# Dispute Resolution Institutions and Strategic Militarization*

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**Abstract**

Extant studies of conflict, negotiation and international relations do not take into account that the institutions used to resolve disputes shape the incentives for entering disputes in the first place. Because engagement in a costly and destructive war is the 'punishment' for entering a dispute, institutions that reduce the chances that a dispute lead to open conflict may make more disputes emerge and incentivize militarization. We provide a simple model in which the support for unmediated peace talks, while effective in improving the chance of peace for a given distribution of military strength, ultimately leads to the emergence of more disputes and to higher conflict outbreak. Happily, we find that not all conflict resolution institutions suffer from these, apparently paradoxical, but actually quite intuitive drawbacks. We identify a form of third-party intervention inspired by the celebrated work by Myerson, and show that it can broker peace in emerged disputes effectively and also avoid perverse militarization incentives.

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# 1 Introduction

A central question in international relations is which institutions are effective in resolving disputes and crises that might otherwise lead to military conflict. Several studies have considered different types of disputes, ranging from international crises to civil and ethnic conflicts, and attempted to make policy-relevant pronouncements on the effectiveness of different conflict resolution institutions.[1,2] In each one of these studies, the starting point of the analysis is a situation of crisis or dispute that may or may not lead to conflict. The questions asked in the analysis are of the following sort: Given a dispute, how will the features of the institution–say commitment, information transmission, the presence of a mediator, external motivations, an audience, trade spillovers –influence the likely resolution?

This paper broadens the scope of analysis by considering a different aspect of the quest for effective conflict resolution institutions. Instead of taking crisis situations as the starting points of the analysis, we ask: What types of crises and disputes are more likely to emerge, given the disputants' expectations about the conflict resolution institutions in place to resolve the dispute? Intuitively, a bloody, 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 crises lead to conflict may at least potentially

[1]A growing body of theoretical work considers how various forms of direct diplomacy can influence the probability of bargaining breakdown (Baliga and Sjöström 2004, Ramsay 2011, Smith 1998, Sartori 2002, Traeger 2011). Others explore the role of mediation and delineate conditions where such third party actions can influence outcomes (Bester and Wärneryd 2006, Fey and Ramsay 2010, Horner, Morelli, and Squintani 2010, Kydd 2003). Still, others look at how standing institutions like the United Nations or ICJ, can influence state actions and the probability of cooperation (Fang 2010, Chapman and Wolford 2010, Gilligan, Johns, and Rosendorf 2010).

[2]There exists a detailed empirical literature on mediation and third party intervention. Rauchhaus (2006) provides quantitative analysis showing that mediation is especially effective when it targets asymmetric information. Similarly, Savun (2008) shows that hard sources of information are very influential and Bercovitch and Houston (2000), and Bercovitch et al. (1991), point out the particular relevance of mediation for peace outcomes when the uncertainty about the disputants' strength is high. More generally, for an overview of the literature on effective forms of negotiations, with and without mediators, see Bercovich and Jackson (2001), Wall and Lynn, (1993). Related empirical research on various forms of third party intervention, such as Dixon (1996) and Frazier and Dixon (2006), finds that mediation can be effective at increasing the probability of settlement and de-escalation of disputes.

breed perverse militarization incentives, and lead to more crises and disputes. This research question is novel in the academic literature. It is important to assess the overall value of conflict-resolution institutions. These institutions should not only be effective in resolving the disputes that emerge, but also in minimizing the chance that disputes and crises emerge.

The payoff to our theoretical approach is that it offers a framework to handle these nuanced considerations. We show that the inclusion of the connection between dispute resolution institutions and militarization incentives may dramatically change established views on the capability of different institution to maintain world peace. Specifically, we find that unmediated peace talks, while effective in reducing the chance that the disputes that emerge turn into open warfare, may provide very perverse incentives for militarization and the emergence of crises and disputes. The expectation that disputes will be dealt with unmediated peace talks may lead to such a higher emergence of disputes that the resulting eventual warfare is higher than it would be in a world in which there is no support for unmediated peace talks by the international community.

The reasoning behind this unexpected and apparently paradoxical result is actually quite simple. Informative communication in unmediated peace talks reduces the uncertainty that each disputant has on the opponents' strengths. When taking as the starting point of the analysis a dispute or crises that has emerged, this reduction of uncertainty decreases the chance that the dispute evolves into open warfare (as was first formally proved by Baliga and Sjostrom, 2004). In other terms, unmediated peace talks reduces the possibility that wars takes place because of the uncertainty which is arises when militarization is a hidden action.[3]

However, this reduction of uncertainty also makes each disputant more willing to acquiesce to the opponent's demands when the latter is highly militarized. Hence, when

[3]Militarization cannot lead to deterrence if it is a hidden action, as there cannot ever be an equilibrium in which disputants militarize and war does not take place, in any reasonable model of conflict: In anticipation that war will not take place, each disputant would deviate at the militarization stage and secretly choose to devote the resources earmarked to militarization to welfare enhancing means (see the discussion in Meirowitz and Sartori, 2008, and Jackon and Morelli, 2009).

expecting that information will be exchanged in peace talks, the benefit for militarization increases, and the potential cost of militarization (which consists in the eruption of war) decreases. As a result, potential disputants have a greater incentive to militarize and enter disputes, so that more crises emerge. Although each crisis is less likely to lead to open warfare, the increased emergence of disputes may well lead to more wars, as we formally show in the model provided in this paper. In other words, the effects of unmediated peace talks on strategic militarization trump the improved odds that players of particular strengths will negotiate a peaceful settlement.

Given this apparently paradoxical, but relatively simple insight, a natural question to ask is whether all conflict resolution institutions suffer from these same drawbacks. Happily, we find that this is not the case. We study third-party intermediation by actors who do not have access to privileged information independently of communication with individual disputants (unlike in Kydd, 2000 and 2003), and who do not have any military or financial capability to enforce peaceful settlements. Hence, the role of the third-parties we study here is only to facilitate negotiations by managing the flow of information among the disputants. In practice, this is achieved mainly by setting the agenda and modes of communication of the peace talks. In the taxonomy of Fisher (1995), the third-party intervention we study is a form of 'pure mediation',[4] whereas it is closer to 'procedural mediation' in the terminology by Bercovich (1997).[5] As the specific form of mediation we

[4]This distinction between *pure mediation,* involving information gathering and settlement proposal making, and *power mediation,* which instead also involves mediator's power to reward, punish or enforce was made by Fisher (1995).

[5]At a conceptual and practical level grouping various institutions together can be problematic. But two main types of third-party intervention have been identified: *communication facilitation mediation*, and *procedural mediation*. In the latter, disputants pre-commit to let the mediator set the procedure for the dispute resolution process. In practice, this seriously limits their capability to negotiate, or renegotiate an agreement outside the mediation process. In this sense, this form of mediation is desciptively the closest to the model adopted in this paper. While not prevalent, procedural mediation is perceived to be an efficient form of mediation in resolving international disputes. Between 1995 and 2011, 427 disputes have been brought for arbitration to the World Trade Organization (WTO database), but most of these cases could be coded, according to our distinction above, as procedural mediations, since enforcement power is very limited in the presence of sovereignty constraints. Since World War I, over 30 territorial disputes have been brought to an international adjudication body (Huth and Allee 2006), which once again took the form of procedural mediation in our terminology given the absence of real enforcement power. Among all other cases in which mediation was involved (roughly fifty percent of cases according to Wilkenfeld et al. 2005),

study is inspired by the celebrated work by Roger Myerson (1979, 1982), we will call it 'Myerson mediation', here.

We find that this type of third-party intervention improves the chances of peace-brokering in emerged disputes more effectively than unmediated-peace talks, and also avoid the perverse militarization incentives that we identified above. Importantly, this is despite the fact that the third party's mandate cannot realistically include the objective of stifling militarization and the prevention of crisis emergence. This is because the disputants militarization decisions are sunk when a third party is called in to mediate on an ongoing dispute. Our deep and general result is that this narrow mandate is irrelevant for the third parties we study here. Their intermediation strategies, while optimally designed to only give the highest chance of war in emerged disputes, also provide the best possible incentives against crisis emergence (within the class of institutions that do not give intermediaries access to privileged information, nor possess the budget to impose peaceful settlements.

The reasoning behind this result is more complex than the intuition behind the drawbacks of unmediated peace talks. The first step in our argument is the application of the 'revelation principle' by Roger Myerson (1982). In our context, this general result implies that an optimal way to organize the third-party intermediation we consider here is as follows. First, disputants report their information independently to the mediator. Second, the mediator submits a settlement proposal to the disputants for their independent approval. Further, there is an equilibrium which maximizes the chance of peace, in which the settlement proposal strategies by the mediator are chosen so as to ensure that disputants will reveal all their private information to the mediator, in anticipation of the settlements they will be proposed.

In practice, the mediator sets the agenda to "collect and judiciously communicate select confidential material" (Raiffa, 1982, 108–109). Obviously, the role for mediation that

it is not clear how many were closer to facilitation mediation without procedural commitment and how many were closer to procedural mediation. Certainly at least some could still be described as applying procedural mediation.

we identify cannot be performed by holding joint, face-to-face sessions with both parties, but requires private and separate caucuses, a practice that is often followed by mediators. The 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, in which a third party conveys information back and forth between parties, providing suggestions for moving the conflict toward resolution (see, for example, Kydd, 2006).

Turning to the precise characterization of the optimal settlement proposal strategies, we find the following. First, a stronger, more militarized disputant must receive more favorable terms of settlement on average, than a weaker one. Otherwise, the stronger disputant will never accept the proposed settlements, preferring instead to wage war in the expectation that his eventual payoff will be larger. But, then, the mediator faces the task of choosing settlements that make sure that weak disputants do not pretend to be stronger, when reporting their information in the first stage of the intermediation. Thus, the mediator proposal strategies are chosen to minimize the expected reward for a weak disputant to pretend that it is strong, when, in fact, it did not militarize. As an unintended consequence, they also minimize the incentives for a weak disputant to militarize and become strong. Hence, the mediators we consider here not only improve the chance that disputes are resolved peacefully relative to unmediated peace talks. They also keep in check the potential disputants incentives to engage in disputes and to militarize.

This paper pushes for a reformulation of the study of conflict and institutional design and draws a finer distinction between different ways of fostering peace for a given crisis; some are also beneficial at reducing militarization while others generate offsetting negative incentives.

Our results are also related to the study of contests and appropriation (see Garfinkel and Skaperdas, 1996, for a survey). In such a conceptualization, strategic militarization is treated as an arms race to prepare for a sure conflict where the military capacities of each country influence the war-payoffs through a contest function. For us, instead, militarization increases the expected payoff of fighting in a crisis. The goal is expected utility maximization in a game in which war is not a foregone conclusion. Players may either reach a settlement or fight, and the militarization choice has strategic effects on both settlements and the odds of fighting.

There is also a recent body of formal theory on endogenous militarization in the shadow of bargaining and war fighting. Meirowitz and Sartori (2008) connect militarization with bargaining behavior 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 in their analysis states observe each other's investment decisions prior to bargaining and thus there is no room for communication of any kind to solve information problems. Akcay, Meirowitz and Ramsay (2012) study investment that influences the value of agreement for one player and disagreement for the other prior to the play of a mechanism and provide a characterization of the equilibrium relationship between the probability of bargaining failure and investment levels. In that paper, however, the investments are over a private value component whereas here investment by either player influences the payoffs of both players.

In a less closely connected literature, militarization is assumed to be observable, and is viewed as a deterrent or a signal.[6] Garfinkel (1990) focuses on a simple repeated armament setting that illustrates this role, and Powell (1993) provides an example of the conditions under which endogenous observable armament can lead to effective deterrence. Similarly, Fearon (1997) argues that observed military expenditures can be a form of costly signaling. Collier and Hoffler (2006) consider the signaling and deterrent effects of armament as competing mechanisms explaining levels of post-conflict military expenditures in countries which had recently experienced a civil war. Chassang and Padro (2008) show that while weapons have deterrence effects under complete information in a repeated game, when adding strategic uncertainty it is no longer true that there is a monotonic relationship

[6] The observability of militarization is crucial for deterrence. On the words of Dr. Strangelove: "Of course, the whole point of a Doomsday Machine is lost, if you *keep it a secret*!"

between the size of an arsenal and the degree of deterrence in equilibrium. For very different reasons, even in our model the effects of endogenous militarization incentives on peace are non-monotonic. Taken together with the point made in footnote (3), this work highlights the importance of whether militarization is observable or not, for the study of deterrence. It is then natural to ask whether mechanisms that improve observability, such as espionage, or military inspections would lead to more or less militarization, deterrence, or conflict. We leave these questions for future research.

## 2 Unmediated Peace Talks and Militarization

In this section we develop the baseline model and augment it to allow for unmediated communication, so as to show that unmediated peace talks may breed perverse incentives for militarization. Unmediated peace talks help resolve disputes by allowing for settlements that would not otherwise be possible when the disputants are strong. But the expectation that war is less likely if a dispute emerges leads to an increased incentive for the actors to militarize. As a result, we show that for some model parameters, unmediated peace talks can increase the overall war probability when militarization decisions are taken into account.

**The Crisis Bargaining Game** Two players, $A$ and $B$, dispute a prize or pie normalized to unit size. If no settlement is reached, the disputants fight. We model bargaining as a Nash demand game with private information (see, e.g. Nash, 1953, and Matthews and Postlewaite, 1989).[7] This game has the advantage of being simple, so that its augmentation to include unmediated pre-play talk and mediation leads to models whose solutions can be described clearly. Our most important results do not depend on our choice of bargaining game, as we will explain later in detail. In the Nash demand game, when players bargain, they simultaneously make demands $x_A$ and $x_B$ both in $[0, 1]$. So like giving a diplomat a

[7] Wittman (2009) and Ramsay (2011) use the same bargaining game in their studies of crisis bargaining.

set of instructions to "…bring back at least a share $x_i$ of the pie," each player $i$ chooses a bargaining strategy that will influence both the settlement (if reached) and the probability of war. If one player's demands are sufficiently generous to accommodate the minimal demands of the other, i.e., if the sum of the demands is less than 1, then the split that emerges from bargaining gives each disputant her demand and half the surplus. If the demands $x_A$ and $x_B$ are incompatible, meaning they sum to more than the whole prize, then no split is feasible and the outcome is war.[8]

War is treated as a lottery that shrinks the expected value of the pie to $\theta < 1$, the odds of winning a war depend on the configuration of arming decisions. Each player can possess one of two possible arming levels, $H$ or $L$, and arming is private information. We will often refer to player with arm level $H$ as a "hawk" and to one with arm level $L$ as a "dove." We describe the players' choice of arming levels later. When the two players are of the same type, each wins the war with probability $1/2$. When a hawk fights against a dove, her probability of winning is $p > 1/2$, and hence her expected payoff is $p\theta$.[9] The dove's payoff is $(1-p)\theta$. Note that whether country $A$ is a hawk or a dove influences country $B$'s payoff from fighting, hence we are in a context of private information of "interdependent value."

In the initial militarization stage, $A$ and $B$ each decide whether to remain doves or to arm and become hawks at a cost $k > 0$. We characterize a mixed arming strategy by $q \in [0, 1]$, the probability of arming and becoming a hawk.[10] The militarization decisions are treated as hidden actions, so neither player observes the choice of the other nation, but in equilibrium the disputants hold correct conjectures of the equilibrium strategy-and thus they know the probability that their opponent has armed. For simplicity, and given the symmetry of the game, we restrict attention to equilibria that are symmetric in the

[8] This protocol is also sometimes called the $\frac{1}{2}$-double auction because the surplus is divided equally.

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

[10] The consideration of mixed strategies in equilibrium 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.

militarization strategies $q$.

When comparing outcomes under different institutions, our welfare analysis focuses on three measures: the equilibrium militarization probability of a country, $q$, the probability of peaceful conflict resolution, $V$, and the total utilitarian ex-ante welfare, $W = \theta(1-V) + V - 2kq$. Before presenting our results, we define the parameter $\gamma \equiv [p\theta - 1/2]/[1/2 - \theta/2]$, representing the ratio of benefits over cost of war for a hawk: the numerator is the gain from waging war against a dove instead of accepting the equal split, and the denominator is the loss from waging war against a hawk rather than accepting the equal split. It subsumes the two parameters $\theta$ and $p$ in a single parameter, and allows a more parsimonious representation of the results. To simplify the exposition, we will henceforth assume that $\gamma \geq 1$, i.e., the benefit of war for a hawk is sufficiently high relative to the cost. In terms of the deep parameters, $\theta$ and $p$, this is equivalent to assuming that $(2p+1)\theta \geq 2$, i.e., that war is not too destructive and that the hawk's advantage over the dove is significant. But one of our main results (Theorem 1) also holds for $\gamma < 1$, as explained in the Appendix.

**Benchmark equilibrium in the crisis bargaining game** Let us start by solving the crisis bargaining game when the militarization strategy $q$ is fixed. This game is characterized by broad equilibrium multiplicity. For example, any demand strictly larger than $1-(1-p)\theta$ leads to war with probability one. This claim is so excessive that even a dove knowing that the opponent is stronger would prefer to fight rather than making such a drastic concession. As a result, there always exists an equilibrium in which war occurs with probability one in the benchmark game. In these equilibria the demands of both types of both players are larger than $1-(1-p)\,\theta$; i.e., in this equilibrium the players always coordinate on war. This equilibrium outcome represents instances in which conflicts erupt or escalate because of failure to coordinate on a peaceful dispute resolution.[11] Through

[11]For example, conflicts often escalate or take place because of successful derailment of peaceful process by fringe extremists (e.g., the assassination of Yitzak Rabin in 1995 contributed to the failure of the peace process, and WWI erupted because of the assassination of Archduke Franz Ferdinand of Austria in 1914). The success of these derailment attempts is highly random, and they may lead to mis-coordination on a grim

successful bargaining in the crisis game, the players can improve the chance of a peaceful outcome. Proposition 1 finds the equilibrium of the crisis bargaining game that maximizes the peace probability $V$, given any arming strategy $q$.

**Proposition 1** *The optimal equilibrium of the crisis bargaining game, as a function of the arming probability $q$ 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 disputants are hawks; hawk players demand $x_H \in [p\theta, 1 - (1 - p) \theta]$ and dove players demand $x_L = 1 - x_H$. For $q < \gamma / (\gamma + 2)$, peace is achieved only if both disputants are doves, the demand of doves is $x_L = 1/2$, whereas hawks trigger war by demanding $x_H > 1/2$.*

This result has fairly natural intuition. When $q$ is large, each player anticipates that the opponent is likely a hawk. If the opponent $j$ plays $x_j = 1/2$ regardless of her type, then each player $i$ can secure the payoff 1/2, by also playing $x_i = 1/2$. Because the opponent is likely a hawk, even a hawk prefers to induce this known payoff, rather than triggering war by making a claim larger than 1/2. And, of course, this is true *a fortiori* for a dove. In fact, the condition $q \geq \gamma / (\gamma + 1)$ corresponds to the inequality $1/2 \geq q\theta/2 + (1 - q) p\theta$, where the right hand side is the expected war payoff of a hawk. In this region of high militarization $q$, peace is achieved in the best equilibrium of the crisis bargaining game.

When $q < \gamma / (\gamma + 1)$ hawks will trigger war unless they expect the opponent to make demands below 1/2. Because the game is symmetric, this implies that peace cannot be achieved when both players are hawks. Doves are less willing to trigger war, and would accept an unequal split to avoid fighting a hawk. Hence it is possible to achieve peace in hawk-dove player dyads, unless the chance $q$ that the opponent is a hawk is too small. The demands $x_H \in [p\theta, 1 - (1 - p) \theta]$ and $x_L = 1 - x_H$ induce equal split among doves, and make sure that neither a hawk nor a dove player wants to deviate and trigger war.

equilibrium by disputants who would otherwise be keen to avoid conflict. At the same time, miscalculation of negotiation tactics by overconfident negotiating delegates may lead to the failure of coordination on peaceful conflict resolution. These events are random and unpredictable within the theoretical framework presented in this paper. We leave it to future research to harness the insights from behavioral sciences and psychology to study them in details.

In this intermediate range of values of $q$ we have only wars between hawks. Finally, when $q < \gamma/(\gamma + 2)$ even doves are unwilling to accept unequal splits: the optimal equilibrium is such that $x_A = x_B = 1/2$, and peace is achieved only by dove dyads.

Having determined the equilibrium of the crisis bargaining game that maximizes the peace probability $V$, given any arming strategy $q$, we now move one step back and study the whole game, which includes also the choice of militarization. Our results will depend on whether the cost of arming, $k$, is larger than the critical threshold $k^* \equiv [(1-\theta)\gamma^2]/[2(\gamma+1)]$. We focus on the case where $k$ is smaller than $\bar{k} \equiv [(1-\theta)\gamma(\gamma+1)]/[2(\gamma+2)]$ as this greatly simplifies the exposition without affecting the insights of the analysis.[12] Importantly, $k^* < \bar{k}$.

We first note that there is always a grim equilibrium outcome in the militarization-bargaining game, in which both players arm with probability $q = 1$, and then fight by making demands larger than $1 - (1-p)\theta$. This 'arm-and-fight' equilibrium represents instances in which disputants arm in the expectation of war, so that eventually war indeed erupts. Unfortunately, history abounds with cases in which this grim course of events took place, and this resulted in very destructive wars. According to some historical reconstructions, one of these cases are the events that led to the outbreak of World War I. As already pointed out, such an equilibrium would not exist if one assumed that arming and militarization were always observable.

Building on this observations, we ask whether the players can improve upon 'arm-and-fight' in any militarization-bargaining game equilibrium in which the crisis-bargaining game play maximizes the chance of peace, given $q$, as outlined in Proposition 1.[13] When this improvement is possible in equilibrium, we determine the militarization-bargaining game equilibrium consistent with Proposition 1 that maximizes the players' welfare $W$. The re-

[12]The full characterization of equilibrium for the remaining range of high costs of militarization is available upon request.

[13]Note that for intermediate values of $q$ many demand strategies $x_H$ by the hawk are consistent with equilibrium. We select the one least favorable to the hawk; i.e., the one with $x_H = p\theta$. This is the natural choice as it minimizes the incentive for militarization among the equilibria listed in Proposition 1

quirement that the equilibrium is consistent with the play in Proposition 1, as opposed to selecting equilibria that minimize the probability of war in the whole game, is motivated by the following idea. Before the initial, and possibly long, process of militarization, the disputants are unlikely to be capable of forming commitments on how to play in the final bargaining game so as to achieve the equilibrium that is optimal for the whole game. Instead, when the crisis emerges in the last stage of the game, they will attempt to coordinate on the equilibrium that minimizes the chances of a destructive war.

**Proposition 2** *Assume that the cost of arming $k$ is smaller than $\bar{k}$.*

1. *For $k \in [0, k^*)$, there does not exist any equilibrium of the game with endogenous militarization in which the crisis-bargaining game play is consistent with Proposition 1. The players cannot improve in equilibrium upon the grim outcome in which they both arm and fight.*

2. *For $k \in \left[k^*, \bar{k}\right]$, the equilibrium consistent with Proposition 1 which maximizes the players welfare $W$ is such that each disputant militarizes with probability $q(k) = \gamma - 2k/(1-\theta)$, and only hawk dyads fight.*

For small costs of militarization, i.e. when $k < k^*$, the players cannot improve on the grim outcome: they arm and fight. Indeed, fighting is always an equilibrium of the crisis bargaining game. For small costs of militarization, players prefer to arm in anticipation of a fight, rather than saving the militarization cost and losing the war. In fact, the disputants are unable to commit to remaining unarmed and peaceful, or even to randomize. Because the cost of arming is small, each disputant has an incentive to deviate, arm and wage war whenever the opponent remains weak, arms or randomizes. For $k \in \left[k^*, \bar{k}\right]$, the disputants neither strictly prefer to remain peaceful, nor to militarize. Indeed, they randomize at the militarization stage, and then fight if and only if they both armed. Not surprisingly, the arming probability decreases as the cost of militarization increases, to reach $q = \gamma / (\gamma + 2)$

for $k = \bar{k}$.[14]

Before introducing unmediated peace talks, we conclude this sub-section by pointing out that some of our results on militarization and bargaining are completely general, and do not depend at all on the simple game form or the bargaining protocol we adopt. In fact, there cannot exist any militarization and bargaining game in which arming is a hidden action, and in which players arm but do not fight in equilibrium. Very simply, because arming is a hidden action, if players anticipate that they will not fight, they will deviate from this hypothesized equilibrium and choose not to arm. It is completely immaterial for this result whether the final bargaining protocol is one of simultaneous demands, as we assumed here for simplicity, or one of sequential moves, or whether it has any further elaboration. Also, as already pointed out, the result that a mixed strategy equilibrium is played for $\left[k^{*}, \bar{k}\right]$ should not be taken as a literal prediction that players are indifferent between arming or not and play randomly. As is well known since Harsanyi (1973), equivalent and more plausible interpretations of mixed strategy equilibria are routinely invoked by applied game theorists to understand mixed strategy equilibria (see footnote 10).

**Unmediated Peace Talks** The previous section has described equilibrium in the militarization-bargaining game. We now augment this game by adding an extra intermediate stage. We assume that after the militarization stage, but before the crisis bargaining game is played, direct bilateral peace talks take place. Talks are modeled as a single peace conference, in which both players $i = A, B$ simultaneously send unverifiable messages $m_i \in \{l, h\}$ to each other, so as to represent their arming type $L$ or $H$. For simplicity, we assume that only one round of communication takes place. But to broaden the scope and capabilities of bilateral peace talks, we allow players to make use of a randomization device, whose realization is observed by both disputants. So, disputants can possibly coordinate on different equilibria of the crisis bargaining game, as a function of both their messages and the realization of

[14] The equilibrium characterization changes discontinuously for $k > \bar{k}$, because, once the dispute has arisen, players fight unless they are both doves.

the public randomization device.

Therefore, our model provides a simple framework to represent meetings in which the disputants conduct unmediated talks, share information, and attempt to find an agreement and coordinate their future play.[15] Any equilibrium has the following form: with some probability, the peace conference is successful, and the disputants agree on a peaceful resolution. With complementary probability, the peace talks fails, and lead to open conflict. In any equilibrium in which information is meaningfully revealed, the probability that the peace conference results in a peaceful resolution depend on the players' types, as we detail below in Proposition 3.

The description of our results for unmediated peace talks is divided in two parts. First, we show that, for any fixed probability of militarization $q$, unmediated peace talks strictly improve the probability of peace and welfare, (except for the trivial case in which $q \geq \gamma/(\gamma+1)$ where peace is always achieved). As we later explain in details, this improvement is due to the fact that participation in peace talks increases the probability that players coordinate on peaceful dispute resolution. This insight is novel in the literature, and complements the findings of Baliga and Sjostrom (2004) who did not include the possibility of coordination with a public randomization device in their model of unmediated peace talks. This result is formally stated in Proposition 3. As in the statement of Proposition 1, we focus on the equilibrium that maximizes the peace probability $V$, for any given arming strategy $q$. For expositional reasons, we focus our attention on equilibria with pure communication strategies.

**Proposition 3** *For any given militarization strategy $q$, the optimal equilibrium of the crisis bargaining game with unmediated peace talks is characterized by two parameters, $p_H$, and $p_M$, and has the following form. Each type truthfully reveals her type during peace talks.*

[15] Aside from capturing literal publicly observed random events that players could condition their behavior on, it is known that public randomization devices can be reconstructed as simultaneous cheap talk (see, e.g. Aumann and Hart, 2003). 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).

*Then, hawk dyads* $(H, H)$ *coordinate on the peaceful demands* $x_A = 1/2$, $x_B = 1/2$ *with probability* $p_H$*, and fight with probability* $1 - p_H$*; asymmetric dyads* $(H, L)$ *coordinate on the peaceful demands* $(p\theta, 1 - p\theta)$ *with probability* $p_M$*, and fight with probability* $1 - p_M$ *— the case for* $(L, H)$ *is symmetric; and dove dyads* $(L, L)$ *achieve peace with probability one, making demands* $x_A = 1/2$, $x_B = 1/2$.

*Specifically, when* $q < \gamma/(\gamma + 2)$, $p_H = 0$ *and* $p_M \in (0, 1)$*; whereas when* $\gamma/(\gamma + 2) \leq q < \gamma/(\gamma + 1)$, $p_M = 1$ *and* $p_H \in (0, 1)$*; finally, when* $q \geq \gamma/(\gamma + 1)$, $p_M = 1$ *and* $p_H = 1$.

*For any given militarization strategy* $q$*, unmediated peace talks improve the peace chance* $v$*, and they improve it strictly whenever* $q < \gamma/(\gamma + 1)$.

The equilibrium in Proposition 3 is best illustrated by comparing it to the optimal equilibrium of the bargaining game without communication, reported in Proposition 1. In both cases disputants play a separating equilibrium (except for the trivial case in which $q \geq \gamma/(\gamma+1)$ where peace is always achieved). In both equilibria, players reveal their types by means of their choices. But in the crisis bargaining 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. Intuitively, sharing information before demands are made allows the players to use this information more efficiently in the crisis bargaining game, thereby improving the chance that the disputants coordinate on a peaceful outcome.

In fact, unmediated communication induces a strict improvement in the probability of peace for $q < \gamma/(\gamma+1)$. Specifically, when $\gamma/(\gamma+2) \leq q < \gamma/(\gamma+1)$, and both players are hawks, the introduction of a peace conference turns the sure event of war (which occurs in the game without talks) into one in which peace occurs with positive probability. Similarly, when $q < \gamma/(\gamma + 2)$, the equilibrium of Proposition 1 is such that war takes place with probability one in asymmetric hawk-dove dyads, but with probability smaller than one when a peace conference is introduced to coordinate future play.

The second part of this subsection studies whether unmediated peace talks improve the chance of peace and the players' welfare in the whole militarization-bargaining game. We proceed as in Proposition 2. double auction. Here, w We ask whether the players can improve upon 'arm-and-fight' in any equilibrium of the game of militarization and bargaining with unmediated peace talks, in which the crisis-bargaining game play maximizes the chances of peace given $q$, as outlined in Proposition 3. Strikingly, we find that this is not the case. Unmediated peace talks give such perverse incentives to militarization that they fully wipe out the players' capability to escape the grim 'arm-and-fight' equilibrium.

**Proposition 4** *For $k \in \left[0, \bar{k}\right)$, there does not exist any equilibrium of the game with endogenous militarization and unmediated bilateral peace talks in which the crisis-bargaining game play is consistent with Proposition 3.*

*Hence, for $k \in (k^*, \bar{k})$, the expectation of unmediated peace talks induces more militarization, and lower peace chance, than in the equilibrium of the game without communication. For $k \leq k^*$, the equilibrium incentives are the same with and without unmediated peace talks.*

In sharp contrast with the benchmark case without communication, unmediated peace talks do not improve on the grim 'arm-and-fight' equilibrium, for the relevant range $[0, \bar{k}]$ of the cost parameter $k$. Hence, for any $k \in (k^*, \bar{k})$, unmediated peace talks induce negative incentives for militarization and reduce the peace chance as well as overall welfare.

The intuition for this seemingly perverse result is simple. Taking as given the probability that each disputant is strong, peace talks improve the chance of a peaceful crisis resolutions by reducing the probability of war when both disputants are hawks (without any change in the hawks payoffs when they meet doves). This is because the disputants are more likely to coordinate on peaceful resolution of the crisis when they meet at peace talks. This increases the expected payoff of becoming strong, and thus disputants arm with higher probability, in equilibrium. Thus, although it is true that unmediated communication improves the chance of peace when taking militarization as exogenous, we show it may be detrimental for peace when one takes the broader view that includes militarization incentives in the model. International support for unmediated peace talks when a dispute emerges may be self-defeating. The expectation of unmediated peace talks may create particularly strong incentives for dispute emergence and militarization. Eventually this may lead to an international community where the chance of peace is lower than in a world where the international community does not provide support for unmediated peace talks.

# 3 Third party intervention

We have shown that bilateral unmediated communication, while reducing the risk of conflict in ongoing crises, may yield more militarization and more destructive crises. We now show that there exist forms of third party interventions that do not suffer from these drawbacks. In fact, it is possible to avoid the militarization incentives mentioned above if a third party is expected to deal with the crises that emerge, even if these third parties have no enforcement power and has no special access to the private information of either disputant.

**Optimal Mediation, Given Militarization** The specific form of third-party intervention we consider is inspired by the celebrated work of Roger Myerson (1979, 1982) and hence we call it 'Myerson mediation'. In the taxonomy of Fisher (1995), Myerson mediation is a form 'pure mediation', whereas it is closer to 'procedural mediation' in the terminology by Bercovich (1997).

A Myerson mediator is a neutral or "honest broker" mediator who does not favor either of the disputants. Examples of such mediators might be Nobel Peace Prize winners like Martti Ahtisaari and Jimmy Carter, or Nongovernmental Organizations like the International Crisis Group. The mediator has a mandate to set the agenda, or procedure, of the peace talks so as to minimize the probability of war when the international crisis erupts, after the militarization stage. That is, we assume our mediators have a narrow mandate to resolve the current conflict and do not take into account the incentives of disputants who, in turn, anticipate the mediation strategies and techniques when they choose whether to militarize before negotiations. Indeed, it would not be realistic to presume that the mediator's mandate included deterring strategic choices that took place before their intervention in the crisis. Rather, our mediator takes the (symmetric) equilibrium militarization probability $q$ as given, and tries to minimize the chance that this dispute ends in war. This assumption mirrors our selection in the benchmark bargaining game and its cheap-talk extension. There we focus on the best equilibria, treating investment decisions as fixed. Our mediator has the same characteristics.

Also note that our Myerson mediator is not endowed with unrealistic "commitment power" either. We assume that the mediator can commit to her proposal during the crisis and will not renegotiate if one or both nations reject her recommendation. This means that we assume the mediator can quit and credibly refuse to broker any subsequent deals, leading to escalation of conflict and war. Specifically, we later show that optimal mediation requires mediators to quit more frequently when disputants declare that they are highly militarized. We also assume that the disputants cannot broker their own deals following the decision to reject the mediator's offers. On the basis of simple data analysis, these assumptions seem realistic to us.[16] We leave the study of mediation under alternative commitment assumptions, and the in-depth empirical assessment of mediator's commitment capabilities to future research.

We begin our analysis by applying a celebrated result, the 'revelation principle' by Myerson (1982) to our crisis bargaining game (in which militarization probability $q$ is taken as given). This general result implies in our context that an optimal way for the media-

[16] Analysis of the ICOW dataset, available upon request, shows that approximately 30% of the mediation attempts resulted in the mediator quitting by our definition. Of failed mediation attempts, mediators quit in approximately 42% of cases. It is clear that mediators do quit in a significant portion of cases in which quitting is called for. Further, an overwhelming majority of mediators in the sample quit the process at least once in their career. 116 of the 134 mediation attempts in the data were mediated by a third party that had quit at least once previously in the panel. This suggests mediators that demonstrate they will withdraw in response to belligerent transgressions are those asked again to mediate crises. Our interpretation of these findings is that mediators need to establish a reputation of being capable to commit to quit, so as to be taken as effective mediators.

tor to set the mediation agenda is as follows. First, disputants report their information independently to the mediator. Second, the mediator submits a settlement proposal to the disputants. After these proposals are made, the players bargain according to the same crisis bargaining game described in the benchmark case above.[17] Further, there is an equilibrium that maximize the chance of peace, in which the settlement proposal strategies by the mediator are chosen so as to ensure that disputants will reveal all their private information to the mediator, in anticipation of the settlements they will be proposed.

This intermediation procedure is often adopted by third-party negotiators in the form of 'shuttle diplomacy', as we discussed in the introduction. Disputants do not report information directly to each other, but through the intermediation of a mediator whose actions are inspired by a principle of confidentiality. The mediator does not share the precise information it receives from each disputant, but has the mandate to submit settlement proposals to the disputants. As we explain later in more detail, the mediator improves the chance of peace for any given arming probability $q$, upon unmediated peace talks, because it is bound by confidentiality and adopts non fully revealing recommendation strategies. As a result, the players' equilibrium beliefs about their opponents' types are not precise. Hence, players have better incentives to disclose their type confidentially to the Myerson mediator than they have when communicating directly.

**Proposition 5** *For any given militarization strategy $q$, the optimal equilibrium of a crisis bargaining game with a Myerson mediator can be characterized by three parameters, $q_H$, $q_M$, $p_M$ and described as follows: Each player truthfully reveals her arms level to the mediator. Then, hawk dyads $(H, H)$ coordinate on the peaceful demands $(1/2,\ 1/2)$ with probability $q_H$, and fight with probability $1 - q_H$; asymmetric dyads $(H, L)$ coordinate on the peaceful demands $(p\theta,\ 1 - p\theta)$ with probability $p_M$, 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 dove dyads*

[17] Alternatively, we could assume that the proposals are submitted for independent approval to the two disputants, and are implemented if both the players approve them, as in Horner, Morelli and Squintani (2010). As we prove in the Appendix, our results are exactly the same with these two game forms.

*$(L, L)$ achieve peace with demands $(1/2,\ 1/2)$ with probability one.*

*Specifically, when $q \leq \gamma/(\gamma+2)$, $q_H = q_M = 0$, and $p_M \in (0,1)$; when $\gamma/(\gamma+2) \leq q < \gamma/(\gamma+1)$, $p_M + q_M = 1$, $q_H \in (0,1)$ and $q_M \in (0,1)$; and finally, when $q \geq \gamma/(\gamma+1)$, $q_M = 1$, and $q_H = 1$.*

*Whenever $\gamma/(\gamma+2) \leq q < \gamma/(\gamma+1)$, mediation strictly improves the peace chance relative to unmediated peace talks. For all values of $q$, mediation yields at least as large chance of peace as unmediated peace talks.*

The above characterization of optimal mediation strategies is based on the following insights. First, a stronger, more militarized disputant must receive more favorable terms of settlement on average, than a weaker one. Otherwise, the stronger disputant will never accept the proposed settlements, preferring instead to wage war in the expectation that his eventual payoff will be larger than the proposed settlement. But, then, the mediator faces the task of choosing settlements that make sure that weak disputants do not pretend to be stronger, when reporting their information in the first stage of the intermediation. Thus, the mediator proposal strategies are chosen to minimize the expected reward for a weak disputant to pretend that it is strong, when in fact it did not militarize.

As a result, when $\gamma/(\gamma+2) \leq q < \gamma/(\gamma+1)$, the optimal settlement proposal strategies require that the mediator adopts a non-fully revealing recommendation strategy.[18] Specifically, a mediator's optimal strategies are such that the hawk's equilibrium beliefs on its opponent's type are not precise. In equilibrium, when a hawk receives recommendation $(p\theta,\ 1-p\theta)$, it knows for sure that the opponent is a dove; whereas when receiving recommendation $(1/2, 1/2)$, the hawk is unsure about the opponent's type, and the strategy is chosen so as to make the type indifferent between accepting the peaceful settlement recommendation and fighting. In fact, when receiving the report stating that one player is a

[18] In the complementary parameter region, optimal mediation strategies are fully revealing and coincide with the unmediated peace talks game equilibrium of Proposition 2. Of course, a mediator who always truthfully relays the players' reports optimally achieves a peace chance equal to the optimal equilibrium of the game with unmediated peace talks.

hawk and the other is a dove, the mediator recommends the symmetric split $(1/2, 1/2)$ with probability $q_M$, instead of the asymmetric splits $(p\theta, 1-p\theta)$. This strategy is equivalent to not revealing to a hawk that the opponent is a dove.

Consequently, mediation strictly improves the peace chance relative to unmediated peace talks, given any fixed arming probability $q$, as it makes a dove more willing to reveal its type to the mediator, than if communicating directly with its opponent. If revealing its type to a hawk opponent, the dove is in a weak bargaining position and surely needs to accept a low payoff, $1-p\theta$, to secure peace. If instead revealing its type to a mediator, the dove is given $1/2$ of the pie with probability $q_M$, and the lower payoff $1-p\theta$ only with probability $p_M = 1-q_M$.

We will later see how this optimal mediation strategy, which minimizes the difference between the hawk's and the dove's utility in the mediation game, also leads to optimal incentives for militarization.

**Mediation and Militarization** We now build on the above result to solve for the militarization equilibrium probability $q$ given that the ensuing dispute is solved via Myerson mediation. The following result characterizes the equilibrium militarization and conflict probability. Importantly, it shows that Myerson mediation does not suffer from the drawbacks presented by unmediated bilateral peace talks. Not only can a Myerson mediator improve the peace chance given militarization strategies $q$ but such a mediator can also improve welfare in the whole game, which captures the "upstream" militarization decisions.

**Proposition 6** *In the crisis bargaining game with a Myerson mediator, the best equilibrium can be characterized as follows: For any militarization cost $k$, there is a unique symmetric equilibrium militarization probability $q(k)$, which strictly decreases in $k$ for $k \in [0, \bar{k}]$, with $q(0) = \gamma/(\gamma+1)$, and $q(\bar{k}) = \gamma/(\gamma+2)$.*[19]

*Myerson mediators improve the chance of peace $V$, and the welfare $W$ with respect to un-*

[19]The explicit formula for the mixing probability is cumbersome, and is relegated to the appendix.

*mediated peace talks, and the benchmark Nash demand game without communication.*

This Proposition finds that the optimal strategies of Myerson mediators, who are only given a mandate to minimize the chance that conflict erupts in the dispute that they mediate, do not breed perverse incentives for dispute emergence and militarization. Refreshingly, the reason for this powerful result is intuitive. As we explained in the discussion after Proposition 5, the optimal mediation strategies are chosen to minimize the expected reward for a dove to pretend that it is a hawk, when, in fact, it did not militarize. As an unintended consequence, they also minimize the incentives for a weak disputant to militarize and become strong. Hence, Myerson mediators not only improve the chance that the disputes that emerge are more often resolved peacefully than with unmediated peace talks. They also keep in check the disputants' incentives to let the dispute emerge, and militarize.

A more formal intuition can be grasped by noting that, given any dispute resolution institution, the equilibrium mixed strategy $q$ of the arming strategy is given by

$$q = \frac{U(H,L) - U(L,L)}{U(H,L) - U(L,L) + U\left(L,H\right) - U(H,H)}, \tag{1}$$

where $U(t_A, t_B)$ is player $A$'s expected payoff in the dispute when the players' types are $t_A$ and $t_B$. Hence, the equilibrium militarization strategy $q$ increases in $U(H,L) - U(L,L)$, the gain for being a hawk instead of a dove, when facing a dove. Similarly, $q$ decreases in $U\left(L,H\right) - U(H,H)$, the loss for being a hawk instead of a dove, when facing a hawk. Myerson mediation penalizes choosing to be a hawk more than bilateral and direct cheap talk, i.e., it makes $U(H,L) - U(L,L)$ smaller and $U\left(L,H\right) - U(H,H)$ larger. Hence, it makes the militarization strategy $q$ smaller in equilibrium.

The key relevance of Proposition 6 lies in the comparison with Proposition 4. The latter shows that, because unmediated peace talks reduce the risk of war in the disputes that emerge, it may paradoxically incentivize arming, and thus ultimately raise the risk of war. Instead, Proposition 6 shows that Myerson mediation does not suffer from this drawback: it improves the chances of peaceful dispute resolution without creating negative militarization distortions. So, while the exact nature of the bargaining or mediation protocol will likely have effects on exact settlements, the probability of war, and the chance of peace, in general there should be a difference in militarization strategies across crises conditional on observed dispute settlement techniques. In fact, empirically, this is sometimes the case. For example, looking at the data from Svensson's (2007) study on the effects of direct negotiations and mediation on agreements in all intrastate armed conflicts between 1989 and 2003, one finds that if you compare the size of government armies in crises with just bilateral negotiations to those with a mediator the first category averages 273,901 troops whereas when a mediator is used the average army size is only 124,277. A simple t-test rejects the hypothesis of no difference in these case at better than a .001 level.

**The Institutional Optimality of Mediation** The previous sub-section proved that Myerson mediation not only improves the chance that disputes that emerge are resolved peacefully more effectively than with unmediated peace talks, but also keeps the potential disputants incentives to let the dispute emerge and militarize in check. Next, we will now show a much stronger result. Myerson 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 'punish' nations for militarizing and entering a dispute in the first place.[20] That is, a mediator with the mandate to consider total welfare and balance the militarization incentives that lead to dispute emergence against the objective to foster peaceful resolution of the disputes that emerge, can do no better than the Myerson mediator with a 'narrow' and more realistic mandate.

**Theorem 1** *Although Myerson mediators may not take into account the incentives they*

[20]Such an optimal hypothetical mediator is not likely available in the real world, and serves only as benchmark to assess how much is lost by the narrow mandate. We maintain the assumption that the optimal institution does not have access to privileged information beyond what it gathers from communication with the disputants and that it is budget balanced. That is, the optimal institutiom cannot bribe or punish the players to force them to settle.

*create for strategic militarization, they are an optimal institution among all budget-balanced institutions with no direct access to disputants information, for the aim of both arms reduction and peace chance maximization in the militarization and bargaining game.*

An intuitive description of the proof of Theorem 1 may be obtained by considering equation (1) again. Recall from Proposition 5 that, under optimal Myerson mediation, (i) dove pairs never fight, (ii) the settlement $(p\theta, 1 - p\theta)$ is chosen so as to keep the payoff of hawks meeting doves as low as possible, and (iii) hawk pairs are more likely to fight than any other type pair. Hence, the mediator minimizes the incentives of a weak nation to pretend that it is strong. As an unintended consequence, it also minimizes the incentives for a weak nation to become strong. That is, Myerson mediation minimizes $U(H, L) - U(L, L)$ and maximizes $U(L, H) - U(H, H)$, among all budget-balanced institutions. Hence, it keeps the upstream incentives to arm in check, and minimizes strategic militarization $q$ in equilibrium. In other words, such a mediator induces the same militarization incentives as the hypothetical institution whose mandate includes deterring militarization which took place before the eruption of the crisis.

Because, by construction, the mediator's strategy in Proposition 5 maximizes the chance of peace given any militarization strategy $q$, the fact that it also minimizes the equilibrium militarization probability implies that it maximizes the overall disputants' welfare, among all budget-balanced institutions.

# 4 Conclusion

This paper pushes scholars of conflict to broaden their field of vision in thinking about institutions. How nations negotiate can affect more than whether the crises that emerge are resolved peacefully; conflict resolution institutions can have pronounced affects on the types of crises that are likely to emerge by shaping militarization incentives. Because engagement in a costly and destructive war can be seen as the 'punishment' for entering a dispute, institutions that reduce the chances that a dispute lead to open conflict may make more disputes emerge and incentivize militarization.

We show that the consideration of militarization incentives is important to assess the effectiveness of conflict resolution institutions. Our formal analysis finds that the support for unmediated peace talks, while effective in improving the chance of peace for a given distribution of military strength, ultimately may lead to the emergence of more disputes and to higher conflict outbreak. Happily, we find that not all conflict resolution institutions suffer from these, apparently paradoxical, but actually quite intuitive drawbacks. We identify a form of third-party intervention inspired by the celebrated work by Myerson, and show that it can broker peace in emerged disputes effectively and also avoid perverse militarization incentives.

Beyond broadening the focus of theoretical work on conflict resolution institutions to consider the effects we describe above, this paper contributes to our understanding of communication and bargaining. A series of paper going back to at least Kydd (2003) focus on the question of whether mediation can improve on direct communication. At the heart of this debate is whether there is value in a mediator with no independent private information and no ability to create external incentives. In the case of private values the answer is no (Fey and Ramsay, 2010), but in the context of interdependent values the answer is yes (Horner Morelli and Squintani, 2010).

In this paper we have focused on how the effectiveness of mediated and unmediated communication can differ as the former does not breed perverse militarization incentives, whereas the latter does. The difference hinges on the confidentiality of communication through a mediator. 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 can optimally shape the equilibrium beliefs players assign to their opponent being a hawk at the time that they must accept or reject an offer. In settings with interdependent values this belief is important as it influences what a hawk will accept. But in settings with private values the type of the other nation is not payoff relevant and thus the ability to influence this belief buys a mediator nothing.

To be sure, mediators improve upon direct communication only if they are capable to commit to quit negotiations in which disputants report that they are highly militarized (and as argued in footnote 16, this supposition often seems realistic to us). This capability, while seemingly counterproductive, is necessary both to avoid that the disputes that emerge erupt in open warfare, and to provide optimal incentives for arming and dispute emergence. Hence, one final take away of this paper is a better understanding of what makes a mediator effective —the confidentiality of communication, the commitment capability, and when such attributes can have the most value —when the uncertainty is about common value components.

# References


[1] Allison, G.T., A. Carnesale, and J.S. Nye Jr (1985) "Hawks, Doves and Owls: A New Perspective on Avoiding Nuclear War," *International Affairs* (Royal Institute of International Affairs), **61(4)**, 581–89.

[2] Baliga, S. and T. Sjöström (2004): "Arms Races and Negotiations," *Review of Economic Studies,* **71(2)**, 351–69.

[3] Bercovitch, J. (1997): "Mediation in International Conflict: An Overview of Theory, a Review of Practice," in I.W. Zartmann and J.L. Rasmussen (eds) *Peacemaking in International Conflict: Methods and Techniques*, Washington D.C.: United States Institute of Peace Press.

[4] Beardsley, K. (2008) "Agreement without Peace? International Mediation and Time Inconsistency," *American Journal of Political Science,* **52(4)**, 723–740.

[5] Bercovitch, J., J.T. Anagnoson, and D. Wille (1991): "Some conceptual issues and empirical trends in the study of successful mediation in international relations," *Journal of Peace Research* **28(1)**, 7–17.

[6] Bercovitch, J. and A. Houston (2000): "Why Do They Do It? An Analysis of the Factors Influencing Mediation Behavior in International Conflicts," *Journal of Conflict Resolution*, **44(2)**, 170–202.

[7] Bercovich, J. and R. Jackson (2001): "Negotiation or Mediation? An Exploration of Factors Affecting the Choice of Conflict Management in International Conflict,"*Negotiation Journal*, **17**, 59–77.

[8] Bester, H. and K. Wärneryd (2006): "Conflict and the Social Contract," *Scandinavian Journal of Economics*, **108(2)**, 231–49.

[9] Blainey, Geoffrey. (1973): The Causes of War, New York: the Free Press.

[10] Brito, D.L. and M.D. Intriligator (1985): " Conflict, War, and Redistribution, " *American Political Science Review*, **79(4)**, 943-57.

[11] Chapman, Terrence L. and Scott Wolfrord. (2010) "International Organization, Strategy, and Crisis Bargaining." *International Organization,* **71(1)**, 227-242.

[12] Chassang, S. and G. Padro i Miquel (2008) "Conflict and Deterrence under Strategic Risk," NBER Working Paper 13964.

[13] Collier, Peter and Anke Hoffler. (2006) "Military Expenditures in Post-Conflict Societies." *Economics and Governance,* **7(1)**, 87–107.

[14] Dixon, W. J. (1996): "Third Party Techniques for Preventing Conflict Escalation and Promoting Peaceful Settlements," *International Organization,* **50:3**, 653-68.

[15] Fang, Songying. (2010): "The Strategic Use of International Institutions in Dispute Settlement." *Quarterly Journal of Political Science,* **63(2)**, 107–131.

[16] Fearon, J.D. (1995): "Rationalist explanations for war," *International Organization,* **49(3)**, 379-414.

[17] Fearon, James D. (1997) "Signaling Foreign Policy Interests: Tying Hands versus Sinking Costs." *The Journal of Conflict Resolution,* **41(1)**, 68–90.

[18] Fey, M. and K. Ramsay (2009): "Mechanism Design Goes to War: Peaceful Outcomes with Interdependent and Correlated Types," *Review of Economic Design*, **13(3)**, 233–250.

[19] Fey, M. and K. Ramsay (2010): "When Is Shuttle Diplomacy Worth the Commute?: Information Sharing through Mediation", *World Politics*, **62(4)**, 529-560.

[20] Fisher, R.J. (1995): "Pacific, Impartial Third Party Intervention in International Conflict: a Review and Analysis." In *Beyond Confrontation: Learning Conflict Resolution in the Post Cold War Era.* Ed. Vasquez, Johnson, Jaffe and Stamato, Ann Arbor: University of Michigan Press, 39–59.

[21] Frazier, Daniel V. and W. J. Dixon. (2006) "Third Party Intermediaries and Negotiated Settlements, 1945-2000," *International Interactions*, **32(4)**, 385-408.

[22] Garfinkel, Michelle R. (1990) "Arming as a Strategic Investment in a Cooperative Equilibrium," *American Economic Review*, Vol. **80(1)**, 50-68.

[23] Garfinkel, Michelle R. and Stergios Skaperdas (1996) *The Political Economy of Conflict and Appropriation*, editors, Cambridge: Cambridge University Press.

[24] Gilligan, Michael, Leslie Johns, and B. Peter Rosendorf. (2010) "Strengthening International Courts and the Early Settlement of Disputes." *Journal of Conflict Resolution,* **54(1)**, 5–38.

[25] Harsanyi, John C. (1973) "Games with randomly disturbed payoffs: a new rationale for mixed-strategy equilibrium points", *International Journal of Game Theory,* **2,** 1–23.

[26] Horner, J., M. Morelli and F. Squintani (2010): "Mediation and Peace", mimeo, *Yale University.*

[27] Intriligator, Michael D. (1964) "Some Simple Models of Arms Races," *General Systems,* **9(1)**, 143-147.

[28] Jackson, M.O. and M. Morelli (2011): "Reasons for War: an Updated Survey," *Handbook on the Political Economy of War* edited by Chris Coyne, Elgar Publishing.

[29] Jackson, M.O., and M. Morelli (2009): "Strategic Militarization, Deterrence and Wars," *Quarterly Journal of Political Science*, **4(4)**, 279-313;

[30] Jervis, Robert (1978): "Cooperation under the Security Dilemma," *World Politics*, **30(2)**, 167-214.

[31] Kelman, H.C. (1958): "Compliance, Identification, and Internalization: Three processes of attitude change," *Journal of Conflict Resolution* **2**, 51–60.

[32] Kleiboer, M. (1996): "Understanding Success and Failure of International Mediation," *Journal of Conflict Resolution*, **40(2)**, 360–89.

[33] Kydd, Andrew (2000): "Arms races and arms control: Modeling the hawk perspective," *American Journal of Political Science*, **44 (2)**, 228-44.

[34] Kydd, Andrew (2003): "Which Side Are You On? Bias, Credibility, and Mediation," *American Journal of Political Science*, **47(4)**, 597–611.

[35] Matthews, Steven A., and Andrew Postlewaite. "Pre-play communication in two-person sealed-bid double auctions." *Journal of Economic Theory*, **48(1)**, 238-263.

[36] Meirowitz, A.H. and K. Ramsay (2009): "Investing in Failure: Equilibrium Constraints on Prior Beliefs in Bargaining Problems," mimeo: Princeton University.

[37] Meirowitz, A.H. and A.E. Sartori (2008): "Strategic Uncertainty as a Cause of War," *Quarterly Journal of Political Science,* **3**, 327–352.

[38] Myerson, R.B. (1979): "Incentive Compatibility and the Bargaining Problem," *Econometrica*, **47(1)**, 61–73.

[39] Myerson, R.B. (1982): "Optimal coordination mechanisms in generalized principal-agent problems," *Journal of Mathematical Economics*, **10(1)**, 67–81.

[40] Nash, John. (1953) "Two-person bargaining games." *Econometrica,* **21(1)**,128–140.

[41] Powell, R. (1993), "Guns, Butter and Anarchy," *American Political Science Review,* **87(1)**, 115-32;

[42] Powell, R. (2006) "War as a Commitment Problem," *International Organization,* **60(1)**, 169-203.

[43] Raiffa, H. (1982): *The Art and Science of Negotiation,* Harvard University Press.

[44] Ramsay, Kristopher W. (2011). "Cheap Talk Diplomacy, Voluntary Negotiations, and Variable Bargaining Power," *International Studies Quarterly*, **55(4)**, 1003–1023.

[45] Rauchhaus, R. W. (2006): "Asymmetric Information, Mediation and Conflict Management," *World Politics*, **58**, 207–241.

[46] Sartori, Anne E. (2002), "The Might of the Pen: A Reputational Theory of Communication in International Disputes," *International Organization*, **56(1)**, 123–151.

[47] Schelling, Thomas C. (1966): *Arms and Influence,* New Haven and London, Yale University Press.

[48] Smith, A. (1998) "Fighting Battles, Winning Wars," *The Journal of Conflict Resolution*, **42(3)**, Opening up the Black Box of War: Politics and the Conduct of War, June, pp. 301-320.

[49] Smith, A. (1998) "International Crises and Domestic Politics," *American Political Science Review*, **92(3)**, 623-638.

[50] Savun, B. (2008) "Information, Bias, and Mediation Success", *International Studies Quarterly*, **52(1)**, 25-47.

[51] Trager, R. (2011) "Multi-Dimensional Diplomacy", *International Organization*, **65(3)**, 469-506.

[52] Touval, S., and I.W. Zartman (1985): "Introduction: Mediation in theory," In *International mediation in theory and practice*, edited by S. Touval and I.W. Zartman, 7–17. Boulder, CO: Westview.

[53] United Nations General Assembly Security Council (2000): Report A/55/305-S/2000/809.

[54] Wagner, R. H. (2000): "Bargaining and War," *American Journal of Political Science*, **44(3)**, 469-84.

[55] Wall, J.A. and A. Lynn (1993): "Mediation: A Current Review," *Journal of Conflict Resolution*, **37(1)**, 160–94.

[56] Watkins, M. (1998): "Building Momentum in Negotiations: Time-Related Costs and Action-Forcing Events," *Negotiation Journal*, **14(3)**, 241–256.

[57] Wilkenfeld, J., Young, K.J., Quinn, D.M. and V. Asal (2005): *Mediating International Crises*, Oxon, U.K.: Routledge.

[58] Wittman, Donald. (2009) "Bargaining in teh Shadow of War: When is a Peaceful Resolution Most Likely?" *American Journal of Political Science,* **55(4)**, 588–602.

[59] Young, O.R. (1967): *The intermediaries: Third parties in international crises*, Princeton, N.J.: Princeton University Press.

# Online Appendix not Submitted for Publication

## Proofs of Results on Unmediated Peace Talks

Throghout the Appendices, we will use the notation $\lambda = q/(1-q)$, which denotes the odds ratio associates with the probability $q$ that players are militarized, as this will simplify calculations.

**Proof of Proposition 1.** First, note that for $q\theta/2 + (1-q)\,p\theta \leq 1/2$, or $q \geq \gamma/\left(\gamma+1\right)$, both doves and hawks can achieve peace by coordinating on the claims $x_A = x_B = 1/2$. When $q < \gamma/\left(\gamma+1\right)$, it is impossible that hawk dyads achieve peace. But it is possible to achieve peace for all other type dyads, as long as the hawk's claim is compatible with an opponent dove's demand. This is achieved by setting $x_L + x_H = 1$, so that peace can be achieved in equilibrium. Also, a hawk must prefer to demand $x_H$ rather than triggering war against a dove by making a higher demand (if meeting a hawk, the demand will result in war anyway). Hence, we need that $x_H \geq p\theta$. Further, a dove must prefer to post her demand $x_L$ rather than triggering war with a hawk, but collecting a higher share of the pie with a dove, by making the demand $1-x_L$. This requirement translates into the following inequality: $\left(1-q\right)/2 + qx_L \geq \left(1-q\right)\left(1-x_L\right) + q\left(1-p\right)\theta$. Bringing together these conditions, we obtain the condition that $q \geq \gamma/\left(\gamma+2\right)$. When this condition fails, it is impossible to achieve peace for mixed hawk-dove dyads. As a result, only dove dyads will achieve peace, by making compatible claims $x_L = 1/2$. ■

**Proof of Proposition 2.** We calculate the equilibrium militarization strategy $q$ given the solution of the crisis bargaining game in Proposition 1.

We first search for completely mixed strategies, i.e., we impose the indifference condition

$$I_L\left(q\right) = I_H\left(q\right) - k;$$

where $I_L\left(q\right)$ and $I_H\left(q\right)$ are the interim payoffs of doves and hawks respectively.

On the basis of Proposition 1, there are two cases to consider.

Case 1: $q \leq \gamma/\left(\gamma+2\right)$. Here, peace is only achieved by dove dyads, and so:

$$I_L\left(q\right) = q(1-p)\theta + (1-q)/2$$

$$I_H\left(q\right) = q\theta/2 + (1-q)p\theta.$$

Solving the indifference condition, we obtain

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

which is an increasing expression in $q$, such that $k(0) = p\theta - 1/2$.

Case 2. $\gamma/(\gamma+2) < q \leq \gamma/(\gamma+1)$. Here, only hawk dyads result in war. Because $x_H = p\theta$ and $x_L = 1 - p\theta$, we obtain:

$$I_L(q) = q(1-p\theta) + (1-q)/2$$

$$I_H(q) = q\theta/2 + (1-q)p\theta.$$

Solving the indifference condition yields:

$$k(\lambda) = (1-\theta)\frac{\gamma - \lambda(1-\gamma)}{2(\lambda+1)},$$

which is a decreasing function in $\lambda$ such that $k^+(\gamma/2) = (1-\theta)\frac{(\gamma+1)\gamma}{2(\gamma+2)} < k^-(\gamma/2) = \frac{(\gamma+3)\gamma}{2(\gamma+2)}(1-\theta)$ and $k(\gamma) = (1-\theta)\frac{\gamma^2}{2(\gamma+1)}$. Inverting the expression $k(\lambda)$, and changing variable to $q$, we obtain:

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

Hence, we obtain that for $k \in [0, (1-\theta)\frac{\gamma^2}{2(\gamma+1)})$, there is no completely mixed strategy equilibrium $q$.

For $k \in [(1-\theta)\frac{\gamma^2}{2(\gamma+1)}, (1-\theta)\frac{(\gamma+1)\gamma}{2(\gamma+2)}]$, the unique completely mixed strategy equilibrium $q(k) = \gamma - \frac{2k}{1-\theta}$ is decreasing in $k$, such that $\lambda\left((1-\theta)\frac{\gamma^2}{2(\gamma+1)}\right) = \gamma$ and $\lambda\left((1-\theta)\frac{(\gamma+1)\gamma}{2(\gamma+2)}\right) = \gamma/2$.

For $k \in ((1-\theta)\frac{(\gamma+1)\gamma}{2(\gamma+2)}, (1-\theta)\frac{\gamma}{2})$, there is no completely mixed strategy equilibrium $q$.

Considering that, for $k \geq (1-\theta)\frac{\gamma}{2}$, there is a pure strategy equilibrium, in which $q = 0$, we can disregard case 1, which yields higher militarization probability and lower welfare.

Now consider pure-strategies. Suppose that $q = 0$, then $I_L(q) = 1/2$ and $I_H(q) = p\theta$.Hence, $q = 0$ is an equilibrium if and only if $k \geq p\theta - 1/2 = (1-\theta)\frac{\gamma}{2}$. In the remaining region, $k < (1-\theta)\frac{(\gamma+1)\gamma}{2(\gamma+2)}$, the 'grim' equilibrium, in which disputants arm and then fight is the unique equilibrium. ■

**Proof of Proposition 3.** In order to prove this result, we first reformulate the problem by substituting the last stage of the game, the double auction 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 $(x, 1-x)$.

It is evident that any outcome of this simpler model is also an equilibrium of our model. Suppose, in fact, that the players agree to the split division $(x, 1-x)$ in the simpler model. Then, they can achieve the outcome $(x, 1-x)$ in the double auction game, by making demands $x_A = x$ and $x_B = 1-x$.

Focusing on fully-separating equilibria, one can also establish the converse result, that any equilibrium of our model (with the double auction game) is also an outcome of this simpler model. In fact, when types fully separate at the cheap talk stage, each player's type is common knowledge in the double auction stage. Hence, in equilibrium, the players know each other's demands. Suppose that, in equilibrium, player $A$ demands $x$. Player $B$'s best response is either to demand $1-x$, or to trigger war with a higher demand. Hence, either peace takes place with the split $(x, 1-x)$, or war occurs. Player $B$'s choice of whether to trigger war or make the demand $1-x$ follows exactly the same calculation that it would make in the simpler model we introduced above, if nature selected the split proposal $(x, 1-x)$. Because the same argument applies to player $A$, we have shown that any fully-separating equilibrium of our model (with the double auction game) is also an outcome of this simpler model.

Note, now, that pure-strategy equilibria of our model belong to two different categories: pooling equilibria and fully-separating equilibria. Of course, the pooling equilibria coincide with the equilibria of the game of conflict without peace talks. Hence, the solution of our problem can be achieved by comparing the equilibria described in Proposition 1, with the optimal (fully-separating) outcomes of the simpler game introduced in this proof, which are fully characterized in Lemma 1 in Horner Morelli and Squintani (2010). These outcomes are the one reported in the statement of Proposition 3. They induce a higher peace chance than the equilibria described in Proposition 1, because it is the case that $p_H > 0$, when $\gamma/2 \leq \lambda < \gamma$, and that $p_M > 0$, when $\lambda < \gamma/2$. ■

**Proof of Proposition 4 .** In the notation of the separating equilibrium, for any given militarization probability, the interim payoffs are:

$$I_L(q) = q(p_M(1-b) + (1-p_M)(1-p)\theta) + (1-q)/2$$

$$I_H(q) = q(p_H/2 + (1-p_H)\theta/2) + (1-q)(p_M b + (1-p_M)p\theta).$$

We search for completely mixed strategies, i.e., we impose that $I_L(q) = I_H(q) - k$. There are two cases.

Case 1: $\lambda \leq \gamma/2$. Substituting the solution described in Proposition 3 into the above expressions, we obtain:

$$I_L(q) = q\left[\frac{1}{1+\gamma-2\lambda}(1-p\theta) + \left(1-\frac{1}{1+\gamma-2\lambda}\right)(1-p)\theta\right] + (1-q)/2$$

$$I_H(q) = q\theta/2 + (1-q)p\theta.$$

Solving the indifference condition, and reparametrizing to get rid of $p$ and $q$, we obtain the $k$ which makes the players indifferent for $\lambda$ and $\gamma$ and $\theta$ fixed:

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

Because $2\lambda \leq \gamma$, this is always positive.

We first differentiate $k(\lambda)$,

$$\begin{aligned}\frac{\partial k(\lambda)}{\partial\lambda} &= \frac{1}{2}(\gamma-2\lambda+1)^{-2}(\lambda+1)^{-2}(\gamma-4\lambda-1)(\gamma+1)(1-\theta)\\ &\propto \gamma-4\lambda-1\end{aligned}$$

The expression is positive for $\lambda < (\gamma-1)/4$ and negative for $\lambda > (\gamma-1)/4$, on the range $\lambda \in [0,\gamma/2]$. Then, we calculate the extremes of the range: $k(0) = (1-\theta)\frac{\gamma}{2}$ and $k(\gamma/2) = (1-\theta)\frac{(\gamma+1)\gamma}{2(\gamma+2)}$. This concludes that the function $k(\lambda)$ equals $(1-\theta)\frac{\gamma}{2}$ at $\lambda = 0$ to then increase until $\lambda = (\gamma-1)/4$ and then decrease until $\lambda = \gamma/2$ reaching $(1-\theta)\frac{(\gamma+1)\gamma}{2(\gamma+2)}$. Noting that $(1-\theta)\frac{\gamma}{2} > (1-\theta)\frac{(\gamma+1)\gamma}{2(\gamma+2)} > 0$, we determine the following conclusions:

For $[k \in (1-\theta)\frac{(\gamma+1)\gamma}{2(\gamma+2)}, (1-\theta)\frac{\gamma}{2})$, there exists a unique equilibrium $\lambda(k)$, the function $\lambda$ is strictly decreasing in $k$. It starts at $\lambda = \gamma/2$ for $k = (1-\theta)\frac{(\gamma+1)\gamma}{2(\gamma+2)}$ and reaches $\lambda(q) = 0$ for $k = (1-\theta)\frac{\gamma}{2}$. The explicit equilibrium solution is cumbersome, and its omission inconsequential.

For $k \in [0, (1-\theta)\frac{(\gamma+1)\gamma}{2(\gamma+2)})$, there does not exist any equilibrium such that $\lambda \leq \gamma/2$.

Case 2. $\lambda \in [\gamma/2, \gamma)$. The interim payoffs are:

$$I_L(q) = q(1-p\theta) + (1-q)/2$$

$$I_H(q) = q\left[\frac{2\lambda-\gamma}{\lambda(\gamma+2)}(1/2) + \left(1-\frac{2\lambda-\gamma}{\lambda(\gamma+2)}\right)\theta/2\right] + (1-q)p\theta.$$

Hence, the indifference condition yields:

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

which is constant in $\lambda$. So, for $k = (1-\theta)\frac{(\gamma+1)\gamma}{2(\gamma+2)}$, all $\lambda \in [\gamma/2, \gamma)$ are an equilibrium, and there is no completely mixed equilibrium for $k < (1-\theta)\frac{(\gamma+1)\gamma}{2(\gamma+2)}$.

Now consider pure-strategies. Suppose that $q = 0$, then $I_L(q) = 1/2$ and $I_H(q) = p\theta$.Hence, $q = 0$ is an equilibrium if and only if $k \geq p\theta - 1/2 = (1-\theta)\frac{\gamma}{2}$. In the remaining region, $k < (1-\theta)\frac{(\gamma+1)\gamma}{2(\gamma+2)}$, the 'grim' equilibrium, in which disputants arm and then fight is the unique equilibrium. ■

## Proofs of the Results on Third Party Intervention

**Proof of Proposition 5.** The proof of this result consists of showing that the optimal strategies of a Myerson mediator coincide with the optimal strategies of a mediator characterized in Horner, Morelli, and Squintani (2010), Lemma 4.

The basic set up is the same in the two papers: There are two players, whose strength can be high with probability $q$ and of low with probability $1-q$; if fighting, the payoffs are $(\theta/2, \theta/2)$ when players have the same strength, and $p\theta$, $(1-p)\theta$ if the first player is stronger. Unlike here, when modeling mediation in HMS, we directly appeal to the revelation principle (Myerson, 1982) and restrict attention, without loss of generality, to direct revelation mechanisms. In a direct revelation mechanism the players privately report their "types", in this case their realized level of militarization, to the mediator. Then, the mediator makes a recommendation to the players, possibly randomizing across recommendations. In this context, such a recommendation may also be to go to "war". Furthermore, without loss of generality, we restricted attention to truthful equilibria of the direct and obedient revelation mechanism, in which the mediators strategies are such that players reveal their types truthfully to the mediator, and the mediator's recommendation is obeyed by the players. By the revelation principle we know that the ex-ante peace probability induced by *any* mediation scheme, within the class of games described above, can also be achieved as the truthful equilibrium of the game induced by the direct and obedient revelation mechanism. For future reference, we here report the mediation program derived in HMS.

$$\min_{b,p_H,p_M,q_M,p_L,q_L} (1-2p_L-q_L)(1-q)^2 + (1-p_M-q_M)\,2q(1-q) + (1-q_H)\,q^2$$

subject to the high-type *ex post* IR constraint

$$bp_M \geq p_M p\theta, \quad (qq_H + (1-q)q_M) \cdot 1/2 \geq qq_H\theta/2 + (1-q)q_M p\theta,$$

to the low type *ex post* IR constraint

$$\begin{aligned}
&p_L b \geq p_L\theta/2, (qp_M + (1-q)p_L)(1-b) \geq qp_M(1-p)\theta + (1-q)p_L\theta/2, \\
&(qq_M + (1-q)q_L) \cdot 1/2 \geq qq_M(1-p)\theta + (1-q)q_L\theta/2,
\end{aligned}$$

to the high-type *ex interim* IC* constraint

$$\begin{aligned}
&q(q_H/2 + (1-q_H)\theta/2) + (1-q)(p_M b + q_M/2 + (1-p_M-q_M)p\theta) \geq \\
&\max\{(qp_M + (1-q)p_L)(1-b), qp_M\theta/2 + (1-q)p_L p\theta\} + \max\{(1-q)p_L b, (1-q)p_L p\theta\} \\
&+ \max\{(qq_M + (1-q)q_L) \cdot 1/2, qq_M\theta/2 + (1-q)q_L p\theta\} \\
&+q(1-p_M-q_M)\theta/2 + (1-q)(1-2p_L-q_L)p\theta,
\end{aligned}$$

and to the low-type *ex interim* IC* constraint

$$\begin{aligned}
&q(p_M(1-b) + q_M/2 + (1-p_M-q_M)(1-p)\theta) \\
&+(1-q)(p_L b + p_L(1-b) + q_L/2 + (1-2p_L-q_L)\frac{\theta}{2}) \geq \\
&\max\{(1-q)p_M b, (1-q)p_M\frac{\theta}{2}\} + \max\{(qq_H + (1-q)q_M) \cdot 1/2, qq_H(1-p)\theta + (1-q)q_M\frac{\theta}{2}\} \\
&+q(1-q_H)(1-p)\theta + q(1-p_M-q_M)\theta/2,
\end{aligned}$$

To see that such an upper bound can be reached by Myerson mediation in our model, it is sufficient to note that any truthful equilibrium achieved by the direct and obedient revelation mechanism is also an equilibrium of our Nash demand game augmented with a Myerson mediator.

Suppose in fact that the mediator's recommendation is for a peaceful split $(x, 1-x)$ of the pie, accepted by the players in the equilibrium of the game induced by the direct revelation mechanism. Then, there is also an equilibrium of the Nash demand game in which the players demand precisely $x_A = x$ and $x_B = 1-x$, thus resolving the dispute peacefully. And we have seen before that the crisis bargaining game always has war equilibria, to reproduce the outcome of a "war recommendation" in the game induced by the direct revelation mechanism. Hence, the direct revelation mechanism yields an upper bound for the peace probability that mediation can achieve in the Nash demand game augmented with a Myerson mediator.

This concludes that the optimal strategies of a Myerson mediator coincide with the optimal strategies of a mediator characterized in Horner, Morelli, and Squintani (2010), Lemma 4 which states that, for any fixed $q$, the specific values of the control variables are:

- For $q \leq \gamma/(\gamma+2)$, $b = p\theta$, $q_L = 1$, $q_H = q_M = 0$, $p_M = \frac{1-q}{(\gamma+1)(1-q)-2q}$.
- For $\frac{\gamma}{\gamma+2} \leq q < \frac{\gamma}{\gamma+1}$, $b = p\theta$, $q_L = 1$, $p_M + q_M = 1$, $q_H = \frac{1-q}{q}\frac{2q-\gamma(1-q)}{(\gamma+1)(1-q)-q}$, $q_M = \frac{1}{\gamma}\frac{2q-\gamma(1-q)}{(\gamma+1)(1-q)-q}$.
- For $q \geq \frac{\gamma}{\gamma+1}$, $b = p\theta$, $q_L = 1$, $q_M = 1$, and $q_H = 1$.

■

**Proof of Proposition 6.** Consider the Myerson mediation game. The expected equilibrium payoffs of a hawk and dove before they report their type to the mediator are, respectively:

$$I_L(q) = q(p_M(1-p\theta) + q_M/2 + (1-p_M-q_M)(1-p)\theta) + (1-q)/2; \tag{2}$$

$$I_H(q) = q(q_H/2 + (1-q_H)\theta/2) + (1-q)(p_M p\theta + q_M/2 + (1-p_M-q_M)p\theta). \tag{3}$$

Hence, at the beginning of the game, the payoff for militarizing is $I_H(q) - k$, whereas the payoff of remaining a dove is $I_L(q)$. An equilibrium with full militarization, $q = 1$, exists when $I_H(1) - k \geq I_L(1)$; likewise, an equilibrium with no militarization, $q = 0$, exists when $I_L(0) \geq I_H(0) - k$; whereas an equilibrium with mixed militarization strategy $q$ exists when $I_L(q) = I_H(q) - k$.

When $k > p\theta - 1/2$, the unique symmetric equilibrium is $q = 0$. In fact, for all $q$,

$$\begin{aligned}
& I_L(q) - I_H(q) + k \\
= \; & q(p_M(1-p\theta) + q_M/2 + (1-p_M-q_M)(1-p)\theta) + (1-q)/2 \\
& - (q(q_H/2 + (1-q_H)\theta/2) + (1-q)(p_M p\theta + q_M/2 + (1-p_M-q_M)p\theta)) + k \\
> \; & q(p_M(1-p\theta) + q_M/2 + (1-p_M-q_M)(1-p)\theta) + (1-q)/2 \\
& - (q(q_H/2 + (1-q_H)\theta/2) + (1-q)(p_M p\theta + q_M/2 + (1-p_M-q_M)p\theta)) + p\theta - 1/2 \\
= \; & \frac{1-\theta}{2(1+\lambda)}(2\lambda p_M - \lambda q_H - \lambda + 2\lambda q_M + \gamma q_M + \lambda\gamma q_M)
\end{aligned}$$

$$= \begin{cases} \frac{1-\theta}{2(1+\lambda)}\left(2\lambda\frac{1}{1+\gamma-2\lambda}-\lambda\right) & \text{if } \lambda < \gamma/2 \\ \frac{1-\theta}{2(1+\lambda)}\left(2\lambda-\lambda\frac{2\lambda-\gamma}{\lambda(\gamma+1-\lambda)}-\lambda+\gamma\frac{2\lambda-\gamma}{\gamma(\gamma+1-\lambda)}+\lambda\gamma\frac{2\lambda-\gamma}{\gamma(\gamma+1-\lambda)}\right) & \text{if } \gamma/2 \leq \lambda < \gamma \\ \frac{1-\theta}{2}\gamma & \text{if } \lambda \geq \gamma. \end{cases}$$

$$= \begin{cases} \frac{1-\theta}{2(1+\lambda)}\frac{(2\lambda-\gamma+1)}{(\gamma-2\lambda+1)}\lambda & \text{if } \lambda < \gamma/2 \\ \frac{1-\theta}{2(1+\lambda)}\frac{\lambda+1}{\gamma-\lambda+1}\lambda & \text{if } \gamma/2 \leq \lambda < \gamma \\ \frac{1-\theta}{2}\gamma & \text{if } \lambda \geq \gamma. \end{cases}$$

These quantities are all positive.

So, suppose that $k \leq p\theta - 1/2 = (1-\theta)\gamma/2$. We now search for mixed strategy equilibria. The indifference condition is:

$$I_L(q) + k = I_H(q)$$

Case 1: $\lambda \leq \gamma/2$. Substituting the mediator's solution into the expressions (2) and (3), we obtain:

$$I_L(q) = q\left[\frac{1}{1+\gamma-2\lambda}(1-p\theta) + \left(1-\frac{1}{1+\gamma-2\lambda}\right)(1-p)\theta\right] + (1-q)/2$$

$$I_H(q) = q\theta/2 + (1-q)p\theta.$$

Solving the indifference condition, and reparametrizing to get rid of $p$ and $q$, we obtain the $k$ which makes the players indifferent for $\lambda$ and $\gamma$ and $\theta$ fixed:

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

Because $2\lambda \leq \gamma$, this is always positive.

We first differentiate $k(\lambda)$,

$$\begin{aligned} \frac{\partial k(\lambda)}{\partial \lambda} &= \frac{1}{2}(\gamma-2\lambda+1)^{-2}(\lambda+1)^{-2}(\gamma-4\lambda-1)(\gamma+1)(1-\theta) \\ &\propto \gamma-4\lambda-1 \end{aligned}$$

The expression is positive for $\lambda < (\gamma-1)/4$ and negative for $\lambda > (\gamma-1)/4$, on the range

$\lambda \in [0, \gamma/2]$. Then, we calculate the extremes of the range:

$$k(0) = (1-\theta)\frac{\gamma}{2} \, and \, k(\gamma/2) = (1-\theta)\frac{(\gamma+1)\gamma}{2(\gamma+2)}.$$

This concludes that the function $k(\lambda)$ equals $(1-\theta)\frac{\gamma}{2}$ at $\lambda = 0$ to then increase until $\lambda = (\gamma-1)/4$ and then decrease until $\lambda = \gamma/2$ reaching $(1-\theta)\frac{(\gamma+1)\gamma}{2(\gamma+2)}$. Noting that $(1-\theta)\frac{\gamma}{2} > (1-\theta)\frac{(\gamma+1)\gamma}{2(\gamma+2)} > 0$, we determine the following conclusions:

- For $[k \in (1-\theta)\frac{(\gamma+1)\gamma}{2(\gamma+2)}, (1-\theta)\frac{\gamma}{2})$, there exists a unique equilibrium $\lambda(k)$. The function $\lambda$ is strictly decreasing in $k$, it starts at $\lambda = \gamma/2$ for $k = (1-\theta)\frac{(\gamma+1)\gamma}{2(\gamma+2)}$ and reaches $\lambda(q) = 0$ for $k = (1-\theta)\frac{\gamma}{2}$.
- For $k \in [0, (1-\theta)\frac{(\gamma+1)\gamma}{2(\gamma+2)})$, there does not exist any equilibrium such that $\lambda \leq \gamma/2$.

The explicit equilibrium solution is cumbersome, and its omission inconsequential.

Case 2. For $\gamma \geq \lambda \geq \gamma/2$, substituting the mediator's solution into the expressions

$$I_L(q) = q\left[\left(1 - \frac{2\lambda-\gamma}{\gamma(\gamma+1-\lambda)}\right)(1-p\theta) + \frac{2\lambda-\gamma}{2\gamma(\gamma+1-\lambda)}\right] + (1-q)/2$$

$$\begin{aligned} I_H(q) &= q\left[\frac{2\lambda-\gamma}{2\lambda(\gamma+1-\lambda)} + \left(1 - \frac{2\lambda-\gamma}{\lambda(\gamma+1-\lambda)}\right)\theta/2\right] \\ &\quad + (1-q)\left[\left(1 - \frac{2\lambda-\gamma}{\gamma(\gamma+1-\lambda)}\right)p\theta + \frac{2\lambda-\gamma}{2\gamma(\gamma+1-\lambda)}\right]. \end{aligned}$$

Again, solving for the indifference condition and reparametrizing, we obtain

$$k(\lambda) = (1-\theta)\frac{(\gamma-\lambda)(\gamma+1)}{2(\gamma-\lambda+1)},$$

or

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

this is again always positive.

Differentiating it, we obtain:

$$\frac{\partial k(\lambda)}{\partial \lambda} = -\frac{1}{2}(\lambda - \gamma - 1)^{-2}(\gamma+1)(1-\theta) < 0.$$

Calculating it at the two extremes $\lambda = \gamma/2$ and $\lambda = \gamma$, we obtain:

$$k(\gamma/2) = (1-\theta)\frac{(\gamma+1)}{(\gamma+2)}\frac{\gamma}{2}, \textit{ and } k(\gamma) = 0.$$

This concludes that, for $k \in \left[0, (1-\theta)\frac{(\gamma+1)}{(\gamma+2)}\frac{\gamma}{2}\right]$, there is a unique mixed strategy equilibrium $\lambda(k)$, with $\gamma/2 \leq \lambda \leq \gamma$, the function $\lambda(k)$ is strictly decreasing, it starts at $\lambda = \gamma$ for $k = 0$, and reaches $\lambda = \gamma/2$ for $k = (1-\theta)\frac{(\gamma+1)}{(\gamma+2)}\frac{\gamma}{2}$.

Wrapping up the two cases, we conclude that there is a unique mixed strategy equilibrium $\lambda^*(k)$. It is strictly decreasing in $k$ for $k \in \left[0, (1-\theta)\frac{\gamma}{2}\right]$, with $\lambda(0) = \gamma$ and $\lambda\left((1-\theta)\frac{\gamma}{2}\right) = 0$, for $k > (1-\theta)\frac{\gamma}{2}$, $\lambda(k) = 0$.

Turning to check for pure-strategy equilibria, we first suppose that $q = \lambda = 0$, then $I_L(q) = 1/2$ and $I_H(q) = p\theta$. Hence, for $k \leq p\theta - 1/2$, $\lambda = 0$ is not an equilibrium. Then, suppose that $q = 1$. The mediator's solution is to assign $q_L = q_M = q_H = 1$, so that the split 1/2 is always assigned regardless of the reports. Hence, the interim payoffs are $I_L(q) = 1/2 = I_H(q)$. So, becoming a hawk with probability one is never an equilibrium. This result completes the proof of Proposition 6. ■

**Proof of Theorem 1.** To prove this result, we first show a useful Lemma that compares the symmetric equilibrium militarization probability in the *arbitration* dispute resolution solution of HMS, with the *mediation* HMS dispute resolution solution. The arbitration dispute resolution in HMS is formulated as mediation, with the only difference that players must commit to agree to the third party recommendation before such recommendations are made. In other terms, the arbitrator is capable of enforcing its recommendation, whereas the mediator's recommendations need to be self enforcing.

Formally, the HMS arbitration program is formalized as follows:

$$\min_{b, p_L, p_M, p_H} (1-q)^2(1-p_L) + 2q(1-q)(1-p_M) + q^2(1-p_H)$$

subject to *ex interim* individual rationality (for the hawk and dove, respectively)

$$(1-q)(p_M b + (1-p_M)p\theta) + q(p_H/2 + (1-p_H)\theta/2) \geq (1-q)p\theta + q\theta/2,$$
$$(1-q)(p_L/2 + (1-p_L)\theta/2) + q(p_M(1-b) + (1-p_M)(1-p)\theta) \geq (1-q)\theta/2 + q(1-p)\theta,$$

and to the *ex interim* incentive compatibility constraints (for the hawk and dove, respectively)

$$(1-q)\left((1-p_M)p\theta + p_M b\right) + q\left((1-p_H)\theta/2 + p_H/2\right) \geq$$
$$(1-q)\left((1-p_L)p\theta + p_L/2\right) + q\left((1-p_M)\theta/2 + p_M(1-b)\right),$$

$$(1-q)\left((1-p_L)\theta/2 + p_L/2\right) + q\left((1-p_M)(1-p)\theta + p_M(1-b)\right) \geq$$
$$(1-q)\left((1-p_M)\theta/2 + p_M b\right) + q\left((1-p_H)(1-p)\theta + p_H/2\right).$$

**Lemma.** The *arbitration* dispute resolution solution of HMS yields the same symmetric equilibrium militarization probability as the *mediation* HMS dispute resolution solution.

**Proof of Lemma.** For any $\gamma$ (including $\gamma < 1$), HMS show that the arbitration solution is:

- For $\lambda \leq \gamma/2$, $b = \frac{1}{2}(\gamma(1-\theta)+1)$, $p_L = 1$, $p_M = \frac{1}{\gamma-2\lambda+1}$, $p_H = 0$;
- For $\gamma/2 < \lambda \leq \gamma$, $b = -\frac{3\lambda-3\gamma-2\theta\lambda+2\theta\gamma+\lambda\gamma-\theta\lambda\gamma-\gamma^2+\theta\gamma^2-1}{-2\lambda+2\gamma+2}$, $p_L = 1$, $p_M = 1$, $p_H = \frac{2\lambda-\gamma}{(\gamma-\lambda+1)\lambda}$.

The militarization strategy $q$ in the arbitration game is given by the indifference condition:

$$\begin{aligned} & I_L(q) = (1-q)\left((1-p_M)p\theta + p_M b\right) + q\left((1-p_H)\theta/2 + p_H/2\right) \\ = \; & (1-q)\left((1-p_L)\theta/2 + p_L/2\right) + q\left((1-p_M)(1-p)\theta + p_M(1-b)\right) - k = I_H(q) - k \end{aligned} \tag{4}$$

Substituting the above solutions in the indifference condition, we find the expressions:

$$k(\lambda) = (1-\theta)\frac{\left(\gamma-\lambda+\lambda\gamma-2\lambda^2\right)(\gamma+1)}{2(\gamma-2\lambda+1)(\lambda+1)}, \textit{for } \lambda \leq \gamma/2, \tag{5}$$
$$k(\lambda) = (1-\theta)\frac{(\gamma-\lambda)(\gamma+1)}{2(\gamma-\lambda+1)}, \textit{for } \gamma/2 < \lambda \leq \gamma, \tag{6}$$

which correspond to the solutions for the militarization game with the HMS optimal mediation solution (for any $\gamma$, including $\gamma < 1$). ■

As a consequence of the above Lemma, we can prove the Theorem simply by showing that the HMS arbitration solution achieves the same outcome as our hypothetical institution that includes militarization deterrence in its objectives. In fact, we prove a stronger result.

We show that the HMS arbitration solution achieves the same welfare as a hypothetical institution that not only aims to keep militarization in check, but is also capable of enforcing its recommendations. Such an institution is represented by the following program. Let the dove and hawk interim expected utilities be, respectively,

$$I_L = q(p_M(1-p\theta) + q_M/2 + (1-p_M-q_M)(1-p)\theta) + (1-q)/2$$

$$I_H = q(q_H/2 + (1-q_H)\theta/2) + (1-q)(p_M p\theta + q_M/2 + (1-p_M-q_M)p\theta).$$

The optimal institution chooses $q$, $b, p_L, p_M$ and $p_H$ so as to solve the program

$$\min_{q,b,p_L,p_M,p_H} (1-q)^2(1-p_L+p_L\theta)+2q(1-q)(1-p_M+p_M\theta-k)+q^2(1-p_H+p_H\theta-2k)$$

subject to the ex-ante obedience constraints:

$$q(1-q)[I_H-k-I_L]=0, q[I_H-k-I_L]\geq 0,\ (1-q)[I_H-k-I_L]\leq 0$$

to the *ex interim* individual rationality (for the hawk and dove, respectively)

$$\begin{aligned} I_H &\geq (1-q)p\theta + q\theta/2, \\ I_L &\geq (1-q)\theta/2 + q(1-p)\theta, \end{aligned}$$

and to the *ex interim* incentive compatibility constraints (for the hawk and dove, respectively)

$$I_H \geq (1-q)((1-p_L)p\theta + p_L/2) + q((1-p_M)\theta/2 + p_M(1-b)),$$

$$I_L \geq (1-q)((1-p_M)\theta/2 + p_M b) + q((1-p_H)(1-p)\theta + p_H/2).$$

In order to proceed with the proof, we distinguish two parts. We first show that HMS arbitrators achieve the same peace chance as the optimal institution define above. Then, we show that they achieve the same militarization probability minimization as the optimal institution. The analysis holds for any $\gamma$, including the case $\gamma < 1$.

To tackle the first problem, we set up the following relaxed problem which describes necessary constraints satisfied by the hypothetical optimal institution defined above. We choose $\{b, p_L, p_M, p_H, q\}$ so as to minimize the war probability

$$W = (1-q)^2(1-p_L) + 2q(1-q)(1-p_M) + q^2(1-p_H)$$

subject to the hawk *interim* individual rationality constraint

$$(1-q)(p_M b + (1-p_M) p\theta) + q(p_H/2 + (1-p_H)\theta/2) \geq (1-q) p\theta + q\theta/2,$$

and to the dove *interim* incentive compatibility constraint

$$\begin{aligned}
&(1-q)((1-p_L)\theta/2 + p_L/2) + q((1-p_M)(1-p)\theta + p_M(1-b)) \geq \\
&(1-q)((1-p_M)\theta/2 + p_M b) + q((1-p_H)(1-p)\theta + p_H/2).
\end{aligned}$$

and to the militarization indifference condition (4).

To solve the relaxed problem, we first solve $b$ in the militarization indifference condition, and substitute it in the hawk *interim* individual rationality constraint, and in the hawk *interim* incentive compatibility constraint. Rearranging, they now take the forms:

$$\begin{aligned}
H &= k + \frac{1}{2}\theta - kq - p\theta - \frac{1}{2}q\theta + pq\theta + \frac{1}{2}p_L - qp_L + qp_M - \frac{1}{2}\theta p_L + q\theta p_L \\
&\quad -q\theta p_M + \frac{1}{2}q^2 p_H + \frac{1}{2}q^2 p_L - q^2 p_M - \frac{1}{2}q^2\theta p_H - \frac{1}{2}q^2\theta p_L + q^2\theta p_M \geq 0 \\
L &= p\theta - \frac{1}{2}\theta - k + \frac{1}{2}\theta p_M + \frac{1}{2}q\theta p_H - p\theta p_M - \frac{1}{2}q\theta p_M - pq\theta p_H + pq\theta p_M \geq 0.
\end{aligned}$$

Note now that $W$ evidently decreases in $p_L$, that $L$ is independent of $p_L$, and that $\partial H/\partial p_L = \frac{1}{2}(q-1)^2(1-\theta) > 0$. Because setting $p_L = 1$ makes $W$ as small as possible without violating the constraints $H$ and $L$, it has to be part of the solution.

Substituting $p_L = 1$ in $W$, $H$, and $L$, we obtain:

$$\begin{aligned}
H &= k - q - kq - p\theta + \frac{1}{2}q\theta + pq\theta + qp_M - q\theta p_M + \frac{1}{2}q^2 - \frac{1}{2}q^2\theta \\
&\quad + \frac{1}{2}q^2 p_H - q^2 p_M - \frac{1}{2}q^2\theta p_H + q^2\theta p_M + \frac{1}{2}, \\
L &= p\theta - \frac{1}{2}\theta - k + \frac{1}{2}\theta p_M + \frac{1}{2}q\theta p_H - p\theta p_M - \frac{1}{2}q\theta p_M - pq\theta p_H + pq\theta p_M, \\
W &= 2q(1-q)(1-p_M) + q^2(1-p_H).
\end{aligned}$$

Now, we observe that $\partial L/\partial p_H = -\theta q(p-1/2) < 0$ that $\partial L/\partial p_M = -\theta(p-1/2)(1-q) < 0$, and that $L = -k$ when $p_M = 1$ and $p_H = 1$. Because $W$ decreases in both $p_M$ and $p_H$, this concludes that the dove incentive compatibility constraint must bind.

We now solve for $p_M$ in the constraint $L = 0$ and substitute it into the expressions for

$W$ and $H$. We obtain

$$\begin{aligned} W &= q^2 p_H + K_1(p,\theta,q,k) \\ H &= -\frac{1}{2}q^2(1-\theta)p_H + K_2(p,\theta,q,k), \end{aligned}$$

where the explicit formulas of $K_1$ and $K_2$ are inessential. Because $W$ increases in $p_H$ and $H$ decreases in $p_H$, this concludes that the constraint $H = 0$ must bind, unless $p_H = 0$ (which does not matter, as it is part of the HMS arbitration solution).

Solving $p_H$ in the hawk ex interim individual rationality constraint, and substituting the solution in the objective $W$, we obtain:

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

This function increases in $q$ for $k \leq (1-\theta)\gamma/2 = p\theta - 1/2$, because:

$$\frac{\partial W}{\partial q} = \frac{2p\theta - \theta - 2k}{1-\theta} \geq \frac{2p\theta - \theta - (2p\theta - 1)}{1-\theta} = 1 > 0.$$

Hence, the minimization of $W$ under the constraints that $H = 0$, $L = 0$, $0 \leq p_M \leq 1$, $0 \leq p_H \leq 1$ and $0 \leq q \leq 1$ is equivalent to the minimization of $q$ subject to the constraints that $H = 0$, $L = 0$, $0 \leq p_M \leq 1$, $0 \leq p_H \leq 1$ and $0 \leq q \leq 1$.

Note now that setting $q = 0$ together with $H = 0$ and $L = 0$ yields $p_H = \frac{\theta(2p-1)(2p\theta-2k-1)}{0} \to +\infty$, because $\theta(2p-1)(2p\theta - 2k - 1) \geq 0$ when $k \leq p\theta - 1/2$. Hence, the solution must have an interior $q$.

We are now ready to show that the minimal value of $q$ subject to the constraints that $H = 0$, $L = 0$, $0 \leq p_M \leq 1$, and $0 \leq p_H \leq 1$ is exactly the equilibrium value of $q$ in the militarization game, assuming that disputes are solved with the HMS optimal arbitration solution. In order to do so, we take the following approach. We first reparametrize all expressions in $\lambda = q/(1-q)$ and $\gamma = (2p\theta - 1)/(1-q)$. Then, we prove that, for every $\lambda$, the minimal value of $k$ subject to the constraints that $H = 0$, $L = 0$, $0 \leq p_M \leq 1$, and $0 \leq p_H \leq 1$ coincides with the expressions (5) and (6) obtained when solving the militarization indifference condition (4) after plugging in the HMS optimal arbitration solution. Because the expressions for $k(\lambda)$ in (5) and (6) are strictly decreasing in $\lambda$, this concludes that the inverse function $k^{-1}(k) = \lambda$ identifies the minimal $q$ subject to the constraints that $H = 0$, $L = 0$, $0 \leq p_M \leq 1$, and $0 \leq p_H \leq 1$, via the increasing relation $q/(1-q) = \lambda$.

By reparametrizing the expressions for $H$ and $L$, setting both of them equal to zero, and solving for $k$ and $p_H$ as a function of $p_M$, we obtain

$$p_H = \frac{(2\lambda p_M - p_M - \gamma p_M + 1)}{(\gamma - \lambda + 1)\lambda} \quad (7)$$

$$k(\lambda) = -\frac{1}{2}(1-\theta)\frac{\left(\lambda p_M - \lambda\gamma - \gamma + \lambda^2\right)(\gamma+1)}{(\gamma+1-\lambda)(\lambda+1)}. \quad (8)$$

Because $k$ decreases in $p_M$ for all $\lambda < \gamma$, we want to set $p_M$ as large as possible. When $p_M = 1$, $p_H = \frac{(2\lambda-\gamma)}{(\gamma-\lambda+1)\lambda}$, which is positive if and only if $\lambda > \gamma/2$.

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

$$k(\lambda) = \frac{1}{2}(1-\theta)\frac{\left(\gamma - \lambda + \lambda\gamma - 2\lambda^2 + \lambda^2 p_H\right)(\gamma+1)}{(\gamma - 2\lambda + 1)(\lambda+1)}. \quad (9)$$

For $\lambda < \gamma/2$, it is the case that $\gamma - 2\lambda + 1 > 0$, and hence this expression increases in $p_H$. We thus set $p_H = 0$ and it is easy to verify that $p_M = \frac{1}{\gamma-2\lambda+1} \in (0,1)$.

Because we have recovered the HMS optimal arbitration solution, the part of the proof concerning peace chance is concluded.

We now turn to show that HMS arbitrators are the optimal mechanism in terms of militarization probability minimization, and achieve the same militarization probability as the optimal institution defined at the beginning of this proof. Our proof approach will be to show that the HMS optimal arbitration solution is the solution of the following relaxed problem:

$$\min_{p_L, p_M, p_H, b} q \text{ s.t. } H = 0,\ L = 0,\ I_H - k = I_L \quad (10)$$

In order to do so, we first reparametrize all constraints in $\lambda = q/(1-q)$ and $\gamma = (2p\theta - 1)/(1-q)$. Then, we prove that, for every $\lambda$, the minimal value of $k(\lambda) = I_H - I_L$ subject to the constraints $0 \le p_L \le 1$, $0 \le p_M \le 1$, $0 \le p_H \le 1$, $H = 0$ and $L = 0$ coincides with the expressions (5) and (6). Because these expressions strictly decrease in $\lambda$, the same reasoning as in the previous part of the proof then concludes that the problem (10) is solved by the HMS optimal arbitration solution.

So, we first differentiate $k(\lambda) = I_H - I_L$ with respect to $p_L$, and obtain the negative derivative $-\frac{1}{2}(1-q)(1-\theta)$. Because we know that $\partial H/\partial p_L > 0$ and $\partial L/\partial p_L = 0$, minimization of $k(\lambda)$ requires setting $p_L = 1$. Then, we note that $\partial k(\lambda)/\partial b > 0$, whereas $\partial H/\partial b > 0$, and hence the constraint $H = 0$ must bind. Then, we see that $\partial k(\lambda)/\partial p_M = b - p\theta - q(1-\theta) < 0$, because $H = 0$ implies that $b - p\theta = \frac{q\theta p_H - qp_H + 2p\theta p_M - 2pq\theta p_M}{2(1-q)p_M} - p\theta = -\frac{1}{2}(1-\theta)\frac{qp_H}{(1-q)p_M} \le 0$. This, together with $\partial L/\partial p_M = -\theta(p - 1/2)(1-q) < 0$ implies that $L$ binds.

Solving for $p_H$ and $b$ in the constraints $H = 0$, $L = 0$, after imposing $p_L = 1$, and substituting the results in $k(\lambda)$, we again obtain the expressions (7) and (8), so that we conclude that for $\lambda > \gamma/2$, the solution is $p_M = 1$, $p_H = \frac{(2\lambda-\gamma)}{(\gamma-\lambda+1)\lambda}$. Likewise, solving for $p_H$ and $b$ in the constraints $H = 0$, $L = 0$, after imposing $p_L = 1$, and substituting the results in $k(\lambda)$, we obtain expression (9), and conclude that the solution is $p_H = 0$ and $p_M = \frac{1}{\gamma-2\lambda+1} \in (0,1)$, for $\lambda < \gamma/2$.

Because we have recovered the HMS optimal arbitration solution, the part of the proof concerning militarization probability is concluded. ■