Ethnic Conflicts, Rumours and an Informed Agent*

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Abstract

Rumours often precipitate ethnic conflicts. There may exist an agent (player b) who knows if the rumour is true or false. We explore the role that such agents play in negating the effects of a bad rumour. Two cases are analysed - b is non-strategic i.e. he reveals his information truthfully and b is strategic and has a commonly known bias towards one ethnicity[1]. There are two states of the world. One in which conflict can be avoided (good state) and one in which it is inevitable (bad state). Rumour is a public signal which is correlated with the bad state of the world and therefore precipitates a conflict situation. Before deciding to fight or not, there is a meeting stage in which player b (if he exists), can send signals to k percent of the population. We find that when b is non-strategic, conflict caused by a false rumour is unlikely to happen when b can meet a large fraction of the population (as in rural areas). This is due to two effects - not only do the players who meet b know that the rumour is false, they also estimate (from the commonly known meeting process) that a large part of the population must also know. This allows them to coordinate, not fight and enjoy the high peace time payoff as opposed to the lower conflict payoff. This could be a possible explanation for the commonly observed phenomenon that ethnic conflicts in India are largely an urban phenomenon.[2] When b is allowed to be strategic and it is known that he has a bias towards one ethnicity, we show that, under parametric restrictions, there are only two equilibrium outcomes possible. In one outcome, everyone fights and conflict occurs with probability one. In the other equilibrium outcome, there may not be conflict when b believes that peace is possible and when b believes that conflict is inevitable, he reveals information in a way which gives his own ethnicity a higher probability of winning.

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[1] Think of b as belonging to one ethnicity.

[2] Raw data on Hindu-Muslim conflict in India reveals that over 70 percent of conflicts between 1950 and 1995 took place in towns or cities (Varshney (2003)). This is severely disproportionate to the fraction of Indian population living in urban areas.

1 Introduction

Rumours have always played a big role in ethnic conflicts. Rumours mobilize people and provide justification to commit violence.[3] The recent conflict in Delhi's Trilokpuri region started because a non-communal fight lead to rumours that it was actually a Hindu-Muslim clash.[4] Other examples of rumours that preceded ethnic violence in India include the Bombay riots (1992-93)[5] (rumours spread that some Pakistanis and an arms shipments had arrived in Bombay) and the Ahmedabad riots (2002)[6] (rumours of Hindu women being raped were circulated). These rumours were false. However, for the people who heard them, there was an apprehension of things to come which led them to commit violent acts. On top of false rumours, some stories are usually blown out of proportion by biased and irresponsible media coverage.[7] This could be because powerful people have vested interests in making the media cover a story in such a manner.

Now, whenever there is a rumour, generally, there are people who know the truth about the rumour i.e. whether it is true or false. In the Trilokpuri violence in New Delhi, natural deaths of people were being passed off as deaths caused by the communal violence.[8] Of course, the families of the deceased knew the truth, and when questioned, confirmed that the deaths were natural. So, generally, the people connected to the rumour know the truth but they can only reveal it to the small population they know. More often than not, they will not have access to a media platform to reveal the truth to all. This would specially be true if the original story was fabricated and pushed into publication by political heavyweights. In this paper, we analyse the role of such people in preventing conflicts. The intuitive idea of our model is the following:

There are two ethnicities in a society - H, M. Each player additionally has two types - G, B. The B players are behavioural and always want to fight. The G players are strategic. There are two states of the world. In the good state of the world, there is no conflict if the G players choose to not fight. In the bad state of the world, conflict is inevitable. Consider a society which hears a 'bad' rumour[9]. The rumour could be true or false. For now, consider the case where the rumour is false. Note that the players in the game don't know whether the rumour is true or not. There may exist a player b who knows if the rumour is true or false. In our model, we will assume that everyone places positive probability on the existence of this player. The bad rumour creates a conflict situation (pre rumour, beliefs are such that peace could be sustained as an equilibrium while post rumour the only equilibrium which remains involves everyone choosing to fight). However, before making the decision to fight or not, there is a meeting stage where players may meet other players. We analyse two cases - b is non-strategic i.e. he reveals his information truthfully and b is strategic and has a commonly known bias towards one ethnicity (b belongs to one ethnicity). b can meet a maximum k

[3] Brass (2011)

[4] Although we give examples from India, our model is more generally applicable.

[5] Vaitla (2011).

[6] Vaitla (2011).

[7] Even in last year's riots in Muzzaffarnagar, Uttar Pradesh, India - local news papers were accused of misleading and inciteful reporting. Additionally, local politicians were said to have circulated a fake video of ethnic killings along with propagating instigative rumours

[8] '*Rumour mongers in both sides spew venom'* - Deccan Herald, November 8, 2014.

[9] 'Bad' rumour refers to a rumour which is highly correlated with the bad state of the world.

fraction of the population.

Consider the case where b is non-strategic and his signals are informative (i.e. rumour being true or false is correlated with state of the world). If players can meet a large fraction of the population (think rural areas with their small populations), they are likely to meet b[10]. So they will learn that the rumour was false. This, by itself, does not make peace possible since it will be optimal to fight if everyone else chooses to fight. The fact that the meeting process is common knowledge allows players to estimate that many others must have also gotten to know the truth. This allows people to coordinate their actions and not fight leading to a lower probability of conflict. On the other hand, if each player meets only a small fraction of the society (think urban areas and large populations), even when a player is made aware that the rumour was false, he realizes that very few people could have stumbled upon this truth which means that most people will fight. This makes it optimal for the player to fight as well, thereby making conflict inevitable. This could be interpreted as one explanation for the following empirical observations:

About 70 percent of all Hindu-Muslim conflicts (and more than 96 percent of deaths in these conflicts) between the years 1950 and 1995 have been reported in urban areas - Varshney (2003), Mitra and Ray (2010). While we do not have the resources to dig empirically into these observation, we find it extremely surprising since over 70 percent of Indians live in rural areas.[11] Presumably, some of this can be explained by under-reporting of rural conflicts, larger populations in urban areas, some villages having just one ethnicity etc. However, we have reasons to believe that these may not account for the statistics completely. For example, Varshney (2003) writes that under-reporting of rural deaths would have to be on the scale of 15-20 times to explain the less than 4 percent of rural deaths in ethnic conflicts. Our explanation may be one part of the whole story.

Now, consider the case of a non-strategic b with a bias and informative signals. In particular, we assume that if b exists he is of H ethnicity and has a utility function such that if he believes that the state is likely to be good, he wants peace to prevail. However, if he thinks that the state is likely to be bad and therefore conflict is inevitable, he wants his own ethnicity to win. In this case, we show that under parametric restrictions, there are only two equilibrium outcomes possible. In one outcome, everyone fights and conflict occurs with probability one. In the other equilibrium outcome, there is no conflict when b believes that peace is possible. If b believes that conflict is inevitable, he reveals information in a way which gives his own ethnicity a higher probability of winning.

This paper serves to point out that rumours are difficult to negate. Irresponsible and dishonest media coverage can transmit bad rumours as public signals which may quickly lead to non-diffusible situations. A credible and honest source of information may be able to prevent conflict as demonstrated by the fact that there are equilibrium with no conflict when b is non-strategic whereas if b is known to be strategic then the only equilibria with no conflict are mixed strategy equilibria where player of the opposite ethnicity are indifferent between fight and not fight. We also demonstrate that sometimes private information is not good enough to make people not fight. Players must know

[10] If he exists.

[11] Census 2011. Moreover, in the period of 1950-1995 (for which we have Hindu-Muslim conflict data - Varshney and Wilkinson), an even larger fraction of the Indian population must have lived in rural areas.

(through common knowledge of meeting process or by the fact that it was shown on TV/radio) that other people also have this information.[12]

Our work is connected to strands of many literatures. There has been substantial work on ethnic conflicts in India. Varshney's book - *'Ethnic Conflict and Civic Life - Hindus and Muslims of India'* comprehensively discusses the issue of ethnic conflict in India against the backdrop of Hindu-Muslim conflicts. He considers several theories of ethnic conflict and concludes that while all these theories have some merit they fail to explain some incidences (or non incidences) of conflict. He goes on to show that the missing story could have been that of the impact of inter-ethnic relationships on reducing probability of conflict. Mitra and Ray (2010) also consider Hindu-Muslim conflict in India. They do an empirical study of Hindu-Muslim violence in India post independence era and conclude that the Hindu groups have been primarily responsible for the Hindu-Muslim violence in post-independence India. Both these authors mention that ethnic conflict seems to happen a lot more in urban areas. However, they do not offer a model to explain it. There have been a series of papers by Esteban and Ray which offer insights into why ethnic conflicts happen. Esteban and Ray (2008) point out why ethnic conflict is more likely to occur than class conflict. In ethnic alliances where there is within-group economic inequality, ethnic conflict is more likely than a class conflict. Esteban and Ray (2011) use a theoretical model to show how within-group heterogeneity in radicalism and income help in precipitating an ethnic conflict. These papers highlight income inequality as a source of ethnic conflict. This could be yet another explanation for the disproportionate percentage of ethnic conflicts in urban areas as these areas are likely to have more income heterogeneity.

Lu et al. (2013) assess the impact of circulation of rumours on regime change by studying a coordination game under a global game structure with both public and private signals. In particular, they study the effect of communication (regarding private information about the state of the world) amongst agents. They conclude that under communication, a rumour proves more impactful in creating mobilization amongst agents (with them sending each other confirmatory messages about their beliefs). Our paper conceptually and structurally differs in three respects : 1) In our paper, all agents observe a single informative public signal about the state of the world upon whose arrival conflict becomes inevitable. 2) Post arrival, there may (or may not) exist only one person with more information about the rumour who communicates with masses to align their actions with his own incentives. In Lu et al. (2013), everyone receives some private signals about the rumour. This seems unlikely to us. 3) In our paper, a capacity for the extent to which communication is possible (k) is imposed. This is critical in our explanation for why most ethnic conflicts may happen in urban areas.

There has been fairly a strong literature on the optimal disclosure of private information spanning across different fields like accounting, economics and finance. Most of this literature is in the context of a firm/manager's decision to disclose private information optimally to the investors/buyers which can affect firm's future values and earnings. Dye (1985) and Jung and Kwon (1988), in the context of managers revealing private information to investors, show that there cannot be a policy

[12]This has been shown to be critical in other environments like global games with noisy information about the payoff structure (Carlsson and Van Damme (1993)).

of full disclosure in equilibrium. This is similar to our result of no-truth telling equilibrium in the case of strategic b. Dye shows that managers may not reveal bad news because investors are unsure of the information possessed by the manager. However, as Dye notes, it is unlikely that very bad news can be suppressed by the manager indefinitely, even in the absence of organizational "leaks" or investigations by financial analysts. All that is required is that investors believe the probability that the manager has received private information increases over time. Jung and Kwon (1988) extends the Dye framework to allow outside investors to revise, in the absence of disclosure, their beliefs about the manager having received no private information. Using this enables them to resolve the problem of potential multiplicity of partial disclosure policies and they are able to establish uniqueness. Since we don't have a dynamic set up like Jung and Kwon (1988) or Dye (1985), we cannot compare our results directly with these papers.

The paper is organized as follows. Section 2 describes the main features of the model and the particular equilibrium concept relevant here. Section 3 deals with the case of player b being non-strategic and we discuss the case of a strategic b player in section 4. A discussion of our assumptions and modelling choices is in section 5. The conclusion is in section 6.

2 Model

2.1 Players

The environment has a continuum of agents and each player can be one of two ethnicities - $\{H, M\}$. For each ethnicity, players in it are indexed by $l \in [0, 1]$. Hence, the set of all players N can be identified with $[0, 1] \times \{H, M\}$ and an arbitrary player will be denoted as $i \in [0, 1] \times \{H, M\}$. For example, $i = (l, H)$ would denote the l-th agent in the ethnic group H. For notational convenience, we shall denote as H the set $[0, 1] \times \{H\}$ and as M the set of agents in $[0, 1] \times \{M\}$. Hence, H and M will represent the two ethnic groups. We endow N with the natural uniform measure and shall denote it by μ. Hence, $\mu(H) = \mu(M) = 1$ implying that each ethnicity has the same mass of agents and hence no ethnic group has an advantage in terms of the number of agents it may be able to mobilize. Additionally, a player can be one of two types - *Good* (G) or *Bad* (B). The two types differ in terms of the actions available to them. Players can decide to fight (f) or not (nf). The G type player is strategic. He can choose either action and fights only if it gives him higher payoff. B type players, on the other hand, always choose to fight.

After a rumour arrives, let there be one non-strategic player (outside the population) b who can prove the veracity of the rumour.[13] The players place positive beliefs on the existence of b.

[13] The assumption that b is outside the population is just for simplicity of calculation. Also, note again that people don't know whether the rumour is true or false ex ante.

2.2 Conflict

If a large enough fraction of at least one group choose to fight then a conflict ensues. If both groups fail to gather enough members to fight, peace prevails. Formally - Let $c \in (0,1)$ be an exogenously given threshold. Given an action profile $a = (a_i)_i$ that is measurable [14], a conflict takes place iff:

$$\max\{n_H(a), n_M(a)\} > c$$

where $n_H(a) = \mu(\{i \in H | a_i = f\})$, $n_M(a) = \mu(\{i \in M | a_i = f\})$.

Conditional on the conflict, probability of winning for any group is given by the following rule:

Given an action profile a, probability of H being the winning group is $\dfrac{n_H(a)}{n_H(a) + n_M(a)}$.

Thus, if there is a conflict then an ethnic group wins with higher probability if more of their members fight than members of the rival group.

2.3 Beliefs about Distribution of Types

At time 0, players are uncertain about the distribution of types in the world. Let ${n^y}_l$ be the fraction of y ethnicity people who are l type. For simplicity, we assume that there are only two kinds of possible type distributions:

Probability ω the type distribution is such that $({n^H}_G, {n^M}_G) = (q, q)$.
Probability $(1-\omega)$ the type distribution is such that $({n^H}_G, {n^M}_G) = (r, r)$

where $(1-q) < c < (1-r)$.

Thus, if (r, r) is the true distribution of G types, then the number of bad types alone is so high that conflict must happen. On the other hand, if (q, q) is the true distribution of types then conflict may not happen if all the G types choose not to fight. We will call (q, q) the good state of the world and (r, r) the bad state of the world. We will be interested in the outcome when the true distribution is (q, q). Mathematical details on the type space and the prior distribution on the type can be found in the appendix.

Here on, unless otherwise stated, everything is described for only the G type player. This is because the B type player's actions are fixed.

2.4 Payoffs

The payoffs to any player i of type G depends on his action, whether or not conflict takes place and whether he was part of the winning or losing side if conflict did take place. Thus, payoffs are

[14] The function induced by the action profile $a : N \to \{f, nf\}$ is measurable

summarized precisely in the matrix below. The really crucial aspect of this matrix is that peace time payoffs ($\alpha + \delta$) are higher than the best conflict payoff (α). We also need that the payoffs are such that it always pays to fight when conflict is inevitable. We will talk more about these modelling choices in the discussion section.

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

Where $\alpha, \beta, \gamma, \delta, \epsilon > 0$. ϵ is small. CW means conflict and win, CL - conflict and lose and NC means no conflict occurs.

2.5 Rumour

A rumour is any piece of news that everyone hears i.e. a public signal. As an example, think of the following event - A news article which declares that H ethnicity people have wantonly killed some M ethnicity people in the neighbouring town. In the current model, a rumour shall be represented as an informative signal about the underlying state of the world unknown to the agents.

2.6 Meeting Process/Obtaining Information

After the rumour stage, people may get additional information in the following manner: If player b exists, he randomly picks k fraction of the population and simultaneously sends them letters with one of two signals - True or False. k is a fixed constant to be interpreted as a capacity constraint. We will discuss the case of b being strategic and non-strategic in different sections. Non-strategic b reveals his signals truthfully to every player he sends letters to. Strategic b's utility function and action space will be described later in section 4. The contents of the letter serve as a signal of the state of the world.[15]

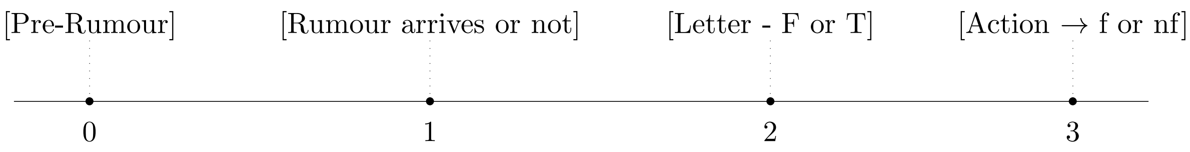
First we discuss the case of non-strategic b. Why should b ever be non-strategic? There could be many interpretations of this - 1. b is an unbiased player who has an honest reputation to protect, 2. b is unaffected by the outcome of conflict (example he does not belong to region where conflict may happen) so he might as well be truthful.

2.7 Timeline

The timeline of events is depicted in the picture below. At time 0, players have priors on true distribution of types, whether a rumour arrives or not and if the rumour does arrive then whether there exists a person who will know more about the rumour. They also have priors on the contents of the letter (if it exists). They update these beliefs as events unfold. Action to fight or not will be

[15]This contrived process of receiving additional information is discussed further in section 5. Our result is not crucially dependent on the above process. We make this modelling choice to make the analysis easier.

taken after the letters stage i.e. after the rumour (where some people get the letter from b[16] and others don't).



2.8 Beliefs and Information

Any player's ethnicity $\{H, M\}$, conflict threshold c, the payoff matrix and the meeting process is common knowledge. The type $(\{G, B\})$ of a player is private knowledge.

All players have common priors.

2.8.1 About Rumour

Conditional on the (q, q) being the true distribution, the rumour arrives with probability $1 - \theta_q$. Conditional on (r, r) being the true distribution, the rumour arrives with probability $1 - \theta_r$. Thus the arrival of a rumour is correlated with the distribution of types in the society.[17]

2.8.2 On existence of b

Conditional on the true distribution being (q, q) and the rumour arriving, the probability that there exists one person who knows more about the rumour is given by ζ_q. Similarly define ζ_r.

2.8.3 On Contents of Letter

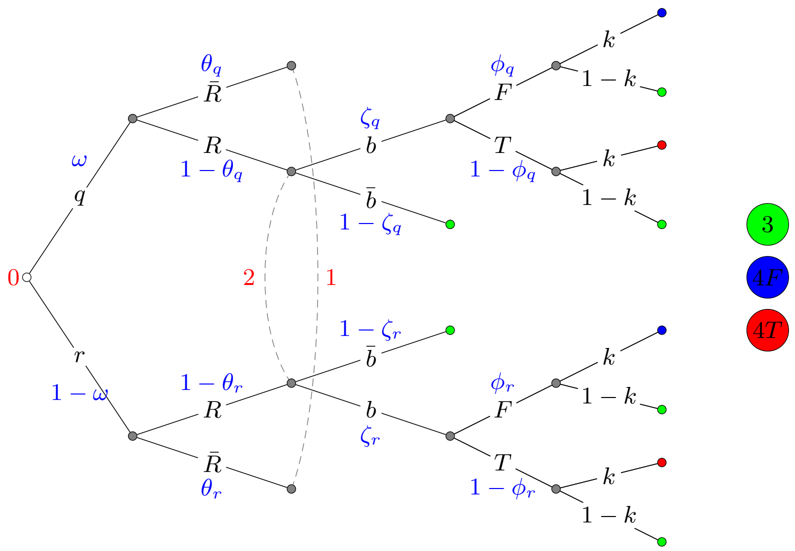
Conditional on the letter arriving, the true distribution of types being (q, q) and b being non-strategic, the probability of receiving the signal F in the letter is given by ϕ_q. Similarly define ϕ_r.

2.9 Game Tree

The game as viewed by any G player is described in this tree. This tree is supposed to depict the case of non-strategic b i.e. b always reveals the his true signal. $\overline{R}$ and $\overline{b}$ indicates the events when rumour does not arrive and non-existence of a player who has additional information about the rumour respectively. Relevant information sets are described by red numbers or the colours green, blue, red. Conditional probabilities are in blue. Pre-rumour everyone is at information set 0. Post rumour everyone is at information set 2. Post letters stage, if a player does not get the letter he will be at one of the six nodes in information set 3 (coloured green). If a player gets the letter from

[16]If b exists.

[17]A canonical example to keep in mind is that the rumour is - "(r, r) is the true distribution of types".



b with the signal F then he is at one of the two nodes in information set $4F$ (coloured blue). If a player gets the letter from b with the signal T then he is at one of the two nodes in information set $4T$ (coloured red).

2.10 Assumptions

1. Players play symmetric (within ethnicity) strategies only.[18]

2. $\zeta_q = \zeta_r = \zeta$.[19]

3. $\alpha + \epsilon + 2\gamma < \beta$

2.11 Equilibrium Concept

People are updating beliefs in a Bayesian manner and they choose actions which are optimal given beliefs. Thus, our equilibrium concept is Perfect Bayesian Equilibrium.

3 Non-Strategic b

In this section we will deal with the case of non-strategic b i.e. b reveals his signals truthfully to all players that he sends letters to. As mentioned before, there could be many interpretations of a non-strategic b player - 1. b is an unbiased player who has an honest reputation to protect, 2. b is unaffected by the outcome of conflict (example he does not belong to region where conflict may happen) so he might as well be truthful.

[18] Thus, people of the same type and same beliefs play the same strategies.

[19] This will make sure that the getting of the letter itself is not informative about the state of the world. We believe this is a reasonable assumption. The fact that there exists someone who knows the truth about the rumour may be independent of the distribution of types in the world.

3.1 Results

In this section we want to show two things. First, the conditions under which rumours *cause* conflict. The first two propositions deal with this. Second, when can this effect of a rumour be negated and how is it related to the size of the population? Theorem 1 answers this question. Note that we will only write strategies for the G type players since the B type players are behavioural and always choose f.

Proposition 1. *Pre rumour, there exists ω^* such that if $\omega > \omega^*$ then there exists an equilibrium in which the G type players choose nf. Moreover, it is the Pareto dominant equilibrium.*

Proof. In the pre-rumour stage (information set 0), people have beliefs ω about the good distribution (q, q) being the actual distribution. Strategies are just a function of types and beliefs. Consider the following pure strategy profile:

$S(G, \omega) = nf$

We want to show that if ω is high enough then it will be optimal for the G players to not fight, given that other G players are playing nf.[20]. Given these strategies, an arbitrary G player will make the following calculations

Payoff from playing $f = \omega(-\gamma) + (1-\omega)(\frac{\alpha-\beta+\epsilon}{2})$

Payoff from playing $nf = \omega(\alpha+\delta) + (1-\omega)(-\beta)$

Clearly, if $\omega \geq \frac{\alpha+\beta+\epsilon}{\alpha+\beta+\epsilon+2(\alpha+\delta+\gamma)}$, then playing nf is best response for G player. So this strategy profile constitutes a Bayesian Nash equilibrium if $\omega \geq \omega^* = \frac{\alpha+\beta+\epsilon}{\alpha+\beta+\epsilon+2(\alpha+\delta+\gamma)}$.

To Show - If $\omega > \omega^*$, then this is the Pareto dominant equilibrium.

Expected payoff from this equilibrium $= \omega(\alpha+\delta) + (1-\omega)(-\beta)$.[21]

There is only one other equilibrium possible in pure strategies - an equilibrium in which both G types and B types play f.

Payoff from this all fight equilibrium $= \frac{\alpha-\beta+\epsilon}{2}$.

It is easy to see that if $\omega > \omega^*$ and $\alpha + \epsilon + 2\gamma < \beta$ (assumption 3) , then ex-ante expected payoff from all fight equilibrium is lower than payoff from equilibrium in which G players don't fight.

Let us check to see if there are any mixed strategy equilibria:

First we need this lemma:

Lemma 1. *In any mixed strategy equilibrium where the G types of both ethnicities play the same*

[20]Note that fight or not fight decisions are actually taken after the letters stage. Here, we ask a hypothetical question - If players were asked to make the decision at information set zero, what would they do? This is important because we want to be able to say that rumour caused conflict i.e. conflict may not have occurred with pre-rumour beliefs but it became inevitable post rumour

[21]We only consider the expected payoffs of the G type when thinking of Pareto dominance. Since the B types are always choosing to fight, clearly they are at least indifferent to the result of their actions.

strategies, the weight on playing f has to be less than or equal to $c - (1 - q)$.

Proof. We will prove by contradiction. Suppose the players of any ethnicity play f with a strictly higher weight than $c - (1 - q)$. Then the fraction of players playing f for that ethnicity is higher than c in any state of the world. This implies that conflict is inevitable. However, when conflict is inevitable then playing f is strictly dominant strategy. Thus, the ethnicities could not be mixing between f and nf. Contradiction. □

Consider now the following strategy:

$$\begin{aligned} S(G,\omega) &= f \ ; \ \textit{probability } p \\ &= nf \ ; \ \textit{probability } (1-p) \end{aligned}$$

where $p \leq c - (1 - q)$.

For mixing to be optimal, payoff from f must be equal to payoff from nf.

Payoff from playing $f = \omega(-\gamma) + (1 - \omega)(\frac{\alpha - \beta + \epsilon}{2})$

Payoff from playing $nf = \omega(\alpha + \delta) + (1 - \omega)(-\beta)$

If the above payoffs are the same then we have:

$$\omega = \omega^*$$

Payoff from this mixed strategy equilibrium $= \omega^*(\alpha + \delta) + (1 - \omega^*)(-\beta)$

Since the ethnicities are symmetric, in any mixed strategy equilibrium, the G players of both ethnicities will play the same strategies. This is obvious from the above proof. Suppose the G players of H ethnicity was playing f with probability p_h and the G players of the other ethnicity were playing f with probability p_m where $p_h \neq p_m$. We can see quite easily from the above proof that a necessary condition for the players of H ethnicity to mix is that $\omega = \omega_h$ and the M ethnicity requires $\omega = \omega_m$ for them to mix in equilibrium where $\omega_h \neq \omega_m$. Thus, an asymmetric mixed equilibrium is not possible.

Comparing ex ante expected payoffs in the three possible equilibria, it is obvious now that if $\omega > \omega^*$, then the equilibrium in which all G players play nf is the Pareto dominant equilibrium. □

The first proposition simply says that - pre-rumour - if the priors on the distribution are such that people place high belief on the distribution with less bad types then there exists an equilibrium in which the good types do not want to fight. There is also an equilibrium in which everyone fights but it is Pareto dominated by the former. We assume that the Pareto dominated equilibrium will not be played.

Proposition 2 describes the conditions under which the arrival of the rumour make peace impossible.

Proposition 2. *Post rumour and Pre-letters (information set 2), if* $\frac{1-\theta_r}{1-\theta_q} > \frac{1-\omega^*}{\omega^*}\frac{\omega}{1-\omega}$*, then not fight cannot be supported as an equilibrium. The only equilibrium is the one in which everyone fights.*

Proof. We will show this by demonstrating that the posterior belief on the good distribution falls below ω^* under the condition

$\frac{1-\theta_r}{1-\theta_q} > \frac{1-\omega^*}{\omega^*}\frac{\omega}{1-\omega}$

Let $P(q/Rumour)$ be the probability that the true distribution is (q,q) given that the rumour has arrived. Then:

$P(q/Rumour) = \frac{\omega(1-\theta_q)}{\omega(1-\theta_q)+(1-\omega)(1-\theta_r)}$

Then $P(q/Rumour) < \omega^*$

$\Leftrightarrow$

$\frac{\omega(1-\theta_q)}{\omega(1-\theta_q)+(1-\omega)(1-\theta_r)} < \omega^*$

$\Leftrightarrow$

$\frac{1-\theta_r}{1-\theta_q} > \frac{1-\omega^*}{\omega^*}\frac{\omega}{1-\omega}$ □

First, note that $\omega > \omega^*$ and $\frac{1-\theta_r}{1-\theta_q} > \frac{1-\omega^*}{\omega^*}\frac{\omega}{1-\omega}$ implies that $(1-\theta_r) > (1-\theta_q)$. Essentially, proposition 2 tells us that if the arrival of the rumour is sufficiently positively correlated to that state of the world in which the true distribution of types is the one in which there are a lot of B type players in each community then conflict is inevitable following the rumour.[22]

Corollary 1. *If* $\omega > \omega^*$ *and* $\frac{1-\theta_r}{1-\theta_q} > \frac{1-\omega^*}{\omega^*}\frac{\omega}{1-\omega}$ *but no rumour appears then we can still support the equilibrium in which the good types don't fight.*

This is plain to see. Since arrival of the rumour is more likely when the true distribution of types is the bad one, not arrival of the rumour is more likely when the true distribution of types is the good one. This implies that the posterior on (q,q) if the rumour does not arrive is higher than ω and therefore higher than ω^*.

Proposition 1, Proposition 2 and Corollary 1 establish conditions under which - before the rumour arrived (or if it does not arrive), G type players would not have chosen to fight but after the rumour arrived everyone chooses to fight and the conflict is inevitable. So if the true distribution of types was (q,q), conflict would not have occurred pre-rumour but it becomes inevitable post rumour. Thus, rumour *induces* conflict. Theorem 1 talks about when this effect of rumour can be reversed.

Theorem 1. *Let* $\omega > \omega^*$ *and* $\frac{1-\theta_r}{1-\theta_q} > \frac{1-\omega^*}{\omega^*}\frac{\omega}{1-\omega}$. *Assume* $\frac{\phi_q}{\phi_r} \geq \frac{(1-\omega)(1-\theta_r)\omega*}{\omega(1-\theta_q)(1-\omega^*)} > 1$. *Then, post letters stage, if* $k \approx 1$ *then no conflict can be an outcome of an equilibrium. If* $k \approx 0$ *then conflict is inevitable.*

[22] Remember there were just two equilibria possible. We have ruled out the one in which the G types don't fight. The only remaining equilibrium is one in which everyone chooses to fight and conflict happens for sure.

Proof. In Appendix. □

The intuition behind theorem 1 is as follows: strategy for a player after the letters stage is a triple - (x, y, z) where x gives the action to take if the player does not get a letter, y gives the action for when the player gets a letter and the letter has the signal - 'False' and z describes the action to be taken if the player gets a letter and the signal is - 'True'. Consider the case when the rumour is actually false. This means that whoever gets the letter - gets the signal -'False'. As $k \approx 0$, a very small fraction of the population gets the letter and this is common knowledge. Thus, most people are at information set 3 and have the same beliefs as the post rumour beliefs at information set 2[23] which makes it optimal for them to fight. The people who get the letter and know that the rumour was false realize that the state of the world is more likely to be (q, q)[24] but they also realize that too many people have not gotten the letter. Since those people are going to fight, conflict is inevitable. In this case, it is optimal for the player to play f since f is dominant strategy if conflict is inevitable. Thus, conflict is the only equilibrium outcome if $k \approx 0$. When $k \approx 1$, the players who don't get the letter think that if b had existed they would have received the letter for sure so they conclude b does not exist. This makes them think that everyone has the post-rumour beliefs. This makes it optimal for them to choose to fight (by proposition 2). On the other hand, the people who do get the letter conclude that almost everyone must have gotten the letter which means that everyone must have realized that the rumour was false. This would mean that almost everyone places high probability (higher than ω^* under the conditions described in the theorem) on the state of the world being (q, q). Then, by proposition 1, there exists a pareto dominant equilibrium in which the G types don't fight. So, it becomes optimal for them to not fight. Therefore, when $k \approx 1$, if (q, q) is the true distribution of types, then conflict will not take place.

We think of urban areas when we think of $k \approx 0$ and villages when $k \approx 1$. This is because rural areas generally have smaller populations where one player may be able to meet a large fraction of the population whereas it is impossible to meet more than a small fraction of a large urban population.

4 Strategic b

Till now, we have assumed that b is non-strategic. He knows if the rumour is true or false. He picks/meets a random selection of a measure k group of players and informs them correctly. In this section we will discuss the case of a strategic b player. First, we need to describe the utility function/payoffs for this player to know how he makes his decisions.

Before describing the utility function for b, we want to point out that we will take as given the parameter restrictions needed for the results in the section on non-strategic b. In particular we assume that the following hold:

[23]This is because $\zeta_q = \zeta_r$.

[24]Since the signal F is much more likely in the state (q, q) according to the condition on ϕ_q, ϕ_r. This can be justified as follows. The need for sending out a false rumour to create conflict will be higher in the state (q, q). This is because unlike the other state, conflict is not inevitable here.

1. $\omega > \omega^*$
2. $\frac{1-\theta_r}{1-\theta_q} > \frac{1-\omega^*}{\omega^*}\frac{\omega}{1-\omega}$
3. $\frac{\phi_q}{\phi_r} > \frac{(1-\omega)(1-\theta_r)\omega*}{\omega(1-\theta_q)(1-\omega^*)} > 1$
4. $\zeta_q = \zeta_r = \zeta$

Like all other players, let b have an ethnicity from the set $\{H, M\}$.[25] In this section, we will assume that if b exists then he has ethnicity H.[26] This is common knowledge. Since the b player is not part of the population, he only gets the payoffs from outcomes. Formally, his payoff matrix is as follows:

CW	CL	NC
α	$-\beta$	$\alpha + \delta$

Where $\alpha, \beta, \gamma, \delta > 0$. CW means conflict and win, CL - conflict and lose and NC means no conflict occurs. Thus, b gets maximum payoff if conflict does not happen. However, if conflict does happen then he would like his own ethnicity to win.

Next we describe the slightly modified timeline of events for the case when b is strategic. After the rumour arrives, if person b exists, then the following happens. b knows whether the rumour is true (T) or false (F). He picks a random selection of a measure k of players from the population. For each player i in this selection he sends one of three messages :

- A letter stating that the rumour is false (LF).
- A letter stating that the rumour is true (LT).
- No letter (NL)[27]

From the players point of view, after a rumour arrives, they can be in one of three information sets. 1) They don't get a letter NL; 2) They get a letter with the signal LT and 3) They get a letter with the signal LF.

4.1 Strategies

We focus on strategies of b that are symmetric within ethnicities. The strategy for b is a function of his own ethnicity, ethnicity of the receiving player, rumour being actually true or false. His action

[25]However, we maintain the assumption that b is outside the population and does not himself fight or not-fight in the conflict. This is just for simplicity of calculations. The same results will go through if b is thought to be a player in the population.

[26]This can be justified by making the assumption that the ethnicity of b is contained in the letter. Letter sending is supposed to represent a meeting process. People know (specially if the player b is one of the players in the population) or can guess the ethnicity of others in India by observing the name, clothes, look of the person.

[27]Receiving no letter is an informative signal about the state since it's in the strategy space for b.

choices are - No Letter, Letter with signal T, Letter with signal F. This is described formally below:

$$f_b : \{H, M\} \times \{H, M\} \times \{T, F\} \to \Delta\{NL, LT, LF\}$$

For simplicity, we will denote letters sent to the opposite ethnicity as NL^d, LT^d, LF^d and same ethnicity as NL^s, LT^s, LF^s. NL^d refers to members of the opposite ethnicity receiving no letter, LT^d refers to members of the opposite ethnicity receiving the signal "rumour is true" from b and LF^d refers to members of the opposite ethnicity receiving the signal "rumour is false" from b. A similar interpretation follows for NL^s, LT^s, LF^s. Since b has been assumed to be of ethnicity H if he exists, his strategy can be described as a function:

$$f_b : \{H\} \times \{T, F\} \to \Delta\{NL^s, LT^s, LF^s\}$$
$$f_b : \{M\} \times \{T, F\} \to \Delta\{NL^d, LT^d, LF^d\}$$

Strategy for any player i of the population is a function from his information set to the action set $\Delta\{f, nf\}$.
For ethnicity H :

$$g^H : \{NL^s, LT^s, LF^s\} \to \Delta\{f, nf\}$$

For ethnicity M :

$$g^M : \{NL^d, LT^d, LF^d\} \to \Delta\{f, nf\}$$

We will assume that the strategy of players is symmetric within ethnicity. Note that the strategies will be symmetric across ethnicities in any equilibrium since the two ethnicities are symmetric.

4.2 Equilibrium

In this section, we investigate the nature of equilibria in this model. We shall focus on two extreme cases (as before)

- $k \approx 0$
- $k \approx 1$

Note that any strategy profile where all agents choose the action f for any signal they receive, constitutes an equilibrium. We will call this the *all-fight equilibrium*. We want to investigate if there are other equilibria in which there is a positive probability of conflict being averted. When $k \approx 0$, all fight equilibrium is the unique equilibrium. This is because b can influence the beliefs of only a small fraction of players. This result follows from the following lemma:

Lemma 2. *There exists $\bar{\zeta}$ such that if $\zeta \leq \bar{\zeta}$ then in any symmetric equilibrium, playing f is the unique best response on receiving the signal NL.*

Proof. Consider any symmetric equilibrium E^*. First note that the probability that person b exists given that a player i has received no letter is given by :

$$\frac{\zeta h^*}{\zeta h^* + (1-\zeta)}$$

where h^* is the probability with which b sends no letter to player i in E^*. Clearly, as $\zeta \to 0$, the probability that player b exists given that no letter was received goes to zero. Thus, if we choose a low enough $\bar{\zeta}$, then, when a player doesn't receive a letter he believes that with very high probability, player b does not exist. This implies that with very high probability, no one received any letter.

Beliefs about state for people who received no letters is the same as post rumour beliefs. This is because existence or non existence of b is not informative about the state (assumption 2). Consider the situation of player who receives no letter. He believes that with very high probability, no player received any letter which implies that he is at a situation where with very high probability, everyone received no letters and have to decide whether to fight or not. Thus the only responses that matter are the equilibrium responses to the signal NL. Suppose the equilibrium response was the following:

Ethnicity H

$$NL^s \to p_H f + (1-p_H) nf$$

Ethnicity M

$$NL^s \to p_M f + (1-p_M) nf$$

Case 1 - $p_H > z$

Clearly then conflict happens with probability 1. Therefore, the unique best response is to play f.

Case 2 - $p_H \in [0, z)$

In this case, the only possible equilibrium corresponds to $p_M = p_H$. This is because the ethnicities are completely symmetric so there cannot be an equilibrium where the two ethnicities randomize with different weights. However, if $p_H = p_M$, it can be shown as an extension of proposition two[28] that given that the other players are playing this way, the unique best response is to play f.

□

Thus, if the probability that b exists is low enough, in any equilibrium, players have to play f as a response to the signal NL. If $k \approx 0$, then almost everyone gets the signal NL. All these players respond with the action f. This makes conflict inevitable which in turn makes it optimal for all other players to play f regardless of the signal they may have received.

[28] Remember that parameter restrictions needed for proposition 2 have been assumed to hold.

We will henceforth assume that $k = 1$.[29]

4.2.1 Truth telling

In this section, we argue that when b's private signal is highly informative, there cannot exist a symmetric (within ethnicities) strategy profile (apart from participating always) where he fully reveals his private information. We express this observation as a proposition below:

Proposition 3. *When $\frac{\phi_q}{\phi_r}$ is high and ζ is low, there cannot be any symmetric equilibrium (different from all-fight) where b's strategy is truth telling i.e. $b's$ strategy is:*

$$f_b(H,T) = LT^s$$
$$f_b(M,T) = LT^d$$
$$f_b(H,F) = LF^s$$
$$f_b(M,F) = LF^d$$

Proof. Suppose not i.e. let's suppose that truth telling on $b's$ part can be an equilibrium strategy. Consider an agent of the opposite ethnicity $i \in M$. If he receives the message LT^d, then he knows with probability close to one that the state of the world is (r, r) and hence believes that conflict is inevitable with a high probability. This is because b's signal is extremely informative ($\frac{\phi_q}{\phi_r}$ is high) and he always reveals his signal truthfully. Hence, if strategies are symmetric everyone from the opposite ethnicity chooses to fight when the message LT^d is received. By lemma 2, all players respond to NL with f in any equilibrium. If i receives LF^d, then it cannot be the case that the action nf is played with positive probability. This is because then b, upon receiving signal T, would deviate to the message LF^d to maximize the probability of his ethnicity winning. Hence, the opposite ethnicity always fights making conflict inevitable. The same ethnicity, knowing that conflict cannot be avoided would always choose to fight. This is a contradiction to the assumption that the equilibrium being played was different from the all-fight equilibrium.

□

The utility function of player b is such that he prefers peace over conflict, but if there is a conflict he wants his ethnicity to win. Player b has an informational advantage over the rest of the players in the game. He knows whether the rumour is actually true or false. The only uncertainty he has is over the state of the world. Suppose player b's signals are very informative i.e. the state is very likely to be good when the rumour is false and very likely to be bad when the rumour is true. Thus, in a truth telling equilibrium, players will respond to the signal F by not fighting.

However if the rumour is true, player b would like his ethnicity to win. If the players of the opposite ethnicity respond to the signal F by playing nf then player b would be tempted to lie and send this signal to players of the opposite ethnicity when the rumour is true. This means b would try

[29] Equality is for simplicity. The same results will go through if k was close to 1 but not equal to it.

to use his informational advantage to manipulate the beliefs of the players of the opposite ethnicity so that they do not participate in the conflict. This is a deviation from the truth telling equilibrium. Therefore, there does not exist a truth telling equilibrium.

4.2.2 Non-truth telling case

When $b's$ signals are very informative and the probability of existence of b is low, we show that a perfect Bayesian equilibrium exists in the class of strategies given below. This class of strategies has the following desirable property: b can successfully avoid conflict when he is sure that the state of the world is good. If he believes that the state of the world is bad, he is able to prevent a sufficient mass of the opposite ethnicity from engaging in conflict thereby providing his own ethnicity with an advantage. Moreover, we show that any equilibrium outcome of the non-truth telling case is either one in which all players play f and conflict is inevitable or one whose outcome can be generated by the class of strategies given below.

$$
\begin{aligned}
&\textbf{b's}\ \ \textbf{strategy}: \qquad (1)\\
&f_b(H,T) = NL^s\\
&f_b(M,T) = q_b^T LT^d + (1-q_b^T)LF^d\\
&f_b(H,F) = zNL^s + (1-z)(q_b^F LT^s + (1-q_b^F)LF^s)\\
&f_b(M,F) = q_b^F LT^d + (1-q_b^F)LF^d\\
&where\ zq + (1-q) = c\\
&\textbf{Player's}\ \ \textbf{strategies}\\
&H\ ethnicity/Same\ ethnicity\\
&g^H(NL^s) = f\\
&g^H(LF^s) = p_s f + (1-p_s)nf\\
&g^H(LT^s) = p_s f + (1-p_s)nf\\
&M\ ethnicity/Opposite\ ethnicity\\
&g^M(Nl^s) = f\\
&g^M(LF^d) = p_d f + (1-p_d)nf\\
&g^M(LT^d) = p_d f + (1-p_d)nf\\
&where\ p_d \leq z,\ \ p_s = 0\ and\ q_b^F, q_b^T \in [0,1]
\end{aligned}
$$

Before proceeding to the next proposition, we make the following parametric restriction on the likelihood of the initial signals i.e. (θ_q, θ_r). We assume that these probabilities are such that post-rumour, if the opposite ethnicity fully participates in the conflict, an agent would :

1. Choose f if a fraction z of good types from his own ethnicity choose f
2. Choose nf if all good types from his own ethnicity refrain from choosing f

The above condition can be interpreted as follows : In 1, a fraction z is enough to guarantee a probability of winning high enough to induce f. In 2, given that nobody from the same ethnicity fights, the probability of winning is low enough to make nf better than f. These conditions can be written explicitly as follows :

$$\omega'(-\gamma) + (1-\omega')[\tfrac{z+(1-r)}{z+r+2(1-r)}(\alpha) + \tfrac{r+(1-r)}{z+r+2(1-r)}(-\beta+\epsilon)] > \omega'(\alpha+\delta) + (1-\omega')(-\beta)$$

$$\omega'(-\gamma) + (1-\omega')[\tfrac{(1-r)}{r+2(1-r)}(\alpha) + \tfrac{r+(1-r)}{r+2(1-r)}(-\beta+\epsilon)] < \omega'(\alpha+\delta) + (1-\omega')(-\beta)$$

Where ω' is the post-rumour belief. Note that the first condition immediately implies Proposition 2. We now establish our next result :

Proposition 4. *There exists $\bar{\sigma} > 0, \bar{\zeta} > 0$ such that if $\infty > \frac{\phi_q}{\phi_r} \geq \bar{\sigma}$ and $\zeta \leq \bar{\zeta}$ there exists a perfect Bayesian equilibrium in the above described class of strategies for a unique p_d.*

Proof. Let $\bar{\sigma} > 0$ and consider a player of the same ethnicity : $i \in H$. We claim that an equilibrium can be supported with $p_s = 0$ and $p_d \leq z$. We check optimality for agent i at each information set. Since he is of the same ethnicity as b, receiving the message LT^s or LF^s perfectly reveals to him that $b's$ private signal is F. For high $\frac{\phi_q}{\phi_r}$ (i.e. signals are very informative), the agent knows that with probability close to one the true state of the world is (q, q). In this case, given the strategies of others, he knows that a proportion z from both ethnicities chooses to fight but this is not enough to start a conflict. Hence, i's optimal strategy is to play nf and get the high peace time payoff. Hence for some σ_1, and any $\frac{\phi_q}{\phi_r} \geq \sigma_1$ the agent's response to LT_s, LF_s is optimal.
Now, consider the signal NL^s. We have already shown that the agent will respond with f (lemma 2). We have shown the optimality of strategies of players from the same ethnicity. We concluded that $p_s = 0, p_d = z$ can be supported as an equilibrium under $\frac{\phi_q}{\phi_r} \geq \sigma_1$ and $\zeta \leq \bar{\zeta}$ for some $\bar{\zeta}$. Let us now discuss the optimality of b's strategy.

Consider first the case that b receives the private signal T. For high $\sigma_2 > 0$ and $\frac{\phi_q}{\phi_r} \geq \sigma_2$, b believes with high probability that the state is (r, r) i.e conflict cannot be avoided. His optimal response is then to maximise the probability of his ethnicity winning, which is achieved by persuading all from his own ethnicity to fight (he does this by sending them all the signal NL^s) and dissuading as large a proportion of the opposite ethnicity (in this case $1 - p_d$) from fighting as possible. Given the strategies of the opposite ethnicity, this is achieved by randomly sending each person either LT^d, LF^d.
Now suppose b has received the signal F. For high $\sigma_3 > 0$ and $\frac{\phi_q}{\phi_r} \geq \sigma_3$, b believes with almost

full certainty that the state is (q, q). He would, in this case, prefer that conflict be averted (thereby achieving $\alpha + \delta$ as payoff) and can enforce a no conflict outcome by adhering to the strategy prescriptions (a fraction z fights from both ethnicities). Note that b decides to make some players from his own ethnicity fight even when he believes that the state is most likely to be (q, q). This is because as long $\infty > \frac{\phi_q}{\phi_r} > 0$, there is always a positive probability of the state being (r, r). b hedges against this risk by making a fraction z from his own ethnicity fight where z good types fighting is the largest fraction of good types which can fight and not cause conflict in the good state (z; $zq + (1 - q) = c$). We have so far shown optimality of the strategies for H ethnicity players and b. We now show optimality for agents of the opposite ethnicity (M). In particular, it will be important to find conditions under which the randomization p_s is optimal.
We first notice that in any equilibrium belonging to the above class of strategies, it is necessarily the case that informed agent sends uninformative signals to members of the opposite ethnicity. This is because the opposite ethnicity plays the same randomisation p_s irrespective of the contents of the letter received implying the that belief at LT^d and LF^d must be same (since randomisation is possible only at a unique belief). Hence, $\Pr(q|LT^d) = \Pr(q|LF^d)$. But this implies that $q_b^T = q_b^F$. As a result, receiving a letter takes the opposite ethnicity back to post-rumour beliefs ω'. Now define the function $g : [0, z] \to \mathbb{R}$ as follows :

$$g(p) = \omega'(-\gamma) + (1 - \omega')[\tfrac{p+(1-r)}{p+r+2(1-r)}(\alpha) + \tfrac{r+(1-r)}{p+r+2(1-r)}(-\beta + \epsilon)] - \omega'(\alpha + \delta) + (1 - \omega')(-\beta)$$

We know from the above conditions that : $g(0) < 0$ and $g(z) > 0$. Also, notice that g is strictly increasing in p. Hence, there exists a unique $p_d \in (0, z)$ such that $g(p_d) = 0$. It is clear that above strategy specification is an equilibrium for this p_d and thresholds by defined by $\bar{\sigma} = \max\{\sigma_1, \sigma_2, \sigma_3\}$ and $\bar{\zeta}$. □

Corollary 2. *In any equilibrium of the form described above, it is necessarily the case that $q_B^T = q_B^F$. As a result, the informed individual never sends an informative signal to the opposite ethnicity players giving them no new information about the state of the world.*

The intuitive idea behind this equilibrium is the following. Suppose player $b's$ signals are very informative i.e. the state is very likely to be good when the rumour is false and very likely to be bad when the rumour is true. When the rumour is false player b would like peace to prevail. When the rumour is true player b thinks that conflict is inevitable. In this case he wants his own ethnicity to win. Suppose there was a signal (T or F) for which, in equilibrium, the opposite ethnicity played nf with a higher probability than when they received the other signal. Then player b would always send this signal. This makes this signal uninformative and essentially means that players of the opposite ethnicity will take the same action regardless of whether the rumour is true or false. The other alternative is that opposite ethnicity players take the same action to both signals (T or F). Therefore, in any equilibrium which is not the all-fight equilibrium, players of the opposite ethnicity must play the same strategy irrespective of rumour being true or false. In particular if they respond in the same way to both signals, it keeps player b indifferent between the two signals. Moreover, the players cannot be playing f with a higher probability than z. This is because in that case, conflict is inevitable which implies the best response for all players is to play f with probability 1 making it the all-fight equilibrium. Essentially, in equilibrium, given the strategies of every player, the opposite ethnicity players are indifferent between playing f, nf before the signals from b arrive. b sends them uninformative signals so that they play nf with some probability in equilibrium. b sends own ethnicity informative signals and therefore uses his informational advantage. When the rumour is false, b believes that the state is extremely likely to be good but hedges against the risk of mistake by sending signals which make some of his own ethnicity fight (but not enough to cause conflict). When the rumour is true, b believes that conflict is inevitable. He sends signals to ensure everyone from his ethnicity chooses to fight.

Before we go further we need the following definition:

Equilibrium Outcome

For any equilibrium E^*, the equilibrium outcome is defined by a pair of tuples - $\{(p_h^T, p_m^T), (p_h^F, p_m^F)\}$. T, F stand for when the rumour is actually true or false respectively. p_i^t ($t \in \{T, F\}$, $i \in \{H, M\}$) describes the fraction of G type i ethnicity players who choose the action f in equilibrium E^* when the rumour is t.

We will now show that, in fact, there can be only two kinds of equilibrium outcomes in symmetric strategies (strategies are symmetric within ethnicity)when $b's$ signals are very informative (i.e. the rumour being true or false is very strongly correlated with state being (r, r) or (q, q) respectively). One outcome is due to the equilibrium in which all players choose the action f as a response to all signals. Any other equilibrium outcome can be obtained as an outcome of the equilibrium strategies described in 1. To show this result, we will need the help of some lemmas.

Lemma 3. *Take any symmetric equilibrium different from all players play f to all signals. There exists $\bar{\zeta}$ such that if $\infty > \frac{\phi_q}{\phi_r} > 0$ and $\zeta < \bar{\zeta}$ then b does not send the signal NL^d to any player of opposite ethnicity.*

Proof. Consider an equilibrium different from one in which players respond to all signals with f. Thus, there exists a signal to which opposite ethnicity players respond with a positive probability of playing nf[30]. By the lemma 2, this signal is different from NL^d. Thus b has a choice between sending NL^d and have the opposite ethnicity fight for sure and this signal, for which there is lower probability of fighting.

Regardless of whether the rumour is true or false or how informative his signal is, it is always weakly better for player b if players of the opposite ethnicity do not fight. In fact, if there is positive probability that the state is (r, r) then it is strictly better for player b to not send the signal NL^d to players of opposite ethnicity and have them play f (lemma 2). The condition $\infty > \frac{\phi_q}{\phi_r} > 0$ guarantees that rumour is true or false is not perfectly informative of state. Thus, b believes that there is always a positive probability that the state is (r, r). Therefore, he will never send the signal NL^d to the opposite ethnicity. □

Lemma 4. *In any symmetric equilibrium where signals are informative ($\frac{\phi_q}{\phi_r}$ is high), all players of the same ethnicity as b will play f when the rumour is true.*

[30]If there is no such signal then we will have to be at the *all fight equilibrium*.

Proof. When signals are very informative, the rumour being true implies that the state is very likely to be (r, r). This implies that conflict is going to happen with a very high probability. In such a situation, player b would like all players of his ethnicity to play f to ensure maximum of probability of winning. Since he has the ability to make this happen (send NL^s to all players of his ethnicity), it will happen in any equilibrium. □

Proposition 5. *Let $O^* = \{(1, h), (j, k)\}$ be an equilibrium outcome for some equilibrium E^*. Let $\bar{\sigma} > 0$. There exists $\phi_q, \phi_r, \bar{\zeta}, p_d, q_b^F, q_b^T$ such that $\frac{\phi_q}{\phi_r} > \bar{\sigma}$ and if $\zeta < \bar{\zeta}$ then the strategies described in 2 constitute an equilibrium and produce the same equilibrium outcome.*

Proof. Note first that we have taken $p_h^T = 1$ in the arbitrary equilibrium outcome described in the proposition. This holds because of lemma 4 and choosing $\frac{\phi_q}{\phi_r}$ high enough.

Suppose outcome O^* is different from all fight i.e. $(h, j, k) \neq (1, 1, 1)$. We will show that O^* can be obtained as an outcome of an equilibrium described in 1 by proving the following:

1. $h = k$.

2. $h \leq z$.

3. $j = z$.

; where z is such that $zq + (1 - q) = c$

Proof for 1

Consider any player i of ethnicity M. By lemma 3, he will never get the signal NL^d. There are two sub cases: Either he responds in the same way to signals T, F. In this case $h = k$. Or, he responds in a different manner to the signals T, F. In this case, it will be optimal for player b to send him the signal for which the probability of an nf response is higher. If b plays this strategy in equilibrium, then player i gets just one uninformative signal in equilibrium (since he will get the same signal regardless of whether the rumour is true or false). Thus, player i will have only one response on the equilibrium path. This would mean that regardless of whether the rumour is true or false the same fraction of M players play f (since we are looking at symmetric equilibrium). Thus, $h = k$.

Proof for 2

Suppose $h > z$. This implies that conflict will always happen since the fraction of M ethnicity players fighting is above the cutoff when the rumour is true and when the rumour is false. In this equilibrium, it will be optimal for player b to send some signal to all players of his ethnicity (H) and have them respond with f.[31] However, players of ethnicity M will realize this and play f as best response themselves. This is a contradiction. Hence $h \leq z$.

Proof for 3

Suppose $j > z$. Then, conflict happens regardless of whether the rumour is true or false. This would lead to ethnicity M responding with all players playing f. However, the best response to this is

[31] He can make this happen because he can always send them NL^s.

$j = 1$. This implies that we have arrived at the all fight equilibrium. However, we assumed before that we are looking at equilibria different from this one. Thus, $j \leq z$.

Suppose $j < z$. Even when the rumour is false and signals are very informative, the condition $\infty > \frac{\phi_q}{\phi_r}$ guarantees that there is a small probability that the state is (r, r). Player b can be better of by sending the signal NL^s to a slightly higher fraction of H ethnicity players such fraction of G type H ethnicity players who play f becomes $j + \epsilon$ and $j + \epsilon < z$. b becomes better off since he avoids conflict and gets high peace payoff if state is actually (q, q) and if, despite his very informative signals, the state happens to be (r, r) then he has increased the probability of his own side winning. Therefore, b will make this deviation and the fraction of good H who fight in equilibrium cannot be j. This is a contradiction.

Therefore we have that $j = z$.

□

5 Discussion

In this section we discuss some of our assumptions and modelling choices. We show that our claims are robust to some alterations.

5.1 Correlation of Distributions

We assume that only those type distributions are possible which lead to people placing positive weights on (q, q) and (r, r) where $(1-r) > c > (1-q)$. This assumption is not crucial to our results. In particular we could have assumed positive weights on a multitude of distribution states like $(q_1, q_2), (q_3, q_4), ..., (q_n, q_{n+1}), (r_1, r_2), (r_3, r_4), ..., (r_m, r_{m+1})$ where $max\{1 - q_i\}_i < c < min\{1 - r_j\}_j$. As long as conflict is inevitable in some states and not in others, our claims will go through. Note that we could allow for beliefs over distributions like (q, r) where $(1 - r) > c > (1 - q)$ as well but these would be uninteresting (if we allowed for such distributions only) since our definition of conflict makes conflict inevitable if even one ethnicity has enough bad types.

5.2 More b in bigger populations?

We have assumed that the number of people who know the truth does not change as we increase the population. It is possible that this goes up for urban areas (places with higher population). However, as long as they don't increase too fast with population so that the fraction of people who meet b is approximately zero (i.e. $k \to 0$), our results will hold.

5.3 Letters interpretation of Meetings

We have used a contrived definition of 'meetings' to say how players find out that the truth about the rumour. However, note that our results depend on three things - the fraction of the population who meet b, the meeting process being common knowledge and that only a signal is exchanged in meetings (types are not revealed). Thus, any meeting process which guarantees that only k fraction will meet b will give the same results. In the case of non-strategic b, we could have the following information dissemination process - b could tell just one person and then that one person may meet others randomly and inform them and then all those people could inform others and so on. If there are finite meeting stages, such that at the end of all meetings only k fraction of players know that the rumour was false, then our claims would go through. The math could become incredibly messy though!

5.4 Non Random Meetings

Potentially, it is more likely that people of the same ethnicity are more likely to meet each other. This spells trouble. Consider an extreme example where player b sends letters to only his own ethnicity. Conflict may be unavoidable now. This is because the other ethnicity does not learn that the rumour is false and will come out to fight. This is enough for conflict to occur. This example can be extended to a situation where the two ethnicities seldom meet in the meeting stage. Thus, low levels of inter-ethnic integration/communication may lead to one ethnic group not finding the truth. This would lead to a higher probability of conflict.[32]

5.5 Cost of participation

We have assumed that there is no cost of participating in a conflict (payoff from fight and lose $(-\beta + \epsilon)$ is similar to payoff from not fight and lose $(-\beta)$). Mathematically, this allows us to say that participating is dominant strategy if a player knows that conflict is inevitable. Consider now the game with a fixed cost c of participating in conflict.[33] Now people have a trade off. Suppose conflict is going to happen for sure. If $c > \epsilon$ then people will not fight. Clearly this would make playing nf more likely in urban areas.[34] However, note that we have also assumed that gains from winning remains the same always. The more natural assumption would have been that the pie is larger in urban areas. If the increase in gains compensate for the private cost then we will still get the same results. Alternatively, our results would go through under the condition that c was low.

[32] The inverse relationship between inter-ethnic relationships and ethnic conflicts has been explored in Varshney (2003) and Dutta (2014) among others.

[33] We have also tried cost functions where the cost of participating is inversely related to the probability of winning. A similar argument can be made there.

[34] Intuitively, since the population is large, one player's participation increases probability of winning by just a little but the private cost of participation is fixed at c.

5.6 Uncertainty about b's ethnicity

In the case of strategic b we have assumed that $b's$ ethnicity is common knowledge. Suppose this was not true and that players of each ethnicity had a belief about $b's$ ethnicity. Let belief of players of ethnicity e about player b being of ethnicity H be given by P_H^e.

The ideal situation for player b would be the case where $P_H^e \approx 1 \; \forall e \in \{H, M\}$ i.e. players of both ethnicities believe that player b is of their own ethnicity. In this case, both ethnicity players will believe that b will send them the right signals and will send the wrong signals to players of the other ethnicity. Thus, here, b can guarantee peace when he believes peace is possible and can guarantee success for his own ethnicity when he believes that conflict is inevitable.

5.7 Limiting k only

Throughout the paper we have focussed on two limiting cases of k. Of course, our results are not severely dependent on this. Any result which works when k is 1 will also work when k is high enough but not 1. A similar cut off argument will hold for $k = 0$. The qualitative results will not change. However, if k is nether too high nor too low, then we might need further conditions on the parameters to make any claims.

5.8 Choice of Utility Function for b

We have made a particular choice for the utility function of the informed agent b. This choice, albeit a natural one, does not encompass all possible cases one may see in the real world. In particular, it may be well known that player b is an extremist kind of player who would prefer a conflict to happen and for his own ethnicity to win. It would be interesting to analyze such variations in the future.

6 Conclusion

This paper looks at rumour induced conflicts. It explores the role of an agent who knows the truth behind the rumour in negating the effects of a bad rumour. We discuss conditions under which rumours cause conflict. We show that pre-rumour if players place high enough belief on the good state of the world then then peace is possible in the good state of the world. The arrival of a bad rumour removes the peaceful equilibrium and the only equilibrium that can be supported is the one in which everyone fights.

Suppose there is a meeting stage after the arrival of the rumour and before players make a decision to fight or not. We consider the role of an informed player (one who knows if the rumour is true or false) in this situation. We deal with two cases. In case 1, the informed player (b) is non strategic and reveals his information truthfully to all players he meets. Theorem 1 shows that if $b's$ information is informative about the state of the world and players meet a large fraction of the population then they are likely to meet b and learn that the rumour was false. On top of this information, common knowledge of the meeting process allows them to guess that many others know this truth as well which allows them to coordinate on not fighting and hence maintain peace. However, if players meet a very small fraction of the population then everyone fighting is the only equilibrium. This is because players realize that even though they know that they can get high payoffs if no conflict occurs, they know that many players do not know this. This provides one explanation to the well documented empirical observation that Hindu-Muslim violence in India is mostly an urban phenomenon.

In the next section we analyze the case of a strategic b with a commonly know bias towards his own ethnicity. b wants peace to prevail if he believes that the state is likely to be good but if he thinks that the state is likely to be bad and conflict is inevitable then he wants his own ethnicity to win. In an environment where b has informative signals, we show that there exists an equilibrium where b can maintain peace if the state is likely to be good and can increase the probability of winning of his own ethnicity by successfully preventing a fraction of the opposite ethnicity from fighting. The paper also shows that when b is strategic and his signals are very informative then there can be only two kinds of equilibrium outcomes possible in symmetric (within ethnicity) strategies. One outcome is the one described above and the other outcome is onw where all players fight.

We present a discussion of our modelling choices and assumptions which points to several possibilities which can still be explored. This paper is a first step in understanding the role of informed players in preventing conflicts that are precipitated by rumours. There can be very interesting extensions of this paper. One can look at a repeated environment where a rumour arrives every period and one player may or may not know more about it. It will be useful to understand the dynamics in such an environment. We can also consider different utility functions foe b and see how the results change. For example, b can be of extremist type who enjoys very high payoffs in case of a conflict. In this case he might have a hard time convincing players of his own ethnicity to fight and players of the opposite ethnicity to not fight. We could also look at an environment where b can choose the portfolio of the people he meets i.e., given his capacity constraint, he can choose what fraction of the players he meets are from either community. In such an environment it will be interesting to look at the optimal portfolio choice and the equilibrium strategies. In this paper we have assumed that both the communities have equal mass of agents. We can consider an environment where one community is a majority and the other is a minority and then look at different situations with b being strategic and belonging to the majority group or minority group. There are many such important and interesting questions to further investigate and we hope this paper will serve as a stepping stone to look into such issues.

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7 Appendix

Statement and Proof of Theorem 1:

Theorem

Let $\omega > \omega^*$ and $\frac{1-\theta_r}{1-\theta_q} > \frac{1-\omega^*}{\omega^*}\frac{\omega}{1-\omega}$. Assume $\frac{\phi_q}{\phi_r} \geq \frac{(1-\omega)(1-\theta_r)\omega*}{\omega(1-\theta_q)(1-\omega^*)} > 1$. Then, post letters stage, if $k \approx 1$ then no conflict can be an outcome of an equilibrium. If $k \approx 0$ then conflict is inevitable.

Proof. **7.1 Type space and prior**

Denote as $T = \{G, B\}^N$ the set of all type profiles. Define $T_q = \{t : \mu(\{i \in H : t_i = G\}) = \mu(\{i \in M : t_i = G\}) = q\}$ and similarly define T_r. We endow T with the appropriate sigma algebra such that the sets of the form T_q and T_r are measurable and we assume that the prior $p \in \Delta(T)$ has the following properties :

1. $p(T_q \cup T_r) = 1$
2. For all $i \in N$, $p(T_q|t_i = G) = \omega \geq \omega^*$
3. $p(t_i = G|T_s) = s\ \forall\ i \in N$ and $\forall s \in \{q, r\}$

The construction of such priors has been discussed in Judd (1985). We may do so here by seperately performing Judd's contruction for T_q and T_r and then naturally extend the measure to the union $T_q \cup T_r$. The first condition says that the type distribution is either (q, q) or (r, r). The second condition says that when an agent learns that he is of type G, his belief about (q, q) is ω. Third, conditional on T_s, the probability of each player being a good type is s.

7.2 Strategies

The tree represents uncertainty faced by a player of good type. He may be at information set $3, 4T$ or $4F$. A strategy prescribes what action to take at each information set.

Definition : For player i, a *strategy* a function $\sigma_i : \{3, 4T, 4F\} \to \Delta\{f, nf\}$.

We shall focus on symmetric strategy profiles.

7.3 Results

First we will identify necessary and sufficient conditions for there to be a mixed strategy equilibrium.

Proposition 6. *Let* $\hat{\sigma} = \frac{(1-\omega)(1-\theta_r)\omega*}{\omega(1-\theta_q)(1-\omega^*)}$. *If* $\frac{\phi_q}{\phi_r} = \hat{\sigma}$ *or* $\frac{1-\phi_q}{1-\phi_r} = \hat{\sigma}$ *then a mixed strategy equilibrium (with strict randomisation at atleast one message) of the following form exists :*

Strategy for each player :

- *NL :* $p_l f + (1 - p_l)nf$
- *LT :* $p_t f + (1 - p_t)nf$
- *LF :* $p_f f + (1 - p_f)nf$

If not, then no such equilibria exist.

Proof. First consider the case where $\frac{\phi_q}{\phi_r} = \hat{\sigma}$. We show that an equilibrium of the above nature for exists with $p_l = 1$, $p_t = 1$ and any $p_f \in (0, \frac{c+q-1}{q}]$. Given a currently held belief $\omega' \in [0,1]$ and fraction $p \in [0, \frac{c+q-1}{q}]$ of good types in each ethnicity playing f , it shall be convenient to define the following values :

- Payoff of an arbitrary player from playing f

$$E_P^{p,\omega'} = \omega'(-\gamma) + (1-\omega')(\tfrac{\alpha-\beta+\epsilon}{2})$$

- Payoff of an arbitrary player from playing nf :

$$E_{NP}^{p,\omega'} = \omega'(\alpha+\delta) + (1-\omega')(-\beta)$$

From Proposition 1, we know that $E_f^{0,\omega^*} = E_{nf}^{0,\omega^*}$. It is also clear that $E_f^{p,\omega'} = E_f^{p',\omega'}$ and $E_{nf}^{p,\omega'} = E_{nf}^{p',\omega'}$ for all $p, p' \in [0, \frac{c+q-1}{q}]$ and $\omega' \in [0,1]$.

Since, at information set NL a player learns that the truth person does not exist, his posterior equals the post rumour belief according to which it is strictly better to fight. Hence $p_l = 1$. Now, since $\frac{\phi_q}{\phi_r} = \hat{\sigma}$, we have $\Pr(q|LF) = \omega^*$ and since the letters are informative we have $\frac{\phi_q}{\phi_r} = \hat{\sigma} > 1$ which implies $\frac{1-\phi_q}{1-\phi_r} < 1$ and hence $\Pr(q|LT) < \Pr(q|LF) = \omega^*$. Notice that $E(f|LT) = E_f^{p_t,\Pr(q|LT)}$ and $E(f|LF) = E_f^{p_t,\Pr(q|LF)}$ and this holds similarly for nf. So we have $E(f|LT) > E(nf|LT)$ and $E(f|LF) = E_f^{0,\omega^*} = E_{nf}^{0,\omega^*} = E(nf|LF)$. Hence, $p_t = 1$ and any $p_f \in (0, \frac{c+q-1}{q}]$ can be sustained as an equilibrium. By a similar argument, it can be shown that for $\frac{1-\phi_q}{1-\phi_r} = \hat{\sigma}$, an equilibrium can be sustained for $p_t \in (0, \frac{c+q-1}{q}]$ and $p_f = 1$.

Now suppose $\frac{\phi_q}{\phi_r} \neq \hat{\sigma}$ and $\frac{1-\phi_q}{1-\phi_r} \neq \hat{\sigma}$. Then, $\Pr(q|LT)$ and $\Pr(q|LF)$ are both not equal to ω^*. Hence, $E(f|LT) = E_f^{0,\Pr(q|LT)} \neq E_{nf}^{0,E_{nf}^{0,\omega^*}} = E(nf|LT)$ and this similarly holds for LF. Hence, no mixing is possible. □

Now we identify conditions for pure strategy equilibria.

7.3.1 (f, f, nf) as an Equilibrium

We will show that the above constitutes an equilibrium. This will imply that if the state is good then there is a high chance of there being no conflict.

Denote as (a, b, c) the strategy $\sigma(3) = a, \sigma(4T) = b$ and $\sigma(4F) = c$ where $\{a, b, c\} \subseteq \{f, nf\}$. We now show conditions under which (f, f, nf) is an equilibrium. Let ϕ_q and ϕ_r be the probability of receiving the message F in the state q and r respectively

Proposition 7. *Suppose the following are true :*

1. $0 < \zeta_q = \zeta_r = \zeta$
2. $k \to 1$
3. $\frac{\phi_q}{\phi_r} > \frac{(1-\omega)(1-\theta_r)\omega*}{\omega(1-\theta_q)(1-\omega^*)} > 1$

then (f, f, nf) can be supported as an equilibrium and no strategy profile with $\sigma(4T) = nf$ can be supported as an equilibrium.

Proof. Since $k \to 1$, any player at information set 3 realizes that the probability that player b exists is close to zero. Also, $\zeta_q = \zeta_r$ implies that this information does not help update the belief about the state of the world. Thus, any player at information set 3 will have post rumour beliefs. Since the belief on the state of the world being (q, q) is strictly less than ω^* (because $\frac{1-\theta_r}{1-\theta_q} > \frac{1-\omega^*}{\omega^*}\frac{\omega}{1-\omega}$) at the post rumour information set (information set 2), it is optimal to play f for any symmetric strategies the other player may be following. It is sufficient to show that this is true when all other G players are playing nf. This has been proved as part of proposition 2.

Now consider the decision at information set $4F$. Under the conditions stated above $Pr(q|4F) > \omega^*$. As the fraction of players getting the letter goes to 1, we know that any player i's belief about the fraction of good types who received the same letter as i goes to 1. Let $k \to 1$. Let $E(f, 4F, q)$ and $E(f, 4F, r)$ be the expected payoff from playing f at information set $4F$ in state q, r respectively. Let $E(nf, 4F, q)$ and $E(nf, 4F, r)$ be the corresponding expected payoffs from nf. Then, the expected payoff from playing f at $4F$ is :

$$\begin{aligned} &E(f, 4F, q)p(q/4F) + E(f, 4F, r)p(r/4F) \\ &= -\gamma p(q/4F) + \frac{\alpha - \beta + \epsilon}{2} p(r/4F) \end{aligned}$$

The expected payoff from playing NP at $4F$ is :

$$\begin{aligned} &E(nf, 4F, q)p(q/4F) + E(nf, 4F, r)p(r/4F) \\ &= (\alpha + \delta)p(q/4F) + (-\beta)p(r/4F) \end{aligned}$$

Since $\frac{\phi_q}{\phi_r} > \frac{(1-\omega)(1-\theta_r)\omega*}{\omega(1-\theta_q)(1-\omega^*)} > 1$, we have that $p(q/4F) > \omega^*$. From proposition 1, this implies that playing nf is optimal for G players. Under the conditions, $Pr(q|4T) < \omega^*$. Therefore, a similar argument can be used to show that it optimal to play f at information set $4T$. It is also clear that no strategy with $\sigma(4T) = nf$ can be supported as an equilibrium. □

Proposition 8. *Assume the following :*

1. $k \to 0$
2. $\frac{(1-\omega)(1-\theta_r)\omega*}{\omega(1-\theta_q)(1-\omega^*)} > 1$

Then, (f, f, f) is the unique symmetric equilibrium

Proof. We first show that no profile of the form (f, l, nf) or (f, nf, b)[35] can be supported as an equilibrium. Now, we have $k \to 0$. Hence, for low values for k, even if the letters are distributed, conflict will inevitably take place since a large fraction of the community (of proportion greater than c) will not have received a letter and will be in information set 3 and choose to play f under the above strategy profile. Hence, agents who do receive the letter would know that a conflict will take place irrespective of the state of the world and would choose to play f since it is a dominant strategy under conflict.

Additionally, we know that (f, f, f) can always be supported as an equilibrium and the above argument establishes it as a unique equilibrium. □

□

[35]Since the events that -letter has signal T and letter has signal F are mutually exclusive, we put the letter $'l'$ in place of the non-relevant action choice. Also, note that we have shown before that playing f is the only optimal strategy at information set 3 in any symmetric equilibrium.