Cheap talk with multiple senders and receivers: Information transmission in ethnic conflicts*

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Abstract

Consider a society with two ethnic groups in which the state of the world is uncertain. Without new information, ethnic conflict ensues. If there is an informed agent who knows the state of the world and can communicate via private cheap talk messages, can she prevent conflict? We find that while a peace-loving informed agent is unable to prevent conflict as she cannot communicate credibly with either ethnicity, an aggressive informed agent can communicate information to her own ethnicity, and therefore prevent conflict with positive probability. Furthermore, we show that when there are two aggressive informed agents (one in each ethnicity), then both ethnic groups receive information, but, under some conditions, there is an informative equilibrium in the environment with one informed agent which generates a higher probability of peace than any informative equilibrium with two informed agents.

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1 Introduction

Consider a society with two ethnic groups[1] that are about to engage in conflict. For example, this could be due to misinformation spread by a politician about the number of extremists in one of the ethnic groups. There is an informed agent who has information about the state of the world (actual number of extremists in the ethnic groups). When can this information increase the probability of peace? There are several roadblocks: a) the informed agent belongs to one of the ethnic groups herself and is known to be biased towards them, making it difficult for her to credibly communicate with the other ethnic group, b) the informed agent may prefer winning the conflict to peace, and c) the informed agent may be able to send private signals to every player which allows her to lie to some players and not to others[2], and this makes it more difficult for her to be credible.

To analyse these questions, we consider a cheap talk game with multiple audiences and either one (baseline case) or two senders. A society has two ethnic groups, each with a mass of players, and each player can be strategic or behavioural. While a strategic player can choose between playing fight or not fight, a behavioural player always fights. There are two states of the world: in the good state, the fraction of behavioural players is lower than that in the bad state. The probability of conflict is convex in the average fraction of players who play fight in both ethnicities. Thus, fixing the fraction of strategic players who fight, the probability of conflict is higher in the bad state. If a conflict occurs, then an ethnicity's probability of winning is positively related to the fraction of its own players who fight (Tullock contest). The payoffs are such that all players taking the action 'fight' is always an equilibrium. We assume that without further information this equilibrium will be played. This is how we model the idea that '*society is on the verge of conflict*'. Although other equilibria also exist, since our focus is on the role of information in preventing conflicts, this assumption allows us to ask how and when new information can steer the society away from the default outcome of conflict. We discuss this assumption in more detail in section 3, and discuss the nature and role of the informed agent next.

While players are uncertain about the state of the world, an informed agent knows it perfectly and can send private cheap talk messages to all players before they make their action choice. We consider two types of informed agents: a peace loving informed agent (prefers peace to own ethnic-

[1]Ethnicity could be based on religion, race, tribe etc.
[2]As opposed to if only public signals were possible.

ity winning a conflict to own ethnicity losing the conflict) and an aggressive informed agent (prefers conflict occurring with own ethnicity winning to peace to own ethnicity losing the conflict)[3]. Our first result is that the peace loving informed agent cannot prevent conflict whereas the aggressive informed agent can. The intuition for this result is as follows. First, due to her bias towards her own ethnic group, irrespective of her preference for peace or conflict, the informed agent cannot communicate credibly with the players of the opposite ethnicity[4]. Second, for any equilibrium play of the opposite ethnicity players, a peace loving informed agent always wants to send that message to her own ethnicity which maximizes the probability of peace, thereby rendering her messages uninformative. The reason for this is that the gain in payoff from the increased probability of peace and the large payoff peace offers compensates for the loss in payoff which comes from the higher probability of losing if a conflict does occur. The gains outweigh the losses because when more own ethnicity players choose to not-fight, the probability of conflict (convex) drops faster than the probability of losing (in the event of a conflict).

On the other hand, an aggressive informed agent is able to send informative messages to her own ethnicity as long as the payoff from peace is not too high (in which case she will also try to induce peace, rendering her messages uninformative) or too low (in which case she will always try to induce conflict which will make her messages uninformative). Although the aggressive informed agent cannot communicate information to the other ethnicity players, the fact that she is able to send informative messages to her own ethnicity players results in her own ethnicity players taking state-dependent actions, and the opposite ethnicity players can rely on this while choosing their state-independent action. If they believe that the state is likely to be one in which many players of the informed agent's ethnicity will play not fight, then it could be optimal for them to play 'not fight', and this results in a higher probability of peace.

Next, we ask if the probability of peace would be higher with two informed agents (one in each ethnicity) compared to when there is only one informed agent?[5] This stems from the observation

[3]Notice that only the informed agent can be peace loving or aggressive. For all other agents in the game, the payoffs are fixed and described in detail in section 2.

[4]She would always prefer to send that message which results in the lowest fraction of opposite ethnicity players playing fight, thus making the message uninformative.

[5]Any equilibrium in the one-informed agent environment can be replicated in the two-informed agents environment if one of the informed agents is uninformative. However, since an environment with two informed agents is additionally instructive only when both informed agents are able to communicate in equilibrium, we restrict our analysis to only those equilibria in which both agents send informative signals.

that with one informed agent, the agent is never able to communicate credibly with the other ethnicity. Therefore, one may imagine that when there is an informed agent in both ethnic groups, then both groups could obtain information in equilibrium, and this improves the probability of peace. We find that when the payoff from peace for the informed agents is neither too high nor too low, then there is a unique informative equilibrium in pure strategies with two informed agents in which the two ethnicities receive perfect information about the state from their respective informed agents. However, surprisingly, more information[6] is not always better for peace. The intuition is as follows. The informative equilibrium features players of the two ethnicities playing opposite actions in equilibrium in any state (all strategic members of one group play fight while all strategic members of the other group play not fight). These coordinated actions are only possible because both groups receive information about the state. Such coordination, however, does not permit the kind of peaceful equilibria that can be achieved with one informed agent where the opposite ethnicity plays not fight in both states (since opposite ethnicity players do not get any information in equilibrium, they have to take the same action in both states in any equilibrium), and the belief of players of the opposite ethnicity is that the state is one in which the informed agent will maximize the probability of peace. The former requires it to be incentive compatible for the informed agent to desire peace. Thus, when the payoff from peace for the informed agent is high enough, the environment with one informed agent generates a higher probability of peace than the environment with two informed agents, and this result is flipped when the payoff from peace falls beyond a threshold.

Thus, the effect of information on welfare can be non-monotonic. When we move from a no-information environment (where neither ethnicity is informed), to a setting where one ethnicity is informed (with one aggressive informed agent), welfare can improve. However, providing information such that both ethnic groups are informed (as in our model with two informed agents) can lead to a decline in welfare.

We contribute to the literature on cheap talk games with multiple receivers and the literature on mediation. Our paper features private messages from the sender and payoff externalities which distinguishes the paper from papers with public signals (Levy and Razin (2004), Baliga and Sjöström (2012)), and those with private signals but no payoff externalities (Farrell and Gibbons (1989),

[6] Now both ethnicities receive perfect information about the state as opposed to the one informed agent case where only her own ethnicity received perfect information in an equilibrium.

Goltsman and Pavlov (2011)). The paper closest to ours is Basu et al. (2019) which features a cheap talk game with multiple audiences along with private signals and payoff externalities. However, unlike that paper, we assume a continuous[7] probability of conflict, and analyze two possible payoff functions for the sender. The continuous and convex probability of conflict overturns the result in Basu et al. (2019) that a peace-loving informed agent can prevent conflict. Furthermore, our study extends to environments with multiple senders, each biased towards different groups, who communicate via cheap talk to receivers from the different groups.

To the best of our knowledge, we are the first to study cheap talk with multiple senders and multiple audiences. Kydd (2003) and Cukierman and Tommasi (1998) also have a result in which only biased players can communicate effectively. The intuition for this is similar to that of our result that peaceful agents are not able to communicate effectively. However, unlike our paper, Cukierman and Tommasi (1998) does not have different groups that can engage in conflict. Thus, the role of a biased informed agent who could serve to coordinate her group in different states is not important in Cukierman and Tommasi (1998). Another modelling choice that distinguishes our analysis from Kydd (2003) and Cukierman and Tommasi (1998) is that we consider multiple senders and their effectiveness (compared to one sender) in reducing the probability of conflict. In a cheap talk model with two senders and one receiver where the sender's bias is uncertain, Karakoç (2022) shows that, under some conditions, a fully revealing equilibrium with one expert is informationally superior to a semi-revealing equilibrium with two experts. Since the receiver's actions are less sensitive to sender messages when there are two senders as compared to when there is only one, a sender has stronger incentives to lie in the former environment. Although this has a similar flavour as our result (one sender can be better than two), the environment in Karakoç (2022) is very different from ours - with uncertain sender bias and only one receiver (which does not allow for payoff externalities as in our model).

2 Model

There are a continuum of players. Each player has an ethnicity ($\in \{E_1, E_2\}$) which is common knowledge, and also has a private action type, Strategic (S) or Behavioural (B). Strategic players

[7] In the fraction of players who play fight.

choose to take one of two actions - fight (f) or not fight (nf), while behavioural players always fight. Both ethnicities have the same mass of players[8].

The state of the world is indicated by the distribution of strategic types in each ethnicity. For simplicity, we assume that there are only two possible type distributions. In the good state (probability ω), the fraction of strategic type players in both ethnicity 1 and 2 is q, and in the bad state (probability (1 - ω)) it is given by r, where $r < q$. We will denote the good/bad state as $(q,q)/(r,r)$ respectively. Thus, there are more behavioural type players in the bad state (r,r) as compared to the good state (q,q). The assumption that there is an equal fraction of strategic players in both ethnicities does not affect the qualitative results.

The actions taken by all players affect the probability that an ethnic conflict will break out. In particular, if F_i is the fraction of E_i ethnicity players who fight (this includes S type players who choose to fight and all B type players), then an ethnic conflict occurs with probability $\left(\frac{F_1+F_2}{2}\right)^2$. Thus, the probability of conflict is increasing and convex in the fraction of players who fight. This reflects the idea that the probability of an ethnic conflict escalates rapidly as more people choose to fight. If a conflict occurs, the probability of winning for the group E_i is $\frac{F_i}{F_i+F_j}$.

The payoff to player i of type S[9] is summarized in Table 1 where $\alpha,\beta,\gamma,\delta,\varepsilon > 0$. Player i's payoff depends upon his own action choice and the conflict outcome. There are three possible conflict outcomes - CW (conflict occurs and i's ethnicity wins), CL (conflict occurs and i's ethnicity loses), and NC represents no conflict. The payoff matrix is common knowledge. We have not chosen specific numerical payoffs to keep the analysis general. Important features of the payoff matrix are: i) $\alpha > -\beta+\varepsilon$ to ensure that the payoff from fighting and winning is better than the payoff from fighting and losing, ii) conflict is never more desirable than peace ($\alpha+\delta > \alpha$), iii) subject to conflict occurring, the payoffs from fighting is better than the payoff from not fighting[10], and finally iv) if a player plays fight and conflict does not happen, we assume that the payoff is negative (this could be interpreted as the cost of being arrested for unruly behaviour).

[8] This is a simplification which is not vital for the qualitative results.

[9] Since B type players are behavioural and always choose fight, we do not explicitly model their payoffs.

[10] This can be because of a 'warm glow' a player might experience by participating in the conflict with players from their own ethnicity (Egorov and Sonin (2014)) or because players who do not fight are ostracized/punished by their communities.

Table 1: Payoffs

	CW	CL	NC
f	α	$-\beta+\varepsilon$	$-\gamma$
nf	$-\beta$	$-\beta$	$\alpha+\delta$

2.1 Informed agent(s)

An informed agent is a special player who knows the state i.e. the distribution of types. The fact that the informed agent knows the state is common knowledge. We consider two environments with informed agents. In the first environment, there is only one informed agent (I_1) and without loss of generality, her ethnicity is E_1 (this is common knowledge). In the second environment, there are two informed agents (I_1, I_2), where the ethnicity of I_j is E_j.

In both environments, the informed agent(s) sends private[11] cheap talk messages to all players about the state of the world. Given a player i, she can send one of two messages - Q or R. We assume that the informed agent(s) is outside the population and does not participate in the conflict. Since I_i does not participate in the conflict, she only cares about the three outcomes: conflict occurs and her own ethnicity E_i wins (payoff α), conflict occurs and E_i loses (payoff $-\beta+\varepsilon$), conflict does not occur (payoff explained below). Let μ be positive. We will call an informed agent peace-loving if her payoff from peace is $\alpha+\mu$ (since then the payoff from peace is higher than the payoff from conflict occurring and her own ethnicity winning for the informed agent), and the informed agent will be considered aggressive if her payoff from peace is $\alpha-\mu$ (since then the payoff from conflict occurring and her own ethnicity winning is higher than the payoff from no conflict for the informed agent). The level of μ measures the intensity of the informed agent's preference for peace or aggression. The informed agent's payoff is common knowledge. Notice that we allow the informed agent's payoff from peace to differ from the rest of the population's payoff from peace. This gives us the flexibility to study the incentives of the informed agent when μ has different levels.

We focus on strategies of the informed agent that are symmetric within ethnicity. I_i's strategy is a function of the ethnicity of the receiving player and the true state of the world (the distribution of types) and is denoted by f_{I_i}. Thus, $f_{I_i}: \{E_1, E_2\} \times \{(q,q),(r,r)\} \to \Delta\{Q,R\}$.

[11] Private messages can be motivated by messages sent via WhatsApp or text - see https://www.unahakika.org/ (informed agent communicates via messages).

We assume that players play symmetric (within ethnicity) strategies. Let s^{E_i} denote the strategy of a player of ethnicity E_i. Then $s^{E_i} : \{Q,R\} \to \Delta\{f,nf\}, i \in \{1,2\}$.

The timeline of events is: at time 0, players have priors about the state of the world. Then, the informed agent(s) sends a private message to every player. All players update beliefs in a Bayesian manner and simultaneously choose actions that are optimal given their beliefs. Our equilibrium concept is Perfect Bayesian Equilibrium.

3 Analysis

Before we begin our analysis of the game with informed agents, we start with a baseline case of an environment where the informed agent does not exist. Subsequently, we will compare the results here with environments with one and two informed agents.

Without any parametric restrictions, it is clear that all players playing fight will be an equilibrium. The intuition is straightforward: if everyone chooses to play 'fight,' the probability of conflict is one. If conflict is inevitable, playing 'not fight' is strictly dominated by playing 'fight.' In addition to this equilibrium, under some conditions, other equilibria exist. For example, if the fraction of strategic types is high enough in the bad state ((r,r)), there exists an equilibrium where all strategic players choose not to fight.

For the purpose of our analysis, we assume that if the players do not receive new information, the all-fight equilibrium will be played. The reason for assuming this is that we want to study the role of informed agents in affecting the probability of peace. If peace is possible without further information, then this question becomes moot. Often, rumours, political rallies or demonstrations can create an atmosphere where conflict is the most likely equilibrium outcome unless people receive new information. For example, imagine a politician delivering a particularly rousing hate-filled speech that has led all players to believe that all other players will fight. At this (unfortunately realistic) point, it is worthwhile asking if new information can increase the probability of peace. As further justification of this assumption, notice that not only is the all-fight equilibrium the only equilibrium which does not require any additional parametric conditions, it also risk dominates the all S players playing 'not-fight' equilibrium when the cost of not being conflict winners is high (β is high).

3.1 One informed agent

Suppose one informed agent exists, and without loss of generality let the informed agent (I_1) belong to ethnicity E_1. We analyse our model for equilibria where I_1 can communicate meaningful information in equilibrium. Thus, we look for *informative equilibria* - where different messages by the informed agent result in different actions (for players of at least one of the two ethnicities). Is peace possible in an informative equilibrium? To answer these questions, we consider two types of informed agents: peace-loving and aggressive.

3.1.1 Peace-loving vs Aggressive informed agent

Recall that $\mu > 0$ and the payoffs of a peace-loving informed agent (with payoffs mentioned in brackets below):

$$\begin{array}{ccccc} \text{Peace} & \succ & \text{Conflict-win} & \succ & \text{Conflict-lose} \\ (\alpha+\mu) & & (\alpha) & & (-\beta+\varepsilon) \end{array}$$

On the other hand, an aggressive informed agent has the following preferences:

$$\begin{array}{ccccc} \text{Conflict-win} & \succ & \text{Peace} & \succ & \text{Conflict-lose} \\ (\alpha) & & (\alpha-\mu) & & (-\beta+\varepsilon) \end{array}$$

Surprisingly, we find that a peace loving informed agent cannot increase the probability of peace, but an aggressive informed agent can. More formally, there is no informative equilibrium if the informed agent is peace-loving whereas one exists when the informed agent is aggressive. Since a peace loving informed agent cannot communicate information in any equilibrium, the analysis is the same as that without an informed agent, and therefore conflict is inevitable. On the other hand, when the informed agent is aggressive, there is an informative equilibrium in which the probability of peace is positive. We formalize this result in the next proposition.

Proposition 1. *There is no informative equilibrium if the informed agent is peace-loving. When the informed agent is aggressive, there exists* $\mu_1, \mu_2, \underline{r}, \overline{q}, \overline{\omega}$ *such that if* $\mu \in [\mu_1, \mu_2]$*,* $r > \underline{r}$*,* $q < \overline{q}$ *and* $\omega < \overline{\omega}$*, then the following strategy profile constitutes an informative equilibrium where the proba-*

bility of peace is positive.

Informed agent's (I_1) strategy:

$f_{I_1}(E_1,(q,q)) = R$

$f_{I_1}(E_1,(r,r)) = Q$

$f_{I_1}(E_2,(q,q)) = Q$

$f_{I_1}(E_2,(r,r)) = Q$

Player's strategies:

E_1 *ethnicity*

$s^{E_1}(Q) = nf$

$s^{E_1}(R) = f$

E_2 *ethnicity*

$s^{E_2}(Q) = nf$

$s^{E_2}(R) = nf$

The proof is in the appendix. First, note that since the informed agent always (irrespective of Peace-loving or Aggressive) benefits from the E_2 ethnicity players not fighting, she is unable to credibly communicate with them[12]. Further, for any equilibrium play of the E_2 ethnicity players, when the informed agent prefers peace over all other outcomes, she always wants to send that message to her own ethnicity which maximizes the probability of peace. The reason for this is that whenever the informed agent can send a message which increases the fraction of her own ethnicity players who play not-fight, the gain in payoff from the increased probability of peace and the large payoff it offers compensates for the loss in payoff which comes from the higher probability of losing if a conflict does occur. This occurs because when more E_1 players play not-fight, the probability of conflict (convex) drops faster than the probability of losing.

Like a peace-loving informed agent, an aggressive informed agent cannot communicate credibly with players of E_2 ethnicity. In the prescribed equilibrium strategies, the informed agent reveals the state truthfully to her own ethnicity, who then all play fight if the state is good, and all strategic

[12]The informed agent will always send the message which results in higher fractions of the E_2 ethnicity players playing not-fight.

type players in E_1 play not fight in the bad state. The E_2 ethnicity players do not get informative messages and all strategic types in E_2 always respond with not-fight. Since no message is informative for them, in any equilibrium the E_2 ethnicity players are indifferent between all messages received and can optimally respond with the same strategy for all messages. For it to be optimal for E_2 ethnicity players to always play not-fight, it must be the case that they believe that the informed agent has sufficiently high incentives to induce peace in some state (μ is low enough) and the probability of that state is high enough (i.e. ω low enough).

For the informed agent, in the bad state, the informed agent faces a trade-off between increasing the probability of conflict and winning (by sending the message R), and the probability of peace (by sending the prescribed message Q). Since the bad state has a high proportion of behavioural types who always choose to fight, the agent cannot significantly improve the probability of winning, as the probability of winning is concave in the fraction of her own ethnicity players who play fight. Therefore, if the reward for peace is large enough, the informed agent will instruct his ethnicity to 'not fight' in the bad state and 'fight' in the good state (where she can influence the probability of winning a lot more). Note that the reward from peace should not be too large though, i.e. μ should be large enough, since if μ is close to zero, the informed agent will be tempted to always induce peace with higher probability (via the message Q) thereby rendering her messages uninformative. For ethnic players E_1, it is optimal to 'not fight' in the bad state if r is large enough (the fraction of players playing not-fight is sufficiently large) and to 'fight' in the good state if q is small enough (the fraction of players playing not-fight is sufficiently small). If the probability of the (r,r) state is high enough, then the E_2 ethnicity players find it optimal to play not fight.

3.2 Two informed agents

In this section, we introduce another informed agent, I_2, where I_2 belongs to ethnicity E_2. In the previous section, we saw that irrespective of the preferences of the informed agent (peace-loving or aggressive), she was never able to credibly communicate with the other ethnicity. When both ethnic groups have an informed agent, our intuition suggests that both ethnicities will receive credible communication from their own ethnicity informed agent. This means that while only one ethnicity had state contingent actions with one informed agent, now this is possible for both ethnicities. What is the nature of equilibria now? Does this improve the probability of peace? We will answer these questions in the analysis here and in the next section.

Before going further, with two informed agents, an equilibrium is said to be informative only if both informed agents communicate meaningful information[13] in that equilibrium. This is because if only one agent is informative, or if neither is, the environment would boil down to the case with only one informed agent or no informed agent, respectively. We understand that any equilibrium in the one-informed agent environment can be replicated in the two-informed agent environment if one of the informed agents is uninformative. However, since an environment with two informed agents is additionally instructive only when both informed agents are able to communicate meaningfully in equilibrium, we restrict our analysis to this class of equilibria.

As before, in any equilibrium, an informed agent will not be able to communicate credibly with players of the other ethnicity. Thus, the equilibrium strategy of any player will depend only upon the message sent by her own ethnicity informed agent. Furthermore, like in the previous section, if any informed agent is peace-loving, she cannot communicate effectively. The intuition is the same as the one used in the case of one informed agent.

Therefore, we will focus on the case where both informed agents are aggressive. In this case, the equilibrium depends on the intensity of aggressiveness (μ). The details are in the appendix. Here we give a short description of our findings. We find four cutoff points - $\mu_1, \mu_2, \mu_3, \mu_4$ such that[14] if μ is below μ_1 or above μ_4, then neither informed agents can communicate information in an equilibrium. In the former case, since the payoff from peace is too high, both are tempted to always send the message that maximizes the probability of peace. In the latter case, since the payoff from winning the conflict is much more than the payoff from peace, both informed agents always send the message which maximizes the probability of conflict and winning. In both cases, the messages are state-independent and, therefore, uninformative. If $\mu \in [\mu_1, \mu_2] \cup [\mu_3, \mu_4]$, then only one informed agent can communicate credibly while the other does not communicate any information to either ethnicity. Thus, for this range of μ, an additional informed agent does not add anything to this environment. Thus, when $\mu \notin (\mu_2, \mu_3)$, we do not have an equilibrium in which both informed agents are communicating meaningful information. When $\mu \in (\mu_2, \mu_3)$, there is a

[13] At least one ethnicity responds differently to different messages sent by the informed agent.

[14] Note that the cut off points μ_1, μ_2 coincide with those described in proposition 1.

unique equilibrium in pure strategies that we describe in the next proposition.

Proposition 2. *There exists $\mu_2, \mu_3, q', \overline{q}$ such that if q, $r \in (q', \overline{q})$ and $\mu \in (\mu_2, \mu_3)$, then the following strategy profile is the unique informative equilibrium in pure strategies.*

Informed agent(s) I_i's strategies:

$f_{I_1}(E_1, (q,q)) = R$

$f_{I_1}(E_1, (r,r)) = Q$

$f_{I_2}(E_2, (q,q)) = Q$

$f_{I_2}(E_2, (r,r)) = R$

$f_{I_i}(E_j, (q,q)) = Q \;\; ; i \neq j$

$f_{I_i}(E_j, (r,r)) = Q \;\; ; i \neq j$

Player's strategies:

E_i ethnicity

$s^{E_1}(Q) = nf$

$s^{E_1}(R) = f$

E_j ethnicity

$s^{E_2}(Q) = nf$

$s^{E_2}(R) = f$

When both ethnicities have their own informed agents, both agents will send perfectly informative messages to their own ethnicities when μ is neither too high nor too low. Moreover, an anti-coordination equilibrium will arise where, in both states, players of one ethnicity choose to fight while those of the opposite ethnicity choose not to fight. This equilibrium emerges because of the concavity of the probability of winning in the fraction of players who choose to fight from the same ethnicity, and the fact that the probability of winning becomes flatter as higher fractions of the opposite ethnicity choose to play fight. If the strategic types in the opposing ethnicity choose not to fight and the payoff from peace is moderate, the probability of winning can be significantly increased if all players fight. On the other hand, if all players in the opposing ethnicity fights, sending more players to fight will not significantly boost the probability of winning since the probability of winning is flatter now, making it optimal to play 'not fight'.

If the payoff from peace increases beyond this moderate level, I_i would avoid sending players of ethnicity E_i to fight in either state. Conversely, if the payoff from peace is below this moderate level, I_i would send everyone to fight in both states. In both cases, the informed agent would be uninformative in equilibrium.

The intuition for uniqueness (in pure strategies) comes from the fact that a) the informed agents cannot communicate credibly to the other ethnicity and b) given the state and the play of the opposite ethnicity, the expected payoff of the informed agents is convex in the fraction of their own players playing not fight, and c) the concavity of the probability of winning. The first two of these conditions lead to the informed agents either inducing all members of their ethnicity to fight or inducing all members of their own ethnicity to play not fight. The convexity of the expected payoff function is induced by the convexity of the probability of conflict. The convexity of the expected payoff allows four possibilities: 1) both ethnicities play the same action in both states, (2) both ethnicities play different actions in both states (our proposed equilibrium), and (3–4) both ethnicities play the same action in one state and different actions in the other (two cases). The concavity of the probability of winning implies that if one ethnicity chooses to fight, the other ethnicity cannot significantly increase its probability of winning by also choosing to fight. This results in strategic substitutability which motivates the other ethnicity to play 'not fight'.

4 Welfare

In an informative equilibrium, is the probability of peace higher with one informed agent or with two informed agents? Note that players of both ethnicities are peace-loving i.e. their highest payoff is achieved if they don't fight and there is no conflict. Therefore, maximizing the probability of peace is a reasonable notion of welfare.

An informative equilibrium for both environments exists only if $\mu \in (\mu_2, \mu_3)$. Therefore, we restrict our analysis to this range of μ. We find that there exists a cut-off point μ' such that if $\mu \in (\mu_2, \mu')$, there is an informative equilibrium in the environment of a single informed agent that generates a higher probability of peace than any informative equilibrium possible with two informed agents. In contrast, if $\mu \in (\mu', \mu_3)$, there is an informative equilibrium in the environment of two informed agents in which the probability of peace is higher than any informative equilibrium that exists with one informed agent. This is highlighted in the next proposition.

Proposition 3. *There exists $q', \overline{q}, \omega'$, and μ' such that:*

(i) If $\mu \in (\mu_2, \mu'), \omega < \omega'$ *and* $q, r \in (q', \overline{q})$*, then there exists an informative equilibrium in the environment with one informed agent in which the probability of peace is higher compared to any informative equilibrium with two informed agents.*

(ii) If $\mu \in (\mu', \mu_3), \omega < \omega'$*, and* $q, r \in (q', \overline{q})$*, then there exists an informative equilibrium in the environment with two informed agents in which the probability of peace is higher compared to any informative equilibrium with one informed agent.*

The formal proof is in the appendix. Here, we give an intuitive idea of how the result works. Notice first that there is a unique equilibrium in pure strategies[15] with two informed agents. In this equilibrium in every state, all members of one ethnicity fight, whereas all members of the other ethnicity play 'not fight'. Thus, in this equilibrium, the probability of peace with two informed agents is given by:

$$\text{P(peace/two informed agents)} = \omega\left(1-\left(\frac{2-q}{2}\right)^2\right)+(1-\omega)\left(1-\left(\frac{2-r}{2}\right)^2\right) \tag{1}$$

A key difference between the case of one informed agent and the two informed agents is that in the former E_2 ethnicity players have to play a state-independent strategy in any equilibrium (since the E_2 ethnicity players cannot receive information in equilibrium). Thus, in the world of one informed agent, if we were to look for equilibria where all E_2 ethnicity players played not fight without obtaining any new information about the state, this would require them to believe that a) the informed agent has enough incentives to induce her own ethnicity to not fight in some state (μ low enough) and b) the prior probability of the aforementioned state is high enough. Such an equilibrium would generate a high probability of peace as it would make it optimal for all players of E_2 to play 'not fight' in equilibrium. When there are two informed agents, players of the E_2 ethnicity receive perfect information about the state from their own informed agent. Thus, their actions are now state contingent in any informative equilibrium. In this case, as highlighted in proposition 2, the unique pure strategy[16] informative equilibrium features anti-coordination strategies. Thus, for a low enough μ and some parameter restrictions on ω, we see that the probability of peace is higher in the case of one informed agent compared to the case of two informed agents.

On the other hand, if the payoff from peace for the informed agents is lower (μ is above a

[15] There is a mixed strategy equilibrium as well and we allow for this in the formal proof.

[16] In the formal proof we also discuss the case of mixed strategies. This does not alter the result.

cut-off point), then there cannot be an equilibrium where all E_2 ethnicity players play not fight in the case of one informed agent. The payoff from peace is bad enough that if all E_2 ethnicity players play not fight, then the informed agent will induce her own ethnicity players to play fight to obtain the relatively[17] high payoff from winning the conflict, which makes E_2 ethnicity players deviate from pure strategy "not fight". This results in a lower probability of peace in the case of one sender of information which falls below the probability of peace in the unique informative two-informed sender equilibrium.

5 Conclusion

In this article, we study an environment with two ethnic groups that are about to engage in conflict unless new information is provided. We ask if an informed agent can improve the probability of peace by sending private cheap talk messages despite being biased towards her own ethnicity. We find that while a peace-loving informed agent cannot communicate credibly, an aggressive one can, and therefore a peaceful equilibrium can only exist with the latter type of informed agent. Furthermore, we find that allowing for two informed agents (one in each ethnicity) does not necessarily lead to informed communication that can improve the probability of peace. This is because in such environments both ethnic groups are informed and take state-dependent actions, which disallows the possibility of an equilibrium where the probability of peace is high - one in which an uninformed ethnicity chooses a state independent action of always not fighting.

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A Appendix

Lemma 1. *The informed agent will not send informative messages to players of the opposite ethnicity.*

Proof. The proof is simple, so we skip the formal language. The idea is that no matter the state, or whether the informed agent is peace loving or aggressive, the informed agent is always better off if fewer players from the opposite ethnicity play fight. Thus, to the other ethnicity players, she will always send that message which induces the highest fraction of the opposite ethnicity players to play not fight. This renders her messages to the opposite ethnicity players uninformative. Furthermore, this means that, in any equilibrium, the opposite ethnicity players will play message-independent actions. □

Proof of Proposition 1

We will prove this proposition in two parts. First, we will show that a peace-loving informed agent cannot send informative messages to any ethnicity. Second, we will demonstrate that the strategy profile described in the proposition for the aggressive informed agent is an equilibrium.

Part 1: Peace loving informed agent

The informed agent (I_1) will not send informative messages to players of the opposite ethnicity E_2 in equilibrium (see Lemma 1). Thus, it is optimal for her to send the message 'Q' to players of ethnicity E_2 in either state. The action of players of ethnicity E_2 will be independent of the informed agent's message. Hence, an informative equilibrium exists only if I_1 can send informative messages to her own ethnicity E_1. Suppose that the players follow the strategy profile:

I_1's strategy:

$f_{I_1}(E_1,(q,q)) = x_1 Q + (1-x_1)R$

$f_{I_1}(E_1,(r,r)) = y_1 Q + (1-y_1)R$

$f_{I_1}(E_2,(q,q)) = Q$

$f_{I_1}(E_2,(r,r)) = Q$

Player's strategies:

E_1 ethnicity

$s^{E_1}(Q) = s(nf) + (1-s)f$

$s^{E_1}(R) = t(nf) + (1-t)f$

E_2 ethnicity

$s^{E_2}(Q) = m(nf) + (1-m)f$

$s^{E_2}(R) = m(nf) + (1-m)f$

Here, the informed agent sends message Q to an x_1 fraction of players and message R to a $1-x_1$ fraction of players of ethnicity E_1 in the good state. Similarly, the same interpretation applies to y_1. Given the strategies of the informed agent and the players, an informative equilibrium requires that $s \neq t$ (i.e., players of ethnicity E_1 take different actions after receiving different messages). If the state is good, then the expected payoff of the peace-loving informed agent ($E\pi_{I_1}$) is as follows:

$$E\pi_{I_1} = p(peace)(\alpha+\mu) + p(conflict)(p(win/conflict)\alpha + p(lose/conflict)(-\beta+\varepsilon))$$

Suppose $s > t$,

$$E\pi_{I_1} = \left[1 - \left(\frac{2(1-q)+q(1-x_1)(1-t)+qx_1(1-s)+q(1-m)}{2}\right)^2\right](\alpha+\mu) + \left(\frac{2(1-q)+q(1-x_1)(1-t)+qx_1(1-s)+q(1-m)}{2}\right)^2$$
$$\left[\frac{1-q+q(1-x_1)(1-t)+qx_1(1-s)}{2(1-q)+q(1-x_1)(1-t)+qx_1(1-s)+q(1-m)}\alpha + \frac{1-q+q(1-m)}{2(1-q)+q(1-x_1)(1-t)+qx_1(1-s)+q(1-m)}(-\beta+\varepsilon)\right]$$

$x_1^* = \frac{(1-qm)(\alpha+\beta-\varepsilon)+2\mu(2-qt-qm)}{2\mu q(s-t)}$ will maximize the expected payoff of I_1 as $E\pi_{I_1}$ is increasing and concave in x_1[18].

Similarly, if the state is bad then the expected payoff of I_1 will get maximized if $y_1^* = \frac{(1-rm)(\alpha+\beta-\varepsilon)+2\mu(2-rt-rm)}{2\mu r(s-t)}$

Note, x_1^* and y_1^* will be greater than one. We can prove this by contradiction. Suppose $x_1^* < 1$, this implies

$$\underbrace{(1-qm)(\alpha+\beta-\varepsilon)}_{>0} + \underbrace{2(2-qs-qm)\mu}_{>0} < 0$$

Hence, it leads to a contradiction. Similarly, we can prove that $y_1^* > 1$. Therefore, the optimal values of x_1 and y_1 will be 1. Similarly, if $s < t$, we can show that the optimal x_1 and y_1 is zero. Thus, optimal $x_1 = y_1$ in any equilibrium. However, this would imply that $s = t$ which is a contradiction to our assumption that it is an informative equilibrium. Thus, there is no informative equilibrium with a peace-loving informed agent.

Part 2: Aggressive informed agent

Suppose that the players follow the strategy profile:

I_1's strategy:

$f_{I_1}(E_1,(q,q)) = xQ + (1-x)R$

$f_{I_1}(E_1,(r,r)) = yQ + (1-y)R$

$f_{I_1}(E_2,(q,q)) = Q$

$f_{I_1}(E_2,(r,r)) = Q$

Player's strategies:

E_1 ethnicity

$s^{E_1}(Q) = nf$

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[18] As $\frac{dE\pi_{I_1}}{dx_1} = \frac{q(s-t)}{4}[2(F_1+F_2)\mu + F_2(\alpha+\beta-\varepsilon)] > 0$. Here, $F_1 = 1-qt-qx_1(s-t) > 0$ & $F_2 = 1-qm > 0$ and $\frac{d^2E\pi_{I_1}}{dx_1^2} = -\frac{1}{2}(q(t-s))^2\mu < 0$ & $\frac{d^2E\pi_{I_1}}{dy_1^2} = -\frac{1}{2}(r(t-s))^2\mu < 0$.
Note that, for all possible actions played by players of both ethnicities, the expected payoff of the peace-loving informed agent is concave in x_1 and y_1; that is, with respect to the fraction of players from ethnicity E_1 who choose to play *not fight*.

$s^{E_1}(R) = f$

E_2 ethnicity

$s^{E_2}(Q) = nf$

$s^{E_2}(R) = nf$

Expected payoff of an aggressive informed agent in good state:

$$E\pi_{I_1}(x) = \left(1 - \left(\frac{2(1-q)+q(1-x)}{2}\right)^2\right)(\alpha - \mu) + \left(\frac{2(1-q)+q(1-x)}{2}\right)^2 \left(\frac{1-qx}{2-q-qx}\alpha + \frac{1-q}{2-q-qx}(-\beta+\varepsilon)\right)$$

Clearly, $E\pi_{I_1}$ is convex in x[19]. Therefore, only corner solutions exist, i.e., I_1 will send either message Q or R.

$$\Delta E\pi_{I_1} \equiv E\pi_{I_1}(x=1) - E\pi_{I_1}(x=0) = \frac{q}{4}\left[(1-q)(\alpha+\beta-\varepsilon) - (4-3q)\mu\right]$$

$\Delta E\pi_{I_1} > 0$ if $\mu < \left(\frac{1-q}{4-3q}\right)(\alpha+\beta-\varepsilon) \equiv \mu_1$. This implies that if $\mu < \mu_1$, then the payoff from sending a message that induces everyone to play *not fight* will lead to a higher expected payoff than sending a message that induces everyone to play *fight*. Therefore, the informed agent will send message Q for $\mu < \mu_1$; otherwise, she will send message R (see Figure 1).

Similarly, if the state is bad, then $\Delta E\pi_{I_1} > 0$ if $\mu < \left(\frac{1-r}{4-3r}\right)(\alpha+\beta-\varepsilon) \equiv \mu_2$. This implies that if $\mu < \mu_2$, then the informed agent will send message Q; otherwise, she will send message R (see Figure 1). Since $\frac{d\mu_1}{dq} < 0$, this implies $\mu_1 < \mu_2$ as $q > r$.

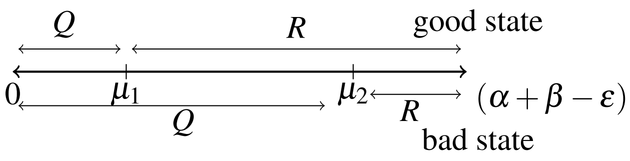

Figure 1: For the proposed strategy profile, this is the informed agent's optimal strategy as a function of the intensity of aggression (μ). In the good state, the informed agent (I_1) will send message Q if $\mu < \mu_1$ and R otherwise. Similarly, in the bad state, the informed agent (I_1) will send message Q if $\mu < \mu_2$ and R otherwise. Hence, she is informative when $\mu \in (\mu_1, \mu_2)$, as she sends different messages in different states—i.e., R in the good state and Q in the bad state.

Therefore, for any $\mu \in (\mu_1, \mu_2)$, there exists an informative equilibrium where the informed

[19] As $\frac{d^2 E\pi_{I_1}}{dx^2} = \frac{q^2}{2}\mu > 0$.
Note that, for all possible actions (i.e., mixed strategies with arbitrary probabilities) played by players of both ethnicities, the expected payoff of the aggressive informed agent is convex in x and y; that is, with respect to the fraction of players from ethnicity E_1 who choose to play *not fight*.

agent (I_1) will send message R in the good state and message Q in the bad state. This strategy profile constitutes an equilibrium if it is optimal for players of both ethnicities to follow their corresponding strategies.

E_1 ethnicity

If $i \in E_1$ receives the message Q, then he will make the following calculation:

Payoff from playing nf $= (1-(1-r)^2)(\alpha+\delta)+(1-r)^2(-\beta)$

Payoff from playing f $= (1-(1-r)^2)(-\gamma)+(1-r)^2\left(\dfrac{\alpha-\beta+\varepsilon}{2}\right)$

Therefore, nf $\succ$ f if $r > 1-\sqrt{\dfrac{2(\alpha+\delta+\gamma)}{2(\alpha+\delta+\gamma)+\alpha+\beta+\varepsilon}} \equiv \underline{r}$.

If $i \in E_1$ receives message R then, he will make the following calculation:

Payoff from playing nf $= \left(1-\left(\dfrac{2-q}{2}\right)^2\right)(\alpha+\delta)+\left(\dfrac{2-q}{2}\right)^2(-\beta)$

Payoff from playing f $= \left(1-\left(\dfrac{2-q}{2}\right)^2\right)(-\gamma)+\left(\dfrac{2-q}{2}\right)^2\left(\dfrac{1}{2-q}(\alpha)+\dfrac{1-q}{2-q}(-\beta+\varepsilon)\right)$

Therefore, f $\succ$ nf if $q < 1+\frac{2(\alpha+\delta+\gamma)+\alpha+\beta+\varepsilon-\sqrt{16(\alpha+\delta+\gamma+\varepsilon)(\alpha+\delta+\gamma)+(\alpha+\beta-\varepsilon)^2}}{2(\alpha+\delta+\gamma+\varepsilon)} \equiv \overline{q}$. Hence, ethnicity E_1 players' actions are optimal when $r > \underline{r}$ and $q < \overline{q}$. Since we assumed $q > r$, players can play their actions only if $\overline{q} > \underline{r}$. Therefore, we need to show that there exist feasible values of q and r such that $q < \overline{q}$ and $r > \underline{r}$, i.e., $(\overline{q}-\underline{r} > 0)$.

$\underline{r}$ always lies within the interval $(0,1)$. Specifically, $\underline{r} > 0$ if $\alpha+\beta+\varepsilon > 0$, and $\underline{r} < 1$ if $\alpha+\delta+\gamma > 0$. Given that all parameters are positive, these conditions are always satisfied.

Similarly, $\overline{q} > 0$ if $\varepsilon > -(\alpha+\delta+\gamma)$. Since all parameters are positive, this condition is always met. Furthermore, $\overline{q} < 1$ if $\beta < 2\alpha+3\delta+3\gamma$. Therefore, $\overline{q}$ and $\underline{r}$ always lie within the interval (0,1) if $\beta < 2\alpha+3\delta+3\gamma$. Conversely, if $\beta > 2\alpha+3\delta+3\gamma$, then $\overline{q}$ would exceed 1.

Therefore, if $\beta \geq 2\alpha+3\delta+3\gamma$, then $\overline{q}-\underline{r} > 0$ because $\overline{q}\geq 1$ and $\underline{r} \in (0,1)$. Thus, we only need to prove that $\overline{q}-\underline{r} > 0$ when $\beta \in (0, 2\alpha+3\delta+3\gamma)$.

Now, if $\beta \in (0, 2\alpha+3\delta+3\gamma)$, then $\frac{d\overline{q}}{d\beta} > 0$ and $\frac{d\underline{r}}{d\beta} > 0$. Since at $\beta = 2\alpha+3\delta+3\gamma$, $\overline{q}-\underline{r} > 0$ because $\overline{q} = 1$ at $\beta = 2\alpha+3\delta+3\gamma$, it is sufficient to show that $\overline{q}-\underline{r} > 0$ at $\beta = 0$. If this holds, then $\overline{q}-\underline{r} > 0$ for all $\beta \in [0, 2\alpha+3\delta+3\gamma]$.

At $\beta = 0$, assume $\varepsilon = 0$:

$$\overline{q} - \underline{r} = \frac{2(\alpha+\delta+\gamma)+\alpha-\sqrt{16(\alpha+\delta+\gamma)^2+\alpha^2}}{2(\alpha+\delta+\gamma)} + \sqrt{\frac{2(\alpha+\delta+\gamma)}{2(\alpha+\delta+\gamma)+\alpha}}$$

Therefore, $\overline{q} - \underline{r} > 0$ if

$$16\alpha(\alpha+\delta+\gamma)^3 + 4\alpha^3(\alpha+\delta+\gamma) + 19\alpha^2(\alpha+\delta+\gamma)^2 > \alpha^4$$

Clearly, this always holds. Moreover, since at $\varepsilon = 0$, $\overline{q} - \underline{r} > 0$, by continuity, for $\varepsilon > 0$ (small enough), $\overline{q} - \underline{r} > 0$ also holds. Hence, $\overline{q} - \underline{r} > 0$.

E_2 ethnicity

If $i \in E_2$ receives the message either Q or R, then he will make the following calculations:
Payoff from playing nf $= \omega\left[\left(1-\left(\frac{2-q}{2}\right)^2\right)(\alpha+\delta)+\left(\frac{2-q}{2}\right)^2(-\beta)\right]+(1-\omega)[(1-(1-r)^2)(\alpha+\delta)+(1-r)^2(-\beta)]$
Payoff from playing f $= \omega\left[\left(1-\left(\frac{2-q}{2}\right)^2\right)(-\gamma)+\left(\frac{2-q}{2}\right)^2\left(\frac{1-q}{2-q}\alpha+\frac{1}{2-q}(-\beta+\varepsilon)\right)\right]+(1-\omega)\left[(1-(1-r)^2)(-\gamma)+(1-r)^2\left(\frac{1}{2}\alpha+\frac{1}{2}(-\beta+\varepsilon)\right)\right]$

At $\omega = 0$, $nf \succ f$ if $r > \underline{r}$ and at $\omega = 1$, $f \succ nf$ if $q < q'$. Therefore, by continuity, there exists an $\omega' \in (0,1)$ that will make player j indifferent between fighting and not fighting. Hence, for every $\omega < \omega'$, choosing 'not fight' is optimal for players of ethnicity E_j. Hence, under certain conditions—specifically when r is sufficiently large ($r > \underline{r}$), q is sufficiently small ($q < \overline{q}$), the bad state is more likely ($\omega < \omega'$), and $\mu \in (\mu_1, \mu_2)$—the strategies played by the players constitute an equilibrium. In this equilibrium, the informed agent (I_1) does not send informative messages to players of opposite ethnicity E_2 but sends fully informative messages to players of her ethnicity, E_1.

Proof of Proposition 2

By Lemma 1, informed agents do not send informative messages to the opposite ethnicity in any equilibrium. We take a general strategy profiles below for the informed agent and show that there is a unique solution to it which matches with the strategy outlined in the proposition. Here, an aggressive informed agent (I_i) is informative if $x_i \neq y_i$ for $i = 1,2$; that is, the informed agent sends different messages to their own ethnicity in different states. We will focus on the equilibrium in which both informed agents are informative, i.e., $x_1 \neq y_1$ and $x_2 \neq y_2$.

Consider the following strategy profile:

I_i's strategy:

$f_{I_i}(E_i,(q,q)) = x_i Q + (1-x_i)R$

$f_{I_i}(E_i,(r,r)) = y_i Q + (1-y_i)R$

$f_{I_i}(E_j,(q,q)) = Q$

$f_{I_i}(E_j,(r,r)) = Q$

Player's strategies:

E_i ethnicity

$s^{E_i}(Q) = nf$

$s^{E_i}(R) = f$

The expected payoff of the informed agent(I_i) in the good state:

$$E\pi_{I_i} = p(peace)(\alpha-\mu) + p(conflict)(p(win/conflict)\alpha + p(lose/conflict)(-\beta+\varepsilon))$$

$$E\pi_{I_i} = \left[1-\left(\frac{2(1-q)+q(1-x_i)+q(1-x_j)}{2}\right)^2\right](\alpha-\mu) + \left(\frac{2(1-q)+q(1-x_i)+q(1-x_j)}{2}\right)^2 \left[\frac{1-q+q(1-x_i)}{2(1-q)+q(1-x_i)+q(1-x_j)}\alpha + \frac{1-q+q(1-x_j)}{2(1-q)+q(1-x_i)+q(1-x_j)}(-\beta+\varepsilon)\right]$$

Taking the second order partial derivative with respect to x_i, we get:

$$\frac{\partial^2 E\pi_i}{\partial x_i^2} = \frac{q^2}{2}\mu > 0 \text{ (Convex)}$$

Since the expected payoff of the informed agents is convex, only corner solutions can exist. Combined with the fact that we are only considering informative equilibria, this implies that informed agents send informative messages to their own ethnicity. First, we show that the following strategy profile constitutes an equilibrium. Subsequently, we demonstrate the uniqueness of the equilibrium.

WLOG, suppose I_2's strategy is:

$f_{I_2}(E_2,(q,q)) = Q$

$f_{I_2}(E_2,(r,r)) = R$

We will determine the range of μ for which it is optimal for I_2 to play in this manner, but first, fixing the strategy of I_2, we determine the optimal strategy of the informed agent I_1 for different ranges of the intensity of aggressiveness, i.e., μ.

I_1's strategy:

$f_{I_1}(E_1,(q,q)) = x_1 Q + (1-x_1)R$

$f_{I_1}(E_1,(r,r)) = y_1 Q + (1-y_1)R$

Now, in the good state,

$$E\pi_{I_1}(x_1) = \left(1 - \left(\frac{2(1-q)+q(1-x_1)}{2}\right)^2\right)(\alpha-\mu) + \left(\frac{2(1-q)+q(1-x_1)}{2}\right)^2\left(\frac{1-qx_1}{2-q-qx_1}\alpha + \frac{1-q}{2-q-qx_1}(-\beta+\varepsilon)\right) \tag{2}$$

$$\Delta E\pi_{I_1} \equiv E\pi_{I_1}(1) - E\pi_{I_i}(0) = \frac{q}{4}((4-3q)(-\mu)+(1-q)(\alpha+\beta-\varepsilon)) \tag{3}$$

Therefore, $\Delta E\pi_{I_1} > 0$ if $\mu < \frac{1-q}{4-3q}(\alpha+\beta-\varepsilon) \equiv \mu_1$. If $\mu < \mu_1$, then I_1's expected payoff is maximized when $x_1 = 1$. This implies that in the good state, if $\mu < \mu_1$, I_1 will send message Q; otherwise, I_1 will send message R. Similarly, in the bad state, there exists $\mu_3 = \frac{1}{4-r}(\alpha+\beta-\varepsilon)$ such that if $\mu < \mu_3$, I_1 sends the message Q; otherwise, I_1 will send the message R. Since I_1 always (in both states) sends the message Q when $\mu < \mu_1$ and always sends the message R when $\mu > \mu_3$, I_1 is informative only when $\mu \in (\mu_1, \mu_3)$. Since we are looking for informative equilibria only, we will focus on this range.

Now, we will find the best response of I_2. For $\mu \in (\mu_1,\mu_3)$, I_1's strategy:

$f_{I_1}(E_1,(q,q)) = R$

$f_{I_1}(E_1,(r,r)) = Q$

Just like our analysis for I_1, we can show that there exists $\mu_2 = \frac{1-r}{4-3r}(\alpha+\beta-\varepsilon)$ and $\mu_4 = \frac{1}{4-q}(\alpha+\beta-\varepsilon)$ such that in the good(bad) state if $\mu < \mu_4(\mu_2)$, I_2 will send message Q(R). Hence, for $\mu \in (\mu_2,\mu_4)$, I_2 sends informative messages to her own ethnicity.

Therefore, for $\mu \in (\mu_2, \mu_3)$ [20] both informed agents are informative, and they will play the following strategies in the equilibrium:

$f_{I_1}(E_1,(q,q)) = R$ and $f_{I_2}(E_2,(q,q)) = Q$

$f_{I_1}(E_1,(r,r)) = Q$ and $f_{I_2}(E_2,(r,r)) = R$

$f_{I_i}(E_j,(q,q)) = Q$

$f_{I_i}(E_j,(r,r)) = Q$

This strategy profile of informed agents constitutes an equilibrium if actions chosen by players of both ethnicities are optimal for them. Let's consider a player $i \in E_1$. If he receives the message Q, he knows the state is bad. He will make the following calculations:

Payoff from playing nf $= \left(1-\left(\frac{1+1-r}{2}\right)\right)^2(\alpha+\delta)+\left(\frac{2-r}{2}\right)^2(-\beta)$

Payoff from playing f $= \left(1-\left(\frac{1+1-r}{2}\right)\right)^2(-\gamma)+\left(\frac{2-r}{2}\right)^2\left(\frac{1-r}{2-r}\alpha+\frac{1}{2-r}(-\beta+\varepsilon)\right)$

Here, nf $\succeq$ f iff payoff from choosing 'not fight' is greater than from choosing 'fight' i.e.,

$$\left(1-\left(\frac{2-r}{2}\right)\right)^2(\alpha+\delta+\gamma)-\left(\frac{2-r}{2}\right)^2\left(\frac{(1-r)(\alpha+\beta)+\varepsilon}{2-r}\right)\geq 0$$

Simplifying this inequality yields:

$$r \geq 1+\frac{2(\alpha+\delta+\gamma)-\sqrt{16(\alpha+\delta+\gamma+\alpha+\beta)(\alpha+\delta+\gamma)+(\alpha+\beta-\varepsilon)^2}}{2(\alpha+\delta+\gamma+\alpha+\beta)} \equiv q'$$

If $i \in E_1$ receives the message R, he knows the state is good. He will make the following calculations:

Payoff from playing nf $= \left(1-\left(\frac{1+1-q}{2}\right)\right)^2(\alpha+\delta)+\left(\frac{2-q}{2}\right)^2(-\beta)$

Payoff from playing f $= \left(1-\left(\frac{1+1-q}{2}\right)\right)^2(-\gamma)+\left(\frac{2-q}{2}\right)^2\left(\frac{1}{2-q}\alpha+\frac{1-q}{2-q}(-\beta+\varepsilon)\right)$

Here, f $\succeq$ nf iff payoff from choosing 'fight' is greater than from choosing 'not fight' i.e.,

$$-\left(1-\left(\frac{2-q}{2}\right)\right)^2(\alpha+\delta+\gamma)+\left(\frac{2-q}{2}\right)^2\left(\frac{\alpha+\beta+(1-q)\varepsilon}{2-q}\right)\geq 0$$

[20]Note that $\mu_2 < \mu_3$, since $\mu_2 = \frac{1-r}{4-3r}$ and $\mu_3 = \frac{1}{4-r}$. Therefore, $\mu_2 < \mu_3$ if $r(r-2) < 0$, which always holds.

Simplifying this inequality yields:

$$q \leq 1 + \frac{2(\alpha+\delta+\gamma) - \sqrt{16(\alpha+\delta+\gamma+\varepsilon)(\alpha+\delta+\gamma)+(\alpha+\beta-\varepsilon)^2}}{2(\alpha+\delta+\gamma+\varepsilon)} \equiv \overline{q}$$

Similarly, let's consider a player $j \in E_2$. If he receives the message Q, he knows the state is good. He will make the following calculations:

Payoff from playing nf $= \left(1-\left(\frac{1+1-q}{2}\right)\right)^2(\alpha+\delta)+\left(\frac{2-q}{2}\right)^2(-\beta)$

Payoff from playing f $= \left(1-\left(\frac{1+1-q}{2}\right)\right)^2(-\gamma)+\left(\frac{2-q}{2}\right)^2\left(\frac{1-q}{2-q}\alpha+\frac{1}{2-q}(-\beta+\varepsilon)\right)$

Here, nf $\succeq$ f iff payoff from choosing 'not fight' is greater than from choosing 'fight' i.e.,

$$\left(1-\left(\frac{2-q}{2}\right)\right)^2(\alpha+\delta+\gamma)-\left(\frac{2-q}{2}\right)^2\left(\frac{(1-q)(\alpha+\beta)+\varepsilon}{2-q}\right) \geq 0$$

Simplifying this inequality yields:

$$q \geq 1 + \frac{2(\alpha+\delta+\gamma) - \sqrt{16(\alpha+\delta+\gamma+\alpha+\beta)(\alpha+\delta+\gamma)+(\alpha+\beta-\varepsilon)^2}}{2(\alpha+\delta+\gamma+\alpha+\beta)} \equiv q'$$

If $j \in E_2$ receives the message R, he knows the state is bad. He will make the following calculations:

Payoff from playing nf $= \left(1-\left(\frac{1+1-r}{2}\right)\right)^2(\alpha+\delta)+\left(\frac{2-r}{2}\right)^2(-\beta)$

Payoff from playing f $= \left(1-\left(\frac{1+1-r}{2}\right)\right)^2(-\gamma)+\left(\frac{2-r}{2}\right)^2\left(\frac{1}{2-r}\alpha+\frac{1-r}{2-r}(-\beta+\varepsilon)\right)$

Here, f $\succeq$ nf iff payoff from choosing 'fight' is greater than from choosing 'not fight' i.e.,

$$-\left(1-\left(\frac{2-r}{2}\right)\right)^2(\alpha+\delta+\gamma)+\left(\frac{2-r}{2}\right)^2\left(\frac{\alpha+\beta+(1-r)\varepsilon}{2-r}\right) \geq 0$$

Simplifying this inequality yields:

$$r \leq 1 + \frac{2(\alpha+\delta+\gamma) - \sqrt{16(\alpha+\delta+\gamma+\varepsilon)(\alpha+\delta+\gamma)+(\alpha+\beta-\varepsilon)^2}}{2(\alpha+\delta+\gamma+\varepsilon)} \equiv \overline{q}$$

Note,

$$q' = 1 + \frac{\overbrace{2(\alpha+\delta+\gamma)}^{A} - \overbrace{\sqrt{16(\alpha+\delta+\gamma+\alpha+\beta)(\alpha+\delta+\gamma)+(\alpha+\beta-\varepsilon)^2}}^{B}}{\underbrace{2(\alpha+\delta+\gamma+\alpha+\beta)}_{C}} < \overline{q} = 1 + \frac{\overbrace{2(\alpha+\delta+\gamma)}^{A} - \overbrace{\sqrt{16(\alpha+\delta+\gamma+\varepsilon)(\alpha+\delta+\gamma)+(\alpha+\beta-\varepsilon)^2}}^{B'}}{\underbrace{2(\alpha+\delta+\gamma+\varepsilon)}_{C'}}$$

because $\overline{q} = \dfrac{A-B'}{C'} > \dfrac{A-B}{C'}$ as $B > B'$. Moreover, $\dfrac{A-B}{C'} > \dfrac{A-B}{C} = q'$ as $C > C'$. Hence, the last two inequalities imply $\overline{q} > q'$.

Therefore $\forall q, r \in (q', \overline{q})$ where $r < q$, following strategy profiles constitutes an informative equilibrium.

I_i's strategies:

$f_{I_1}(E_1,(q,q)) = R$ and $f_{I_2}(E_2,(q,q)) = Q$

$f_{I_1}(E_1,(r,r)) = Q$ and $f_{I_2}(E_2,(r,r)) = R$

$f_{I_i}(E_j,(q,q)) = Q$

$f_{I_i}(E_j,(r,r)) = Q$

Player's strategies:

E_i ethnicity

$s^{E_i}(Q) = nf$

$s^{E_i}(R) = f$

We now provide an argument for the uniqueness of the equilibrium. The idea is that since informed agents must send fully informative messages in any equilibrium, convexity of the informed agent's payoffs and the assumption that players use pure strategies, there are only four possible candidate equilibria: (1) both ethnicities play the same action in both states, (2) both ethnicities play different actions in both states (our proposed equilibrium), and (3–4) both ethnicities play the same action in one state and different actions in the other (two cases). Cases 3 and 4 cannot constitute informative equilibria. As one of the ethnicities chooses the same action in both states, this cannot be an informative equilibrium as its informed agent does not send any meaningful information. Since we focus only on informative equilibria, these cases must be excluded. We are left with the scenario where both ethnicities play the same action in both states. This too cannot sustain an equilibrium. If one ethnicity plays *fight* in one state, the informed agent of the other ethnicity will find it optimal to send a message that induces *not fight*, due to strategic substitutability. Therefore, the only strategy profile which could be an equilibrium is the one in which both ethnicities play different actions in both states. Hence, there exists a unique equilibrium in pure strategies satisfying the informativeness condition.

Proof of proposition 3

Proof. We start with a lemma which highlights possible equilibrium strategies.

Lemma 2. *If both informed agents are aggressive and informative, then, in any state, players of both ethnicities cannot simultaneously play mixed strategies in equilibrium.*

Proof. We will prove this in two parts: first, we will show that they can not both play asymmetric mixed strategies in equilibrium, and second, we will demonstrate that they can not both play symmetric mixed strategies.

Part I: We will prove by contradiction that players cannot play asymmetric mixed strategies in equilibrium. Suppose that the players can play the asymmetric strategies in the equilibrium. Suppose, in the good state, players follow the strategy profile:

$$E_1 \ plays - s_1(nf) + (1-s_1)f$$

$$E_2 \ plays - s_2(nf) + (1-s_2)f$$

Now, players from ethnicity E_1 will make the following calculations:
Payoff from playing nf $= \left[\left(1-\left(\frac{2(1-q)+q(1-s_1)+q(1-s_2)}{2}\right)^2\right)(\alpha+\delta)+\left(\frac{2(1-q)+q(1-s_1)+q(1-s_2)}{2}\right)^2(-\beta)\right]$
Payoff from playing f

$$= \left[\left(1-\left(\frac{2(1-q)+q(1-s_1)+q(1-s_2)}{2}\right)^2\right)(-\gamma)+\left(\frac{2(1-q)+q(1-s_1)+q(1-s_2)}{2}\right)^2\left(\frac{1-qs_1}{2-qs_1-qs_2}\alpha+\frac{1-qs_2}{2-qs_1-qs_2}(-\beta+\varepsilon)\right)\right]$$

It will be optimal for the player from E_1 ethnicity to play the mixed strategy if they are indifferent between playing 'fight' and 'not fight.' Therefore, we need the condition that:

$$\left[\left(1-\left(\frac{2(1-q)+q(1-s_1)+q(1-s_2)}{2}\right)^2\right)(\alpha+\delta+\gamma)-\left(\frac{2(1-q)+q(1-s_1)+q(1-s_2)}{2}\right)^2\left(\frac{(1-qs_1)(\alpha+\beta)+(1-qs_2)\varepsilon}{2-qs_1-qs_2}\right)\right]=0$$

Similarly, for players from ethnicity E_2 to be indifferent between fight and not fight, we need:

$$\left[\left(1-\left(\frac{2(1-q)+q(1-s_1)+q(1-s_2)}{2}\right)^2\right)(\alpha+\delta+\gamma)-\left(\frac{2(1-q)+q(1-s_1)+q(1-s_2)}{2}\right)^2\left(\frac{(1-qs_2)(\alpha+\beta)+(1-qs_1)\varepsilon}{2-qs_1-qs_2}\right)\right]=0$$

If $s_1 \neq s_2$, then for the above two conditions to hold simultaneously, we require $\alpha = -\beta + \varepsilon$ which is a contradiction to our assumption on payoffs (payoff from conflict and win is better than payoff from conflict and losing). Similarly, we can argue that players of both ethnicities cannot play asymmetric mixed strategies in the bad state.

Part II: From the proof of proposition 2, we know that the informed agents will send perfectly informative messages to players of their own ethnicity and uninformative messages to players of the other ethnicity. Thus, the strategy for players will depend only on the message from their own ethnicity informed agent. Suppose that the strategy profile of the players is as follows:

$s^{E_1}(Q) = s^{E_2}(Q) = s(nf) + (1-s)f$

$s^{E_1}(R) = s^{E_2}(R) = t(nf) + (1-t)f$

Thus, here we assume that both ethnic groups will play symmetric equilibrium strategies if I_1, I_2 have incentives to send the message Q in the same state to their respective ethnicity players. Note that $s \neq t$ (else there is no meaningful information sent by I_1). Suppose $t > s$. Now, similar to the proof of proposition 2, we can show that there exists μ_1', μ_2' such that informative messages can only be sent by both I_1, I_2 when $\mu \in (\mu_1', \mu_2')$. Furthermore, in any state if E_2 ethnicity players are playing $s(nf) + (1-s)f$, then the best response by I_1 is to send the message which results in E_1 ethnicity players play $t(nf) + (1-t)f$. Also, in any state if E_2 ethnicity players are playing $t(nf) + (1-t)f$, then the best response by I_1 is to send the message which results in E_1 ethnicity players play $s(nf) + (1-s)f$. Since $t > s$, this contradicts our assumption of symmetric strategies.

□

(i) To show that, under certain conditions, the probability of no conflict is higher with one informed agent compared to two, we must identify an informative equilibrium in the one informed agent case which generates a higher probability of peace than the most peaceful informative equilibrium with two agents.

First, we identify the informative equilibrium with two informed agents which generates the highest probability of peace. As before, neither informed agent will send informative messages to players of the other ethnic group. This results in the player strategies depending only upon the message from their own group informed agent. Further, as we have seen in the proof of proposition 2, the informed agent will always send fully informative messages to her own ethnic group players.

It is easy to show (from the proof of proposition 2) that it is not incentive compatible for the informed agents to have all strategic members of both ethnic groups play pure strategy not fight in any state. By Lemma 2, players of both ethnicities cannot play mixed strategies in equilibrium. The next best strategy profile (for generating peace) is that one ethnicity plays not fight while the other ethnic group mixes between fight and not fight. Consider the following strategy profile.

I_1's strategy:

$f_{I_1}(E_1,(q,q)) = R$

$f_{I_1}(E_1,(r,r)) = Q$

$f_{I_1}(E_2,(q,q)) = Q$

$f_{I_1}(E_2,(r,r)) = Q$

I_2's strategy:

$f_{I_2}(E_1,(q,q)) = Q$

$f_{I_2}(E_1,(r,r)) = Q$

$f_{I_2}(E_2,(q,q)) = Q$

$f_{I_2}(E_2,(r,r)) = R$

E_1 ethnicity

$s^{E_1}(Q) = nf$

$s^{E_1}(R) = s(nf) + (1-s)f$

E_2 ethnicity

$s^{E_2}(Q) = nf$

$s^{E_2}(R) = t(nf) + (1-t)f$

The probability of peace if this strategy profile is an equilibrium is:

$$\text{P(peace/two informed agents)} = \omega\left(1-\left(\frac{2-q-qs}{2}\right)^2\right) + (1-\omega)\left(1-\left(\frac{2-r-rt}{2}\right)^2\right) \quad (4)$$

If the above strategy profile is an equilibrium then it will generate the highest probability of peace in an informed equilibrium with two informed agents. Even without finding conditions under which the above constitutes an equilibrium, we can show that there exists an informative equilibrium with only one informed agent in which the probability of no conflict is higher than the probability of no conflict in this strategy profile with two informed agents. Consider the following strategy profile in the environment with one informed agent:

I_1 strategy:

$f_{I_1}(E_1,(q,q)) = R$

$f_{I_1}(E_1,(r,r)) = Q$

$f_{I_1}(E_2,(q,q)) = Q$

$f_{I_2}(E_2,(r,r)) = Q$

Player strategies:

E_1 ethnicity

$s^{E_1}(Q) = nf$

$s^{E_1}(R) = s(nf) + (1-s)f$

E_2 ethnicity

$s^{E_2}(Q) = nf$

$s^{E_2}(R) = nf$

Before we go further, notice that as we are looking at exactly the same incentives, the mixing probability s above is the same as that in the two agent candidate strategy profile. As in the analysis for proposition 1, we find that there exists $\mu_g = \frac{1-q}{4-3q-qs}(\alpha+\beta-\varepsilon)$ and $\mu_b = \frac{1-r}{4-3r-rs}(\alpha+\beta-\varepsilon)$ such that given the strategy of the players, the informed agent's strategy is optimal when $\mu \in (\mu_g, \mu_b)$. Here, $\frac{\partial \mu_g}{\partial q} = \dfrac{s-1}{(4-3q-qs)^2} < 0$. This implies that $\mu_g < \mu_b$, meaning that I_1 will send message R in the good state and message Q in the bad state for a range of $\mu \in (\mu_g, \mu_b)$. Further, note that when $s = 0$, $\mu_g(s=0) = \mu_1$ (from Proposition 1) $= \dfrac{1-q}{4-3q}(\alpha+\beta-\varepsilon)$. Similarly, $\mu_b(s=0) = \mu_2$ (from Proposition 1) $= \dfrac{1-r}{4-3r}(\alpha+\beta-\varepsilon)$. At $s=1$, we have $\mu_g = \mu_b = \dfrac{1}{4}(\alpha+\beta-\varepsilon) \equiv \mu'$. Figure 2 illustrates the different cutoffs.

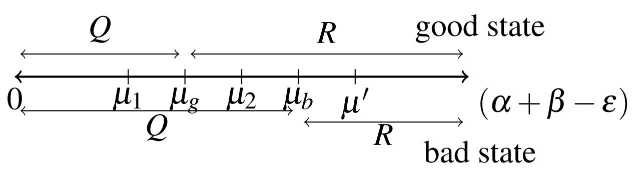

Figure 2: For the proposed strategy profile, this is the informed agent's optimal strategy as a function of the intensity of aggression (μ). In the good state, the informed agent (I_1) will send message Q if $\mu < \mu_g$ and R otherwise. Similarly, in the bad state, the informed agent (I_1) will send message Q if $\mu < \mu_b$ and R otherwise. Hence, she is informative when $\mu \in (\mu_g, \mu_b)$, as she sends different messages in different states—i.e., R in the good state and Q in the bad state.

Next, we show that players of both ethnicities are playing optimally:

E_1 ethnicity

Let $i \in E_1$ receive message Q. Then, he will make the following calculations:

Payoff from playing $nf = (1-(1-r)^2)(\alpha+\delta)+(1-r)^2(-\beta)$

Payoff from playing f= $(1-(1-r)^2)(-\gamma)+(1-r)^2\left(\frac{\alpha-\beta+\varepsilon}{2}\right)$

Therefore, $nf \succ f$ if:

$$r > \sqrt{\frac{2(\alpha+\delta+\gamma)}{2(\alpha+\delta+\gamma)+\alpha+\beta+\varepsilon}} \equiv \underline{r}$$

Let $i \in E_1$ receive message R. Then, he will make the following calculations:

Payoff from playing $nf = \left(1-\left(\frac{2-q-qs}{2}\right)^2\right)(\alpha+\delta)+\left(\frac{2-q-qs}{2}\right)^2(-\beta)$

Payoff from playing $f = \left(1-\left(\frac{2-q-qs}{2}\right)^2\right)(-\gamma)+\left(\frac{2-q-qs}{2}\right)^2\left(\frac{1-qs}{2-q-qs}\alpha+\frac{1-q}{2-q-qs}(-\beta+\varepsilon)\right)$

Thus, players from ethnicity E_1 would be indifferent between playing fight and not fight if for $s \in (0,1)$:

$$\underbrace{\left(1-\left(\frac{2-q-qs}{2}\right)^2\right)(\alpha+\delta+\gamma)-\left(\frac{2-q-qs}{2}\right)^2\left(\frac{(1-qs)(\alpha+\beta)+(1-q)\varepsilon}{2-q-qs}\right)}_{LHS=\text{ payoff from nf } - \text{ payoff from f}} = 0$$

At $s=0$, $f \succ nf$ (i.e., LHS <0) if

$$q < \overline{q} \equiv 1+\frac{2(\alpha+\delta+\gamma)+\alpha+\beta+\varepsilon-\sqrt{16(\alpha+\delta+\gamma+\varepsilon)(\alpha+\delta+\gamma)+(\alpha+\beta-\varepsilon)^2}}{2(\alpha+\delta+\gamma+\varepsilon)}$$

Similarly, at $s=1$, $nf \succ f$ (i.e., LHS >0) if

$$q > \underline{r} \equiv 1-\sqrt{\frac{2(\alpha+\delta+\gamma)}{2(\alpha+\delta+\gamma)+\alpha+\beta+\varepsilon}}$$

Therefore, for any $q \in (\underline{r}, \overline{q})$, by the Intermediate Value Theorem, there exists $s(q) \in (0,1)$ such that players are indifferent between playing *fight* and *not fight* (i.e., LHS = 0).

E_2 ethnicity

If $j \in E_2$ receives message Q. Then, he will make the following calculation:

Payoff from playing nf $=\omega\left(\left(1-\left(\frac{2-q-qs}{2}\right)^2\right)(\alpha+\delta)+\left(\frac{2-q-qs}{2}\right)^2\right)(-\beta)\right)+(1-$

$\omega)((1-(1-r)^2)(\alpha+\delta)+(1-r)^2(-\beta))$

Payoff from playing f $=\omega\left(\left(1-\left(\frac{2-q-qs}{2}\right)^2\right)(-\gamma)+\left(\frac{2-q-qs}{2}\right)^2\right)\left(\frac{1-q}{2-q-qs}(\alpha)+\frac{1-qs}{2-q-qs}(\alpha)\right)\Bigg)+$
$(1-\omega)\left((1-(1-r)^2)(-\gamma)+(1-r)^2\left(\frac{\alpha-\beta+\varepsilon}{2}\right)\right)$

Therefore $nf \succ f$, if

$$\omega\left[\left(1-\left(\frac{2-q-qs}{2}\right)^2\right)(\alpha+\delta+\gamma)-\left(\frac{2-q-qs}{2}\right)^2\right)\left(\frac{(1-q)(\alpha+\beta)+(1-qs)\varepsilon}{2-q-qs}\right)\Bigg]$$
$$+(1-\omega)[(1-(1-r)^2)(\alpha+\delta+\gamma)-(1-r)^2\left(\frac{\alpha+\beta+\varepsilon}{2}\right)\Bigg]>0$$

At $\omega=0$, if $r>\underline{r}$, then clearly $nf \succ f$. Hence, by continuity, for small ω (say less than a threshold of ω_1), $nf \succ f$ also holds. Therefore, this strategy profile constitutes an equilibrium with one informed agent where,

$$\text{P(peace/one informed agent)}=\omega\left(1-\left(\frac{2-q-qs}{2}\right)^2\right)+(1-\omega)(1-r)^2 \tag{5}$$

And, from 4, we have

$$\text{P(peace/two informed agents)}=\omega\left(1-\left(\frac{2-q-qs}{2}\right)^2\right)+(1-\omega)\left(1-\left(\frac{2-r-rt}{2}\right)^2\right)$$

Clearly, the probability of peace with one informed agent is greater than that with two informed agents if $\omega\neq 1$. Therefore, if $\mu\in(\mu_g,\mu_b)\subset(\mu_1,\mu')$, $q,r\in(q',\overline{q})$, and $\omega<\omega_1$, the ex-ante probability of peace in an informed equilibrium is higher with one informed agent than with two informed agents.

(ii) To show that, under certain conditions, the probability of peace is higher with two informed agents compared to one informed agent, we must identify an informative equilibrium with two informed agents in which the probability of peace is higher than that of the most peaceful informative equilibrium with only one informed agent.

We prove this by comparing all possible equilibria with one informed agent to the unique pure-strategy informative equilibrium with two informed agents (already identified in Proposition 2). In this equilibrium, the probability of peace with two informed agents is:

$$\text{P(peace/two informed agents)}=\omega\left(1-\left(\frac{2-q}{2}\right)^2\right)+(1-\omega)\left(1-\left(\frac{2-r}{2}\right)^2\right)$$

With one informed agent, Lemma 1 tells us that the informed agent I_1 does not send informative messages to ethnicity E_2 in any equilibrium. Since players from ethnicity E_2 are uninformed, they follow the same action regardless of the state — either *fight*, *not fight*, or a mixed strategy. If E_2 players always choose *fight*, the probability of peace will be lower with one informed agent than the probability of peace with two informed agents. If they always choose *not fight*, no informative equilibrium exists when $\mu > \mu'$ (from part 1, when ethnicity E_2 always plays *not fight*, an informative equilibrium exists only for $\mu < \mu'$). Thus, when $\mu > \mu'$, the only possible equilibrium that could result in a higher probability of peace than the pure strategy equilibrium with two informed agents is one in which players from ethnicity E_2 play a mixed strategy.

Suppose that players of ethnicity E_2 play a mixed strategy (σ_2) where they choose *not fight* with probability p and *fight* with probability $1-p$. By Lemma 2, players of both ethnicities cannot play mixed strategies in equilibrium. Therefore, players from ethnicity E_1 must play a pure strategy in equilibrium.

Consider the following strategy profile:

I_1's strategy:

$f_{I_1}(E_1,(q,q)) = xQ + (1-x)R$

$f_{I_1}(E_1,(r,r)) = yQ + (1-y)R$

$f_{I_1}(E_2,(q,q)) = Q$

$f_{I_1}(E_2,(r,r)) = Q$

Player's strategies:

E_1 ethnicity

$s^{E_1}(Q) = nf$

$s^{E_1}(R) = f$

E_2 ethnicity

$s^{E_2}(Q) = p(nf) + (1-p)f$

$s^{E_2}(R) = p(nf) + (1-p)f$

There are two possible pure strategies from E_1 ethnicity players which can exist in an informative equilibrium - all play fight in good state and not fight in the other, and vice versa. The above strategy profile allows for both. As in the analysis for Proposition 1, we find that there exists $\mu'_g = \left(\frac{1-qp}{4-q-2qp}\right)(\alpha+\beta-\varepsilon)$ and $\mu'_b = \left(\frac{1-rp}{4-r-2rp}\right)(\alpha+\beta-\varepsilon)$ such that given the strategy of the players, the informed agent's strategy is informative when $\mu \in (\mu'_b, \mu'_g)$ and $p < \frac{1}{2}$[21]. Here, $\frac{d\mu'_g}{dq} = \dfrac{1-2p}{(4-q-2qp)^2}(\alpha+\beta-\varepsilon)$. Therefore, $\frac{d\mu'_g}{dq} > 0$ if $p < \frac{1}{2}$, which implies that $\mu'_g > \mu'_b$. The informed agent I_1 will send message Q in the good state and message R in the bad state for a range of $\mu \in (\mu'_b, \mu'_g)$.

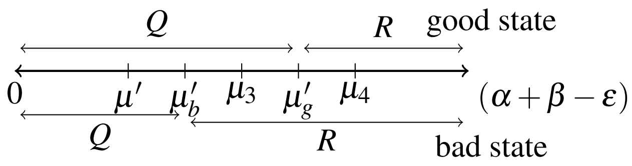

Figure 3: For the proposed strategy profile, this is the informed agent's optimal strategy as a function of the intensity of aggression (μ). In the good state, the informed agent (I_1) will send message Q if $\mu < \mu'_g$ and R otherwise. Similarly, in the bad state, the informed agent (I_1) will send message Q if $\mu < \mu'_b$ and R otherwise. Hence, she is informative when $\mu \in (\mu'_b, \mu'_g)$, as she sends different messages in different states—i.e., Q in the good state and R in the bad state.

Even without identifying the conditions under which the strategy profile described in A is an equilibrium, if ω is low (say less than a cut-off ω_2), then we can show that the probability of peace is higher with two informed agents compared to that with one informed agent. This is because here when the state is bad, in the one informed agent environment, E_1 ethnicity plays 'fight' while E_2 ethnicity players mix between fight and not fight. On the other hand, in unique pure strategy equilibrium with two informed agents, one ethnicity plays fight and the other plays pure strategy not fight.

Choose $\omega' = min\{\omega_1, \omega_2\}$ so that both claims hold for the same parameters.

□

[21]For $p \in \left(\frac{1}{2}, 1\right)$, μ'_g and $\mu'_b < \mu'$ we do not need to consider this case, as we are only comparing the two environments—one with a single informed agent and the other with two informed agents—for values of $\mu > \mu'$. $\mu'_b(p=0) = \mu_3$ (from Proposition 2) $= \dfrac{1}{4-r}(\alpha+\beta-\varepsilon)$. At $p = \dfrac{1}{2}$, we have $\mu'_g = \mu'_b = \mu'$ (same as in part 1) $\equiv \dfrac{1}{4}(\alpha+\beta-\varepsilon)$. Furthermore, note that when p = 0, $\mu'_g(p=0) = \mu_4$ (from Proposition 2) $= \dfrac{1}{4-q}(\alpha+\beta-\varepsilon)$. Figure 3 illustrates the different cutoffs.