Dispute Resolution Institutions and Strategic Militarization

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Engagement in a destructive war can be understood as the "punishment" for entering into a dispute. Institutions that reduce the chance that disputes lead to war make this punishment less severe. This may incentivize hawkish policies like militarization and potentially offset the benefits of peace brokering. We study a model in which unmediated

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peace talks are effective at improving the peace chance for given militarization but lead to more militarization and ultimately to a higher incidence of war. Instead, a form of third-party mediation inspired by work of Myerson effectively brokers peace in emerged disputes and also minimizes equilibrium militarization.

I. Introduction

A voluminous literature seeks to understand which institutions effectively resolve disputes that might otherwise lead to military conflict. The emergence of a dispute is usually taken as the starting point of the analysis so as to ask questions of the sort, given a dispute, how will different institutions such as mediated or unmediated peace talks likely influence the outcome?[1] This paper broadens the scope of analysis. Instead of taking disputes as given, we ask, how are disputes likely to emerge, given the players' expectations about the conflict resolution institutions that will be adopted by the international community? Intuitively, a costly and wasteful conflict can be understood as the eventual "punishment" for militarizing and entering a dispute in the first place. Hence, institutions that minimize the chances that disputes end in conflict may breed militarization and lead to the emergence of more dangerous disputes. Evaluating this possibility is an important part of forming an assessment of the overall value of conflict resolution institutions.[2]

This paper shows that the analysis of the connection between dispute resolution institutions and militarization incentives may challenge established views. Specifically, we provide a model of militarization and negotiation in which unmediated peace talks are effective in reducing the chance of conflict in ongoing disputes for any given distribution of military strength but create perverse equilibrium incentives for militarization and thus alter the mix of disputes that emerge. This negative effect is so strong in our framework that the resulting equilibrium total probability of warfare becomes higher than in the case in which unmediated peace talks are not supported by the international community.

[1] Recent theoretical work analyzes the effectiveness of peace talks and third-party mediation as conflict resolution institutions (e.g., Kydd 2003; Bester and Wärneryd 2006; Fey and Ramsay 2010; Hörner, Morelli, and Squintani 2015). Others consider how various forms of direct diplomacy can influence the probability of conflict (e.g., Smith 1998; Sartori 2002; Baliga and Sjöström 2004; Ramsay 2011). Wall and Lynn (1993) and Bercovich and Jackson (2001) review the empirical literature on the effectiveness of mediation as a conflict resolution institution.

[2] The possibility that well-meaning third-party intervention may lead to perverse incentives for the emergence of disputes is a concern of academics and practitioners alike. For example, Kuperman (2008) presents evidence that expectations of humanitarian military intervention have emboldened weaker groups to trigger conflict against dominant entities (see also De Waal 2012). Kydd and Straus (2013) provide a theoretical model of this issue. Unlike us, they do not consider mediation and do not endogenize militarization choices in their analysis.

To glean some intuition for this finding, let us consider as the starting point of the analysis an ongoing dispute that has already emerged, taking the players' militarization levels decisions as given. Significant resources are devoted to guarding their secrecy, and the players are uncertain about each other's strength.[3] This uncertainty leads to wars: strong players who do not know their opponents' strength are willing to take their chances and fight. Informative communication with unmediated peace talks reduces the uncertainty and hence decreases the chance that the dispute evolves into open warfare.[4]

Now take a step back and consider the whole strategic interaction including the players' secret militarization decisions. Unmediated peace talks reduce the expected downside of arming and entering into the dispute, as they reduce the chance of an eventual destructive conflict. Hence, players have a greater incentive to militarize. For given militarization, disputes are less likely to evolve into open warfare, but the increased militarization leads to more conflict. As we will explain in Section III, the overall probability of conflict turns out to be higher than without unmediated peace talks.

Because of this insight, it is natural to ask whether all conflict resolution institutions suffer from these same drawbacks. We find that this is not the case. We identify a type of third-party intermediation, inspired by the work of Myerson (1979, 1982) and called "Myerson mediation" here, that improves the chances of peace brokering in ongoing disputes more effectively than unmediated peace talks and also reduces equilibrium militarization. Importantly, this occurs despite the fact that the mediator's mandate cannot realistically include the objective of preventing militarization; the players' militarization decisions have already taken place when the mediator is called in to deal with the ongoing dispute, and so controlling this incentive must be viewed as beyond her mandate or concern.

This form of mediation is conducted by third parties who do not have access to privileged information, nor to the military or financial capability of enforcing peaceful settlements. Hence, the mediator's role is to facilitate negotiations by managing the flow of information among the players. This is achieved by setting the agenda of the peace talks and by steering their proceedings, to "collect and judiciously communicate select confidential material" (Raiffa 1982, 108–9). In the taxonomy of Fisher (1995), Myerson mediation is a form of "pure mediation," whereas it is closer to "procedural

[3] This description is not remarkable because of the extent to which states and other disputant entities engage in espionage and counterespionage, as well as manipulating beliefs about their actual military strength. Among some famous episodes of manipulations, Soviets flew jets with fake missiles in parades, and Serbians put cardboard tanks in their towns during NATO-led air strikes. Likewise, the prospects of the Star Wars program sponsored by the Reagan administration were grossly exaggerated.

[4] This result was first proved formally by Baliga and Sjöström (2004). Our analysis complements their findings: we identify reasons different from the ones they singled out, for which communication reduces the chance of conflict in ongoing disputes.

mediation" in the terminology of Bercovich (1997). A review of the literature finds evidence that this form of mediation is often employed.[5]

As well as comparing the effectiveness of mediated and unmediated peace talks, we provide a broader result on Myerson mediation within our framework. Optimal mediation strategies, while designed to give the highest chance of peace only in ongoing disputes, also provide the best possible incentives against militarization within the class of institutions that do not give intermediaries access to privileged information or a budget to make transfers to players. Put more succinctly, in our model the narrow mandate of these mediators does not entail any welfare loss.

Some intuition for this result can be provided in two parts. The first one is the application of the revelation principle by Myerson (1982). An optimal way for the mediator to organize and steer the peace talks is that, first, the players report their information independently to the mediator, and then the mediator submits a settlement proposal to the players for their approval. In practice, this could be achieved in a two-step process. First, the mediator holds private and separate caucuses with the players. Then she holds a joint summit in which settlements are proposed to the disputants.[6] The revelation principle ensures that there is an equilibrium that maximizes the chance of peace in which in anticipation of the mediator's settlement proposal strategies the players reveal all their private information to the mediator.

The second part of our evaluation of Myerson mediation is based on the characterization of the optimal settlement proposal strategies that will induce the players to reveal their information to her. Because militarized players are more likely to win wars, they must receive more favorable terms of settlement than weak players, on average. Otherwise, strong players will not accept the proposed settlements and will wage war in the expectation

[5] Scholars in international relations have identified two main types of mediation: communication facilitation mediation and procedural mediation. The latter is the closest to this paper's model, because players precommit to let the mediator set the procedure and steer the dispute resolution process. In practice, this impedes their capability of negotiating or renegotiating an agreement outside the mediation process. Procedural mediation is widely adopted as it is perceived to be the most effective form of mediation. Since World War I, over 30 territorial disputes have been brought to an international adjudication body (Huth and Allee 2006), which took the form of procedural mediation. Among all other cases in which mediation was involved (roughly 50 percent of cases according to Wilkenfeld et al. [2005]), many can be coded as procedural mediation. Also, 427 disputes have been brought up for "arbitration" within the World Trade Organization between 1995 and 2011 (WTO database). This form of arbitration shares similarities with procedural mediation, because the enforcement is based on the actions of individual WTO member states.

[6] This practice of "shuttle diplomacy" has become popular since Henry Kissinger's efforts in the Middle East in the early 1970s and the Camp David negotiations mediated by Jimmy Carter. The mediator conveys information back and forth between parties, providing suggestions to steer the peace talks toward a peaceful conflict resolution, and then organizes a summit in which settlement proposals are submitted to the disputants for approval (see, e.g., Kydd 2003). As is standard in applied theory, the revelation principle allows us to conveniently summarize the outcomes of the equilibrium play in these more complex caucuses.

of a higher payoff. But since strong players tend to receive better settlements, the mediator needs to make sure that weak players do not want to pretend to be strong when reporting their information in the first stage of the intermediation. The mediator can achieve outcomes that unmediated communication cannot by strategically garbling information. She manages sometimes to keep strong players unaware that their opponents are weak and convince them to accept less favorable terms of settlement. In fact, optimal mediation strategies minimize the expected reward for a weak player to pretend that it is strong when, in fact, it did not militarize. As an unintended consequence, optimal mediation strategies also minimize the equilibrium incentives for a weak player to militarize and become strong at the arming stage of the game.

In our model, mediation not only improves the chance that disputes are resolved peacefully relative to unmediated peace talks but also reduces equilibrium incentives to militarize and enter a dispute as a strong player.

II. Literature Review

The results in this paper are related to the study of contests and appropriation (see Garfinkel and Skaperdas [1996] for a survey). In this conceptualization strategic militarization is treated as an arms race to prepare for a sure conflict in which the military capacities of each country influence the war payoffs through a contest function. In our model instead, militarization increases the expected payoff of fighting in a dispute, but war is not a foregone conclusion. Players may either reach a settlement or fight; the militarization choice has strategic effects on the settlements, the odds of fighting, and the payoffs from fighting.

There is also a recent body of theoretical models of endogenous militarization in the shadow of negotiation and war fighting. Meirowitz and Sartori (2008) connect militarization with negotiation but provide only results on the impossibility of avoiding conflict. They do not study optimal mechanisms or make comparisons across different institutions. Jackson and Morelli (2009) consider militarization and war but assume that disputants observe each other's investment decisions prior to negotiations. Thus, there is not incomplete information in their analysis.

Our study of Myerson mediation falls within the literature of mechanism design that dates back at least to Hurwicz (1960). But unlike most mechanisms considered in economics applications, our international conflict mediators do not have the power to enforce their settlement decisions.[7] A key distinguishing feature of international relations is that the

[7] Among the theoretical papers that study self-enforcing mechanisms in contexts different from international relations, see Matthews and Postlewaite (1989), Banks and Calvert (1992),

players involved are sovereign entities, and hence there is no legitimate or recognized third party to which they can credibly delegate decision and enforcement power (see, e.g., Waltz 1959). For this reason, mechanism design models of international relations should dispense with the assumption that the mediators can enforce decisions and focus on self-enforcing mechanisms.

In our model militarization is a hidden action and, hence, cannot lead to deterrence.[8] Other models have considered the role of observable militarization as a deterrent or a signal in the context of models of repeated armament (e.g., Garfinkel 1990; Powell 1993; Fearon 1997), whereas Collier and Hoeffler (2006) consider deterrence to explain postconflict military expenditure data in countries that have recently experienced a civil war. Chassang and Padró i Miguel (2010) show that while weapons have deterrence effects under complete information in a repeated game, when adding strategic uncertainty there is no longer a monotonic relationship between the size of an arsenal and the equilibrium degree of deterrence. For different reasons, the effects of endogenous militarization incentives on peace are nonmonotonic also in our model. Taken together with our results, this body of work may lead one to ask whether mechanisms that improve observability of militarization (such as espionage or military inspections) would lead to more or less militarization, deterrence, or conflict. We leave these questions for future research.

III. Unmediated Peace Talks and Militarization

In this section, we develop the baseline model of militarization and negotiation, and then we augment it to consider unmediated communication. We show that unmediated peace talks help resolve disputes for given militarization decisions. But because this institution creates the expectation that war among militarized players is less likely, it increases equilibrium militarization, provided that militarization costs are neither too high nor too low. In this case, when militarization strategies are taken into account, unmediated peace talks increase the overall conflict probability.

Cramton and Palfrey (1995), Forges (1999), Skreta (2006), Compte and Jehiel (2009), and Goltsman et al. (2009).

[8] There cannot be an equilibrium in which players militarize and war does not take place, in any reasonable model of conflict in which militarization is a hidden action. In anticipation that war will not take place, each player would deviate at the militarization stage and secretly choose to devote the resources earmarked to militarization to welfare-enhancing means (see the discussions in Meirowitz and Sartori [2008] and Jackson and Morelli [2009]). Observability of militarization is crucial for deterrence. In the words of Dr. Strangelove, "Of course, the whole point of a Doomsday Machine is lost, if you 'keep it a secret'!"

The Baseline Model of Militarization and Negotiation

The analysis starts with the description of a model of militarization and negotiation with neither mediated nor unmediated peace talks.[9] The model introduced is deliberately minimal so that its augmentation to include communication and mediation leads to results that are simple to describe.

Two players, A and B, dispute a pie normalized to unit size. If no peaceful settlement is reached, the players fight. Conflict is treated as a lottery that shrinks the expected value of the pie to $\theta < 1$.[10] The odds of winning a war depend on the players' military strength. Each player's strength is private information and can be either high, H, or low, L. When the players' strength is the same, each wins the war with probability one-half. When a strong player fights a weak one, the former wins with probability p greater than one-half so that its expected payoff is $p\theta$, whereas the weak player's payoff is $(1 - p)\theta$.[11] Note that whether player A is strong or weak influences player B's payoff from fighting; hence we are in a context of private information of interdependent value. In the online appendix, we show that our results extend in a standard model of conflict with continuous military strengths and contest success functions à la Tullock (1980).

In the initial militarization stage, A and B each decide whether to remain militarily weak or to arm and become strong, at cost $k > 0$. The militarization decisions are treated as hidden actions, so neither player observes the choice of the other one.[12] We characterize a mixed arming strategy by $q \in [0, 1]$, the probability of arming and becoming strong.[13] For

[9] Ideally, this model represents a world in which there is no support for these initiatives by the international community.

[10] Conflict destruction need not only consist of physical war damages, but may also include forgone gains from trade and increased military flow costs.

[11] We assume that $p\theta > 1/2$; otherwise the dispute can be trivially resolved by agreeing to split the pie in half.

[12] For expositional purposes, we assume that military strength is entirely private information. Our results hold also if the players have some information on each other's military strength, as long as there is also some residual private information.

[13] The consideration of mixed strategies should not be taken as literally claiming that players are indifferent and randomize when making their choices. As is known since Harsanyi (1973), mixed-strategy equilibria can be explained as the limit of pure-strategy equilibria of a game in which players are not precisely sure about the payoffs of opponents. Further, an alternative interpretation of our model is that q is the level of investment in uncertain military technologies that lead to high military strength with probability q, and low strength otherwise, and that such technologies bear the linear cost qk. With this interpretation, it is irrelevant for our analysis whether the level of investment q is observable or unobservable. It is possible to reinterpret military strength as the resolve of the political and military apparatus, or as the people's attitudes toward war. In the former case, the "militarization" of the apparatus corresponds to the inefficient appointment of bellicose policy and military officers. In the latter case, the (possibly observable) strategy q represents investment in censorship and military propaganda that costs qk and that succeeds in radicalizing attitudes with probability q.

simplicity, given the symmetry of the game, we focus the analysis on equilibria that are symmetric in the militarization strategies q.

After militarization decisions have been made, players attempt to negotiate a peaceful agreement and avoid a destructive war. Several game forms may be adopted, but none would succeed in avoiding militarization or conflict.[14] In the interest of tractability and to make the exposition concrete, we represent negotiations as a Nash demand game (see Nash [1953] and Matthews and Postlewaite [1989] for the private information case considered here). Players simultaneously make demands x_A and x_B both in [0, 1], analogously to giving their diplomats a set of instructions to "bring back at least a share x_i of the pie." If the players' demands are compatible, that is, if $x_A + x_B \leq 1$, then each player i receives a split of the pie equal to its demand x_i plus half the surplus $1 - x_A - x_B$. If the demands x_A and x_B are incompatible, that is, if $x_A + x_B > 1$, then the outcome is war. Besides its simplicity, the Nash demand game is often seen as a reasonable starting point to model international negotiations.[15]

To make the exposition more parsimonious, we introduce the parameter $\gamma \equiv (p\theta - 1/2)/(1/2 - \theta/2)$, which subsumes the two parameters θ and p. The numerator of γ is the gain of a strong player from waging war against a weak player instead of accepting the equal split, and the denominator is the loss from waging war against a strong player rather than accepting the equal split. So γ represents the ratio of benefits over the cost of war for a strong player. Every equilibrium of the whole game of militarization and negotiation is assessed with three welfare measures: the equilibrium militarization probability q; the associated ex ante probability of conflict, denoted by C; and the players' joint ex ante welfare, $W \equiv 1 - C(1 - \theta) - 2kq$.

We do not see the choice of the Nash demand game to represent negotiations as overly restrictive. This section's results can be shown to hold more generally.[16] But it is important that the Nash demand game has "conflict equilibria" in which the players coordinate on war with probability one

[14] Because militarization is a hidden action, there cannot exist any game of militarization and negotiation in which players arm with positive probability but do not fight in equilibrium (peace by deterrence). If players anticipate that they will not fight, then they will secretly deviate from this hypothesized equilibrium and choose not to arm. Likewise, there cannot exist an equilibrium in which players do not ever militarize, as each one of them will have the unilateral incentive to secretly militarize and subjugate the opponent.

[15] Wittman (2009) and Ramsay (2011) use the Nash demand game in their studies of conflict. Baliga and Sjöström (2015) adopt a slightly more elaborated version of the Nash demand game as a workhorse model of conflict. Jarque, Ponsati, and Sakovics (2003) develop a repeated version of the Nash demand game.

[16] For example, they hold if adopting many variations of the Nash demand game, including a "smoothed" Nash demand game, in which incompatible demands lead to a peaceful settlement with probability decreasing in the demands' distance. And this section's results are preserved also in modifications of the negotiation game that move further away from the Nash demand game.

because their demands are incompatible.[17] This equilibrium outcome captures instances in which conflicts break out because of failure to coordinate on a peaceful dispute resolution and is consistent with the historical record.[18] Even a "rationalistic" theory of war should not exclude the possibility of coordination failure as a cause of conflict (see, e.g., the discussions in Fey and Ramsay [2007] and Jackson and Morelli [2011]).

Likewise, the results of the next section (that mediation does not worsen militarization incentives in international negotiations) hold with any model of negotiations that, just like the Nash demand game, does not constrain the effectiveness of mediation at the negotiation stage, after arming decisions have been made. Modeling negotiations with constraining game forms that limit the role for a mediator is difficult to justify in our context, as one would like results that are as "game-free" as possible in how they treat negotiations.

Solution of the Baseline Model

We begin our analysis by solving for equilibrium at the negotiation stage, after militarization decisions have been made; that is, we solve the Nash demand game holding the militarization probability q fixed. As a function of q, lemma 1 reports the equilibrium of the Nash demand game that maximizes the probability $V(q)$ of peaceful resolution of the dispute.

LEMMA 1. As a function of the arming probability q, the equilibrium of the Nash demand game that maximizes the peace probability $V(q)$ is as follows. For $q \geq \gamma/(\gamma + 1)$, the players always achieve peace by playing $x_A = x_B = 1/2$. For $\gamma/(\gamma + 1) > q \geq \gamma/(\gamma + 2)$, peace is achieved unless both players are strong; strong players demand $x_H \in [p\theta, 1 - (1 - p)\theta]$ and weak players demand $x_L = 1 - x_H$. For $q < \gamma/(\gamma + 2)$, peace is achieved only if both players are weak: weak players demand $x_L = 1/2$, whereas strong players trigger war by demanding $x_H > 1/2$.

A summary of the arguments leading to this result is as follows. When q is sufficiently large, $q \geq \gamma/(\gamma + 1)$, each player $i = A, B$ anticipates that the opponent is likely strong and prefers not to trigger a fight. Both players demand an equal share $x_i = 1/2$ and peace is achieved. Conversely,

[17] Any demand strictly larger than $1 - (1 - p)\theta$ leads to war with probability one, because even a weak player who knows that the opponent is strong would prefer to fight than to acquiesce to this demand.

[18] Failure of coordination on a peaceful solution of disputes can take place for a number of reasons. For example, conflicts may break out because of successful derailment by fringe extremists (e.g., the assassination of Yitzak Rabin in 1995 contributed to the failure of the Oslo peace process, and World War I started because of the assassination of Archduke Franz Ferdinand of Austria in 1914). Further, miscalculation of strength by overconfident or biased leaders may hinder coordination on peaceful conflict resolution. Likewise, miscalculation of negotiation tactics by delegates may lead to the failure of peace brokering initiatives.

when $q < \gamma/(\gamma + 1)$, strong players are not afraid to make prevaricating demands $x_H > 1/2$. When, in addition, $q \geq \gamma/(\gamma + 2)$, the risk of facing a strong player is still sufficiently high that weak players want to avoid war and make demands compatible with the strong players' demands (i.e., $x_L = 1 - x_H$). So war breaks out only in strong player pairs. Instead, when q is sufficiently small, $q < \gamma/(\gamma + 2)$, weak players prefer to make demands that trigger war with strong players, and peace is achieved only by weak player pairs.

Having calculated the optimal equilibrium of the Nash demand game for any given militarization probability q, we now move one step back and solve for the optimal equilibrium of the whole game, which includes also the militarization stage. For any given value of the cost of arming k, lemma 2 calculates the equilibrium of our militarization and negotiation game that maximizes the players' welfare W, calculated as a function of the equilibrium militarization probability q and of the corresponding equilibrium probability $V(q)$ of a peaceful negotiation resolution.[19] For expositional ease, we here report only the case in which the militarization cost k is neither too small nor too large. Specifically, we work under the parameter restriction that $k \geq \underline{k} \equiv (1 - \theta)\gamma/2 \cdot \gamma/(\gamma + 1)$ and $k \leq \bar{k} \equiv (1 - \theta)\gamma/2 \cdot (\gamma + 1)/(\gamma + 2)$.[20]

Lemma 2. When the cost of arming $k \in [\underline{k}, \bar{k}]$, the equilibrium of the militarization and negotiation game that maximizes the players' welfare W is such that each player militarizes with probability $q(k) = \gamma - 2k/(1 - \theta) \in [\gamma/(\gamma + 2), \gamma/(\gamma + 1)]$, strong players demand $x_H = p\theta$, weak players demand $x_L = 1 - p\theta$, and war breaks out if and only if both players are strong.

First, we show that when the arming cost k lies between $\underline{k}$ and $\bar{k}$, the strategies described in lemma 2 are an equilibrium of the militarization and negotiation game in which players arm with probability $q(k) = \gamma - 2k/(1 - \theta) \in [\gamma/(\gamma + 2), \gamma/(\gamma + 1)]$, strong players demand $x_H = p\theta$ in the Nash demand game, weak players demand $x_L = 1 - p\theta$, and war breaks out if and only if both players are strong. Intuitively, when the militarization cost k is neither too small, $k \geq \underline{k}$, nor too large, $k \leq \bar{k}$, players are willing to randomize their arming decision q with "intermediate" values that lie between $\gamma/(\gamma + 2)$ and $\gamma/(\gamma + 1)$. At the negotiation stage, the strategies of this equilibrium are consistent with the equilibria selected by lemma 1. Hence, this equilibrium maximizes the peace probability $V(q)$ at the negotiation stage.[21]

[19] Formally, the equilibrium welfare is $W = 1 - [1 - V(q)](1 - \theta) - 2kq$, whereas the equilibrium conflict probability is $C = 1 - V(q)$.

[20] The full characterization of equilibrium for the complementary military cost range is in the online appendix.

[21] Note also that the arming strategy $q(k) = \gamma - 2k/(1 - \theta)$ decreases in k and is such that $q(\underline{k}) = \gamma/(\gamma + 1)$ and $q(\bar{k}) = \gamma/(\gamma + 2)$: The equilibrium probability $q(k)$ spans the

The second step is based on showing that there cannot exist any other equilibrium with a smaller militarization probability q. The reason is that for $\gamma/(\gamma + 2) \le q < \gamma/(\gamma + 1)$, the equilibrium of lemma 2 yields the highest possible payoffs to weak players, the lowest payoffs to strong players, and hence the lowest ex ante equilibrium incentives to militarize. At the negotiation stage, strong players demand $x_H = p\theta$ in the Nash demand game, weak players demand $x_L = 1 - p\theta$, and war breaks out if and only if both players are strong. There cannot exist any equilibrium with lower strong players' payoffs, as these players can secure exactly these payoffs by fighting. Conversely, there cannot be any equilibrium of the Nash demand game with higher weak players' payoffs. The reason is that the equilibrium of lemma 2 minimizes the probability that weak players get involved in fights and awards them the highest possible share of the pie, $1 - p\theta$, that avoids conflict with strong players.

Because the equilibrium of lemma 2 minimizes the arming probability q at the militarization stage and maximizes the peace probability $V(q)$ in the ensuing negotiation stage, it immediately follows that it maximizes welfare W in the whole game of militarization and negotiation.

Unmediated Peace Talks

The previous part of the section has described the game of militarization and negotiation. We now augment this game by adding an intermediate stage. We assume that after the militarization stage, but before the negotiation game is played, direct bilateral peace talks take place. Talks are modeled as a meeting in which the players share information and attempt to find a (self-enforcing) agreement to coordinate their future play. In the meeting, both players $i = A, B$ simultaneously send unverifiable messages $m_i \in \{l, h\}$ to each other, so as to represent their arming strength L or H.[22] Then the meeting continues with the players trying to find an agreement. Every equilibrium has the following form: with some probability, the meeting is "successful," and the players agree on a peaceful resolution. With complementary probability, the meeting fails and leads to conflict escalation. In any equilibrium in which information is meaningfully revealed, the probability that the meeting results in a peaceful resolution depends on the players' self-reported arming strengths.

In more formal terms, we allow players to make use of a joint randomization device, whose realization is observed by both players. So players can possibly coordinate on different equilibria of the negotiation game,

entire range $[\gamma/(\gamma + 2), \gamma/(\gamma + 1)]$ for which the optimal equilibrium of the Nash demand game is such that war breaks out only if both players are strong.

[22] For simplicity, we assume that only one round of unmediated communication takes place.

as a function of both their messages and the realization of the randomization device.[23] It is important that we can exploit the equilibrium multiplicity of the Nash demand game to model the possibility that the players' attempts to coordinate on a peaceful outcome fail. Not only is this a realistic assumption, as already pointed out earlier. It is also the only reason why unmediated peace talks succeed in strictly improving the chance of peaceful resolution of disputes at the negotiation stage, after arming decisions have been made. It can be proved that in the absence of this possibility of coordination on different equilibria of the Nash demand game, unmediated peace talks would not improve the chance of peaceful dispute resolution (and, hence, they would not be organized in the first place). As anticipated in the introduction, this insight is novel and complements the findings of Baliga and Sjöström (2004), whose model of unmediated peace talks does not include the possibility of a meeting that acts as a joint randomization device to select across different continuation equilibria.

These insights are formalized in lemma 3. For brevity, this result focuses on the case in which $\gamma \geq 1$ or, equivalently, that $(p + 1/2) \cdot \theta \geq 1$, that is, that war is not too destructive and the strong player's military advantage is significant.[24] Of course, for any fixed probability of militarization q, there exist uninformative, babbling, equilibria in the game with unmediated peace talks that induce the same outcomes and probability of peace $V(q)$ as the equilibria of the Nash demand game without peace talks. Most importantly, there also exist equilibria that strictly improve the probability of peace $V(q)$, except for the trivial case in which $q \geq \gamma/(\gamma + 1)$, where peace is achieved even in the Nash demand game without peace talks. Lemma 3 characterizes these equilibria that strictly improve the chance of peace $V(q)$, focusing on equilibria with pure communication strategies for clarity of exposition. The statement uses the functions $\bar{p}_M$ and $\bar{p}_H$ defined as follows: $\bar{p}_M(q) = 1/[(1 + \gamma) - 2q/(1 - q)]$ and $\bar{p}_H(q) = 0$ for $q < \gamma/(\gamma + 2)$, and $\bar{p}_M = 1$ and $\bar{p}_H = 1 - \gamma/[q(\gamma + 2)]$ for $\gamma/(\gamma + 2) \leq q \leq \gamma/(\gamma + 1)$.

Lemma 3. For any given arming probability q, there exist equilibria of the negotiation game with unmediated peace talks with at least the same peace chance $V(q)$ as the equilibria of the negotiation game without peace talks. For any $\gamma \geq 1$ and any $q < \gamma/(\gamma + 1)$, there also exist equilibria with pure communication strategies that strictly increase the peace chance. In every such equilibrium, players truthfully reveal their arming strength.

[23] The same communication model is used by Krishna and Morgan (2004) and Aumann and Hart (2003) in different contexts. The latter prove that joint randomization can be reconstructed as simultaneous cheap talk. Hence, by allowing for public randomization devices, we are ensuring that the logic of our result holds for a large class of models of communication (albeit in a reduced-form representation).

[24] The characterization of the equilibria that improve peace chance $V(q)$ with respect to the Nash demand game without peace talks for the case $\gamma < 1$ is in lemma 5 in the appendix.

Then strong player pairs coordinate on the peaceful demands $x_A = 1/2$, $x_B = 1/2$ with probability $p_H \le \bar{p}_H(q)$, and fight with probability $1 - p_H$; asymmetric pairs (H, L) settle on the peaceful demands $(b, 1 - b)$, where $b \in [p\theta, 1 - (1 - p)\theta]$, with probability $p_M \le \bar{p}_M(q)$, and fight with probability $1 - p_M$; the case for (L, H) is symmetric; and weak player pairs achieve peace with probability one, with demands $(1/2, 1/2)$. The equilibrium that maximizes $V(q)$ is such that $b = p\theta$, $p_M = \bar{p}_M(q)$, and $p_H = \bar{p}_H(q)$.

This result is best explained by considering the equilibrium that maximizes the peace chance, $V(q)$, and by comparing it to the equilibrium that maximizes $V(q)$ in the Nash demand game without communication, reported in lemma 1. In both cases, the players play a separating equilibrium; that is, the players reveal their strengths by means of their equilibrium choices. But in the Nash demand game without peace talks, this information is revealed only after demands are made, whereas with unmediated communication, the information is shared before the demands are made. Sharing information before demands are made allows the players to use this information more efficiently in the negotiation game, thereby improving the chance that the players coordinate on a peaceful outcome. Specifically, when $\gamma/(\gamma + 2) \le q < \gamma/(\gamma + 1)$, the equilibrium that maximizes $V(q)$ in the Nash demand game without peace talks involves war with probability one among strong players. The introduction of unmediated peace talks in the Nash demand game makes it possible for strong players to coordinate on a peaceful outcome resolution with the strictly positive probability $\bar{p}_H(q)$. Similarly, when $q < \gamma/(\gamma + 2)$, the addition of unmediated peace talks to the Nash demand game improves the chance of peace from zero to $\bar{p}_M(q) > 0$, in asymmetric pairs composed of a strong and a weak player.

We now turn to consider the implications of unmediated peace in the whole game of militarization and negotiation and provide the main result of this section, proposition 1. Let us define as *equilibrium selection* of the negotiation game with unmediated peace talks, a function that associates an equilibrium to every given arming probability q. Proposition 1 considers every equilibrium selection that (uniformly and strictly) increases the chance of peace $V(q)$ relative to the negotiation game without peace talks. It shows that they all lead to higher equilibrium militarization q in the whole game of militarization and negotiation, relative to the game without peace talks.[25] This effect is so severe that unmediated peace talks also increase the overall level of conflict C and reduce the ex ante players' welfare

[25] There are also uninformative equilibria that induce the same outcomes as the negotiation game without peace talks. The focus on informative equilibria that improve the chance of peace $V(q)$ is justified by simple "forward-induction" arguments. There are significant political and financial costs to organizing peace talks. It does not seem plausible that belligerent parties would go through all this trouble to meet and only babble.

W. While the characterization of the equilibria of the negotiation game with unmediated peace talks of lemma 3 focuses on pure communication strategy equilibria, proposition 1 covers also the case of mixed-strategy equilibria, if any exist. Again, we restrict the statement to $\gamma \geq 1$ for ease of exposition.[26]

PROPOSITION 1. For any militarization cost $k \in [\underline{k}, \bar{k}]$ and benefit/cost ratio parameter $\gamma \geq 1$, every equilibrium selection of the negotiation game with unmediated peace talks that uniformly strictly increases the peace probability $V(q)$ relative to the negotiation game without peace talks leads to a strict increase of equilibrium militarization probability q, to a strict increase in the overall conflict probability C, and to a strict decrease of ex ante welfare W, in the associated equilibrium of the whole game of militarization and negotiation.

The intuition for this result is that, in some sense, unmediated peace talks are victims of their own success. We know from lemma 2 that, for $k \in [\underline{k}, \bar{k}]$, the optimal equilibrium of the militarization and negotiation game without peace talks is such that the arming strategy q lies between $\gamma/(\gamma + 2)$ and $\gamma/(\gamma + 1)$, players fight only if both are strong, and weak players obtain $1/2$ when facing a weak player and $1 - p\theta$ when facing a strong one. The key step in our argument is that it is impossible to raise the weak players' payoffs and to lower the strong players' payoffs, in any equilibrium of the negotiation game with unmediated peace talks.

Consider the militarization and negotiation game with unmediated peace talks. For brevity, let us focus on the case in which players use pure equilibrium strategies at the negotiation stage; that is, they play according to the characterization of lemma 3.[27] Then, as in the militarization and negotiation game without peace talks, the players' equilibrium arming strategy q lies between $\gamma/(\gamma + 2)$ and $\gamma/(\gamma + 1)$ when $k \in [\underline{k}, \bar{k}]$. Most importantly, the weak players' expected payoffs cannot be higher than in the equilibrium of the game without peace talks of lemma 2: Their payoff is $1/2$ against weak opponents, whereas it is $1 - b \leq 1 - p\theta$ with probability $p_M \leq 1$ and $(1 - p)\theta < 1 - p\theta$ with probability $1 - p_M$ when facing strong opponents. In the equilibrium of the militarization and negotiation game without peace talks characterized in lemma 2 instead, the weak players' payoff is $1 - p\theta$ with probability one.

Turning to the expected payoff of becoming strong, we see that it is higher with unmediated peace talks than without communication. Relative to the equilibrium of lemma 2, every equilibrium of lemma 3 reduces the probability that strong player pairs fight from one to $1 - p_H$, so that strong players achieve weakly larger payoffs when they face weak players.

[26] The analysis for $\gamma < 1$ is in the online appendix.
[27] Mixed-strategy equilibria are dealt with in the proof of proposition 1 in the appendix.

Because unmediated peace talks raise the payoffs of strong players and weakly lower weak players' payoffs, they induce players to choose a higher equilibrium militarization probability q. If the probability q that the opponent militarizes did not increase, each player i's expected benefit for arming would outweigh the expected punishment. Player i would then have a strict preference to militarize. This is impossible in equilibrium because randomization at the arming stage requires that the players are indifferent between militarizing and not.

For any given probability q, the probability $V(q)$ that ongoing disputes are resolved peacefully is increased by unmediated peace talks. But this probability, $V(q)$, decreases with higher militarization, q, and this makes the overall probability of conflict, C, higher in the militarization and negotiation game with unmediated peace talks than in the game without peace talks.

To see why this last result holds, denote by $\bar{q}$ and by $\hat{q}$, respectively, the militarization probability in the optimal equilibrium of the game without peace talks and of the game with unmediated peace talks, and denote by $\bar{C} = \bar{q}^2$ and $\hat{C} = \hat{q}^2(1 - p_H)$ the associated conflict probabilities. Suppose by contradiction that $\bar{C} \geq \hat{C}$: unmediated peace talks do not increase the equilibrium conflict probability relative to the militarization and negotiation game without peace talks.

Consider the probability that a strong player fights in equilibrium. Because weak players do not fight, this probability is $\bar{q}$ in the game without peace talks and $\hat{q}(1 - p_H)$ in the game with unmediated peace talks. The probability that the opponent is strong is higher with unmediated peace talks than without: $\hat{q} > \bar{q}$. So if it were the case that $\bar{C} = \bar{q}^2 \geq \hat{C} = \hat{q}^2(1 - p_H)$, it would follow that $\bar{q}^2 > \hat{q}^2(1 - p_H)$; the probability that a strong player fights would be lower in the game with peace talks than in the game without communication.

Because the only punishment for militarization is conflict in strong player pairs, players would then strictly prefer to militarize, but again this is impossible in equilibrium. Thus, it must be the case that $\bar{C} < \hat{C}$: unmediated peace talks increase the equilibrium conflict probability relative to the game without communication. And because unmediated peace talks increase the equilibrium arming probability q and the overall conflict probability C, it is immediate that they also reduce the welfare W.

IV. Mediation

We have shown that in our model, bilateral unmediated peace talks, exactly because of the way in which they reduce the risk of conflict in ongoing disputes, lead to more equilibrium militarization and a higher level of conflict. We now show that there exist forms of third-party intermediation that improve the effectiveness of peace talks over unmediated communication, without leading to more militarization.

Optimal Mediation, Given Militarization

The specific form of intermediation we consider is inspired by the work of Myerson, and we call it "Myerson mediation," or "mediation" for brevity. A Myerson mediator is a neutral or "honest broker" who does not favor either of the players. The mediator has a mandate to set the agenda of the peace talks and to steer the proceedings, so as to try to resolve the dispute that she is called to mediate. Her "narrow" mandate cannot realistically include also shaping the beliefs and incentives of potential future players, who base militarization choices also on expectations on how mediators will deal with eventual disputes. So a mediator in our model takes the symmetric equilibrium militarization probability q as given and tries to maximize the chance of a peaceful resolution of the dispute she is mediating.

We begin our analysis by applying the "revelation principle" of Myerson (1982) to our Nash demand negotiation game. An optimal way for the mediator to set the agenda is as follows. First, the players report their information independently to the mediator. Second, the mediator organizes and steers a meeting in which she submits a settlement proposal to the players. After the proposals are made, the players bargain according to the Nash demand game, as in the model of unmediated peace talks of the previous section.[28] Again, every equilibrium is such that, with some probability, the meeting is successful and the players' demands align with the mediator's proposals; with complementary probability, the meeting fails and conflict breaks out, and the probability that the meeting is successful depends on the mediator's proposals. Further, for any given militarization probability, q, this negotiation game with mediation has an equilibrium that maximizes the chance of peace, $V(q)$, in which the mediator's proposal strategies lead the players to reveal all their private information to the mediator in anticipation of the proposals that she will make.

Disputants do not report information directly to each other, but through a mediator whose conduct is inspired by a principle of confidentiality. As we explain later in more detail, players have better incentives to disclose their type confidentially to the mediator than they have when communicating directly. Further, the mediator makes the settlement proposals and steers the peace talks optimally. As a result, mediation improves the chances that peace talks are successful and the dispute is resolved peacefully, relative to the game with unmediated peace talks (and to the game without peace talks), for any given arming probability q.

Lemma 4 describes the optimal mediation strategies, given the militarization probability q. To minimize the chance that an ongoing dispute

[28] Alternatively, we could assume that the proposals are submitted for independent approval to the two players and are implemented if both players approve them, as in Hörner et al. (2015). As we prove in the appendix, our results are exactly the same with these two game forms.

turns into war, mediators must be able to commit to mediation strategies that include the possibility that peace talks fail. With some probability, mediators must be able to quit the peace talks when one or both players claim to be strong, although this leads to escalation of conflict. Such commitments make information disclosure by the contestants possible, as they provide a "punishment" for weak players who lie and pretend they are strong. On the basis of all the evidence available, it seems realistic to allow for the possibility that mediators are capable of committing to quitting peace talks if some contingencies arise.[29]

Additionally, our model does not include the possibility of negotiation outside the mediation process. Players are not likely to go back to the negotiation table in the attempt to broker a deal without the help of the mediator, once the mediation process has failed.[30] Nevertheless, our results do not change if there is a positive probability that players can renegotiate after the mediated peace talks fail or if there is a positive probability that the mediator called to settle the dispute is not capable of quitting, as long as these probabilities are not too large. When this is the case, the optimal mediation strategies can fully accommodate for these exogenous probabilities by increasing the probability that mediators capable of commitment quit in the appropriate circumstances.

Lemma 4. For any given militarization strategy q, the optimal equilibrium of the negotiation game with Myerson mediation is characterized as follows. Each player truthfully reveals its strength to the mediator. Strong player pairs coordinate on the peaceful demands $(1/2, 1/2)$ with probability q_H and fight with probability $1 - q_H$; asymmetric pairs (H, L) coordinate on the peaceful demands $(p\theta, 1 - p\theta)$ with probability p_M and on the demands $(1/2, 1/2)$ with probability q_M, and fight with probability $1 - p_M - q_M$—the case for (L, H) is symmetric; and weak player pairs do not fight and achieve the payoffs $(1/2, 1/2)$ in expectation. When $q \leq \gamma/(\gamma + 2)$, $q_H = q_M = 0$ and $0 < \bar{p}_M < p_M < 1$; when $\gamma/(\gamma + 2) < q < \gamma/(\gamma + 1)$, $p_M + q_M = 1$, $0 < \bar{p}_H < q_H < 1$, and $q_M \in (0, 1)$; and when

[29] For example, the online appendix of Hörner et al. (2015) provides empirical evidence that mediators, disputants, and the international community recognize the value of a mediator's commitment to quitting. Successful mediators achieve a reputation of not bending the rules and procedures that they set out at the inception of the mediation, including the commitment to quitting in a set of predetermined circumstances. We have also interviewed a real-life experienced mediator, Gianluca Esposito, executive secretary at the Council of Europe, who participated in a number of international mediations, including the ones associated with the Bosnian war. He confirmed that mediators understand very much the importance of being able to credibly set the rules of the mediation process and credibly threaten to quit if players persist with excessive demands (i.e., in the context of our paper, if both report to be militarily strong). The views expressed by Esposito do not necessarily reflect the views of the Council of Europe.

[30] There are many reasons for this. For example, "audience costs" are recognized to provide an important channel that makes war threats credible in the case of failed negotiations (e.g., Tomz 2007).

$q \geq \gamma/(\gamma + 1)$, $q_M = q_H = 1$.[31] Whenever $\gamma < 1$ and/or $q > \gamma/(\gamma + 2)$, as long as $q < \gamma/(\gamma + 1)$, mediation strictly increases the peace chance $V(q)$ relative to any equilibrium of the negotiation game with unmediated peace talks. For all values of q and γ, mediation weakly increases the chance of peace $V(q)$.

The above characterization of optimal mediation strategies is based on the following insights. First note that a strong, militarized player must receive more favorable terms of settlement, on average, than a weak player. Otherwise, the strong player would reject the settlement, in the expectation that the war payoff will be larger. But favorable settlements to self-reported strong players provide an incentive for weak players to lie and pretend to be strong when reporting their information to the mediator. To support the optimal equilibrium, the settlement proposal strategies are such that weak players do not want to lie. The key insight here is that a weak player is more willing to reveal its strength confidentially to a mediator who adopts optimal strategies than she is when communicating directly with the opponent. The reason is that the mediator does not always reveal that one is weak to her opponent.

Consider the case of $\gamma \geq 1$ and $\gamma/(\gamma + 2) < q < \gamma/(\gamma + 1)$. If revealing its arming strength to a strong opponent, the weak player will surely need to accept a low payoff, $1 - p\theta$, to secure peace. If instead it is communicating through the mediator, the weak player is proposed one-half of the pie with probability q_M and the lower payoff $1 - p\theta$ only with probability $p_M = 1 - q_M$. When receiving the proposal $(1/2, 1/2)$, the strong player does not know if the opponent is strong or weak. The randomization value q_M is chosen so as to make the strong player exactly indifferent between accepting the proposal $(1/2, 1/2)$ and fighting.[32]

Because mediation raises the expected payoff of weak players who truthfully report their strength, it achieves separation between weak and strong players with a lower punishment for weak players who lie and pretend to be strong, that is, with a lower equilibrium conflict probability among

[31] The precise formulas are as follows: when $q \leq \gamma/(\gamma + 2)$, $p_M = (1 - q)/[(\gamma + 1)(1 - q) - 2q]$; and when $\gamma/(\gamma + 2) \leq q < \gamma/(\gamma + 1)$,

$$q_H = \frac{1 - q}{q} \frac{2q - \gamma(1 - q)}{(\gamma + 1)(1 - q) - q}$$

and

$$q_M = \frac{1}{\gamma} \frac{2q - \gamma(1 - q)}{(\gamma + 1)(1 - q) - q}.$$

[32] As a result, optimal mediation strategies minimize the difference between strong and weak players' expected payoffs, among all mediation strategies p_M, p_H, and q_H that make the players truthfully reveal their types. Later, we will see how this also creates optimal incentives for militarization.

self-reported strong players than unmediated peace talks. Formally, it is the case that $q_H(q) > \bar{p}_H(q)$, for any given militarization probability $q \in (\gamma/(\gamma+2), \gamma/(\gamma+1))$. All other player pairs avoid conflict with probability one, both with mediated and with unmediated peace talks, $p_M(q) + q_M(q) = 1$ and $\bar{p}_M(q) = 1$. Hence, mediation strictly increases the peace chance $V(q)$ relative to any equilibrium of the negotiation game with unmediated peace talks. So for $\gamma \geq 1$ and any given arming probability $\gamma/(\gamma+2) < q < \gamma/(\gamma+1)$, the optimal mediation strategies cannot be reconstructed with unmediated peace talks, and mediation strictly improves the chance of peaceful dispute resolution.[33]

In short, the mediator improves the equilibrium chances that peace talks are successful by collecting information confidentially from the players and by making settlement proposals that do not fully reveal the players' strengths. Such a confidential management of information cannot be achieved by unmediated peace talks in which the disputants meet face to face.

Mediation and Militarization

We now build on the characterization of the optimal equilibrium of the negotiation game with mediation (lemma 4) to solve for the militarization equilibrium probability q given that the ensuing dispute is solved optimally with Myerson mediation. The following result characterizes the equilibrium militarization and negotiation strategies. It shows that mediation does not suffer from the drawbacks of unmediated bilateral peace talks. Not only does the mediator improve the peace chance given militarization strategies q, but she also improves welfare in the whole game, which includes the militarization decisions.

PROPOSITION 2. Consider a game of militarization and negotiation with a mediator who adopts the optimal mediation strategies described in lemma 4. For any militarization cost $k \in [\underline{k}, \bar{k}]$, the unique equilibrium militarization strategy is

$$q(k) = \frac{(1+\gamma)[2k - \gamma(1-\theta)]}{2k(2+\gamma) - (1+\gamma)^2(1-\theta)},$$

which strictly decreases in k and is such that $q(\underline{k}) = \gamma(\gamma+1)/[\gamma + (\gamma+1)^2]$ and $q(\bar{k}) = \gamma/(\gamma+2)$. Mediation strictly reduces the overall conflict and militarization probabilities C and q and strictly increases the welfare W,

[33] The analysis of the other cases in which mediation strictly increases the peace chance $V(q)$ is analogous, and we deal with it in the proof of lemma 4 in the appendix. The result that mediation weakly increases the chance of peace $V(q)$ for all values of q and γ is an immediate consequence of the revelation principle by Myerson (1982).

with respect to any equilibrium of the game of militarization and negotiation with unmediated peace talks and to any equilibrium of the baseline game without communication.

Despite the mediators' narrow mandates to minimize the chance of conflict outbreak only in the disputes they mediate, proposition 2 finds that optimal mediation strategies do not lead to higher equilibrium militarization. They strictly improve the chances of peace and welfare relative to all equilibria of the game of militarization and negotiations with unmediated peace talks or without communication.

The arguments that yield proposition 2 are summarized as follows. We have seen in proposition 1 that unmediated peace talks raise equilibrium militarization because, by improving the chance of peace in the negotiation game, they raise the payoffs of strong players and weakly lower the weak players' payoffs. Instead, optimal mediation strategies increase the probability of peace in strong player pairs without increasing the strong players' payoffs, relative to the game of militarization and negotiation without (mediated or unmediated) peace talks. As explained after lemma 4, in fact, the strong players' expected payoffs in the optimally mediated negotiation game exactly equal their payoffs when fighting, just like the strong players' payoffs of the optimal equilibrium of the negotiation game without peace talks (cf. lemma 2). Further, optimal mediation strategies strictly increase the weak players' payoffs relative to the negotiation game without communication. Again, this is in contrast with unmediated peace talks: as we have seen in lemma 3, they cannot raise the payoff of weak players relative to the game of militarization and negotiation without peace talks.

As noted above, these differences between mediated and unmediated communication arise because the mediator collects information confidentially from the players and makes proposals that do not fully reveal a player's strength to its opponent. This form of information management cannot be achieved by unmediated peace talks in which the disputants meet face to face. The implications are that, while the adoption of unmediated peace talks to settle conflicts raises equilibrium arming in our model, optimal mediation strategies improve the chances of peaceful dispute resolution without generating negative militarization distortions.

The Institutional Optimality of Mediation

The previous part of this section proved not only that mediation is more effective than unmediated peace talks at improving the chance of peace in ongoing disputes but also that it keeps in check equilibrium militarization. We now provide a stronger result. Mediation achieves the same welfare as a hypothetical optimal third-party intervention mechanism in which the third party has the broader mandate to commit to "punishing" players for militarizing as they enter a dispute in the first place.[34] That is, a hypothetical mediator with the "broad" mandate to maximize total welfare and keep equilibrium militarization in control can do no better than the Myerson mediator with a "narrow" and more realistic mandate to foster the peaceful resolution of only the dispute that she is called to settle.[35]

THEOREM 1. Myerson mediation achieves the same welfare, and the same militarization and conflict probability, as a hypothetical optimal institution that recommends militarization strategies, collects players' arming strength reports, and makes settlement proposals, with the objective to maximize players' welfare W.

This result holds because there does not exist any (budget-balanced) mechanism that can increase the weak players' expected payoffs nor reduce the strong players' payoffs, relative to Myerson mediation. In fact, regardless of whether they are proposed the settlement payoff of $1/2$ or $p\theta$, strong players are exactly indifferent between accepting the mediator's proposal and fighting. Hence, their payoffs cannot be further decreased with any other mechanism, and conversely, the weak players' share of the pie cannot be further increased. At the same time, the mediator's optimal strategies maximize the probability that the dispute is resolved peacefully and hence that the pie is not damaged by conflict. Because there does not exist any mechanism that can increase the weak players' payoffs nor reduce the strong players' payoffs, Myerson mediation minimizes equilibrium militarization among all budget-balanced mechanisms.

Importantly, this virtuous effect on militarization is an unintended consequence of the mediators' objective to resolve peacefully only the disputes they are called to settle. By the revelation principle, these objectives are achieved with equilibria in which players reveal their strength to the mediator truthfully. Further, strong players must be offered more favorable terms of settlement, on average, than weak players. Else they will not accept the proposed settlements, as they expect a higher payoff from triggering a conflict. This generates an incentive for weak players to lie and pretend that they are stronger when they report their strength to

[34] Such an optimal hypothetical institution is not likely available in the real world and serves only as a benchmark to assess how much is lost by the narrow mediator's mandate. We maintain the assumption that this third party does not have access to privileged information beyond what it gathers from communication with the players and that she is constrained by a balanced budget. That is, she cannot bribe or punish the players to force them to settle their dispute. The mandate of this hypothetical third party is defined precisely in the appendix.

[35] As we explained after lemma 4, our analysis and results do not change if there is a positive probability that the players can renegotiate when the mediator quits the peace talks or that the mediator called to settle the dispute is not capable of committing to quitting, as long as these probabilities are not too large. Specifically, we show in the appendix that theorem 1 extends (whenever $k \leq \bar{k}$), as long as the sum of these probabilities is not larger than a given threshold, which is a function of the model's parameters.

the mediator. The most potent punishment to discourage weak players from lying is the expectation of conflict among self-reported strong players. But the mediation's objective is that this punishment is used on a path with the smallest possible probability. So the optimal peaceful settlements proposals are designed to keep the expected payoffs of weak players as high as possible when they reveal their strength and as low as possible when they pretend to be stronger (within the constraint that such proposals need to be acceptable to both strong and weak players).

In other words, Myerson mediation keeps the expected settlement payoffs of self-reported weak players as high as possible and the payoffs of self-reported strong players as low as possible. As a consequence, mediation winds up making the equilibrium expected payoffs of strong players as low as possible and the equilibrium payoffs of weak players as high as possible among all budget-balanced mechanisms.

In short, the optimal mediation strategies are designed to minimize the expected reward for a weak player to pretend that it is strong when, in fact, it did not militarize; but as an unintended consequence, they also minimize the equilibrium incentives for the weak player to militarize and become strong. So optimal mediation strategies yield the smallest possible equilibrium arming probability q in the game of militarization and negotiation among all budget-balanced mechanisms. By construction, they also maximize the chance of peace given any militarization strategy q. Hence, we conclude that optimal Myerson mediation strategies maximize the overall players' welfare among all budget-balanced mechanisms.

V. Conclusion

This paper pushes scholars of conflict to broaden their field of vision in thinking about institutions. How players engaged in a dispute negotiate affects more than whether the disputes that emerge are resolved peacefully. By shaping militarization incentives, conflict resolution institutions influence the types of disputes that emerge. To the extent that engagement in a costly and destructive war can be seen as the punishment for arming and entering a dispute, institutions that reduce the chances of open conflict in emerged disputes may lead to more militarization and make more dangerous disputes emerge.

We show that considering militarization is important when assessing the overall effectiveness of conflict resolution institutions. In our model, the use of unmediated peace talks, while effective in improving the chance of peace for a given distribution of military strength, leads to more equilibrium militarization and ultimately to higher chances of conflict outbreak. Happily, not all conflict resolution institutions suffer from these drawbacks. We identify a form of third-party intervention that brokers peace in ongoing disputes effectively and also minimizes equilibrium militarization.

This paper also contributes to our understanding of communication and negotiations in international relations. A series of papers going back to at least Kydd (2003) study the question of whether mediation improves on direct unmediated communication in ongoing disputes. At the heart of this debate is whether there is value in a mediator with no independent private information and without a budget to intervene militarily or create external incentives. In the case in which each player's private information is of private value, for example, when it concerns the individual cost of war, the answer is no (Fey and Ramsay 2010). But the answer is yes when considering private information of interdependent value, such as one's arming strength, for example (Hörner et al. 2015).[36] This paper has identified a separate reason why mediation improves on unmediated communication: the latter breeds perverse equilibrium militarization incentives, whereas the former minimizes equilibrium militarization.

We conclude by relating our findings with the study of optimal taxation with mechanism design, a large literature that dates back at least to Diamond and Mirrlees (1971). The issue of tax evasion is of course a main concern of policy makers. Tax auditing is an imperfect system to tackle tax evasion, and one may want to complement it with direct mechanisms that discourage income underreporting, especially by high-income earners. And at the same time, a concern of the optimal taxation literature is that the tax system does not reduce the incentives to work and increase one's income. Our results may be related to these issues. We have found that the optimal mediation mechanism simultaneously discourages weak players from falsely reporting that they are strong and minimizes the equilibrium incentive that they militarize and become strong in the first place. This suggests that results that identify taxation schemes that do not upset income generation incentives may also provide insights on how to foster truthful income reporting.

Appendix

Proof of Lemma 1

First, note that for $q\theta/2 + (1 - q)p\theta \leq 1/2$ or $q \geq \gamma/(\gamma + 1)$, both weak and strong players can achieve peace by coordinating on the claims $x_A = x_B = 1/2$. When $q < \gamma/(\gamma + 1)$, it is impossible for strong player pairs to achieve peace. But it is possible to achieve peace for all other pairs of players in equilibrium, as long as

[36] The difference hinges on the role of the mediator's confidentiality in peace talks. Because of the mediator's confidentiality, players have better incentives to disclose their information than when communicating directly. By adopting a non–fully revealing recommendation strategy, the mediator optimally shapes each player's equilibrium beliefs about the opponent's strength. In settings with interdependent values, this belief is important as it influences the player's equilibrium demands. But in settings with private values, the type of the opponent is not directly payoff relevant, and thus the ability to influence this belief buys the mediator nothing.

strong and weak players' demands are compatible, that is, $x_L + x_H = 1$. Also, a strong player must prefer to demand x_H rather than triggering war against a weak player by making a higher demand (if meeting a strong player, the demands will result in war anyway). Hence, we need that $x_H \geq p\theta$. Further, a weak player must prefer to demand x_L rather than triggering war with a strong player, but collecting a higher share of the pie with a weak player, by making the demand $1 - x_L$. This requirement translates into the following inequality: $(1 - q)/2 + qx_L \geq (1 - q)(1 - x_L) + q(1 - p)\theta$. Bringing together these two conditions, we obtain the conditions that $q \geq \gamma/(\gamma + 2)$. When this condition fails, it is impossible to achieve peace for asymmetric pairs composed of a strong and a weak player. As a result, only weak player pairs achieve peace, by demanding $x_L = 1/2$. QED

Proof of Lemma 2

The proof proceeds in two parts.

In the first part, we suppose that the Nash demand game is played according to the equilibrium selection of lemma 1 with $x_H = p\theta$ for $\gamma/(\gamma + 2) \leq q < \gamma/(\gamma + 1)$.

As a function of the equilibrium militarization strategy q, the expected payoff of arming and becoming strong is

$$U(H; q) = \begin{cases} (1 - q)p\theta + q\theta/2 - k & \text{if } q < \gamma/(\gamma + 1) \\ 1/2 - k & \text{if } q \geq \gamma/(\gamma + 1), \end{cases} \tag{A1}$$

whereas the expected payoff of not arming is

$$U(L; q) = \begin{cases} (1 - q)/2 + q(1 - p)\theta & \text{if } q < \gamma/(\gamma + 2) \\ (1 - q)/2 + q(1 - p\theta) & \text{if } \gamma/(\gamma + 2) \leq q < \gamma/(\gamma + 1) \\ 1/2 & \text{if } q \geq \gamma/(\gamma + 1). \end{cases} \tag{A2}$$

The equilibrium arming probability q is given by the indifference equation

$$U(H; q) = U(L; q). \tag{A3}$$

It is immediate that this equation cannot hold for any $q \geq \gamma/(\gamma + 1)$, because $k \geq \underline{k} > 0$ implies $U(H; q) < U(L; q)$. For $q < \gamma/(\gamma + 1)$, the function $U(H; q)$ is linear in q with negative slope $-(p - 1/2)\theta$. The function $U(L; q)$ is piecewise linear in q with a discontinuity point at $q = \gamma/(\gamma + 2)$ such that

$$\lim_{q \uparrow \gamma/(\gamma+2)} U(L; q) < \lim_{q \downarrow \gamma/(\gamma+2)} U(L; q).$$

The function $U(L; q)$ has negative slope $-[1/2 - (1 - p)\theta]$ for $q < \gamma/(\gamma + 2)$ and negative slope $-(p\theta - 1/2)$ on $\gamma/(\gamma + 2) \leq q < \gamma/(\gamma + 1)$. Because $U(H; q) = p\theta - k > 1/2 = U(L; q)$ for $q = 0$ and the slope of $U(H; q)$ is less negative than the slope of $U(L; q)$ for $q < \gamma/(\gamma + 2)$, the indifference equation (A3) cannot have a solution $q < \gamma/(\gamma + 2)$.

Because the slope of $U(H; q)$ is more negative than the slope of $U(L; q)$ for $\gamma/(\gamma + 2) \leq q < \gamma/(\gamma + 1)$, there can exist at most a single value of q such that equation (A3) holds, and this equilibrium militarization strategy q lies in

$[\gamma/(\gamma+2), \gamma/(\gamma+1))$. Solving the resulting equation $p\theta(1-q)+q\theta/2-k=(1-q)/2+q(1-p\theta)$ yields the solution $q(k)=\gamma-2k/(1-\theta)$. This function decreases in k and is such that $q(\bar{k})=\gamma/(\gamma+2)$ and $\lim_{k\downarrow \underline{k}} q(k)=\gamma/(\gamma+1)$.

We have concluded that, if the Nash demand game is played according to the equilibrium selection of lemma 1 with $x_H = p\theta$ for $\gamma/(\gamma+2)\leq q<\gamma/(\gamma+1)$, then for any $k \in (\underline{k}, \bar{k}]$, the militarization and negotiation game has an equilibrium in which players arm with probability $q(k)=\gamma-2k/(1-\theta)\in[\gamma/(\gamma+2), \gamma/(\gamma+1))$, strong players demand $x_H = p\theta$, weak players demand $x_L = 1-p\theta$, and war erupts only if both players are strong, as stated in the proposition proved here. This equilibrium exists also for $k=\underline{k}$, because also for $q=\gamma/(\gamma+1)$, the Nash demand game has an equilibrium in which peace is achieved unless both players are strong, strong players demand $x_H = p\theta$, and weak players demand $x_L = 1-p\theta$.

The second part of the proof shows that the equilibrium just described maximizes the players' welfare W in the militarization and negotiation game.

Consider any other equilibrium of the whole militarization and negotiation game, hence allowing for any equilibrium of the Nash demand game, beyond the equilibrium selected in lemma 1.

Suppose that $q\leq\gamma/(\gamma+1)$. In this case, strong players fight each other in any equilibrium of the Nash demand game and obtain the payoff of $\theta/2$. A strong player's payoff against a weak player cannot be lower than $p\theta$ in any equilibrium of the Nash demand game, because the strong player can guarantee at least that payoff by fighting. Hence, for any $q\leq\gamma/(\gamma+1)$, the equilibrium expected payoff $\hat{U}(H;q)$ of arming and becoming strong cannot be lower than the payoff $U(H;q)$ reported in expression (A1) determined by the Nash demand game equilibrium selection of lemma 1.

Conversely, we now show that the equilibrium expected payoff $\hat{U}(L;q)$ of remaining weak cannot be higher than the payoff $U(L;q)$ of expression (A2), which is also determined by the equilibrium of lemma 1. For every $q\leq\gamma/(\gamma+1)$, in fact, the equilibrium of lemma 1 minimizes the probability that weak players fight and gives them the highest possible share of the pie $x_L = 1-p\theta$ that secures peace when meeting a strong opponent, in the case in which $\gamma/(\gamma+2)\leq q<\gamma/(\gamma+1)$.

Because $U(H;q)\leq\hat{U}(H;q)$ and $U(L;q)\geq\hat{U}(L;q)$ for every $q\leq\gamma/(\gamma+1)$, there cannot exist any value $\hat{q}$ strictly smaller than the value q that solves the indifference equation (A3) and such that the indifference condition $\hat{U}(H;\hat{q})=\hat{U}(L;\hat{q})$ holds. We have concluded that the equilibrium derived in the first part of the proof minimizes the militarization probability q among all equilibria of the militarization and negotiation game.

For q in the relevant range $[\gamma/(\gamma+2), \gamma/(\gamma+1))$, this equilibrium's strategies at the Nash demand stage conform with the equilibrium of lemma 1. Hence this equilibrium also minimizes the probability of conflict, given the militarization strategy q. As a result, it also maximizes players' welfare W among all equilibria of the militarization and negotiation game. QED

Proof of Lemma 3

We first reformulate the unmediated communication problem by substituting the Nash demand game, with the following, simpler, model. Given messages $m=(m_A, m_B)$ and the outcome of the public randomization device, nature selects a split proposal x, and the players simultaneously choose whether to agree to the pie division $(x, 1 - x)$ or not.

Every outcome of this simpler communication model is also an equilibrium of the Nash demand game with unmediated peace talks. Suppose, in fact, that the players agree to the split division $(x, 1 - x)$ in this simpler communication model. Then they can achieve the outcome $(x, 1 - x)$ in the Nash demand game by making demands $x_A = x$ and $x_B = 1 - x$.

Every separating equilibrium of the Nash demand game with unmediated peace talks is also an equilibrium of the simpler communication model. In a separating equilibrium, each player's strength is common knowledge in the Nash demand stage of the game. Hence, in equilibrium, the players know each other's demands. If a player i demands x, his opponent j's best response is either to demand $1 - x$ and secure peace or to trigger war with a higher demand. Player j's choice of whether to trigger war or make the demand $1 - x$ follows exactly the same calculation that j would make in the simpler model in which j needs only to either agree to the split $(x, 1 - x)$ or not. We have shown that every separating equilibrium of our Nash demand game with unmediated peace talks is also an equilibrium of the simpler communication model introduced above.

The pure-strategy equilibria of this communication model can be either pooling or separating. Of course, the former coincide with the equilibria of the Nash demand game without peace talks. Hence, all the pure-strategy equilibria that improve the peace chance $V(q)$ can be determined as separating equilibria of the simpler game introduced in this proof. These equilibria are characterized in the proof of lemma 4 of Hörner et al. (2015), and they are reported in the statement of the result proved here. QED

We now complete the analysis of lemma 3 to cover the case $\gamma < 1$.

Define the functions $\hat{b}$, $\hat{p}_H$, and $\hat{p}_M$ as follows: when $q < \gamma/(2\gamma + 1)$, $\hat{p}_H(q) = 0$, $\hat{p}_M(q) = (1 - q)/(\gamma + 1)(1 - 2q)$, and $\hat{b}(q) = q(1 - \theta) + p\theta(1 - q) + \frac{1}{2}q\theta$; when

$$q \in \left[\frac{\gamma}{2\gamma + 1}, \min\left\{\frac{1}{\gamma + 2}, \frac{\gamma}{\gamma + 1}\right\}\right),$$

$$\hat{b}(q) = \frac{1}{2}\left\{1 - \frac{(1 - q)[1 - 2\theta + 4\theta^2 p(1 - p)]}{\theta(2p - 1)}\right\},$$

$\hat{p}_M(q) = 1$, and $\hat{p}_H(q) = [q - \gamma(1 - 2q)]/q(\gamma + 1)$; and finally, when $1/(\gamma + 2) \leq q < \gamma/(\gamma + 1)$, $\hat{b}(q) = p\theta$, $\hat{p}_M(q) = 1$, and $\hat{p}_H(q) = [2q - \gamma(1 - q)]/q(\gamma + 2)$.

Lemma 5. For any given militarization probability q and benefit/cost ratio parameter $\gamma < 1$, there exist equilibria of the negotiation game with unmediated peace talks with at least the same peace chance $V(q)$ as the equilibria of the negotiation game without peace talks. For any $q < \gamma/(\gamma + 2)$ or $\gamma/(2\gamma + 1) \leq q < \gamma/(\gamma + 1)$, there also exist equilibria with pure communication strategies that strictly increase the peace chance. Every such an equilibrium is characterized by three parameters, $b \geq \hat{b}$, $p_H \leq \hat{p}_H(q)$, and $p_M \leq \hat{p}_M(q)$, and has the same form as the equilibria of lemma 3. The equilibrium that maximizes $V(q)$ is such that $b = \hat{b}$, $p_H = \hat{p}_H(q)$, and $p_M = \hat{p}_M(q)$.

Proof. Following the same arguments as in the proof of lemma 3, which considered the case $\gamma \geq 1$, all the equilibria that can improve the peace chance $V(q)$ over the equilibria of the Nash demand game without peace talks can be determined as separating equilibria of the game introduced in the proof of lemma 3. These equilibria are characterized in the proof of lemma 4 of Hörner et al. (2015), and they are reported in the statement of the lemma proved here. The result that such separating equilibria do not improve for $V(q)$ over the equilibria of lemma 1 for

$$q \in \left[\frac{\gamma}{\gamma + 2}, \frac{\gamma}{2\gamma + 1}\right)$$

is shown with direct calculations, which we omit as they are not insightful. QED

Proof of Proposition 1

We know from lemma 2 that, for $k \in [\underline{k}, \bar{k}]$, the optimal equilibrium of the militarization and negotiation game without peace talks is such that the arming strategy q lies between $\gamma/(\gamma + 2)$ and $\gamma/(\gamma + 1)$, strong players demand $x_H = p\theta$ at the negotiation stage, and weak players demand $x_L = 1 - p\theta$. Further, players fight only if both are strong. Weak players' payoffs are 1/2 when facing a weak player and $1 - p\theta$ when facing a strong one.

Suppose that $\gamma/(\gamma + 2) \leq q < \gamma/(\gamma + 1)$. Consider the pure communication strategy separating equilibria of the Nash demand game with unmediated cheap talk described in lemma 3. Relative to the equilibria of lemma 2, these equilibria reduce the probability that pairs of strong players fight each other from one to $1 - p_H$, where $0 < p_H \leq \bar{p}_H$. Of course they cannot reduce the probability that weak players fight, and they cannot increase the weak players' payoff because $1 - b \leq 1 - p\theta$. Hence, the equilibria of lemma 3 increase the payoff of strong players in the Nash demand game and cannot increase the payoff of weak players. Specifically, the equilibria of lemma 3 raise the payoff for arming to

$$\hat{U}(H; q) = (1 - q)b + q[\theta/2(1 - p_H) + p_H/2] - k \tag{A4}$$

and weakly decrease the payoff for remaining weak to

$$\hat{U}(L; q) = (1 - q)/2 + q[(1 - p_M)(1 - p)\theta + p_M(1 - b)]. \tag{A5}$$

Again, the equilibrium militarization strategy q solves the indifference condition $U(L; q) = U(H; q)$, so that

$$\begin{aligned} q = \min\{&(b - k - 1/2) \div \{b - (1/2 - \theta/2)p_H - \theta/2 \\ &+ [1 - b - \theta(1 - p)]p_M + (1 - p)\theta - 1/2\}, 1\}. \end{aligned} \tag{A6}$$

This quantity decreases in p_M and increases in p_H, so it is minimized setting $p_M = 1$ and $p_H = 0$, so as to obtain

$$q = \min\left\{\frac{b - k - 1/2}{1/2 - \theta/2}, 1\right\};$$

this quantity increases in b and p_H, and it is minimized setting $b = p\theta$, so as to obtain $q = \gamma - 2k/(1-\theta)$, which is the arming probability of the optimal equilibrium of the militarization and negotiation game without peace talks.

Suppose now that $q < \gamma/(\gamma+2)$. By lemma 3, peace talks can improve the peace chance $V(q)$ in equilibrium only by reducing the conflict probability in asymmetric player pairs from one to $1 - p_M < 1$. Hence, peace talks yield weak players the equilibrium payoffs

$$\begin{aligned}\hat{U}(L;q) &= (1-q)/2 + q[(1-p)\theta(1-p_M) + p_M(1-b)] \\ &< (1-q)/2 + q(1-p\theta),\end{aligned}$$

without reducing the strong players' payoffs $U(H;q)$. We know from the proof of lemma 2 that, for $k \in [\underline{k}, \bar{k}]$, the unique value of q such that $U(H;q) = (1-q)/2 + q(1-p\theta)$ is such that $q \in [\gamma/(\gamma+2), \gamma/(\gamma+1)]$. A fortiori, there cannot exist a value of $q < \gamma/(\gamma+2)$ such that $U(H;q) = \hat{U}(L;q)$.

We now consider mixed communication strategy separating equilibria of the Nash demand game with unmediated cheap talk, if any exists.

We separately consider the cases in which strong players and weak players randomize. It cannot be the case that both weak and strong players are indifferent between reporting L and H because the strong players' conflict payoffs are strictly larger than the weak players' payoffs.

Suppose that strong players randomize and reveal their strength with probability $\sigma_H \in [0,1]$. Then the following indifferent condition must hold:

$$\begin{aligned}&(1-q)[(1-p_M)p\theta + p_M b] + q(1-\sigma_H)\theta/2 \\ &\quad + q\sigma_H[(1-p_H)\theta/2 + p_H/2] \\ &= (1-q)\max\{p\theta, 1/2\} + q(1-\sigma_H)\theta/2 \\ &\quad + q\sigma_H[(1-p_M)\theta/2 + p_M \max\{\theta/2, 1-b\}],\end{aligned}$$

where, again, the settlement proposal b is subject to the constraint $b \geq p\theta$. The left-hand side is the payoff obtained by reporting the true strength H, and the right-hand side is the payoff for reporting arming strength L. Note that, after reporting that it is weak, the strong player is still able to reject the settlement proposals $1/2$ and $1-b$ and fight. This is what it does in equilibrium, because the fighting payoffs, $p\theta$ and $\theta/2$, are larger than $1/2$ and $1-b$, respectively, for $\gamma \geq 1$. (This is also the reason why the strong player's payoff is $\theta/2$ against another strong player who reports to be weak, an event that obtains with probability $q(1-\sigma_H)$.) Thus, the strong player payoff in equilibrium is $U(H;q) = (1-q)p\theta + q\theta/2 - k$ as in the optimal equilibrium of the game without peace talks (cf. lemma 2). Further, the equilibrium payoff of weak players is

$$\begin{aligned}\hat{U}(L;q) &= (1-q)/2 + q(1-\sigma_H)(1-p)\theta \\ &\quad + q\sigma_H[(1-p_M)(1-p)\theta + p_M(1-b)],\end{aligned}$$

and this quantity cannot be larger than the payoff of weak players in the pure communication strategy equilibria of lemma 3, which is reported in expression (A5). Hence, we conclude that randomization by strong players cannot lead to a lower equilibrium arming strategy q than in the pure communication strategy equilibria of lemma 3.

Let us turn to randomization by weak players, supposing that they report to be strong with positive probability $1 - \sigma_L$. Then the following indifference condition must hold:

$$\begin{aligned}(1-q)\sigma_L/2 &+ [q+(1-q)(1-\sigma_L)][(1-p_M)(1-p)\theta + p_M(1-b)] \\ &= (1-q)\sigma_L[(1-p_M)\theta/2 + p_M b] + [q+(1-q)(1-\sigma_L)] \\ &\quad \times [(1-p_H)(1-p)\theta + p_H/2],\end{aligned} \tag{A7}$$

whereas, for the players to be indifferent between arming and not, the following condition must hold:

$$\begin{aligned}(1-q)\sigma_L/2 &+ [q+(1-q)(1-\sigma_L)][(1-p_M)(1-p)\theta + p_M(1-b)] \\ &= (1-q)\sigma_L[(1-p_M)p\theta + p_M b] + [q+(1-q)(1-\sigma_L)] \\ &\quad \times [(1-p_H)\theta/2 + p_H/2] - k.\end{aligned} \tag{A8}$$

Subtracting equation (A7) from (A8) and rearranging, we obtain the following expression that pins down the equilibrium militarization q as an inverse function of k:

$$\begin{aligned}\tilde{k}(q) = &(1-q)\sigma_L(1-p_M)(p\theta - \theta/2) \\ &+ [q+(1-q)(1-\sigma_L)](1-p_H)[\theta/2 - (1-p)\theta].\end{aligned} \tag{A9}$$

This function increases in q as

$$\partial k(q; p_M, p_H, \sigma_L)/\partial q = \theta\sigma_L(p_M - p_H)(2p-1)/2 > 0.$$

So we need only to show that it is the case that $\tilde{k}(q) \geq \bar{k}$ for $q = \gamma/(\gamma+2)$.

In fact, the equilibrium militarization strategy $q(k)$ strictly decreases in k in the game without peace talks (cf. lemma 2) and is such that $q(k) = \gamma/(\gamma+2)$ for $k = \bar{k}$. Consider then the inverse function $k(q) = q^{-1}(q)$ that identifies the militarization cost k such that the equilibrium arming strategy takes the value q in the game without peace talks. Because $q(k)$ strictly decreases in k, the inverse function $k(q)$ strictly decreases in q, and it is such that $k(q) = \bar{k}$ for $q = \gamma/(\gamma+2)$. So if $\tilde{k}(\gamma/(\gamma+2)) \geq \bar{k}$, it follows that $\tilde{k}(q) \geq k(q)$ for any $q \in [\gamma/(\gamma+2), \gamma/(\gamma+1)]$, and hence it cannot be the case that there exists $\gamma/(\gamma+2) \leq q' < q \leq \gamma/(\gamma+1)$ such that $\tilde{k}(q') = k(q) \in [\underline{k}, \bar{k}]$. And, for any $q' < \gamma/(\gamma+2)$ such that $\tilde{k}(q') = k(q) \in [\underline{k}, \bar{k}]$, the mixed-strategy equilibrium strictly decreases the peace probability in emerged disputes relative to the optimal equilibrium of the game without peace talks. In fact, the peace probability in the latter is $1 - q^2$, and in the former it is

$$\begin{aligned}V(q') = &1 - (1-q)^2(1-\sigma_L)^2 - 2q(1-q)[\sigma_L(1-p_M) - (1-\sigma_L)] - q^2 \\ &< 1 - q^2,\end{aligned}$$

because $p_H = 0$ and $p_M < 1$ as a consequence of $q' < \gamma/(\gamma+2)$.

In sum, if $\tilde{k}(q) \geq \bar{k}$ at $q = \gamma/(\gamma+2)$, then the equilibrium militarization probability is higher in the optimal equilibrium of the game without peace talks than in every equilibrium of the game with unmediated peace talks such that weak players randomize messages and that the peace chance $V(q)$ is larger than without peace talks.

We now prove that $\tilde{k}(\gamma/(\gamma+2)) \geq \bar{k}$. By substituting equation (A7) in the expression (A9), we obtain the expression

$$\tilde{k}(q) = \frac{\theta(2p-1)/2}{1-\theta+(2p-1)\theta}(2bp_M - 2p\theta p_M + 1 - 2\theta - \sigma_L - 2p_M + 2p\theta + q\sigma_L + \theta\sigma_L + 2\theta p_M + \sigma_L p_M - q\theta\sigma_L - q\sigma_L p_M - \theta\sigma_L p_M + q\theta\sigma_L p_M).$$

Because $\tilde{k}(q)$ increases in b, we make it as low as possible, setting $b = p\theta$, and obtain

$$\tilde{k}(q) = \frac{\theta(2p-1)/2}{1-\theta+(2p-1)\theta}(1 - 2\theta - \sigma_L - 2p_M + 2p\theta + q\sigma_L + \theta\sigma_L + 2\theta p_M + \sigma_L p_M - q\theta\sigma_L - q\sigma_L p_M - \theta\sigma_L p_M + q\theta\sigma_L p_M).$$

This expression decreases in p_M and σ_L, as

$$\partial\tilde{k}(q)/\partial p_M \propto -(1 - \sigma_L + q\sigma_L + 1)(1-\theta) < 0$$

and

$$\partial\tilde{k}(q)/\partial\sigma_L \propto -(1-\theta)(1-p_M)(1-q) < 0.$$

Setting p_M and σ_L as high as possible, $p_M = 1$ and $\sigma_L = 1$, we obtain $\tilde{k}(q) = \bar{k}$, for $q = \gamma/(\gamma+2)$, as we intended to do.

We are left only to inspect the effect of unmediated peace talks on the conflict probability C and on the players' welfare W. Because conflict erupts only in strong player pairs and only with probability $1 - p_H$, it takes the simple form

$$C = q^2(1-p_H). \tag{A10}$$

Recalling that q is minimized setting $b = p\theta$ and $p_M = 1$ and substituting expression (A6) into (A10), we obtain

$$C = \min\left\{1, \left[\frac{\gamma - 2k/(1-\theta)}{1-p_H}\right]^2 (1-p_H)\right\} = \min\left\{1, \frac{[\gamma - 2k/(1-\theta)]^2}{1-p_H}\right\},$$

which clearly increases in p_H. Hence, the overall conflict probability is minimized setting $p_H = 0$ as in the optimal equilibrium of the militarization and negotiation game without peace talks.

Because the welfare takes the simple form

$$W = 1 - C(1-\theta) - 2kq$$

and the conflict probability C increases in p_H, it follows that the welfare is maximized setting $p_H = 0$, again. QED

Proof of Lemma 4

The proof of this result consists in showing that the optimal equilibrium strategies of a Myerson mediator in our Nash demand game coincide with the optimal mediation strategies in the following simpler game. First, each player i sends a message m_i to the mediator. Then the mediator recommends a split of the pie $(x, 1-x)$ as a function of the received messages (m_A, m_B). The split is implemented if and only if both players accept, and conflict erupts if at least one player rejects it.

Because this simple game is a direct revelation game, the revelation principle by Myerson (1982) implies that every equilibrium of our Nash demand game with a mediator is also an equilibrium of this simpler game.

To prove the converse, consider any equilibrium of the simple game introduced above. Take any message pair (m_A, m_B), and suppose that the mediator recommends the split of the pie $(x, 1 - x)$ and the players accept it. Then, for the same message pair (m_A, m_B), the mediator of our model can recommend that the players demand precisely $x_A = x$ and $x_B = 1 - x$ in the Nash demand game, and the players will be willing to implement these recommendations, thus also averting war. If instead the mediator recommends the split of the pie $(x, 1 - x)$ and one or both players reject it in the equilibrium of the simple direct revelation game, then the mediator of our model can recommend that the players make excessive demands (e.g., $x_A = x_B = 1$) and coordinate the players on the conflict equilibrium of the Nash demand game.

We have concluded that the optimal strategies of a mediator in our Nash demand game coincide with the optimal strategies of a mediator in the simpler game introduced above. These strategies are characterized in lemma 4 of Hörner et al. (2015), and they are reported in the statement of lemma 4.

Direct comparison of these strategies with the formulas of p_M and p_H of lemmas 3 and 5 shows that (i) for $\gamma \geq 1$ and $\gamma/(\gamma + 2) < q < \gamma/(\gamma + 1)$, mediation strictly improves the peace chance $V(q)$ relative to the optimal equilibrium (and hence to any equilibrium) of the Nash demand game with unmediated peace talks; that (ii) for $\gamma \geq 1$ and all other values of q, mediation yields the same peace chance $V(q)$ as unmediated peace talks; that (iii) for $\gamma < 1$ and either $q < \gamma/(2\gamma + 1)$,

$$q \in \left[\frac{\gamma}{2\gamma + 1}, \min\left\{\frac{1}{\gamma + 2}, \frac{\gamma}{\gamma + 1}\right\}\right),$$

or

$$\frac{1}{\gamma + 2} \leq q < \frac{\gamma}{\gamma + 1},$$

mediation strictly improves the peace chance $V(q)$ relative to any equilibrium of the Nash demand game with unmediated peace talks; and that (iv) mediation yields the same peace chance $V(q)$ as unmediated peace talks for $\gamma < 1$ and $q \geq \gamma/(\gamma + 1)$. QED

Proof of Proposition 2

Consider the game of militarization and negotiation, in which the negotiations are conducted by a mediator. Because of lemma 4, each player's expected equilibrium payoffs for militarizing and for remaining weak are, respectively,

$$U(L; q) = q[p_M(1 - p\theta) + q_M/2 + (1 - p_M - q_M)(1 - p)\theta] + (1 - q)/2 \quad \text{(A11)}$$

and

$$\begin{aligned} U(H; q) = {} & q[q_H/2 + (1 - q_H)\theta/2] \\ & + (1 - q)[p_M p\theta + q_M/2 + (1 - p_M - q_M)p\theta] - k. \end{aligned} \quad \text{(A12)}$$

The values of p_M, q_M, and q_H depend on whether $q < \gamma/(\gamma + 2)$ or $\gamma/(\gamma + 2) \leq q \leq \gamma/(\gamma + 1)$: for the same arguments as in lemma 2, there cannot exist an equilibrium with $q > \gamma/(\gamma + 1)$ when $k \in [\underline{k}, \bar{k}]$.

We consider the case in which $q < \gamma/(\gamma + 2)$ first. Substituting the values of p_M, q_M, and q_H reported in lemma 4 into the expressions (A11) and (A12) and changing variables, we obtain

$$\begin{aligned} U(L; q) &= \frac{q}{2}\left\{\frac{(1-q)[1-\gamma(1-\theta)]}{(\gamma+1)(1-q)-2q} + \frac{[\gamma(1-q)-2q][\theta-(\gamma+1)(1-\theta)]}{(\gamma+1)(1-q)-2q}\right\} \\ &\quad + \frac{1-q}{2}; \\ U(H; q) &= \frac{q}{2}\theta + \frac{1-q}{2}[\gamma(1-\theta)+1]. \end{aligned}$$

Solving the indifference condition $U(L; q) = U(H; q)$, we obtain the value of militarization cost k that makes the players indifferent between arming and remaining weak, as a function of the mixed strategy q and the model's parameters:

$$k(q) = \frac{1}{2}(1-\theta)(\gamma+1)\frac{q(1+q)-\gamma(1-q)}{2q-(\gamma+1)(1-q)}. \tag{A13}$$

Differentiating $k(q)$ with respect to q, we obtain

$$\begin{aligned} \frac{\partial k(q)}{\partial q} &= -\frac{1}{2}(1-\theta)(\gamma+1)(1-q)\frac{3q-\gamma(1-q)+1}{(3q-\gamma+q\gamma-1)^2} \\ &\propto -3q-1+\gamma(1-q). \end{aligned}$$

The expression is positive for $q < (\gamma - 1)/(\gamma + 3)$ and negative for $q > (\gamma - 1)/(\gamma + 3)$, on the range $q \in [0, \gamma/(\gamma + 2)]$; further, $k(q) = (1 - \theta)\gamma/2$ at $q = 0$ and $k(q) = \bar{k}$ at $q = \gamma/(\gamma + 2)$. We have thus concluded that there does not exist any equilibrium such that $q \leq \gamma/(\gamma + 2)$ for $k \leq \bar{k}$.

Turning to the case $\gamma/(\gamma + 2) \leq q < \gamma/(\gamma + 1)$, the expressions (A11) and (A12) take the following forms:

$$\begin{aligned} U(L; q) &= q\left\{\left[1-\frac{1}{\gamma}\frac{2q-\gamma(1-q)}{(\gamma+1)(1-q)-q}\right](1-p\theta) \right. \\ &\quad \left. + \frac{1}{\gamma}\left[\frac{2q-\gamma(1-q)}{(\gamma+1)(1-q)-q}\right]\frac{1}{2}\right\} + \frac{1-q}{2}, \\ U(H; q) &= q\left\{\frac{1-q}{q}\left[\frac{2q-\gamma(1-q)}{(\gamma+1)(1-q)-q}\right]\frac{1}{2} \right. \\ &\quad \left. + \left[1-\frac{1-q}{q}\frac{2q-\gamma(1-q)}{(\gamma+1)(1-q)-q}\right]\frac{\theta}{2}\right\} \\ &\quad + (1-q)\left\{\left[1-\frac{1}{\gamma}\frac{2q-\gamma(1-q)}{(\gamma+1)(1-q)-q}\right]p\theta \right. \\ &\quad \left. + \frac{1}{\gamma}\left[\frac{2q-\gamma(1-q)}{(\gamma+1)(1-q)-q}\right]\frac{1}{2}\right\} - k. \end{aligned}$$

Solving the indifference condition $U(L; q) = U(H; q)$, we obtain the expression reported in the statement of the proposition proved here:

$$q(k) = (1 + \gamma)\frac{2k - \gamma(1 - \theta)}{2k(2 + \gamma) - (1 + \gamma)^2(1 - \theta)}. \tag{A14}$$

This function strictly decreases in k as $\partial q(k)/\partial q \propto -2(1 - \theta)(\gamma + 1)$and takes the values $q(\underline{k}) = \gamma(\gamma + 1)/[\gamma + (\gamma + 1)^2]$ and $q(\bar{k}) = \gamma/(\gamma + 2)$ at the extreme of the interval $[\underline{k}, \bar{k}]$. Because $\gamma/(\gamma + 1) > \gamma(\gamma + 1)/[\gamma + (\gamma + 1)^2]$, we conclude that for $k \in [\underline{k}, \bar{k}]$, there is a unique equilibrium of the game of militarization and optimally mediated negotiation. The equilibrium militarization strategy q takes the expression (A14).

Theorem 1, proved below, states that optimal Myerson mediation strategies achieve the same welfare as a hypothetical institution that chooses militarization strategies, collects players' arming strength reports, and makes settlement proposals with the objective to maximize the players' welfare W. Hence, optimal mediation strategies weakly improve welfare W relative to all equilibria of the game of militarization and negotiation with unmediated peace talks or without communication. In fact, a possible mediator's strategy is not to mediate at all (thereby replicating all equilibria of the militarization and negotiation game without peace talks). And by the revelation principle by Myerson (1982), the mediator can also reproduce all equilibria of the game of militarization and negotiation with unmediated peace talks (here, this is done by setting $q_M = 0$).

We want to prove that, for $k \in [\underline{k}, \bar{k}]$, the welfare improvement of optimal mediation strategies is strict. By proposition 1, we need only to compare the optimal equilibrium of the militarization and negotiation game with mediation, with the optimal equilibrium of the militarization and negotiation game without peace talks, reported in lemma 2. That these equilibria do not yield the same welfare follows from the fact that $q_H > 0$; that is, strong player pairs do not fight with probability one at the negotiation stage in the optimal equilibrium of the game with mediation, for the relevant equilibrium militarization range

$$\gamma/(\gamma + 2) \le q \le \gamma(\gamma + 1)/[\gamma + (\gamma + 1)^2] < \gamma/(\gamma + 1).$$

QED

Proof of Theorem 1

To prove this result, we first show a useful lemma that compares the optimal equilibrium welfare of the militarization and negotiation game with mediation, with the equilibrium welfare of the militarization and negotiation game, in which negotiations are optimally settled by a Myerson arbitrator. Such an arbitrator acts analogously to our mediator, with one key difference. Once both players have individually agreed that the dispute will be settled by the arbitrator, the international community provides the arbitrator with the means to enforce her recommendations. This is in stark contrast with mediators who cannot enforce their recommendations.

Arguments identical to the ones of the proof of lemma 4 show that, for any given arming probability q, the optimal Myerson arbitrator strategies (b, p_L, p_M,

p_H) coincide with the solution of the arbitration program calculated in lemma 1 of Hörner et al. (2015): for $q \leq \gamma/(\gamma + 2)$, $b = [\gamma(1 - \theta) + 1]/2$, $p_L = 1$,

$$p_M = \frac{1 - q}{(\gamma + 1)(1 - q) - 2q},$$

and $p_H = 0$; for $\gamma/(\gamma + 2) < q \leq \gamma/(\gamma + 1)$,

$$b = \frac{1}{2}\frac{1 - 2q + \gamma(1 - q) + (1 - \theta)(\gamma + 2)[\gamma(1 - q) - q]}{1 - 2q + \gamma(1 - q)},$$

$p_L = 1$, $p_M = 1$, and

$$p_H = \frac{1 - q}{q}\frac{2q - \gamma(1 - q)}{1 - 2q + \gamma(1 - q)}.$$

Lemma A below shows that the equilibrium welfare of the militarization and negotiation game with optimal mediation and arbitration strategies is the same. This result is of independent interest, and it reinforces the main finding of proposition 1 of Hörner et al. (2015) (the main result of that paper) that mediation and arbitration are equally effective in maximizing the probability of peace, taking the militarization probability q as given.

LEMMA A. The equilibrium welfare in the game of militarization and optimally mediated negotiations is the same as the equilibrium welfare in the game of militarization and negotiations settled optimally by a Myerson arbitrator.

Proof of lemma A. The equilibrium militarization strategy q when negotiations are settled by an arbitrator is given by the indifference condition

$$\begin{aligned} U(L; q) &= (1 - q)[(1 - p_M)p\theta + p_M b] + q[(1 - p_H)\theta/2 + p_H/2] \\ &= (1 - q)[(1 - p_L)\theta/2 + p_L/2] \\ &\quad + q[(1 - p_M)(1 - p)\theta + p_M(1 - b)] - k \\ &= U(H; q). \end{aligned} \tag{A15}$$

Substituting the arbitration solution (p_L, p_M, p_H) in this indifference condition, we obtain the expression (A13) for $q \leq \gamma/(\gamma + 2)$ and the expression (A14) for $\gamma/(\gamma + 2) \leq q \leq \gamma/(\gamma + 1)$, which correspond to the inverse of the arming strategy in the optimal equilibrium of the militarization and negotiation game with mediation.

We have concluded that the optimal equilibrium militarization probabilities q in the game with a mediator and with an arbitrator are the same. Because proposition 1 of Hörner et al. (2015) proves that mediation and arbitration are equally effective in maximizing the probability of peace, for any militarization probability q, we conclude that also the equilibrium welfare W's of the militarization and negotiation game with a mediator and with an arbitrator are the same. QED

As a consequence of the above lemma, we can prove the theorem simply by showing that the optimal equilibrium welfare of the militarization and negotiation game with a Myerson arbitrator achieves the same welfare as our hypothetical institution that includes militarization deterrence in its objectives.

In fact, we prove a stronger result. We show that the arbitration solution achieves the same welfare as an even more powerful hypothetical institution that not only aims to keep militarization in check but also is capable of enforcing its recommendations.

Letting weak and strong players' interim expected payoffs be, respectively,

$$\begin{aligned} U_L &= (1-q)[(1-p_L)\theta/2 + p_L/2] + q[(1-p_M)(1-p)\theta + p_M(1-b)], \\ U_H &= (1-q)[p_M b + (1-p_M)p\theta] + q[p_H/2 + (1-p_H)\theta/2], \end{aligned}$$

this hypothetical institution chooses q, b, p_L, p_M, and p_H so as to maximize the welfare

$$W = (1-\theta) + (1-q)^2 p_L\theta + 2q(1-q)(p_M\theta - k) + q^2(p_H\theta - 2k) \tag{A16}$$

subject to the ex ante obedience constraints

$$\begin{gathered} q(1-q)[U_H - k - U_L] = 0, \\ q[U_H - k - U_L] \geq 0, \quad (1-q)[U_H - k - U_L] \leq 0, \end{gathered} \tag{A17}$$

to the interim individual rationality constraints (for strong and weak players, respectively),

$$\begin{aligned} U_H &\geq (1-q)p\theta + q\theta/2, \\ U_L &\geq (1-q)\theta/2 + q(1-p)\theta, \end{aligned} \tag{A18}$$

and to the interim incentive compatibility constraints (for strong and weak players)

$$\begin{aligned} U_H &\geq (1-q)[(1-p_L)p\theta + p_L/2] + q[(1-p_M)\theta/2 + p_M(1-b)], \\ U_L &\geq (1-q)[(1-p_M)\theta/2 + p_M b] + q[(1-p_H)(1-p)\theta + p_H/2]. \end{aligned} \tag{A19}$$

In order to prove that the optimal equilibrium of the militarization and negotiation game with Myerson arbitration achieves the same welfare as this hypothetical institution, we proceed in two steps.

The first step consists in showing that the solution (b, p_L, p_M, p_H, q) of the program that minimizes the conflict probability,

$$C = (1-q)^2(1-p_L) + 2q(1-q)(1-p_M) + q^2(1-p_H) \tag{A20}$$

subject to the ex ante indifference constraint (A17), to the strong players' interim individual rationality constraint (A18), and to the weak players' interim incentive compatibility constraint (A19), coincides with the solution (b, p_L, p_M, p_H) of the program that minimizes the militarization probability q, together with the resulting minimal q, under the same constraints (A17)–(A19).

A consequence of this result is that this solution (b, p_L, p_M, p_H, q) solves the welfare maximization program (A16).

To prove this result, we first solve b in the indifference constraint (A17) and substitute it in the constraints (A18) and (A19). Rearranging, these two constraints now take the forms, respectively,

$$U_H = k(1-q) - \frac{\theta(1-q)(2p-1)}{2} + \frac{(1-\theta)(1-q)^2 p_L + 2(1-q)qp_M + q^2 p_H}{2} \geq 0, \tag{A21}$$

$$U_L = \frac{\theta(2p-1)[1-(1-q)p_M - qp_H]}{2} - k \geq 0. \tag{A22}$$

Note now that the conflict probability C of expression (A20) decreases in p_L, that U_L is independent of p_L, and that U_H increases in p_L. Because setting $p_L = 1$ makes C as small as possible without violating the constraints $U_H \geq 0$ and $U_L \geq 0$, it has to be part of the solution (b, p_L, p_M, p_H) of the conflict probability C minimization program above. Substituting $p_L = 1$ in C and U_H, we thus obtain the simpler expressions

$$C = 2q(1-q)(1-p_M) + q^2(1-p_H), \tag{A23}$$

$$U_H = k(1-q) - \frac{1}{2}\theta(1-q)(2p-1) + \frac{1}{2}[(1-\theta)(1-q)^2 + 2(1-q)qp_M + q^2 p_H]. \tag{A24}$$

Now, we observe that U_L decreases in p_H and p_M and that $U_L = -k$ when $p_M = 1$ and $p_H = 1$. Because $V(q)$ increases in both p_M and p_H, this concludes that the constraint $U_L \geq 0$ must bind.

We now solve for p_M in the constraint $U_L = 0$ and substitute it into the expressions (A23) and (A24) of C and U_H. We obtain

$$C = q^2 p_H + K_1(p, \theta, q, k),$$
$$U_H = -\frac{1}{2}q^2(1-\theta)p_H + K_2(p, \theta, q, k),$$

where the explicit formulas of K_1 and K_2 are inessential. Because C increases in p_H and U_H decreases in p_H in the above expressions, this concludes that the constraint $U_H \geq 0$ must bind.

Setting $p_L = 1$ and solving for p_M and p_H in the binding constraints (A21) and (A22), $U_L = 0$ and $U_H = 0$, and substituting the solution in the objective function C, we obtain

$$C = \frac{2(k - p\theta)(1-q) + 1 - q\theta}{1-\theta}.$$

This function increases in q for $k \leq (p - 1/2)\theta = (1-\theta)\gamma/2$. (For $k > (1-\theta)\gamma/2$, the problem becomes trivial as militarization is so expensive that there is an equilibrium of the militarization and negotiation game in which the militarization probability q is zero, and peace obtains.) Hence, the minimization of C under the constraints that $U_H = 0$, $U_L = 0$, $0 \le p_M \le 1$, and $0 \le p_H \le 1$ is equivalent to the minimization of q subject to the constraints that $U_H = 0$, $U_L = 0$, $0 \le p_M \le 1$, $0 \le p_H \le 1$, and $0 \le q \le 1$.

The second step of the proof that the optimal equilibrium of the militarization and negotiation game with Myerson arbitration achieves the same welfare as the hypothetical institution that solves program (A16) consists in showing that the solution (p_L, p_M, p_H, q) of the minimization of q subject to the constraints $U_H = 0$, $U_L = 0$, $0 \le p_M \le 1$, $0 \le p_H \le 1$, and $0 \le q \le 1$ is exactly equal to the optimal equilibrium strategies of the game of militarization and negotiation with Myerson arbitration, reported before lemma A.

We begin by noting that setting $q = 0$ together with $U_H = 0$ and $U_L = 0$ yields

$$p_H = \frac{\theta(2p - 1)(2p\theta - 2k - 1)}{0} \to +\infty,$$

because $\theta(2p - 1)(2p\theta - 2k - 1) \ge 0$ when $k \le p\theta - 1/2 = (1 - \theta)\gamma/2$. Hence, the solution (p_L, p_M, p_H, q) of the minimization of q subject to the constraints that $H = 0$, $L = 0$, $0 \le p_M \le 1$, $0 \le p_H \le 1$, and $0 \le q \le 1$ must be interior; that is, it must be such that $q \in (0, 1)$.

Then to calculate this solution (p_L, p_M, p_H, q), we proceed as follows.

First, we calculate the minimal value $k(q)$ that satisfies $U_H = 0$ and $U_L = 0$ subject to the constraints $0 \le p_M \le 1$ and $0 \le p_H \le 1$.

Solving for k and p_H as a function of p_M, we obtain

$$\begin{aligned} p_H &= \frac{1 - q}{q} \cdot \frac{1 - q - p_M[1 - 3q + \gamma(1 - q)]}{1 - 2q + \gamma(1 - q)}, \\ k(q) &= \frac{1}{2}(\gamma + 1)(1 - \theta)\frac{\gamma(1 - q) - q(1 - q)p_M - q^2}{1 - 2q + \gamma(1 - q)}. \end{aligned}$$

Because $k(q)$ decreases in p_M for all $q < \gamma/(\gamma + 1)$, we want to set p_M as large as possible. When $p_M = 1$, we obtain the solution

$$p_H = \frac{1 - q}{q}\frac{2q - \gamma(1 - q)}{1 - 2q + \gamma(1 - q)},$$

which lies in [0, 1] if and only if $q \ge \gamma/(\gamma + 2)$. We note that this expression is part of the optimal Myerson arbitrator strategies (b, p_L, p_M, p_H) for $\gamma/(\gamma + 2) \le q \le \gamma/(\gamma + 1)$.

Further, setting $p_M = 1$, we obtain also

$$k(q) = \frac{1}{2}(\gamma + 1)(1 - \theta)\frac{\gamma(1 - q) - q}{1 - 2q + \gamma(1 - q)}.$$

Because

$$k'(q) \propto -\frac{1}{2}(\gamma + 1)(1 - \theta)/(2q - \gamma + q\gamma - 1)^2,$$

this expression strictly decreases in k.

Likewise, solving for k and p_M as a function of p_H, we obtain

$$k(q) = \frac{1}{2}(\gamma + 1)(1 - \theta)\frac{\gamma(1 - q) + q^2 p_H - q(1 + q)}{(\gamma + 1)(1 - q) - 2q},$$
$$p_M = \frac{(1 - q)^2 - qp_H[1 - 2q + \gamma(1 - q)]}{(1 - q)[(\gamma + 1)(1 - q) - 2q]}. \tag{A25}$$

For $q \leq \gamma/(\gamma + 2)$, the expression $k(q)$ increases in p_H. We thus set $p_H = 0$ and obtain the solution

$$p_M = \frac{1 - q}{(\gamma + 1)(1 - q) - 2q},$$

which lies in $[0, 1]$ if and only if $q \leq \gamma/(\gamma + 2)$. Again, we note that this expression is part of the optimal Myerson arbitrator strategies (b, p_L, p_M, p_H) for $q \leq \gamma/(\gamma + 2)$. Further, when $p_H = 0$, we obtain also

$$k(q) = \frac{1}{2}(\gamma + 1)(1 - \theta)\frac{\gamma(1 - q) - q(1 + q)}{(\gamma + 1)(1 - q) - 2q}. \tag{A26}$$

Because

$$k'(q) = -\frac{1}{2}(1 - \theta)(\gamma + 1)(1 - q)[1 + 3q - \gamma(1 - q)]/(3q - \gamma + q\gamma - 1)^2,$$

this expression strictly decreases in k.

Because the whole function $k(q)$ strictly decreases in q on the whole range $[0, \gamma/(\gamma + 1)]$, the inverse function $q(k) = k^{-1}(k)$ identifies the minimal militarization probability q subject to the constraints that $U_H = 0$, $U_L = 0$, $0 \leq p_M \leq 1$, and $0 \leq p_H \leq 1$.

Direct calculations show that the inverse of the function $q(k)$ reported in expression (A13) for $q \leq \gamma/(\gamma + 2)$ and in expression (A14) for $\gamma/(\gamma + 2) \leq q \leq \gamma/(\gamma + 1)$ coincides with the function $k(q)$ reported in expression (A26).

Thus, we have shown that the solution (p_L, p_M, p_H, q) of the minimization of q subject to the constraints $U_H = 0$, $U_L = 0$, $0 \leq p_M \leq 1$, $0 \leq p_H \leq 1$, and $0 \leq q \leq 1$ takes exactly the same values of q, p_L, p_M, and p_H as the optimal equilibrium strategies of the game of militarization and negotiation with Myerson arbitration.

This result yields theorem 1 because (i) the optimal arbitration strategies satisfy all the constraints of the program (A16) that calculates the optimal choice q, b, p_L, p_M, and p_H of the welfare maximization problem of the hypothetical institution capable of enforcing its recommendations; (ii) the constraints that $U_H = 0$, $U_L = 0$, $0 \leq p_M \leq 1$, $0 \leq p_H \leq 1$, and $0 \leq q \leq 1$ correspond to the constraints (A17)–(A19) that are weaker than the constraints of program (A16); and (iii) the solution (p_L, p_M, p_H, q) of the minimization of q subject to the constraints $U_H = 0$, $U_L = 0$, $0 \leq p_M \leq 1$, $0 \leq p_H \leq 1$, and $0 \leq q \leq 1$ also maximizes welfare W under the same constraints.

We conclude by considering the possibility that there is a positive probability ρ that the players can renegotiate a peaceful agreement when the mediator quits the peace talks, or there is a positive probability χ that the mediator called to settle the dispute is not capable of committing to quitting the peace talks. The optimal equilibrium of the militarization and negotiation game with mediation is still achieved, as long as the probabilities ρ and χ are not too large. In this case, the same interim expected payoffs as in the optimal equilibrium (and hence the same interim behavior of players and ex ante payoffs) are achieved if mediators able to commit to quitting peace talks modify their strategies by appropriately increasing the probability of quitting. As a result, theorem 1 extends.

Specifically, when $k \in [\underline{k}, \bar{k}]$, we know from proposition 2 that the optimal equilibrium of the militarization and negotiation game with mediation is such that conflict arises only in strong player pairs, and with probability

$$1 - q_H = 1 - \frac{[2k(\gamma + 2) - \gamma(\gamma + 1)(1 - \theta)][(\gamma + 1)(1 - \theta) - 2k]}{(\gamma + 1)^2(1 - \theta)[2k - \gamma(1 - \theta)]},$$

as is shown substituting the militarization probability expression

$$q = (1 + \gamma)\frac{2k - \gamma(1 - \theta)}{2k(2 + \gamma) - (1 + \gamma)^2(1 - \theta)}$$

into the formula for

$$q_H = \frac{1 - q}{q}\frac{2q - \gamma(1 - q)}{(\gamma + 1)(1 - q) - q}.$$

At most, the mediator able to commit can quit with probability one if both players report they are strong, so that the overall probability that conflict breaks out among two self-reported strong players is $(1 - \rho) - \chi = 1 - \rho - \chi$. As long as this quantity is weakly larger than $1 - q_H$, or

$$\rho + \chi \leq \frac{[2k(\gamma + 2) - \gamma(\gamma + 1)(1 - \theta)][(\gamma + 1)(1 - \theta) - 2k]}{(\gamma + 1)^2(1 - \theta)[2k - \gamma(1 - \theta)]}, \qquad \text{(A27)}$$

the optimal equilibrium of the militarization and negotiation game with mediation is still achieved, because the mediator able to commit can compensate for the possibility of renegotiation and the presence of mediators not able to commit to quitting. Hence, theorem 1 extends under condition (A27).

Turning to the case in which $k < \underline{k}$, the online appendix shows that the optimal equilibrium of the militarization and negotiation game with mediation follows the exact same characterization as $k \in [\underline{k}, \bar{k}]$. Hence, condition (A27) guarantees that theorem 1 extends also for $k < \underline{k}$. In the case in which $k > \bar{k}$, instead, the online appendix shows that the optimal equilibrium of the militarization and negotiation game with mediation is such that conflict breaks out with probability one in strong player pairs (and with probability $1 - p_M > 0$ in asymmetric player pairs). So theorem 1 does not extend only in the case in which $k < \underline{k}$ and $\rho + \chi > 0$. QED

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