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

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Abstract

We model a society with two ethnic groups in which the state of the world is uncertain. Without new information, ethnic conflict is inevitable. 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, a more aggressive informed agent can communicate information to her own ethnicity, and therefore prevent conflict with positive probability. Furthermore, we show that if each ethnicity has their own informed agent, 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 that are about to engage in conflict. There is an informed agent who has information about the state of the world. When can this information increase the

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probability of peace? There are several roadblocks: a) the informed agent belongs to one of the ethnicities and is known to be biased towards them, making it difficult for her to credibly communicate with the other ethnicity, b) the informed agent may prefer 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[1] but 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, 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: a good state where the fraction of strategic players is high and a bad state where the fraction of behavioural players is high. The probability of conflict is a convex function of the average fraction of players who play fight across both ethnicities. Thus, fixing the strategies of the strategic players, the probability of conflict is higher in the bad state. If a conflict occurs, then an ethnicity's probability of winning is positively dependent on the fraction of its own players who fight as a ratio of all players who fight. 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. The payoffs are such that all players playing fight is always an equilibrium and 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*'. This model allows us to ask how and when the informed agent's messages can steer the society away from conflict.

We consider two types of informed agents: a peace loving informed agent (prefers peace to own ethnicity winning a conflict), and an aggressive informed agent (prefers conflict occurring with own ethnicity winning to peace). 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, the informed agent cannot communicate credibly with the players of the opposite ethnicity[2]. 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 it 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 deviate to not-fight, the probability of conflict (convex) drops faster than the probability of losing (linear). On the other hand, an aggressive informed agent is able to send informative messages 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 also try to induce conflict which will make her messages uninformative).

Next, we ask if the probability of peace would be higher with two informed agents (one in each

[1] As opposed to if only public signals were possible.

[2] 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.

ethnicity) compared to when there is only one informed agent?[3] This stems from the observation that with one informed agent, the agent is never able to communicate credibly with the other ethnicity. Therefore, one may imagine that both ethnic groups having their own informed agent could allow both groups to obtain information in equilibrium, and this improves the probability of peace. We find an interval such that when the payoff from peace for the informed agents is within this interval, 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, more information[4] is not always better for peace. 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 induce peace. The former requires it to be incentive compatible for the informed agent to induce 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 cutoff point.

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), 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[5] probability of conflict, and analyze two possible utility 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 receivers. 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

[3] We understand that 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.

[4] 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.

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

effectively. However, the channel for why aggressive informed agents can communicate information, and the fact that we consider multiple senders distinguishes our paper from Kydd (2003) and Cukierman and Tommasi (1998).

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 Bad (B). S-type players are strategic and can choose to take one of two actions - fight (f) or not fight (nf), while B-type players always fight. Both ethnicities have the same mass of players[6].

The state of the world is indicated by the distribution of private types. Let n_l^y be the fraction of y ethnicity players who are l type. For simplicity, we assume that there are only two possible type distributions. With probability ω (common prior), the type distribution is $(n_S^{E_1}, n_S^{E_2}) = (q,q)$, and with probability (1 - ω) it is $(n_S^{E_1}, n_S^{E_2}) = (r,r)$, where $q > r$. Thus, there are more behavioural bad type players in the state (r,r) as compared to the state (q,q).

The actions chosen by all players affect the probability that an ethnic conflict will break out. In particular, if A_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 $\left(\frac{A_i + A_j}{2}\right)^2$. Thus, the probability of conflict is increasing and convex in the fraction of players who fight. This reflects the idea that the probability of conflict increases rapidly as more people choose to fight. If a conflict occurs, the probability of winning for the group E_i is $\frac{A_i}{A_i + A_j}$.

The payoff to player i of type S[7] are 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 a no-conflict event. The payoff matrix is common knowledge. We assume that $\alpha > -\beta + \varepsilon$ to ensure that the payoff from fighting and winning is better than the payoff from fighting and losing. Further, note that conflict is never more desirable than peace ($\alpha + \delta > \alpha$). If a player plays fight and conflict does not happen, we assume the payoff is negative (this could be interpreted as the cost of being arrested for unruly behavior).

Table 1: Payoffs

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

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

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

2.1 Informed agent(s)

An informed agent is a special player who knows the distribution of types. The fact that the informed agent knows the distribution perfectly is common knowledge. We consider two environments with informed agents. In the first, there is only one informed agent (z_1) and her ethnicity is E_1 (this is common knowledge). In the second environment, there are two informed agents (z_1, z_2), where the ethnicity of z_i is E_i.

In both environments, the informed agent(s) sends private[8] cheap talk messages to all players about the state of the world. Given a player i, she can send one of two messages - message Q or a message R. We assume that the informed agent(s) is outside the population and does not participate in the conflict. Since z_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 happen (payoff $\alpha + \mu$). 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 signs and levels. We will call an informed agent peace-loving if μ is positive, and the informed agent will be considered aggressive if μ is negative (since then the payoff from conflict occurring and her own ethnicity winning is higher than the payoff from no conflict for the informed agent). Depending upon the sign, the level of μ measures the intensity of the peace preference or aggression of the informed agent. μ is common knowledge.

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

[8]Private messages can be motivated by messages sent via Whatsapp or text.

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 main 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. Further, 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 losing the conflict is high (β is high). All players playing fight (without new information) can be justified by a politician delivering a particularly rousing hate-filled speech which 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. We tackle this question in our analysis.

3.1 One informed agent

Suppose one informed agent exists, and suppose that the informed agent (z_1) belongs to ethnicity E_1. We analyse our model for equilibria where z_i can communicate information in equilibrium. Thus, we look for *informative equilibria* - where the informed agent is able to transmit information[9] to at least one ethnicity. Is peace possible in an informative equilibrium? What are the incentives of the informed agent to induce peace? To answer these questions, we consider two types of informed agents: peace-loving and aggressive.

3.1.1 Peace-loving vs Aggressive informed agent

Suppose $\mu > 0$ and a peace-loving informed agent has the following preferences (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

[9]The message of the informed agent changes the belief of the recipient about the state of the world.

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, an informative equilibrium exists 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 exist $\mu_1, \mu_2, \underline{r}, \overline{q}, \overline{\omega}$ 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 probability of peace is positive.*

Informed agent's (z_i) strategy:
$f_{z_1}(E_1, (q,q)) = R$
$f_{z_1}(E_1, (r,r)) = Q$
$f_{z_1}(E_2, (q,q)) = Q$
$f_{z_1}(E_2, (r,r)) = Q$

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[10]. 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 lower probability of winning 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 (linear).

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 (q,q), and all strategic type players in E_1 play not fight in the other 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 infor-

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

mative 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 think 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 (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 bad types who always choose to fight, the agent cannot significantly improve the probability of winning. 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, z_2, where z_2 belongs to ethnicity E_2. In the previous section, we saw that given the preferences of the informed agent (peace-loving or aggressive), she was never able to credibly communicate with the other ethnicity. Now, our intuition suggests that both ethnicities will receive credible communication. 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 information 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 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 this class of equilibria.

As before, 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[11] 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 peace maximizing message. 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 information. When $\mu \in (\mu_2, \mu_3)$, there is a 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) z_i's strategies:
$f_{z_i}(E_i, (q,q)) = R$
$f_{z_i}(E_i, (r,r)) = Q$
$f_{z_j}(E_j, (q,q)) = Q$
$f_{z_j}(E_j, (r,r)) = R$
$f_{z_i}(E_j, (q,q)) = Q$
$f_{z_i}(E_j, (r,r)) = Q$
Player's strategies:
E_i ethnicity
$s^{E_i}(Q) = nf$
$s^{E_i}(R) = f$
E_j ethnicity
$s^{E_j}(Q) = nf$
$s^{E_j}(R) = f$

When both ethnicities have their own informed agents, both agents will be perfectly informative to their own ethnicities when μ is neither too high or 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 chooses 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 play

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

fight won't 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, z_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, z_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. This leads to them 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.

4 Welfare

Is the probability of peace higher with one informed agent or with two informed agents? Note that players of both ethnicities are inherently peace-loving, that is, their payoff from peace is highest. 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 $q', \overline{q}$, and μ' such that:*

(i) If $\mu \in (\mu_2, \mu')$ 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 $\mu \in (\mu', \mu_3)$ 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[12] 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

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

is given by:

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

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 correct 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 by proposition 2, the unique pure strategy[13] 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 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[14] 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 paper we study an environment with two ethnic groups that are about to engage in conflict. 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

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

[14] Compared to peace.

the probability of peace is high - one in which an ethnicity always chooses to not fight (as is possible in equilibrium when an ethnicity is uninformed).

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A Appendix

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

Proof. Suppose that the players follow the strategy profile:

z_i's strategy:

$f_{z_i}(E_i,(q,q)) = x_iQ + (1-x_i)R$

$f_{z_i}(E_i,(r,r)) = y_iQ + (1-y_i)R$

$f_{z_i}(E_j,(q,q)) = x_jQ + (1-x_j)R$

$f_{z_i}(E_j,(r,r)) = y_jQ + (1-y_j)R$

Player's strategies:

E_i ethnicity

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

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

E_j ethnicity
$s^{E_j}(Q) = m(nf) + (1-m)f$
$s^{E_j}(R) = n(nf) + (1-n)f$

Assume $m = n$, then EU_{z_i} in good state would be as follows:,

$$EU_{z_i} = \left[1 - \left(\frac{2(1-q) + q(1-x_i)(1-t) + qx_i(1-s) + q(1-m)}{2}\right)^2\right](\alpha+\mu) + \left(\frac{2(1-q) + q(1-x_i)(1-t) + qx_i(1-s) + q(1-m)}{2}\right)^2$$
$$\left[\frac{1-q+q(1-x_i)(1-t)+qx_i(1-s)}{2(1-q)+q(1-x_i)(1-t)+qx_i(1-s)+q(1-m)}\alpha + \frac{1-q+q(1-m)}{2(1-q)+q(1-x_i)(1-t)+qx_i(1-s)+q(1-m)}(-\beta+\varepsilon)\right]$$

Taking the partial derivative with respect to m, we get:

$$\frac{\partial EU_{z_i}}{\partial m} = \frac{q}{4}\left[(1-qt+qx_i(t-s))(\alpha+\beta-\varepsilon+2\mu) + 2(1-qm)(\alpha+\beta-\varepsilon+\mu)\right] > 0$$

Similarly, in the bad state, $\frac{\partial EU_{z_i}}{\partial m} > 0$. Since EU_{z_i} is increasing in m, if $m \neq n$ (without loss of generality, say $m > n$), then z_i will always send message Q to players of ethnicity E_j. Conversely, if $m < n$, z_i will always send message R to players of ethnicity E_j to maximize their expected payoff. Therefore, when $m \neq n$, z_i will send uninformative messages to players of ethnicity E_j (*opposite ethnicity*). On the other hand, if $m = n$, then players do not respond to the informed agent's messages, and thus, the informed agent has no incentive to send informative messages. □

Proof of Proposition 1.

Case 1: Peace loving informed agent

By Lemma 1, the informed agent (z_1) will not send informative messages to players of opposite ethnicity E_2 in equilibrium (say send Q in both states). Therefore, the action of players of ethnicity E_2 would be independent of the informed agent's message. Hence, an informative equilibrium exists only if the informed agent can send informative messages to her ethnicity E_1. Suppose that the players follow the strategy profile:
z_1's strategy:
$f_{z_1}(E_1,(q,q)) = x_1Q + (1-x_1)R$
$f_{z_1}(E_1,(r,r)) = y_1Q + (1-y_1)R$
$f_{z_1}(E_2,(q,q)) = Q$
$f_{z_1}(E_2,(r,r)) = Q$
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
$s^{E_2}(Q) = m(nf) + (1-m)f$
$s^{E_2}(R) = m(nf) + (1-m)f$

If the state is good then EU_{z_1} will be as follows,

$$EU_{z_1} = p(peace)(\alpha+\mu) + p(conflict)(p(win/conflict)\alpha + p(lose/conflict)(-\beta+\varepsilon))$$

Assume $s > t$,

$$EU_{z_1} = \left[1 - \left(\frac{2(1-q)+q(1-x_1)(1-t)+qx_1(1-s)+q(1-m)}{2}\right)^2\right](\alpha+\mu) + \left(\frac{2(1-q)+q(1-x_1)(1-t)+qx_1(1-s)+q(1-m)}{2}\right)^2$$
$$\left[\frac{1-q+q(1-x_1)(1-t)+qx_1(1-s)}{2(1-q)+q(1-x_1)(1-t)+qx_1(1-s)+q(1-m)}\alpha + \frac{1-q+q(1-m)}{2(1-q)+q(1-x_1)(1-t)+qx_1(1-s)+q(1-m)}(-\beta+\varepsilon)\right]$$

$x_1^* = \frac{(1-qm)(\alpha+\beta-\varepsilon)+2\mu(2-qt-qm)}{2\mu q(s-t)}$ will maximize the expected utility of z_1 as EU_{z_1} is concave in x_1[15]. Similarly, if the state is bad then the expected utility of z_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 is a contradiction. Similarly, we can prove that $y_1^* > 1$. Therefore, optimal x_1 and y_1 will be more than one. Since EU_{z_1} is concave in x_1 and y_1, z_1 will choose $x_1^* = y_1^* = 1$, this implies the informed agent will send the message Q in both states i.e., uninformative message. If $s < t$, maximizing her expected utility will result in $x_1^* = y_1^* = 0$. Consequently, in both states, she will send message R only to players of her ethnicity. Moreover, $s = t$ implies no informative equilibrium as players of E_1 choose the same action irrespective of the message received. Given that she sends the same message to her ethnicity regardless of the true states of the world, it follows that there doesn't exist any informative equilibrium in the presence of a peace-loving informed agent.

Case 2: Aggressive informed agent

In the presence of an aggressive informed agent, there exist multiple informative equilibria. One of the informative equilibria has the following features. Clearly, by Lemma 1, an aggressive informed agent also cannot credibly communicate with the opposite ethnicity. Therefore, an informative equilibrium exists if the aggressive informed agent can credibly communicate with her ethnicity. Suppose that the players follow the strategy profile:

z_1's strategy:
$f_{z_1}(E_1,(q,q)) = xQ + (1-x)R$
$f_{z_1}(E_1,(r,r)) = yQ + (1-y)R$
$f_{z_1}(E_2,(q,q)) = Q$
$f_{z_1}(E_2,(r,r)) = Q$
Player's strategies:
E_1 ethnicity
$s^{E_1}(Q) = nf$
$s^{E_1}(R) = f$

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[15] $\frac{d^2EU_{z_1}}{dx_1^2} = -\frac{1}{2}(q(t-s))^2\mu < 0$ and $\frac{d^2EU_{z_1}}{dy_1^2} = -\frac{1}{2}(r(t-s))^2\mu < 0$.

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

Informed agent
If the state is good, then

$$EU_{z_1}(x) = \left(1 - \left(\frac{2(1-q)+q(1-x)}{2}\right)^2\right)(\alpha-\mu) + \left(\frac{2(1-q)+q(1-x)}{2}\right)^2 \left(\frac{1-qx}{2-q-qx}\alpha + \frac{1-qx}{2-q-qx}(-\beta+\varepsilon)\right)$$

Clearly, EU_{z_1} is convex in x. Therefore, only corner solutions exist, i.e., z_1 will send either message Q or R.

$$\Delta EU_{z_1}(.) \equiv EU_{z_1}(1) - EU_{z_1}(0) = \frac{q}{4}\left[(1-q)(\alpha+\beta-\varepsilon) - (4-3q)\mu\right]$$

$\Delta EU_{z_1}(.) > 0$ if $\mu < \left(\frac{1-q}{4-3q}\right)(\alpha+\beta-\varepsilon) \equiv \mu_1$. This implies that if $\mu < \mu_1$, then the informed agent will send message Q; otherwise, she will send message R.

Similarly, if the state is bad, then $\Delta EU_{z_1}(.) > 0$ 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. Since $\frac{d\mu_1}{dq} < 0$, this implies $\mu_1 < \mu_2$.

Therefore, for any $\mu \in (\mu_1, \mu_2)$, there exists an informative equilibrium where the informed agent (z_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 $= (1-(1-r)^2)(-\gamma) + (1-r)^2\left(\frac{\alpha-\beta+\varepsilon}{2}\right)$
Therefore, nf $\succ$ f if $r > 1 - \sqrt{\frac{2(\alpha+\delta+\gamma)}{2(\alpha+\delta+\gamma)+\alpha+\beta+\varepsilon}} \equiv \underline{r}$.

If $i \in E_1$ receives message R then, he will make the following calculation:
Payoff from playing nf $= \left(1-\left(\frac{2-q}{2}\right)^2\right)(\alpha+\delta) + \left(\frac{2-q}{2}\right)^2(-\beta)$
Payoff from playing f $= \left(1-\left(\frac{2-q}{2}\right)^2\right)(-\gamma) + \left(\frac{2-q}{2}\right)^2\left(\frac{1}{2-q}(\alpha) + \frac{1-q}{2-q}(-\beta+\varepsilon)\right)$
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., $(\overline{q} - \underline{r} > 0)$.

Clearly, $\underline{r}$ always lies within the interval (0,1). Specifically, $\underline{r}$ is greater than zero if $\alpha+\beta+\varepsilon >$

0. Given that all parameters are positive, this condition is always satisfied. Additionally, $\underline{r}$ will be less than one if $\alpha+\delta+\gamma>0$, which also holds under the assumption that all parameters are positive.

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 $\frac{dr}{d\beta}>0$. Therefore, if at $\beta=0$, $\overline{q}-\underline{r}>0$, then for all β, $\overline{q}-\underline{r}>0$.

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 $=\omega\left[\left(1-\left(\frac{2-q}{2}\right)^2\right)(\alpha+\delta)+\left(\frac{2-q}{2}\right)^2(-\beta)\right]+(1-\omega)[-\beta]$

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

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 (z_i) does not send informative messages to players of opposite ethnicity E_2 but sends fully informative messages to players of her ethnicity, E_1. Consequently, players of ethnicity E_2 choose to play 'not fight' in both states, while players of ethnicity E_1 choose to play 'fight' in the good state and 'not fight' in the bad state.

Proof of Proposition 2

We are focusing on the possible equilibrium in pure strategies for players of both ethnicities. Suppose that the players follow the strategy profile:

z_i's strategy:

$f_{z_i}(E_i,(q,q))=x_iQ+(1-x_i)R$

$f_{z_i}(E_i,(r,r)) = y_iQ + (1-y_i)R$
$f_{z_i}(E_j,(q,q)) = Q$
$f_{z_i}(E_j,(r,r)) = Q$
Player's strategies:
E_i ethnicity
$s^{E_i}(Q) = nf$
$s^{E_i}(R) = f$
If the state is good then,

$$EU_{z_i} = p(peace)(\alpha - \mu) + p(conflict)(p(win/conflict)\alpha + p(lose/conflict)(-\beta + \varepsilon))$$

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

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

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

Since the expected payoff of informed agents is convex. Therefore, only corner solutions exist. Assume, z_j's strategy:
$f_{z_j}(E_j,(q,q)) = Q$
$f_{z_j}(E_j,(r,r)) = R$
z_i's strategy:
$f_{z_i}(E_i,(q,q)) = x_1Q + (1-x_1)R$
$f_{z_i}(E_i,(r,r)) = y_1Q + (1-y_1)R$
Now, in the good state,

$$EU_{z_i}(x_i) = \left(1 - \left(\frac{2(1-q)+q(1-x_i)}{2}\right)^2\right)(\alpha-\mu) + \left(\frac{2(1-q)+q(1-x_i)}{2}\right)^2 \left(\frac{1-qx_i}{2-q-qx_i}\alpha + \frac{1-q}{2-q-qx_i}(-\beta+\varepsilon)\right)$$

$$\Delta EU_{z_i}(.) \equiv EU_{z_i}(1) - EU_{z_i}(0) = \frac{q}{4}((4-3q)(-\mu) + (1-q)(\alpha+\beta-\varepsilon))$$

Therefore, $\Delta EU_{z_i}(.) > 0$ if $\mu < \frac{1-q}{4-3q}(\alpha+\beta-\varepsilon) \equiv \mu_1$. If $\mu < \mu_1$, then z_i's expected utility is maximized when $x_i = 1$. This implies that in the good state, if $\mu < \mu_1$, z_i will send message Q; otherwise, z_i will send message R.

In the bad state,

$$EU_{z_i}(y_i) = \left(1 - \left(\frac{2-r+r(1-y_i)}{2}\right)^2\right)(\alpha-\mu) + \left(\frac{2-ry_i}{2}\right)^2 \left(\frac{1-ry_i}{2-ry_i}\alpha + \frac{1}{2-ry_i}(-\beta+\varepsilon)\right)$$

$$\Delta EU_{z_i}(.) \equiv EU_{z_i}(1) - EU_{z_i}(0) = \frac{r}{4}((4-r)(-\mu) + (\alpha+\beta-\varepsilon))$$

Therefore, $\Delta EU_{z_i}(.) > 0$ if $\mu < \frac{1}{4-r}(\alpha+\beta-\varepsilon) \equiv \mu_3$. If $\mu < \mu_3$, then z_i's expected utility is maximized when $y_i = 1$. This implies that in the bad state, if $\mu < \mu_3$, z_i will send message Q; otherwise, z_i will send message R.

Given the strategy of z_j, we found the best response for z_i. Now, given the z_i strategy for $\mu \in (\mu_1, \mu_3)$, we will find the best response of z_j.
For $\mu \in (\mu_1, \mu_3)$, z_i's strategy:
$f_{z_i}(E_i, (q,q)) = R$
$f_{z_i}(E_i, (r,r)) = Q$
Assume z_j's strategy:
$f_{z_j}(E_j, (q,q)) = x_j Q + (1-x_j)R$
$f_{z_j}(E_j, (r,r)) = y_j Q + (1-y_j)R$
in the good state,

$$EU_{z_j}(x_j) = \left(1 - \left(\frac{2-q+q(1-x_j)}{2}\right)^2\right)(\alpha-\mu) + \left(\frac{2-qx_j}{2}\right)^2\left(\frac{1-qx_j}{2-qx_j}\alpha + \frac{1}{2-qx_j}(-\beta+\varepsilon)\right)$$

$$\Delta EU_{z_j}(.) \equiv EU_{z_j}(1) - EU_{z_j}(0) = \frac{q}{4}((4-q)(-\mu) + (\alpha+\beta-\varepsilon))$$

Therefore, $\Delta EU_{z_j}(.) > 0$ if $\mu < \frac{1}{4-q}(\alpha+\beta-\varepsilon) \equiv \mu_4$. If $\mu < \mu_4$, then z_j's expected utility is maximized when $x_j = 1$. This implies that in the good state, if $\mu < \mu_4$, z_j will send message Q; otherwise, z_j will send message R.

Similarly, in the bad state,

$$EU_{z_j}(y_j) = \left(1 - \left(\frac{2(1-r)+r(1-y_j)}{2}\right)^2\right)(\alpha-\mu) + \left(\frac{2(1-r)+r(1-y_j)}{2}\right)^2\left(\frac{1-ry_j}{2-r-ry_j}\alpha + \frac{1-r}{2-r-ry_j}(-\beta+\varepsilon)\right)$$

$$\Delta EU_{z_j}(.) \equiv EU_{z_j}(1) - EU_{z_j}(0) = \frac{r}{4}((4-3r)(-\mu) + (1-r)(\alpha+\beta-\varepsilon))$$

Therefore, $\Delta EU_{z_j}(.) > 0$ if $\mu < \frac{1-r}{4-3r}(\alpha+\beta-\varepsilon) \equiv \mu_2$. If $\mu < \mu_2$, then z_j's expected utility is maximized when $y_j = 1$. This implies that in the good state, if $\mu < \mu_2$, z_j will send message Q; otherwise, z_i will send message R. Hence, for $\mu \in (\mu_2, \mu_4)$, z_j is informative to his ethnicity. Moreover, for $\mu \in (\mu_2, \mu_3)$ both informed agents are informative and they will play the following strategies in the equilibrium:
$f_{z_i}(E_i, (q,q)) = R$ and $f_{z_j}(E_j, (q,q)) = Q$
$f_{z_i}(E_i, (r,r)) = Q$ and $f_{z_j}(E_j, (r,r)) = R$
$f_{z_i}(E_j, (q,q)) = Q$
$f_{z_i}(E_j, (r,r)) = Q$
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 $i \in E_i$. 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 $i\in E_i$ 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.,

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

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 $j\in E_j$. 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 $j\in E_j$ 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:

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

Therefore $\forall q,r\in(q',\overline{q})$ where $r<q$, following strategy profiles constitutes an informative equilibrium[16].
z_i's strategies:
$f_{z_i}(E_i,(q,q))=R$ and $f_{z_j}(E_j,(q,q))=Q$
$f_{z_i}(E_i,(r,r))=Q$ and $f_{z_j}(E_j,(r,r))=R$
$f_{z_i}(E_j,(q,q))=Q$
$f_{z_i}(E_j,(r,r))=Q$
Player's strategies:
E_i ethnicity
$s^{E_i}(Q)=nf$
$s^{E_i}(R)=f$
This equilibrium is unique in pure strategies.

Lemma 2. *If both informed agents are aggressive and informative, players of both ethnicity cannot play mixed strategy in equilibrium.*

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

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

[16]Clearly, q' < q. As if $B<B'$ and $C<C'$ then $\frac{A-B}{C}>\frac{A-B'}{C}>\frac{A-B'}{C'}$.

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 the payoff from fighting is equal to the payoff from not fighting. This results in the following condition:

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

Similarly, players from ethnicity E_2 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

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

It will be optimal for the player from E_2 ethnicity to play the mixed strategy if they are indifferent between playing 'fight' and 'not fight.' Therefore, we need the condition that the payoff from fighting is equal to the payoff from not fighting. This results in the following conditions:

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

Both conditions will be satisfied if $s_1 = s_2$. However, an asymmetric mixed strategy requires $s_1 \neq s_2$. Similarly, in the bad state, if players follow the strategy profile:

$$E_1\ plays - t_1(nf)+(1-t_1)f$$
$$E_2\ plays - t_2(nf)+(1-t_2)f$$

Therefore, both players can play mixed strategy in the equilibrium if $t_1 = t_2$. This is a contradiction. Hence, there is no equilibrium in which players can play an asymmetric mixed strategy.

Part II: From Part I, we derived that players can adopt a mixed strategy if, in the good state, $s_1 = s_2 = s$, and in the bad state, $t_1 = t_2 = t$. Therefore, players can play a symmetric mixed strategy in equilibrium if the informed agents send strategy-consistent messages in equilibrium. Suppose the strategy profile of the players is as follows:
E_i ethnicity
$s^{E_i}(Q) = s(nf)+(1-s)f$
$s^{E_i}(R) = t(nf)+(1-t)f$
Therefore, a symmetric mixed strategy equilibrium exists if the informed agents send the same message, i.e., either Q or R in a given state. Moreover, from Lemma 1, the informed agents cannot send informative messages to players of the opposite ethnicity. As a result, the player's actions will be independent of the messages from the informed agent of the opposite ethnicity. Therefore, we will focus on the messages sent by the informed agents to their ethnicity. Let the informed agent's strategy profile be as follows:
z_i's strategy:

$$f_{z_i}(E_i,(q,q)) = x_iQ+(1-x_i)R$$

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

If the state is good, then:

$$EU_{z_i} = p(\text{peace})(\alpha-\mu) + p(\text{conflict})\left(p(\text{win/conflict})\alpha + p(\text{lose/conflict})(-\beta+\varepsilon)\right)$$

Assume $s > t$,

$$EU_{z_i} = \left[1-\left(\frac{2(1-q)+q(1-x_i)(1-t)+qx_i(1-s)+q(1-x_j)(1-t)+qx_j(1-s)}{2}\right)^2\right](\alpha-\mu)+\left(\frac{2(1-q)+q(1-x_i)(1-t)+qx_i(1-s)+q(1-x_j)(1-t)+qx_j(1-s)}{2}\right)^2$$
$$\left[\frac{1-q+q(1-x_i)(1-t)+qx_i(1-s)}{2(1-q)+q(1-x_i)(1-t)+qx_i(1-s)+q(1-x_j)(1-t)+qx_j(1-s)}\alpha+\frac{1-q+q(1-x_j)(1-t)+qx_j(1-s)}{2(1-q)+q(1-x_i)(1-t)+qx_i(1-s)+q(1-x_j)(1-t)+qx_j(1-s)}(-\beta+\varepsilon)\right]$$

Since $\frac{\partial^2 EU_i}{\partial x_i^2} = \frac{q^2}{2}\mu > 0$ (Convex), therefore, only corner solutions exist. This implies that an informed agent will not mix between messages. Now we need to check whether both informed agents can send the same message, i.e., either Q or R in the good state.

Assume it is optimal for z_j to send message Q (implies $x_j = 1$) in the good state and R (implies $y_j = 0$) in the bad state. Then:

$$EU_{z_i}(x_i) = \left[1-\left(\frac{2(1-q)+q(1-x_i)(1-t)+qx_i(1-s)+q(1-s)}{2}\right)^2\right](\alpha-\mu)+\left(\frac{2(1-q)+q(1-x_i)(1-t)+qx_i(1-s)+q(1-s)}{2}\right)^2$$
$$\left[\frac{1-q+q(1-x_i)(1-t)+qx_i(1-s)}{2(1-q)+q(1-x_i)(1-t)+qx_i(1-s)+q(1-s)}\alpha+\frac{1-q+q(1-s)}{2(1-q)+q(1-x_i)(1-t)+qx_i(1-s)+q(1-s)}(-\beta+\varepsilon)\right]$$

Therefore, $\Delta EU_{z_i}(.) \equiv EU_{z_i}(1) - EU_{z_i}(0) > 0$ if $\mu < \frac{1-qs}{4-3qs-qt}(\alpha+\beta-\varepsilon) \equiv \mu_1'$. If $\mu < \mu_1'$, then z_i's expected utility is maximized when $x_i = 1$. This implies that in the good state, if $\mu < \mu_1'$, z_i will send message Q; otherwise, z_i will send message R.

Similarly, in the bad state:

$$EU_{z_i}(y_i) = \left[1-\left(\frac{2(1-r)+r(1-y_i)(1-t)+ry_i(1-s)+r(1-t)}{2}\right)^2\right](\alpha-\mu)+\left(\frac{2(1-r)+r(1-y_i)(1-t)+ry_i(1-s)+r(1-t)}{2}\right)^2$$
$$\left[\frac{1-r+r(1-y_i)(1-t)+ry_i(1-s)}{2(1-r)+r(1-y_i)(1-t)+ry_i(1-s)+r(1-t)}\alpha+\frac{1-r+r(1-t)}{2(1-r)+r(1-y_i)(1-t)+ry_i(1-s)+r(1-t)}(-\beta+\varepsilon)\right]$$

Therefore, $\Delta EU_{z_i}(.) \equiv EU_{z_i}(1) - EU_{z_i}(0) > 0$ if $\mu < \frac{1-rt}{4-3rt-rs}(\alpha+\beta-\varepsilon) \equiv \mu_3'$. If $\mu < \mu_3'$, then z_i's expected utility is maximized when $y_i = 1$. This implies that in the bad state, if $\mu < \mu_3'$, z_i will send message Q; otherwise, z_i will send message R. Hence, z_i will be informative only if $\mu \in (\mu_1', \mu_3')$. Now, given the strategies of z_i , i.e., send message R in the good state and message Q in the bad state and $\mu \in (\mu_1', \mu_3')$, we need to show that z_j will also send R in the good state and Q in the bad state for the strategy to be symmetric. Therefore, if the state is good then,

$$EU_{z_j}(x_j) = \left[1-\left(\frac{2(1-q)+q(1-x_j)(1-t)+qx_j(1-s)+q(1-t)}{2}\right)^2\right](\alpha-\mu)+\left(\frac{2(1-q)+q(1-x_j)(1-t)+qx_j(1-s)+q(1-t)}{2}\right)^2$$
$$\left[\frac{1-q+q(1-x_j)(1-t)+qx_j(1-s)}{2(1-q)+q(1-x_j)(1-t)+qx_j(1-s)+q(1-t)}\alpha+\frac{1-q+q(1-t)}{2(1-q)+q(1-x_j)(1-t)+qx_j(1-s)+q(1-t)}(-\beta+\varepsilon)\right]$$

Therefore, $\Delta EU_{z_j}(.) \equiv EU_{z_j}(1) - EU_{z_j}(0) > 0$ if $\mu < \frac{1-qt}{4-3qt-qs}(\alpha+\beta-\varepsilon) \equiv \mu_4'$. If $\mu < \mu_4'$, then z_j's expected utility is maximized when $x_j = 1$. This implies that in the good state, if $\mu < \mu_4'$, z_j will send message Q; otherwise, z_2 will send message R.

Similarly, in the bad state, $\Delta EU_{z_j}(.) \equiv EU_{z_j}(1) - EU_{z_j}(0) > 0$ if $\mu < \frac{1-rs}{4-3rs-rt}(\alpha+\beta-\varepsilon) \equiv \mu_2'$. If $\mu < \mu_2'$, then z_j's expected utility is maximized when $y_j = 1$, meaning that in the bad state, if $\mu <$

μ_2', z_j will send message Q; otherwise, z_j will send message R. Therefore, both informed agents are informative only if $\mu \in (\mu_2', \mu_3')$. However, the informed agents will send different messages in both states, which leads to the play of an asymmetric mixed strategy in equilibrium. As shown in Part I, players cannot play an asymmetric mixed strategy; they can only play a symmetric mixed strategy in equilibrium. However, it is not optimal for the informed agents to send messages consistent with a symmetric strategy in equilibrium. Therefore, players cannot play a mixed strategy in equilibrium if both informed agents are aggressive and informative. □

Proof of proposition 3

Proof. (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 equilibrium where one informed agent achieves a higher peace probability than the most peaceful equilibrium with two agents. Notably, there is a unique pure-strategy equilibrium with two informed agents. Furthermore, by Lemma 2, players of both ethnicities cannot play mixed strategies in equilibrium, though players of one ethnicity might. Thus, the informative equilibrium with two informed agents results in the following actions by players of both ethnicities:

E_i ethnicity

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

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

E_j ethnicity

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

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

This strategy profile will constitute the most informative equilibrium when both informed agents are informative. Thus, it is sufficient to find an equilibrium where the probability of no conflict with one informed agent is higher than the probability of no conflict in this equilibrium.

One informed agent

z_i's strategy:

$f_{z_i}(E_i, (q,q)) = xQ + (1-x)R$

$f_{z_i}(E_i, (r,r)) = yQ + (1-y)R$

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

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

Player's strategies:

E_i ethnicity

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

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

E_j ethnicity

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

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

Since the expected payoff of z_i is convex in x and y, she will either send Q or R in any given state. In the good state, she will always send Q if the expected payoff from sending Q is greater than that of sending R. Thus, z_i will always send Q in the good state if:

$$\mu < \frac{1-q}{4-3q-qs}(\alpha+\beta-\varepsilon) \equiv \mu_g$$

Similarly, in the bad state, z_1 will always send Q if:

$$\mu < \frac{1-r}{4-3r-rs}(\alpha+\beta-\varepsilon) \equiv \mu_b$$

Here, $\frac{\partial \mu_g}{\partial q} = \dfrac{s-1}{(4-3q-qs)^2} < 0$. This implies that $\mu_g < \mu_b$, meaning z_i will send message R in the good state and Q in the bad state for a range of $\mu \in (\mu_1, \mu')$.

E_i ethnicity

Let $i \in E_i$ 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 $i \in E_i$ 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 $s \in (0,1)$:

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

At $s=0$, the equation holds for:

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

Similarly, at $s=1$, the equation holds for:

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

Therefore, by the intermediate value theorem, there exists $s \in (0,1)$ and $q \in (\underline{q}, \overline{q})$ such that players are indifferent between playing fight and not fight.

E_j ethnicity

If $j \in E_j$ 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 $= \omega\left(\left(1-\left(\frac{2-q-qs}{2}\right)^2\right)(-\gamma)+\left(\frac{2-q-qs}{2}\right)^2\right)\left(\frac{1-q}{2-q-qs}(\alpha)+\frac{1-qs}{2-q-qs}(\alpha)\right)\right)+(1-\omega)\left((1-(1-r)^2)(-\gamma)+(1-r)^2\left(\frac{\alpha-\beta+\varepsilon}{2}\right)\right)$
Therefore $nf \succ f$, if

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

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

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

And,

$$\text{P(peace/two informed agents)} = \omega\left(1-\left(\frac{2-q-qs}{2}\right)^2\right)+(1-\omega)\left(1-\left(\frac{2-r-rt}{2}\right)^2\right) \quad (3)$$

Clearly, from (3) and (4), the probability of peace with one informed agent is greater than that with two informed agents if $\omega \neq 1$. Therefore, if $\mu \in (\mu_2, \mu')$ and $q, r \in (q', \overline{q})$, the ex-ante probability of no conflict is higher with one informed agent than with two informed agents.

(ii) To show that, under certain conditions, the probability of no conflict is higher with two informed agents compared to one informed agent, we need to establish that there exists an equilibrium with two informed agents where the probability of no conflict is greater than the most peaceful equilibrium achievable with just one informed agent. In the case of two informed agents, we have a unique equilibrium in pure strategy where,

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

However, with one informed agent, multiple equilibria exist. Without loss of generality, assume that the informed agent belongs to ethnicity E_1. Hence, by Lemma 1, the informed agent will not send informative messages to ethnicity E_2. Since the players of ethnicity E_2 are uninformed, they will follow the same action regardless of the state — either 'fight,' 'not fight,' or a mixed strategy. If players from ethnicity E_2 always choose 'fight,' the probability of peace will be lower with one informed agent than the expected probability of peace with two informed agents. Moreover, if they always choose 'not fight,' no informative equilibrium exists when $\mu > \mu'$, leading to a probability of peace with one informed agent being zero—clearly less than the expected probability of peace with two informed agents. Thus, the only possible equilibrium that could result in a higher probability of peace than the expected probability of peace with two informed agents is one where players of ethnicity E_2 play mixed strategy.

Now, suppose players choose 'not fight' with probability p and 'fight' with probability $1-p$. This leads to two main subcases:

First, when players of ethnicity E_1 play a mixed strategy in equilibrium. If players from ethnicity E_1 adopt mixed strategies, we must first rule out the possibility of asymmetric mixed strategies. By Lemma 2, players cannot play asymmetric mixed strategies in equilibrium. Therefore, players of ethnicity E_1 must play a symmetric mixed strategy. This implies that players from ethnicity E_1 will follow the same strategy in both states. Hence, this cannot be an informative equilibrium.

Second when players of ethnicity E_1 play pure strategies. Since players of ethnicity E_2 are uninformed, they will follow the same strategy in both states. Thus, we need to focus on the case where players of ethnicity E_2 adopt a mixed strategy while players of ethnicity E_1 adopt a pure strategy.

Suppose that the players follow the strategy profile:

z_1's strategy:

$f_{z_1}(E_1,(q,q)) = xQ + (1-x)R$

$f_{z_1}(E_1,(r,r)) = yQ + (1-y)R$

$f_{z_1}(E_2,(q,q)) = Q$

$f_{z_1}(E_2,(r,r)) = Q$

Player's strategies:

E_1 ethnicity

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

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

E_2 ethnicity

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

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

Informed agent

If the state is good, then

$$EU_{z_1}(x) = \left(1 - \left(\frac{2(1-q)+q(1-p)+q(1-x)}{2}\right)^2\right)(\alpha-\mu) + \left(\frac{2(1-q)+q(1-p)+q(1-x)}{2}\right)^2 \left(\frac{1-qx}{2-qp-qx}\alpha + \frac{1-qp}{2-qp-qx}(-\beta+\varepsilon)\right)$$

Clearly, EU_{z_1} is convex in x. Therefore, only corner solutions exist, i.e., z_1 will send either message Q or R.

$$\Delta EU_{z_1}(.) \equiv EU_{z_1}(1) - EU_{z_1}(0) = \frac{q}{4}[(1-qp)(\alpha+\beta-\varepsilon) - (4-q-2qp)\mu]$$

$\Delta EU_{z_1}(.) > 0$ if $\mu < \left(\frac{1-qp}{4-q-2qp}\right)(\alpha+\beta-\varepsilon) \equiv \mu_g'$. This implies that if $\mu < \mu_g'$, the informed agent will send message Q; otherwise, they will send message R.

Similarly, if the state is bad, $\Delta EU_{z_1}(.) > 0$ if $\mu < \left(\frac{1-rp}{4-r-2rp}\right)(\alpha+\beta-\varepsilon) \equiv \mu_b'$. This implies that if $\mu < \mu_b'$, the informed agent will send message Q; otherwise, they will send message R.

Note that $\frac{d\mu_g'}{dq} = (1-2p)(\alpha+\beta-\varepsilon)$. Therefore, $\frac{d\mu_g'}{dq} > 0$ if $p < \frac{1}{2}$, which implies that $\mu_g' > \mu_b'$ when $p < \frac{1}{2}$. Furthermore, $\lim_{p\to 0}\mu_g' = \frac{1}{4-q}(\alpha+\beta-\varepsilon) \equiv \mu_4$, and $\lim_{p\to\frac{1}{2}}\mu_g' = \frac{1}{4}(\alpha+\beta-\varepsilon) \equiv \mu'$.

Thus, if $p < \frac{1}{2}$, there exists a range of $\mu \in (\mu', \mu_4)$ where an informative equilibrium exists in which the informed agent (z_1) sends message Q in the good state and message R in the bad state to players of ethnicity E_1. Given the informed agent's strategy, the key question remains whether it is optimal for players of both ethnicities to follow their stated strategies.

E_1 ethnicity

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

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

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

At $p = 0$, $nf \succ f$ (already proven in Equilibrium 2). Now, $\frac{d\pi(nf)}{dp} > 0$, and $\frac{d\pi(f)}{dp}$ could be positive or negative. Clearly, if $\frac{d\pi(f)}{dp} \leq 0$, then $nf \succ f$. However, if $\frac{d\pi(f)}{dp} > 0$, then $nf \succ f$ if, at $p = \frac{1}{2}$, $nf \succ f$.

At $p = \frac{1}{2}$

Payoff from playing nf $= \left(1 - \left(\frac{4-3q}{4}\right)^2\right)(\alpha+\delta) + \left(\frac{4-3q}{4}\right)^2(-\beta)$

Payoff from playing f $= \left(1 - \left(\frac{4-3q}{4}\right)^2\right)(-\gamma) + \left(\frac{4-3q}{4}\right)^2\left(\frac{2(1-q)}{4-3q}(\alpha) + \frac{2-q}{4-3q}(-\beta+\varepsilon)\right)$

Therefore, nf $\succ$ f if $q > \frac{24(\alpha+\delta+\gamma)+14(\alpha+\beta)+10\varepsilon - \sqrt{(24(\alpha+\delta+\gamma)+14(\alpha+\beta)+10\varepsilon)^2 - 32(\alpha+\beta+\varepsilon)(9(\alpha+\delta+\gamma)+6(\alpha+\beta)+3\varepsilon)}}{9(\alpha+\delta+\gamma)+6(\alpha+\beta)+3\varepsilon} \equiv q'''$. Feasible q exists if $q''' < 1$. q''' would be less than one if $\varepsilon < 3.375(\alpha+\delta+\gamma)$. This always holds as we assume $\varepsilon < 3(\alpha+\delta+\gamma)$.

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

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

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

At $p = 0$, $f \succ nf$ (already proven in Equilibrium 2). Now, $\frac{d\pi(nf)}{dp} > 0$, and $\frac{d\pi(f)}{dp}$ could be positive or negative. However, $f \succ nf$ if, at $p = \frac{1}{2}$, $f \succ nf$.

At $p = \frac{1}{2}$

Payoff from playing nf $= \left(1 - \left(\frac{4-r}{4}\right)^2\right)(\alpha+\delta) + \left(\frac{4-r}{4}\right)^2(-\beta)$

Payoff from playing f $= \left(1-\left(\frac{4-r}{4}\right)^2\right)(-\gamma)+\left(\frac{4-r}{4}\right)^2\left(\frac{2}{4-r}(\alpha)+\frac{2-r}{4-r}(-\beta+\varepsilon)\right)$

Therefore, f $\succ$ nf if $r < \frac{8(\alpha+\delta+\gamma)+2(\alpha+\beta)+6\varepsilon-\sqrt{(8(\alpha+\delta+\gamma)+2(\alpha+\beta)+4\varepsilon)^2-32(\alpha+\beta+\varepsilon)(\alpha+\delta+\gamma+\varepsilon)}}{2(\alpha+\delta+\gamma+\varepsilon)} \equiv r'''$. Feasible r exists if $r''' > 0$. r''' would be more than zero if $(\alpha+\beta+\varepsilon)(\alpha+\delta+\gamma+\varepsilon) > 0$. This always holds.

E_2 ethnicity

Let $j \in E_2$ receive message Q or R then, he will make the following calculations:

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

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

At $\omega = 0$, $f \sim nf$ if $p = \frac{4(\alpha+\delta+\gamma)+3(\alpha+\beta)-\sqrt{(4(\alpha+\delta+\gamma)+3(\alpha+\beta))^2-8(\alpha+\delta+\gamma+\alpha+\beta)(\alpha+\beta+\varepsilon)}}{2(\alpha+\delta+\gamma+\alpha+\beta)r} \equiv p'$. Hence, players of ethnicity E_2 can mix between 'fight' and 'not fight' if $p' \in (0,1)$. p' is always greater than 0, and for some parametric values, it is less than 1. Therefore, by continuity, $f \sim nf$ also holds for sufficiently small ω.

Thus, when ω is small enough, playing the mixed strategy σ_2 is optimal for players of ethnicity E_2. Under certain conditions—specifically when r is sufficiently small ($r < r'''$), q is sufficiently large ($q > q'''$), the bad state is more likely ($\omega < \omega'$), and $\mu \in (\mu', \mu_4)$—the strategies played by the players constitute an equilibrium.

In this equilibrium, the informed agent does not send informative messages to players of ethnicity E_2 but sends fully informative messages to players of his ethnicity, E_1. Consequently, players of ethnicity E_2 choose to mix between 'not fight' and 'fight' with probability $p < \frac{1}{2}$ in both states, while players of ethnicity E_1 choose to 'not fight' in the good state and 'fight' in the bad state. Here,

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

Therefore, for low ω, if $\mu \in (\mu', \mu_3)$ and $q, r \in (q', \overline{q})$ then the probability of no conflict is higher with two informed agents compared to one informed agent. □