (7) through (9). Propositions (7) and (8) are not controversial and they support (9), which was the proposed correction introduced earlier in this section. This result is also consistent with the argument in this section regarding a player's subjective certainty of her share of a peaceful settlement. The costs of war guarantee the existence of the bargaining range when p(Z)=1. Under values other than 1 for p(Z), the existence of the bargaining range is conditioned on the values of other parameters, as noted earlier.

This correction can be restated now more fully: As long as equilibrium are endogenous, the costs of war are not sufficient to establish the bargaining range, whether because these costs establish the existence of peaceful settlements only under limited conditions, or because these costs do not guarantee that mutually preferable peaceful settlements are enforceable.

The attractiveness of the attempt to secure the existence of the bargaining range via the costs of war was that here we have a self-evident fact, outside of the purposive reach of humans, which does not require interpretation, which is perspective-free, and which relieves us of the burden of judgment. That war entails costs is a transparent truth. It was the self-evident fact that the option of war entailed costs that was intended to underwrite the existence of the bargaining range and thus the puzzle of war. However, we see that this fact is not enough to guarantee the existence of a common bargaining range.

Conclusion

Two general conclusions regarding the costs of war have been drawn. The proposed correction can now be stated in light of these conclusions: The costs of war are not necessary for the existence of an invulnerable division when the allocation associated with division is exogenously fixed. The costs of war are not a sufficient condition on the existence of the bargaining range, defined as those settlements that are both mutually preferable to war and invulnerable to problems of enforceability, when equilibrium are endogenous.[10] Until these sufficiency conditions are met, the puzzle of war is not a fully convincing standard or exemplar for bargaining theories and models of war and conflict.

The methodological solution to the indeterminacy associated with endogenous equilibrium appears to be to impose exogenous structure on the bargaining problem[11] by fixing the existence of the bargaining range via an exogenous variable – the costs of war. This solution to the problem of endogenous equilibrium thus depends directly on the credibility of the core proposition of the puzzle of war, that is, that the exogenous costs of war are sufficient for the existence of the bargaining range when equilibrium is endogenous. I have argued that this

proposition, while central to the puzzle of war, is not supported in the construction of the puzzle: the costs of war are not sufficient.

Notes

[1] Slantchev and Tarar (2011: 137)

[2] See, for example, Fey and Ramsay, (2007: 741); p. 741; Powell, (2002: 8-10, 2004: 231, 2006): 169); Slantchev (2003: 123, 2011: 136); Leventoğlu and Tarar (2008: 536-537); Schultz (2010: 282-283); Frieden, and Lake, (2005: 146-147); Lake and Rothchild (1996: 45-46); Leventoğlu and Slantchev (2007: 756); Meirowitz and Sartori (2008: 327-328); Schultz and Lewis, (2003: 346); Jackson and Morelli (2011); Goemans (2000: 24ff.); Reiter (2009: 100ff.), Arena and Nicoletti (2014: 397) .

[3] Compare Powell (1996: 256). Garfinkel and Skaperdas (2000: 796) use resources allocated to armaments, rather than power per se, to specify the probability of winning. Also see Hirshleifer (1991, 1989) for a "conflict success function" modelled on a production function.

[4] In his original argument, Harsanyi moved back and forth between 'types' and 'attribute vectors'. The type of actor can be linked to different variables related to intentions (for example, resolve) and to capabilities (for example, armament levels etc.). This variety suggests that types, at least for the purposes of this paper, have to be understood, not only in relation to private information, but also in relation to theories of war that specify relevant attributes, and relations among them.

[5] The treatment of common knowledge (CK) in the puzzle of war has been influenced by the work of Aumann and Harsanyi. The standard structure of CK also has roots in philosophy, notably, in Lewis. Aumann (1987, 1976); Harsanyi (1982 [1967-1968); Lewis (1976).

[6] Bayesianism does not solve this problem of forward induction. See Hacking, (2001: 258-260, 1967); Schick (1997: 133, 144-145).

[7] The unsupported assumption here, where the probability of enforcement =1, is much like an assumption that agreed-upon shares become part of the bargainers' property rights (Usher, 2012: 34-35). If property rights are complete, the probability of enforcement of a peaceful settlement is 1, basically by definition, which renders the settlement invulnerable by definition.

[8] As Powell (2012) notes, subsequent work on wars and international crises has focused increasingly on commitment problems in games of complete information. For one recent illustration, see Tarar (2013). The latter also demonstrates the theoretical interest in the interaction of information and commitment problems in war and crises.

[9] This definition draws on Aumann (1990); Przeworski, (2007); Weingast (2007).

[10] It can be noted that these conclusions hold when actors are unitary. Thus, even granting that actors are unitary, the construction of the puzzle of war needs correction. For one argument that war is not necessarily ex post inefficient when actors are not unitary, see Chiozza and Goemans (2004).

[11] "Genuine bargaining is, almost by definition, indeterminate." Usher (2012: 28).

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