Doubts and Dogmatism in Conflict Behavior

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Abstract

This paper studies a game of conflict where two individuals fight in order to choose a policy. Intuitively, conflicts will be less violent if individuals entertain the possibility that their opponent may be right. Why is it so difficult to observe this attitude? To answer this question, this paper considers a model of indoctrination where altruistic advisors (such as, preachers or parents), after receiving signals from Nature, send messages to the participants in the conflict. In some cases, as a result of indoctrination, both individuals never doubt about the possibility of being wrong, although all available information suggests otherwise. In other cases, one of the two individuals is excessively reasonable: he believes that the opponent may be right even when all the evidence indicates beyond any doubt that the policy preferred by the opponent is suboptimal. The common feature in both cases is that information is distorted, although in different directions. The model has a rich set of predictions concerning the incidence and intensity of conflict, and the evolution of indoctrination strategies over time.

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"I believe that we can avoid violence only in so far as we practice this attitude of reasonableness in dealing with one other in social life. [This attitude] may be characterized by a remark like this: "I think I am right, but I may be wrong and you may be right." [...] One of the main difficulties is that it always takes two to make a discussion reasonable." Karl Popper (1963, p. 357)

1. Introduction

It is intuitive that individuals will be more (resp. less) willing to exert effort in a conflict, when they believe that the conflict has high (resp. low) stakes. As suggested in the quote by Karl Popper (1963), violence in conflicts can be reduced if individuals entertain the possibility that they may be wrong and that their opponent may be right. How do people form these beliefs? Various episodes of escalation in ideological violence across the world suggests that individuals often engage in a great deal of reality distortions which lead them to negate the possibility of being wrong. Other evidence seems to suggest that in some other cases reality is distorted in the opposite direction: some individuals seem to overestimate the possibility that the opponent may be right.[1] In this paper, we build a model where two individuals play a game of conflict over an ideological dimension. In the context of our model, we intend to understand whether and in which direction beliefs in conflict behavior are distorted.

Our first point of departure is to assume that individuals' preference rankings over policy alternatives are state-dependent and that the current state of the world is not observable by the two participants in the conflict. This implies that the two parties cannot be ex-ante certain about the optimality of the policy that they are trying to impose. The second crucial feature of our model is that each opponent relies on the information provided by an altruistic advisor (such as, a preacher or a parent), who is assumed to be better (although not necessarily perfectly) informed about the current state.

Since the general setup with two opponents and two advisors is somewhat involved (see Section 3), in Section 2 we first focus on a simpler setup with three individuals: a "student", an "opponent" and a "preacher" who is (more or less) altruistic *vis-à-vis*

[1] In their classic works, Ferenczi (1932) and Freud (1937) first argued that one psychological means of dealing with an external threat is to identify with the aggressor: that is, to take as one's own those standards, values, or demeanor that hitherto created anxiety and pain.

the student.[2] To justify the asymmetry between the two parties of the conflict, in Section 2 we suppose that the opponent's preferred policy is constant regardless of the state of the world. This implies that the opponent does not need to be informed about the current state in order to know which policy maximizes his utility. In contrast, we suppose that the student's preferences are state-dependent. More specifically, in one state of the world, the optimal policy of the student is different from the one of the opponent, while in another state of the world the policy preferred by the opponent is also optimal for the student. Moreover, assume that the initial prior of the preacher and of the student is that the state where preferences are not aligned is more likely. The timing of our model is as follows. Nature privately sends to the preacher a signal that is (not necessarily fully) informative about the current state; the preacher updates his prior and decides which message to send to his student. Upon receiving a message from the preacher, the student naively forms his beliefs about the current state. Then, both individuals simultaneously decide the effort level in the conflict. We assume that the individual that exerts the highest effort wins and is able to impose his preferred policy.

In this paper, we will solve the information transmission game between the preacher and his student as well as the subsequent game of conflict between the student and the opponent. The first questions that we intend to answer are the following. When facing an opponent that has no doubt, does the preacher have an incentive to send a truthful message? If not, does the preacher have an incentive to remove or instill doubts in his student?

A preview of our results is the following. Whether or not the preacher is truthful depends on a crucial parameter: the prior probability of being in a state where preferences are not aligned. In particular, manipulation of information does not take place when the prior probability is sufficiently low. Since we expect that prior probability to be high in a heterogeneous society, this suggests that manipulation of information is less likely in homogenous societies.

Second, we show that in societies that are sufficiently heterogenous, truthful reporting does not generally take place. The type of manipulation that is observed depends on another crucial parameter of the model: the degree of preacher's altruism, which measures how much does the preacher internalize the effort cost exerted by the student.

[2] The term "preacher" is used here with no religious connotation. It indicates a wise and trusted adviser or guide.

When altruism is low, we find that the preacher induces a dogmatic attitude in his student by removing any doubt that the student may have had about the possibility that the opponent's preferred policy is optimal for him. This occurs even when the signal that the preacher receives from Nature indicates that the opponent may be right. As a result, the dogmatic student strenuously fights because he incorrectly excludes the possibility that the policy that the opponent would choose may be optimal. This leads to conflicts that are more violent than the ones that we would have observed if information had not been manipulated.

When altruism is high (or even perfect), we obtain that the preacher induces a skeptical attitude by always instilling in his student the doubt that opponent may be right even when the evidence received by the preacher indicates that the policy that the opponent would choose is certainly not optimal. As a result, the skeptical student exerts little effort because he incorrectly entertains the possibility that the policy that the opponent is trying to impose may be optimal also for him. Skepticism leads to more moderate conflicts, but it also leads to asymmetric outcomes: the opponent wins and is able to implement his preferred policy more often than the student.

It should be stressed that the incentive to manipulate beliefs does not arise here because agents derive utility from anticipation of future payoffs, as in Akerlof and Dickens (1982).[3] In this model, the preacher manipulates information in order to affect his student's behavior in the conflict and, due to the existence of strategic interdependence between agents' effort decisions, to also affect the behavior of the opponent. The incentive to induce a dogmatic attitude can be easily understood: removing doubts has a *motivating effect* because it induces the student to exert higher effort. Clearly, this effect is more valuable to the preacher, the lower his altruism parameter. But, why would a preacher ever want to instill doubts in his student after learning that the opponent's preferred policy is not optimal? Instilling doubts decreases the probability that the student enters the conflict and, consequently, increases the probability that the suboptimal policy is implemented. This is clearly welfare reducing for both the preacher and the student. However, instilling doubts has a *moderating effect* on the conflict: it decreases the average effort exerted by *both* opponents and reduces the conflict's Pareto inefficiency. Then, conditional upon the student exerting a positive effort, the preacher obtains a larger payoff in the conflict. In contrast to the motivating effect, the moderating effect is more valuable to the preacher, the higher his altruism parameter.

[3] Recent models where beliefs affect agents' utilities through anticipation of future payoffs include Caplin and Leahy (2001), Brunnermeier and Parker (2005), Köszegi (2006), and Benabou (2008, 2009).

One can then show that if the preacher is sufficiently altruistic, the moderating effect dominates and, consequently, skeptical attitudes may be observed.

Two simple extensions are then analyzed. First, in Section 2.3 we suppose that upon receiving a message that instills doubts, the student can conduct autonomous research, which is not manipulable and is successful only with some probability. The results show that in societies where research is often successful, dogmatic attitudes are less likely to be observed. Second, in Section 2.4 we consider a dynamic model where the probability of research's success increases over time if in the previous period research was conducted. In the context of our model, we show the possibility of a dogmatic trap: societies that are initially dogmatic may find it difficult to sustain truthful reporting in later periods. The underlying reason is that dogmatism induces individuals not to conduct research; as a result, the probability of success of future research does not increase, thereby providing future generations with no incentive to abandon dogmatism. The good news is that truthful reporting is also an absorbing state: societies where information is not manipulated give incentives to conduct research, which improves the effectiveness of future research and provides future generations with even more incentives to report truthfully. On the contrary, we show that skepticism cannot be observed for a long period of time. Luckily, it is not replaced by dogmatism but by truthful reporting.

Finally, in Section 3 we consider a model where the utilities of both opponents are state-dependent and where both individuals are associated to a preacher. In this case, we show that besides the motivating effect, removing doubts has also a *preempting effect*: the preacher induces the opponent to exert lower effort, without decreasing the effort level of his own student. As a result of this effect, we obtain that one of the two preachers will always induce a dogmatic attitude. This finding confirms Popper's pessimism about the possibility to observe an attitude of reasonableness in both opponents.

This model yields some predictions about the incidence and the intensity of conflict. In particular, the results confirm the intuition that more heterogenous societies (that is, societies that are ex-ante more likely to disagree) have a higher risk to enter into a conflict. More surprisingly, conditional on conflict occurring, the intensity of conflict may not be monotone in the degree of ex-ante heterogeneity. The latter result occurs because, as described above, in more divided societies one of the two individuals may be induced to have a skeptical attitude, which reduces the overall effort exerted in the conflict.

This paper is related to recent literature that deals with other examples of distorted collective understanding of reality, such as anti and pro-redistribution ideologies (Bénabou, 2008, Bénabou and Tirole, 2006), over-optimism (or over-pessimism) about the value of existing cultural norms (Dessi, 2008), contagious exuberance in organizations (Bénabou, 2009), and no-trust-no-trade equilibria due to pessimistic beliefs about the trustworthiness of others (Guiso *et al.*, 2008). A common trait of these phenomena is that individuals rely on distorted evidence about the current state of the world. In Bénabou (2008, 2009), the individuals themselves distort their own processing of information. Here instead we consider a model of indoctrination where the opponents in the conflict receive (possibly manipulated) information from their preachers (or parents).[4] Contrary to Guiso *et al.* (2008), where parents can perfectly choose the beliefs of their children, indoctrination possibilities are more limited here because preachers can affect students' beliefs only by misreporting the private signals that they have received. In contrast to Bénabou (2009), where censorship and denial occur because individuals have anticipatory feelings, in our model a preacher may decide to misreport the truth for a different set of reasons: to motivate his own student (a similar motive is also present in, for instance, Bénabou and Tirole, 2002, 2006) and also, because of the existence of strategic interdependence between agents' effort decisions, to affect the strategy of the opponent.[5] Notice that the latter, but not the former, motive is also present if preachers are perfectly altruistic. This implies that in our model misreporting may occur also when the utility of the preacher coincides with the one of the student.[6]

This paper is also related to the literature on social conflict. Starting from the classic contributions by Grossman (1991) and Skaperdas (1992), the literature has developed theoretical models to study the determinants of social conflict.[7] Recently, Caselli and Coleman (2006) and Esteban and Ray (2008, 2009) have focused on the role

[4] However, as discussed in Bénabou and Tirole (2006), a model of indoctrination is formally identical to a model where individuals with imperfect willpower distort the information they have received to affect their effort decision in the future. See also the discussion at the end of Section 2.1.

[5] In Bénabou (2009) there is no strategic interdependence between agents' effort decisions.

[6] In Carillo and Mariotti (2000) and Bénabou and Tirole (2002, 2006), a necessary condition to have strategic ignorance or beliefs manipulation is to have disagreement between the multiples selves (that is, time-inconsistent preferences). See also the classic model of strategic information transmission of Crawford and Sobel (1982), where the sender has no incentive to misreport if he has the same utility of the receiver.

[7] See Blattman and Miguel (2008) for a survey.

of ethnic divisions; Besley and Persson (2008a, 2008b) have investigated the economic determinants of social conflict, while Weingast (1997) and Bates (2008) have studied the importance of institutional constraints. It should be noticed that in virtually all papers on the subject, the parties in the conflict fight over a given amount of resources. In contrast, we consider here a conflict over an ideological dimension, which we expect to be more susceptible to beliefs' manipulation. Two recent papers have also studied how the outcome of a conflict (or of a bargaining under the threat of war) can be manipulated. In Jackson and Morelli (2007), citizens may strategically delegate the leadership of their country to a more hawkish politician in order to extract more transfers from the other country. Baliga and Sjöström (2009) consider a model of conflict where each opponent has private information about his cost of waging war. In their model, an extremist group, who is able to observe the type of one opponent, may engage in various acts (such as, a terroristic attack) so as to affect the fighting strategies of both opponents. Finally, it also bears mentioning the work by Anderlini *et al.* (2009). They consider a dynastic game of conflict with private communication across generations and show that destructive wars can be sustained by a sequential equilibrium for some system of beliefs. However, their model is very different from ours along various dimensions. For example, in their setting communication is about past history, which has no direct effect on current payoffs, while in our model it concerns the current state of nature, which directly affects players' payoffs.

The remainder of the paper is as follows. In Section 2, we analyze the basic setup with one preacher, one student and one opponent. Section 3 considers a slightly different setup with two preachers and two students. Section 4 concludes.

2. The Model

Consider a model with three players: A, B and $\widehat{A}$. Individuals A and B are assumed to play a game of conflict. Individual A is associated to $\widehat{A}$, whose role is to provide information to A. Individual $\widehat{A}$ is assumed to be altruistic towards A. Throughout this paper, we shall refer to $\widehat{A}$ as the "preacher" and to A as the "student". Alternatively, one could think of $\widehat{A}$ and A as, respectively, a parent and a son or as two multiple selves that exist at different times within the same individual.[8]

[8] On the latter possibility, see the discussion at the end of Section 2.1. According to yet another interpretation, one could view $\widehat{A}$ as a politician. A few papers analyze the political supply of biased beliefs. See, for instance, Glaeser (2005) who studies the incentives of politicians to supply hate-

It is important to emphasize that the game of conflict analyzed here does not concern the division of a given amount of resources.[9] Instead, the conflict is over the choice of a policy $x \in X$. We will assume that X includes only two alternatives: $X = \{a, b\}$.

The model is sufficiently general to admit various interpretations. For example, it could describe a conflict between two political factions in order to decide the type of economic policy (government intervention vs. laissez faire) or the type of constitution (theocracy vs. secular democracy) to adopt in the country. Also, the model could offer insights into more innocuous conflicts: for instance, a couple choosing between two dining options.

Players' utilities are assumed to depend on x but also on the current state of the world $\theta \in \Omega$. In most of this paper, with the exception of Section 3, we assume that there are only two possible states of the world: $\Omega = \{\theta_1, \theta_D\}$. The state is randomly drawn by Nature. In state θ_1 we assume that the preferences of A and B are aligned: the policy that maximizes the utility of both individuals is the same. In state θ_D we assume instead that individuals disagree on the correct policy to implement: the policies that maximize the utility of the two individuals are different. Throughout the paper we will denote θ_1 as the *state of agreement* and θ_D as the *state of disagreement*. The assumption that individuals with different views may sometimes agree seems quite natural. For example, in particular circumstances an individual who usually supports free-market policies may agree with a left-wing individual about the opportunity of government intervention.

The utility of individual i, where $i = A$,B, is

$$U^i(c_i, x, \theta) = -c_i + u_i(x, \theta), \tag{1}$$

where c_i is the cost of effort exerted in the conflict and $u_i(x, \theta)$ is a term that depends on the current state θ and on policy x.[10]

More specifically, we will assume that in the state of agreement θ_1 policy b is optimal for both individuals. Conversely, in the state of disagreement θ_D individual A's preferred policy is a, while B's preferred policy is b. The following matrix summarizes the preferred policies by each individual in each state:

creating stories against poor (or rich) minorities in order to block (or pass) redistribution policies.

[9]This assumption is made in virtually all the literature on social conflict discussed in the Introduction.

[10]Instead of a game of conflict, one could think that the two individuals are playing a bargaining game. In this case, c_i should be interpreted as the delay cost in the negotiation.

	A's optimal policy	*B*'s *optimal policy*
θ_1	b	b
θ_D	a	b

For simplicity, it is assumed that the term $u_i(x, \theta)$ is either zero or one: it is equal to one if the appropriate policy for individual i in state θ is selected, and zero otherwise. More formally,

$$\begin{aligned} u_A(b, \theta_1) &= u_B(b, \theta_1) = u_A(a, \theta_D) = u_B(b, \theta_D) = 1, \\ u_A(a, \theta_1) &= u_B(a, \theta_1) = u_A(b, \theta_D) = u_B(a, \theta_1) = 0. \end{aligned}$$

As mentioned above, $\widehat{A}$ is assumed to be (more or less) altruistic towards A. His utility is

$$U^{\widehat{A}}(c_A, x, \theta) = -\beta c_A + u_A(x, \theta). \tag{2}$$

Let $0 \leq \beta \leq 1$. When $\beta = 1$, the utility of $\widehat{A}$ coincides with the one of A. When $\beta < 1$, the preacher is not fully altruistic *vis-à-vis* his student: $\widehat{A}$ does not fully internalize the cost of effort exerted by A. This seems quite natural. After all, c_A is the effort exerted by A, not by $\widehat{A}$. However, notice that the preacher does not disagree with his student on the right policy to adopt in each state θ.

We assume incomplete information about the current state of the world. Individuals have a common prior on θ. The prior probability that all agents assign to the state of disagreement is denoted by $P(\theta_D)$. We will assume that $P(\theta_D) \in (1/2, 1)$: that is, the two individuals are (ex-ante) more likely to be in a state of disagreement than in a state of agreement. To some extent, $P(\theta_D)$ can be viewed as a measure of societal *heterogeneity*. In fact, it seems intuitive that two randomly selected individuals from a heterogenous society are likely to disagree on various issues; consequently, we expect them to have a high prior $P(\theta_D)$.

Finally, it is important to notice the asymmetry between A and B. Individual B, unlike A, does not need to know the current state in order to decide which policy to adopt in case of victory: he has no doubt that b is the appropriate policy. On the contrary, A needs to know the current state of nature in order to know which is the appropriate policy to adopt.[11]

[11] This is going to change in Section 3, where we will assume that the optimal policy of *both* individuals depends on the current state.

2.1 Timing and Information Structure

The period is divided in three sub-periods: $t = 0, 1, 2$. At $t = 0$, the *message game* between $\widehat{A}$ and A takes place. At $t = 1$, A and B play a *game of conflict*. At $t = 2$, the winner decides the policy. See Figure 1 for the timing. We now discuss each stage in detail.

At $t = 0$, Nature sends to $\widehat{A}$ a signal $s \in \{s_{CAU}, s_{IDY}\}$ which is (not necessarily fully) informative about the current state θ. It is crucial to assume that this signal is privately observed by $\widehat{A}$. We now describe each signal. Signal s_{CAU} is perfectly informative and reveals that the state is θ_D. The subscript CAU stands for "conflict as usual" because, unconditional on the signal, θ_D is the most likely state. Conversely, signal s_{IDY} is not perfectly informative. It indicates that the state *may* not be a state of conflict. The subscript IDY stands for "idiosyncratic" because this signal suggests that the state may not be θ_D.

The conditional probabilities of receiving signals s_{CAU} and s_{IDY} in state θ_1 are

$$P(s_{CAU} \mid \theta_1) = 0 \text{ and } P(s_{IDY} \mid \theta_1) = 1. \tag{3}$$

In state θ_D, they are

$$P(s_{CAU} \mid \theta_D) = \gamma \text{ and } P(s_{IDY} \mid \theta_D) = 1 - \gamma, \tag{4}$$

where $\gamma \in [0, 1]$.

Let $\mu^{\widehat{A}}(s)$ denote $\widehat{A}$'s posterior probability of being in state θ_D upon receiving signal s. Preacher $\widehat{A}$ updates his prior according to Bayes' Rule:

$$\mu^{\widehat{A}}(s_{IDY}) = \frac{P(\theta_D)(1-\gamma)}{1 - P(\theta_D) + P(\theta_D)(1-\gamma)}, \tag{5}$$

$$\mu^{\widehat{A}}(s_{CAU}) = 1. \tag{6}$$

The parameter γ can be viewed as a measure of the precision of Nature's signals. In fact, when $\gamma = 1$, the evidence received by $\widehat{A}$ is perfectly informative. Instead, when $\gamma = 0$, the preacher's posteriors upon receiving s_{IDY} coincide with his initial priors.

Upon receiving a signal from Nature, $\widehat{A}$ decides which messages $m_{\widehat{A}}$ to send, where $m_{\widehat{A}} \in \{s_{CAU}, s_{IDY}\}$. The message is public. A communication strategy for $\widehat{A}$ specifies a message for any signal s. Throughout this paper we assume that A is *naive*: A believes the signal that $\widehat{A}$ sends. In other words, A does not realize that the preacher

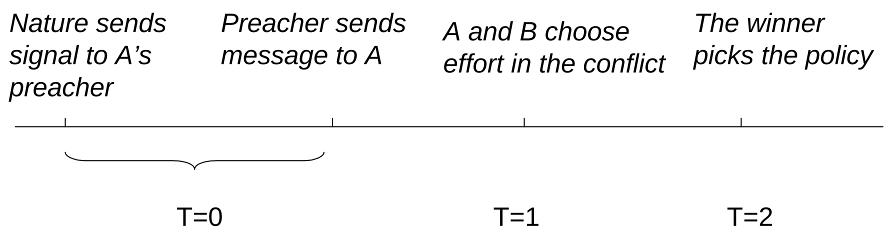

Figure 1: Timeline

may not always tell the truth. (Also notice that the naivete of A is known to B and to $\widehat{A}$.) Consequently, upon receiving message $m_{\widehat{A}}$, A's posterior, which is denoted by $\mu^A(m_{\widehat{A}})$, is equal to (5) when $m_{\widehat{A}} = s_{IDY}$ and is equal to (6) when $m_{\widehat{A}} = s_{CAU}$. The naivete assumption is somewhat justified because of the particular relationship between preacher and student and on the assumption that $\widehat{A}$ is altruistic *vis-à-vis* A.[12] Finally, it is important to notice that the preacher cannot fabricate new evidence that would allow him to perfectly choose the posterior of his student. Instead, we assume here that $\widehat{A}$ can affect A's beliefs only by misreporting the signal received from Nature.[13]

At $t = 1$, we posit the following game of conflict. Individuals A and B simultaneously choose effort levels c_A and c_B, where $c_A, c_B \geq 0$. The probability of i winning the contest given his own effort decision and the one of the opponent is

$$p_i(c_i, c_{-i}) = \begin{cases} 0 \text{ if } c_i < c_{-i}, \\ 1 \text{ if } c_i > c_{-i}, \\ \frac{1}{2} \text{ if } c_i = c_{-i}. \end{cases}$$

In words, the individual that exerts the highest effort wins with probability one. This technology of conflict, which is extremely sensitive to effort differences, turns out to be analytically tractable for our purposes.[14] An effort strategy for i specifies an effort level for any message $m_{\widehat{A}}$.[15]

[12] We briefly discuss what happens when A is not naive at the end of Section 2.2.3 and in footnote 20.

[13] A similar assumption is also made in Bénabou and Tirole (2006), Bénabou (2008, 2009), and Dessi (2008).

[14] In the social conflict literature, this technology of war is considered, for instance, by Jackson and Morelli (2007, ex. 3). This type of contest, known in the literature as all-pay auction, has also been considered by the lobbying and rent-seeking literature: e.g., Ellingsen (1991), Baye *et al.* (1993), and Che and Gale (1998). For a survey of other technologies of conflict, see Garfinkel and Skaperdas (2007).

[15] Notice that, due to strategic interdependence in the game of conflict, $m_{\widehat{A}}$ affects the effort decision of B indirectly, through its effect on A's beliefs.

At $t = 2$, the winner is selected and picks the policy. The decision strategy D_i specifies the policy decision by i in case of victory.

The equilibrium of the game we have just described is quite standard. At each stage, players maximize their expected utility given their beliefs at that stage and given the strategies of the other players. The only non-standard assumption is that A naively believes the message sent by $\widehat{A}$.

Before moving to the characterization of the equilibrium, we stress that our model of indoctrination could be interpreted as an intrapersonal game between two multiple selves within the same individual.[16] In lieu of assuming that information is provided by $\widehat{A}$, we could assume that A is able to observe s. If A discounts future payoffs using quasi-hyperbolic discounting, at $t = 0$ he may have an incentive to engage in denial to influence the game of conflict between his other self at $t = 1$ and B. More in particular, suppose that from the perspective of time $t = 0$, the discount factor between $t = 1$ and $t = 2$ is $1/\beta > 1$, while the discount factor between $t = 0$ and $t = 1$ is 1. However, due to time-inconsistent preferences, at $t = 1$ (when the effort decision is made) A discounts the payoff at $t = 2$ (when the policy is implemented) with a discount factor equal to 1. It is easy to verify that the intertemporal utility of A as of $t = 0$ is equal to β-times the utility in (2), while the intertemporal utility of A at $t = 1$ would look as (1). As a result, the equilibrium message strategy of the preacher would coincide with the censoring strategy of an individual with imperfect willpower.

2.2 Equilibrium Characterization

We solve the model by backward induction.

2.2.1 Policy Decisions

At $t = 2$, the decision rule of individual B in case of victory in the conflict is trivial. For all $m_{\widehat{A}}$,

$$D_B(m_{\widehat{A}}) = b.$$

The decision by A is also straightforward: A picks a only if his posterior probability of being in a state of conflict is greater than 1/2. That is,

$$D_A(m_{\widehat{A}}) = \begin{cases} a & \text{if } \mu^A(m_{\widehat{A}}) > 1/2, \\ b & \text{if } \mu^A(m_{\widehat{A}}) \leq 1/2. \end{cases}$$

[16] On this point, see also Bénabou and Tirole (2006, p. 708).

2.2.2 The Game of Conflict

We now determine the effort decisions at $t = 1$. At the beginning of $t = 1$, both A and B observe the message $m_{\widehat{A}}$ sent by $\widehat{A}$. Individual B knows that A is naive and, consequently, he is able to figure out $\mu^A(m_{\widehat{A}})$, the probability assessment of player A of being in state θ_D. To find out the equilibrium in the game of conflict, two cases must be considered. First, suppose $\mu^A(m_{\widehat{A}}) \leq 1/2$. In this case, A agrees with B that b is the correct policy to adopt. Then, $c_A, c_B = 0$.

Second, suppose $\mu^A(m_{\widehat{A}}) > 1/2$. In this case, a conflict is inevitable. As we will see in Proposition 1, the equilibrium is in continuous mixed strategies. Let $G_i(.)$ denote the equilibrium cumulative distribution of individual i's effort. The expected payoff to A from exerting effort c_A is

$$EU^A = [1 - G_B(c_A)]\left(1 - \mu^A(m_{\widehat{A}})\right) + G_B(c_A)\mu^A(m_{\widehat{A}}) - c_A. \tag{7}$$

That is, with probability $G_B(c_A)$ individual A wins (this occurs because B exerts effort c_A or less) and implements policy a, which gives A an expected payoff equal to $\mu^A(m_{\widehat{A}})$. With complementary probability, B wins and implements b, which gives A an expected payoff equal to $1 - \mu^A(m_{\widehat{A}})$. It should be transparent from (7) that the stakes in the conflict (i.e., the payoff difference between winning and losing) for A are increasing in $\mu^A(m_{\widehat{A}})$. The reason is twofold. First, the higher $\mu^A(m_{\widehat{A}})$, the stronger A's confidence about the optimality of policy a. This implies that the expected payoff of winning is increasing in $\mu^A(m_{\widehat{A}})$. Second, higher values of $\mu^A(m_{\widehat{A}})$ imply fewer doubts about the possibility that policy b could be optimal. The expected payoff of losing is then decreasing in $\mu^A(m_{\widehat{A}})$.

We can rewrite (7) as

$$EU^A = \left(1 - \mu^A(m_{\widehat{A}})\right) + G_B(c_A)\left(2\mu^A(m_{\widehat{A}}) - 1\right) - c_A. \tag{8}$$

From expression (8) notice that A will never bid more than $2\mu^A(m_{\widehat{A}}) - 1$. The reason is easily understood: an effort level strictly greater than $2\mu^A(m_{\widehat{A}}) - 1$ would at most allow A to win with probability one. One can see that by exerting an effort level equal to zero, A would obtain a greater payoff. Note that A's valuation goes to zero when $\mu^A(m_{\widehat{A}})$ goes to $1/2$. In fact, when the two states become equally likely, A has weak reasons to enter into a conflict: eventually, when $\mu^A(m_{\widehat{A}}) = 1/2$ player A is willing to let B decide and pick b.

The expected payoff to B is instead

$$EU^B = G_A(c_B) - c_B$$

Note that B's valuation is 1, which is (weakly) greater than A's valuation. This is intuitive: B has no doubts that b is the right policy. Then, the stakes in the conflict for B are higher than for A since policy a is for sure not the optimal policy for B.

The game of conflict that we have just described has the following unique equilibrium.

PROPOSITION 1: *(Hillman and Riley, 1988) Suppose that $\widehat{A}$ sends message $m_{\widehat{A}}$. If $0 \leq \mu^A(m_{\widehat{A}}) \leq 1/2$, we have $c_A = c_B = 0$ and policy b is selected. If instead $1/2 < \mu^A(m_{\widehat{A}}) \leq 1$, the equilibrium cumulative distribution functions of effort levels by A and B are, respectively,*

$$G_B(c_A) = \frac{c_A}{2\mu^A(m_{\widehat{A}}) - 1},$$

$$G_A(c_B) = 1 - (2\mu^A(m_{\widehat{A}}) - 1) + c_B.$$

This implies that for individual B the mixed strategy is a uniform distribution over the interval $\left[0, 2\mu^A(m_{\widehat{A}}) - 1\right]$. For A there is a positive probability equal to $2(1 - \mu^A(m_{\widehat{A}}))$ of exerting zero effort. Thereafter, A's mixed strategy is also a uniform distribution over the interval $\left[0, 2\mu^A(m_{\widehat{A}}) - 1\right]$.

The proof of Proposition 1 is contained in the appendix. A few features of the equilibrium described in Proposition 1 are worth noting. First, the maximum effort level of both individuals is given by $2\mu^A(m_{\widehat{A}}) - 1$, the valuation of the lower-valuing individual. This suggests, as we will see in the next section, that by instilling doubts in his student preacher $\widehat{A}$ is able to reduce the escalation of violence in the conflict. Second, the lower-valuing individual exerts zero effort with positive probability, which is decreasing in $\mu^A(m_{\widehat{A}})$; in contrast, individual B always enters the conflict. Finally, conditional upon exerting a positive effort, A adopts the same uniform distribution as B.

Using the characterization of Proposition 1, for any given s, and knowing the preacher's equilibrium message strategy, we can compute expected total effort in the conflict,

$$E(c_A + c_B; s) = (2\mu^A(m_{\widehat{A}}) - 1)\mu^A(m_{\widehat{A}}). \tag{9}$$

Not surprisingly, (9) is increasing in $\mu^A(m_{\widehat{A}})$.

We now introduce a definition that will be often used in the paper.

Definition: *A* ***total conflict*** *is defined as a conflict where the valuation for winning is 1 for both individuals.*

That is, a total conflict arises when $\mu^A(m_{\widehat{A}}) = 1$. In this case, individual A (possibly incorrectly) expects to receive zero in case of loss and one in case of victory. From the results of Proposition 1 we know that when $\mu^A(m_{\widehat{A}}) = 1$ both players enter with probability one and effort is distributed uniformly on the interval $[0, 1]$. Notice that total conflicts are particularly inefficient. In fact, both A and B expect to receive zero from a total conflict. The two individuals would then be better off if they could commit to exert zero effort and toss a coin to decide the winner.

2.2.3 Message Strategies

Depending on the underlying parameters (namely, β, γ and the initial prior of being in state θ_D) we will show (see Propositions 2 and 3) that three message strategies may occur. First, there exists a region of parameter values where the preacher reports Nature's signals in a *truthful* manner. Second, for other parameters values we obtain that $\widehat{A}$ always sends message s_{CAU} regardless of the actual signal received from Nature. In this case, we say that $\widehat{A}$ induces a *dogmatic attitude* in his student.[17] That is, $\widehat{A}$ removes any doubt from A even when the actual signal sent by Nature is noisy. Finally, there exists a third region of parameter values where $\widehat{A}$ always sends message s_{IDY} regardless of the actual signal. In this other case, we say that $\widehat{A}$ induces a *skeptical attitude* in his student.[18] That is, A is induced to doubt about the optimality of policy a even when s is perfectly informative and indicates that a is the optimal policy to adopt.

To begin with, in Lemmas 1 and 2 we compute the payoffs to $\widehat{A}$ for each message and for each Nature's signal.

[17] According to Popper (1963, p. 50), "dogmatic attitude is [...] related to the tendency to verify our laws and schemata by seeking to apply them and to confirm them, even to the point of neglecting refutations." Following the pioneering work of Rokeach (1960), the psychological literature has investigated dogmatism as a personality trait and developed various measures (such as, the Rokeach Dogmatism Scale) to assess the extent to which individuals' belief systems are open or closed.

[18] Throughout the paper we use the word skepticism to indicate an attitude of (systematic) doubt.

LEMMA 1: *Let $s = s_{CAU}$. If $\widehat{A}$ is truthful, his expected payoff is*

$$-\frac{\beta}{2}+\frac{1}{2}. \tag{10}$$

If instead $\widehat{A}$ sends the false message s_{IDY}, his expected payoff is

$$\left(2\mu^{A}\left(s_{IDY}\right)-1\right)\frac{1-\beta\left(2\mu^{A}(s_{IDY})-1\right)}{2}. \tag{11}$$

LEMMA 2: *Let $s = s_{IDY}$. If $\widehat{A}$ is truthful, his expected payoff is*

$$\left(2\mu^{A}\left(s_{IDY}\right)-1\right)\frac{1-\beta\left(2\mu^{A}\left(s_{IDY}\right)-1\right)}{2}+2\left(1-\mu^{A}\left(s_{IDY}\right)\right)\left(1-\mu^{\widehat{A}}\left(s_{IDY}\right)\right). \tag{12}$$

If instead $\widehat{A}$ sends the false message s_{CAU}, his expected payoff is

$$-\frac{\beta}{2}+\frac{1}{2}. \tag{13}$$

The proofs of Lemmas 1-2 are contained in the appendix. To understand (11) and (12), notice that from Proposition 1 we know that with probability $2\mu^{A}\left(s_{IDY}\right)-1$ individual A enters the conflict upon receiving message s_{IDY}. Conditional on A exerting a positive effort, both individuals have the same probabilities of winning. Notice that expression (12) contains an extra term compared to (11). This occurs because, whenever A exits the conflict, $\widehat{A}$ expects to obtain a positive payoff when $s = s_{IDY}$ but not when $s = s_{CAU}$. Finally, expressions (10) and (13) are the preacher's utilities of inducing A to play a total conflict. Note that the lower β, the higher the preacher's utility from a total conflict.

To understand $\widehat{A}$'s choice between sending a truthful message and sending a false message, we need to compare expression (10) with expression (11) and expression (12) with expression (13). It turns out that β is a crucial parameter in these comparisons. Proposition 2 shows that when β is above 1/2, $\widehat{A}$ may have an incentive to always send message s_{IDY} regardless of the actual s. When instead β is below 1/2, Proposition 3 shows that $\widehat{A}$ may have an incentive to always send message s_{CAU}. The intuition behind these results is the following. On the one hand, $\widehat{A}$ has an incentive to remove A's doubts about the possibility that B may be right in order to increase A's effort in the conflict. This *motivating effect* is present in our model because the preacher does not fully internalize the cost of effort of A. On the other hand, $\widehat{A}$ may want to instill doubts in A to reduce the inefficiency of the game of conflict. To understand this *moderating effect,* recall from Proposition 1 that if A has more doubts, conflicts are less violent (hence, less inefficient) because the equilibrium effort levels of *both* players decrease. The cost of instilling doubts when doubts are not justified by evidence (that is, when $s = s_{CAU}$) is that A exits the conflict with higher probability and b, which is suboptimal for A in state θ_D, is more often implemented. The preacher then chooses the message strategy that optimally solves the trade-off between, on the one hand, inducing A to enter the conflict more often but obtaining a smaller return whenever A enters the conflict and, on the other hand, making A enter less often but obtaining a larger return, conditional on A entering the conflict. The importance of the two effects depends, among other things, on β. Consider, for instance, a preacher with high β. The motivating effect is not very valuable for him because his expected payoff from a total conflict is close to zero (see Lemmas 1 and 2). Therefore, a sufficiently altruistic preacher would rather increase the expected payoff of a conflict than maximize the probability that A exerts positive effort. The converse holds true for a preacher with low β: his expected payoff from a total conflict is so large that he always prefers to maximize the probability that A enters the conflict, even at the cost of inducing a total conflict. This is why we may observe skeptical (resp. dogmatic) attitudes when β is high (resp. low).

Proposition 2 considers the case where $\widehat{A}$ is sufficiently altruistic ($1/2 \leq \beta \leq 1$). Notice that the case of perfect altruism is also included.

PROPOSITION 2: (Skepticism) *Fix γ and suppose that $1/2 \leq \beta \leq 1$. For all $P(\theta_D) \leq \overline{P}$, where*

$$\overline{P} = \frac{1}{2\beta(1-\gamma)+\gamma},$$

information transmission is truthful. When instead $P(\theta_D) > \overline{P}$, preacher $\widehat{A}$ reports s_{IDY} regardless of Nature's signal.

The message of Proposition 2 is twofold. First, it states that when β is sufficiently high, $\widehat{A}$ may have an incentive to send message s_{IDY} after all signals s. As we discussed before, instilling doubts is a defence mechanism which moderates the escalation of violence in the conflict. Second, Proposition 2 says that skeptical attitudes are observed when $P(\theta_D)$ is sufficiently large (i.e., above the cutoff $\overline{P}$). The reason behind this result is the following. Suppose that $\widehat{A}$ receives signal s_{CAU}. Then, $\mu^{\widehat{A}}(s_{CAU}) = 1$. If $P(\theta_D)$ is low, sending the false message s_{IDY} would instill a great amount of doubt in A since $\mu^{A}(s_{IDY})$ is increasing in $P(\theta_D)$. In this case, the difference between the preacher's posterior after the true signal and the student's posterior after the false message would be large and this would cause an excessive reduction of A's effort level. As a result, conditional on A exerting a positive effort, the preacher's payoff would be high, but the probability of A exerting positive effort is so low that policy b is almost always implemented. This explains why sending the false message s_{IDY} when $s = s_{CAU}$ and $P(\theta_D)$ is low is not a profitable strategy for $\widehat{A}$.

Proposition 3 discusses the case when $0 \leq \beta < 1/2$.

PROPOSITION 3: (Dogmatism) *Fix γ and suppose that $0 \leq \beta < 1/2$. For all $P(\theta_D) \leq \widehat{P}$, where*

$$\widehat{P} = \frac{1}{2(1-\beta)(1-\gamma)+\gamma},$$

information transmission is truthful. When instead $P(\theta_D) > \widehat{P}$, preacher $\widehat{A}$ always reports s_{CAU} regardless of Nature's signal.

The previous proposition establishes that when β is sufficiently low, $\widehat{A}$ may have an incentive to send message s_{CAU} after all signals s. The preacher's message confirms the student's prior even when the actual signal goes against it. As a result, individuals always engage in a total conflict. As in Proposition 2, manipulation of information occurs when $P(\theta_D)$ is sufficiently large (i.e., above the cutoff $\widehat{P}$). To see this, suppose that $P(\theta_D)$ is just above 1/2. After receiving signal s_{IDY}, preacher $\widehat{A}$ would change his view about the optimality of a and start to believe that b is the correct decision. Then, he has no incentive to send message s_{CAU}, which would induce A to enter a total conflict with the goal of imposing the "wrong" policy.

In Figure 2, for a given γ, we draw the parameter regions in the $(P(\theta_D), \beta)$ space where beliefs' manipulation occurs. As stated in Propositions 2 and 3, $\widehat{A}$ sends truthful reports when $P(\theta_D)$ is sufficiently low. When instead $P(\theta_D)$ is large, we observe either dogmatism (in the lower-right region) or skepticism (in the upper-right region). Also notice that truthful reporting is more likely to occur when β is around 1/2. From

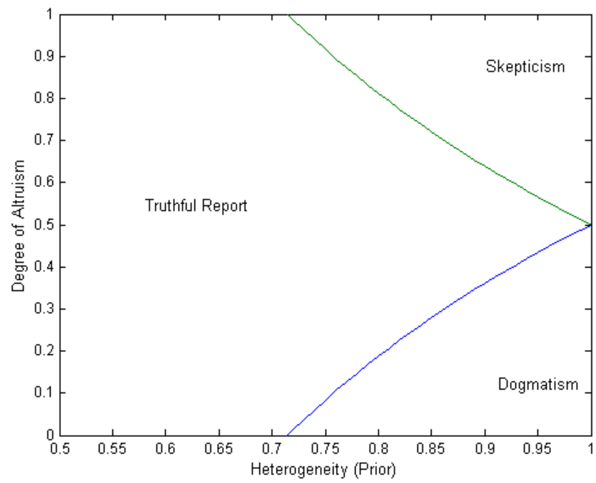

Figure 2: Beliefs Manipulation in the $(P(\theta_C), \beta)$ space with $\gamma = 0.6$

Figure 2, it is easy to observe that *ceteris paribus* an increase of β may move from the dogmatic to the truthful region. However, a large increase of β may move from the dogmatic to the skeptical region. As a result, it is unclear whether or not an increase of β provides stronger incentives to report truthfully. Finally, if Nature's signals become more precise (i.e., γ increases), it is easy to verify that both cutoffs $\widehat{P}$ and $\overline{P}$ increase, thereby reducing the incentives to manipulate beliefs. We state without proof the following Corollary.

Corollary 1: *The higher $P(\theta_D)$ and the lower γ, the stronger the incentives to manipulate signals. An increase of β has instead an ambiguous effect on the incentives to report truthfully; an increase of β reduces the incentives to induce a dogmatic attitude, but it may favor the occurrence of skeptical attitudes.*

Before concluding, we briefly discuss what would happen if A were not naive. Take the region of parameter values where truthful reports occur according to Propositions 2 and 3. It is easy to see that informative communication would also occur if A were not naive.[19] Instead, if we are in the parameter region where the preacher has an incentive to misrepresent the facts, A would ignore the message of his preacher: A's probability assessment of being in state θ_D would then coincide with his prior.

[19] Without the naivete assumption, however, there would also exist a "babbling equilibrium" for the same parameter values.

2.2.4 Incidence and Intensity of Conflict

In this section, we study how the likelihood that a conflict occurs and the total effort levels exerted in the conflict depend on the underlying parameters of our model.

First, we compute the probability that a conflict occurs (or incidence of conflict):

$$\Pr(\text{conflict}) = \begin{cases} \gamma P(\theta_D) \text{ if } P(\theta_D) \leq \frac{1}{2-\gamma}, \\ 1 \text{ if } P(\theta_D) > \frac{1}{2-\gamma}. \end{cases} \tag{14}$$

That is, the incidence of conflict has a discontinuous jump at $1/(2-\gamma)$. To understand (14), notice that for all $m_{\widehat{A}}$ we have that $\mu^A(m_{\widehat{A}}) > 1/2$ when $P(\theta_D) > 1/(2-\gamma)$. This implies that regardless of $\widehat{A}$'s message strategy, conflicts always occur when $P(\theta_D) > 1/(2-\gamma)$. When instead $P(\theta_D) \leq 1/(2-\gamma)$, one can verify from Propositions 2 and 3 that $\widehat{A}$ is truthful. Since $\mu^A(s_{IDY}) \leq 1/2$, a conflict arises only when $\widehat{A}$ sends message s_{CAU}, an event occurring with probability $\gamma P(\theta_D)$.

Note that the probability of observing a conflict does not depend on β and is increasing in $P(\theta_D)$. Since $P(\theta_D)$ is likely to be high in heterogeneous societies, this suggests that (not surprisingly) conflicts are less likely in uniform societies. This result is in line with the empirical findings of Montalvo and Reynal-Querol (2005), who find that ethnic polarization (which can viewed as a proxy of ex-ante heterogeneity) is positively correlated with the incidence of conflict.

The comparative statics with respect to γ is ambiguous. On the one hand, an increase of γ increases the incidence of conflict when $P(\theta_D)$ is low because the probability of observing signal s_{CAU} increases linearly in γ. On the other hand, an increase of γ moves up $1/(2-\gamma)$, the threshold where the incidence of conflict jumps up. This occurs because when γ is large, A enters the conflict after message s_{IDY} only for high values of $P(\theta_D)$. It is then easy to see that higher precision of Nature's signals increases (resp. decreases) the likelihood that a conflict occurs when $P(\theta_D)$ is low (resp. high). The next proposition summarizes the discussion above.

PROPOSITION 4:

(i) The incidence of conflict is increasing in $P(\theta_D)$.

(ii) The incidence of conflict does not depend on β.

(iii) Suppose that γ increases from $\underline{\gamma}$ to $\overline{\gamma}$, with $0 \leq \underline{\gamma} < \overline{\gamma} \leq 1$. Then, for all $P(\theta_D) \leq 1/(2-\underline{\gamma})$, the incidence of conflict strictly increases, while for all $P(\theta_D) > 1/(2-\underline{\gamma})$ the incidence weakly decreases.

Besides the incidence of conflict, it is worth studying its intensity. The two variables do not necessarily go together. We will see, for instance, that in homogenous societies (that is, in societies where $P(\theta_D)$ is low) peace is more likely but that, conditional on conflict occurring, conflicts are violent.

As a measure of the intensity of conflict, we compute expected total effort by taking expectations over the space of possible signals. Let $\phi(s)$ denote the probability of observing signal s, which can be derived from (3) and (4). Expected total effort is then given by

$$E(c_A + c_B) = \phi(s_{IDY})E(c_A + c_B; s_{IDY}) + \phi(s_{CAU})E(c_A + c_B; s_{CAU}). \tag{15}$$

To help intuition, we derive $E(c_A + c_B)$ for two simple cases: $\beta = 1$ and $\beta = 0$. (For the general case, see the proof of Proposition 5 in the appendix)

When $\beta = 1$, expected total effort is

$$E\left(c_A + c_B\right) = \begin{cases} \gamma P(\theta_D) \text{ if } P(\theta_D) \leq \frac{1}{2-\gamma}, \\ (2\mu^A\left(s_{IDY}\right) - 1)\mu^A\left(s_{IDY}\right) \text{ if } P(\theta_D) > \frac{1}{2-\gamma}. \end{cases} \tag{16}$$

Knowing that $\mu^A\left(s_{IDY}\right)$ coincides with (5), in the right panel of Figure 3 we draw expected total effort as a function of $P(\theta_D)$. To understand (16), recall from the previous discussion that when $P(\theta_D) \leq 1/(2-\gamma)$ a conflict occurs only when s_{CAU} is observed. With probability $\gamma P(\theta_D)$ expected total effort is then equal to one. When instead $P(\theta_D) > 1/(2-\gamma)$ from Proposition 2 we know that the preacher has an incentive to send message s_{IDY} regardless of the signal he has received; expected effort when the message is s_{IDY} can be derived from (9). Figure 3 shows that the intensity of conflict is not monotone in $P(\theta_D)$.[20]

Suppose instead that $\beta = 0$. Then,

$$E\left(c_A + c_B\right) = \begin{cases} \gamma P(\theta_D) \text{ if } P(\theta_D) \leq \frac{1}{2-\gamma}, \\ 1 \text{ if } P(\theta_D) > \frac{1}{2-\gamma}. \end{cases} \tag{17}$$

To understand (17), recall from Proposition 3 that when $P(\theta_D) > 1/(2-\gamma)$ the preacher has an incentive to send message s_{CAU} regardless of the signal he has received.

In Proposition 5, we study how expected total effort varies with the parameters of the model.

[20] Notice that the non-monotonicity result would also hold if A is not naive. In this case, when $P(\theta_D) > 1/(2-\gamma)$ the student ignores the message of his preacher. By replacing $\mu^A\left(s_{IDY}\right)$ with the prior $P(\theta_D)$ in expression (16), one can verify that the intensity of conflict drops at $1/(2-\gamma)$.

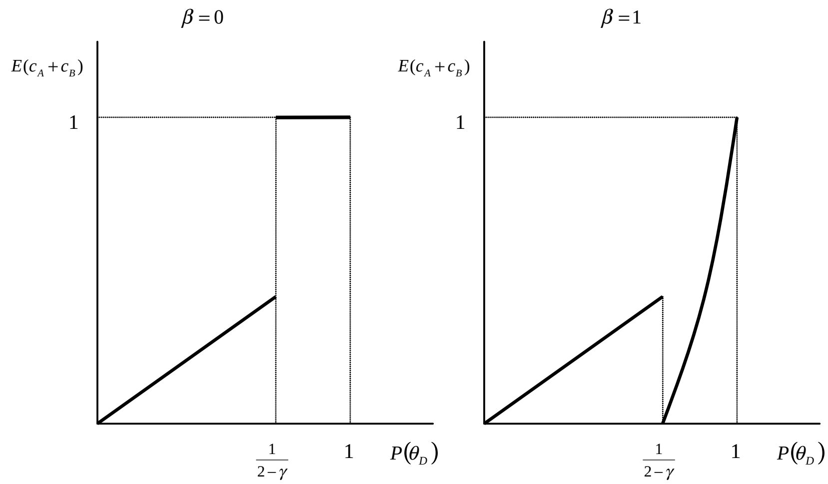

Figure 3: Expected Total Effort when $\beta = 0$ (Left Panel) and $\beta = 1$ (Right Panel).

PROPOSITION 5:

(i) *The intensity of conflict is weakly increasing in* $P(\theta_D)$ *when* $\beta < 1/2$ *and non-monotone in* $P(\theta_D)$ *when* $\beta \geq 1/2$.

(ii) The intensity of conflict is decreasing in β.

(iii) Suppose that γ *increases from* $\underline{\gamma}$ *to* $\overline{\gamma}$, *with* $0 \leq \underline{\gamma} < \overline{\gamma} \leq 1$. *Then, the intensity of conflict strictly increases when* $P(\theta_D) \leq 1/(2 - \underline{\gamma})$ *and weakly decreases when* $P(\theta_D)$ *is close to one.*

The proof of Proposition 5 is contained in the appendix. The second part of result (i) is in line with recent empirical evidence that studies the consequences of ethnic heterogeneity on the duration of civil wars, which can be viewed as a proxy of the effort levels exerted by the two parties in the conflict. For example, Montalvo and Reynal-Querol (2007) and Collier *et al.* (2004), find that ethnicity has a nonlinear effect on the duration of civil wars: the duration of a conflict is at its maximum for intermediate values of ethnic heterogeneity.

2.3 Dogmatism and Mistakes

Proposition 3 shows that dogmatism leads to violent conflicts by distorting the effort decision of A. However, it is important to stress that in the previous sections we obtained that dogmatism does not distort the final policy decision. In other words, the decision that A makes at $t = 2$ on the basis of $m_{\widehat{A}}$ is the same that he would make if he knew the true signal. This result occurs because $\widehat{A}$ does not disagree with his student on the correct policy to implement in each state and, as a result, he does not manipulate information to the point of inducing the wrong policy decision in the final stage. However, besides causing violent conflicts, one would expect dogmatism to also lead to distorted policy decisions. A simple extension of the previous setup would capture this cost as well.

In this section, we suppose that A is able to conduct autonomous research in order to find out the current state of the world. This possibility will be used only when A receives message s_{IDY}. This assumption seems quite natural. In fact, after receiving message s_{CAU}, A has no doubts that the state is θ_D. Therefore, from A's perspective, autonomous research is not needed.

More precisely, the timing is now as follows. As before, at $t = 0$ preacher $\widehat{A}$ observes evidence $s \in \{s_{CAU}, s_{IDY}\}$ and sends a message to A. If $\widehat{A}$ sends message s_{CAU}, the game unfolds exactly as before. If instead $\widehat{A}$ sends message s_{IDY}, we now assume that individual A is able, if he decides so, to conduct costless research in order to discover the current state. For the sake of tractability, we also assume that research is not manipulable by A himself. With probability $\pi \in [0, 1]$ research is successful and A is able to *perfectly* observe the actual state of the world. With complementary probability $1 - \pi$, research is not successful (NS denotes unsuccessful research). Let $\mu^A(s_{IDY}, NS)$ denotes the posterior probability of individual A after receiving message s_{IDY} and after unsuccessful research. The probability of success is independent from θ. To simplify the analysis, we assume that B observes $m_{\widehat{A}}$ as well as the research outcome. As before, at $t = 1$ individuals simultaneously choose the effort levels in the conflict and the final decision is made at $t = 2$.

We now study whether the possibility of autonomous research affects the message strategy of the preacher. First, it is easy to see that regardless of the true signal, the expected utility of the preacher after sending message s_{CAU} is, as in Lemmas 1 and 2, equal to

$$-\frac{\beta}{2} + \frac{1}{2}. \tag{18}$$

(Recall that after message s_{CAU} we assumed that the student does not do research.) In Lemma 3, we compute the payoffs to $\widehat{A}$ of sending message s_{IDY}. Does A decide to conduct autonomous research after receiving s_{IDY}? It turns out (see the proof of Proposition 6) that A is indifferent between conducting and not conducting research; in

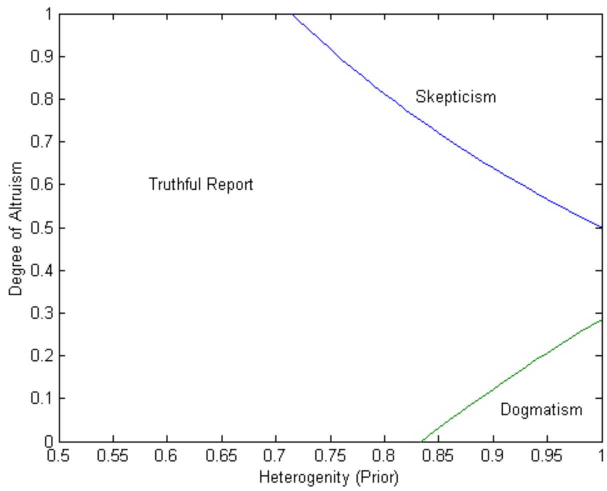

Figure 4: Beliefs Manipulation with Autonomous Research ($\pi = 0.4, \gamma = 0.6$)

what follows we will assume that A, upon receiving message s_{IDY}, does indeed conduct autonomous research.

LEMMA 3: *Let $s = s_{CAU}$. If $\widehat{A}$ sends the false message s_{IDY}, his expected payoff is:*

$$(1-\pi)\left(2\mu^A\left(s_{IDY}, NS\right) - 1\right)\frac{1-\beta(2\mu^A\left(s_{IDY}, NS\right) - 1)}{2} + \pi\frac{1-\beta}{2}. \tag{19}$$

Suppose instead that $s = s_{IDY}$. If $\widehat{A}$ is truthful, his expected payoff is:

$$(1-\pi)\left[\left(2\mu^A\left(s_{IDY}, NS\right) - 1\right)\frac{1-\beta(2\mu^A\left(s_{IDY}, NS\right) - 1)}{2} + 2(1-\mu^A\left(s_{IDY}, NS\right))^2\right] + \\ +\pi\left[\mu^A\left(s_{IDY}\right)\frac{(1-\beta)}{2} + 1 - \mu^A\left(s_{IDY}\right)\right]. \tag{20}$$

The proof of Lemma 3 is contained in the appendix. To find out the equilibrium message strategy of the preacher, it is instructive to consider the extreme cases of $\pi = 0$ and $\pi = 1$. It is straightforward to see that when $\pi = 0$ the setup analyzed here is identical to the one analyzed in the previous sections: the message strategies are then exactly the same as in Propositions 2 and 3. Consider instead the other extreme: $\pi = 1$. Does $\widehat{A}$ have an incentive to send message s_{CAU} when $s = s_{IDY}$? It is easy to see, by comparing (20) to (18), that when $\pi = 1$ the answer is negative:

inducing A to conduct research when $s = s_{IDY}$ is strictly preferable to sending message s_{CAU}. To understand this result, notice that if the student discovers that the state is θ_1, the preacher obtains a payoff equal to 1, which is strictly greater than the payoff of sending message s_{CAU}. If instead A discovers that the current state is θ_D, the preacher obtains the same payoff that he would have obtained by sending the false message s_{CAU}. Therefore, dogmatism never arises when $\pi = 1$. Figure 4 draws the message strategies in the $(\beta, P(\theta_D))$ space for an intermediate value of π. One can see that dogmatism is still observed when β is sufficiently low and $P(\theta_D)$ sufficiently large, but that the region of parameter values where dogmatism occurs has shrunk compared to Figure 2. Overall, these results suggest that in societies where research is likely to be successful, it is more difficult to observe dogmatic attitudes.

It is interesting to note that the incentives to induce skeptical attitudes are *not* affected by π. To see this, it is enough to observe that (19) is greater than (18) if and only if (11) is greater than (10). This implies that the region of parameter values where skepticism occurs is identical to the one characterized in Proposition 2.

Proposition 6 describes the message strategies when A is allowed to conduct autonomous research.

PROPOSITION 6: *Suppose* $1/2 \leq \beta \leq 1$. *For all* $\pi \in [0, 1]$ *the parameters where we observe skeptical attitudes are the same ones that we have characterized in Proposition 2. Suppose instead that* $0 \leq \beta < 1/2$. *The incentives to induce dogmatic attitudes are weaker when* π *is positive. In particular, there exists a level of research effectiveness* $\widetilde{\pi} < 1$, *which depends on* $\beta, P(\theta_D)$ *and* γ, *such that for all* $\pi > \widetilde{\pi}$ *the preacher is truthful.*

Since dogmatism sometimes prevents A from conducting potentially successful research, Proposition 6 establishes that when π is sufficiently low, dogmatism, besides leading to violent conflicts, may induce A to make wrong policy decisions. Clearly, these mistakes could have been avoided if information had been truthfully transmitted.

2.4 Dynamics

We now consider a simple dynamic extension to the model with autonomous research that we analyzed in the previous section. To understand what follows, it helps to remind the reader that in our static model the incentives to misrepresent (in either way) the facts are decreasing in γ and that the incentives to induce dogmatic attitudes are decreasing in π (see Corollary 1 and Proposition 6, respectively).

Let τ denote the time, where $\tau = 1, 2, ..., \infty$.[21] Consider an OLG model where A-type and B-type individuals live for two periods. When they are young, individuals exert effort in a conflict; when they are old, they become preachers (or parents). We denote by A_τ (resp. B_τ) the A-type (resp. B-type) individual that was born at time τ. At each τ the active players in the model are A_τ, $A_{\tau-1}$ and B_τ.[22] Individual A_τ is associated to $A_{\tau-1}$, a preacher that was born at time $\tau - 1$. At each τ, Nature draws the current state of the world θ_τ. We suppose that draws are i.i.d. across time. Preacher $A_{\tau-1}$ observes evidence $s_\tau \in \{s_{CAU}, s_{IDY}\}$ (as before, its precision is summarized by γ_τ) and sends a message to A_τ. Nature's signals are also assumed to be i.i.d. across time. As in Section 2.3, after message s_{IDY} individual A_τ conducts autonomous research which is successful with probability π_τ. After receiving a message from $A_{\tau-1}$ and after observing the research's outcome, individuals A_τ and B_τ play a game of conflict in order to choose the policy to implement at time τ, which is denoted by x_τ. We assume that individual A_τ is naive when he is young; when he is old, he becomes aware that his student is naive towards him. The two-period utility of a young individual of type i (where $i = A, B$) that was born at time τ is

$$U^{i,\tau} = -c_{i,\tau} + u_i(x_\tau, \theta_\tau) - \beta c_{i,\tau+1} + u_i(x_{\tau+1}, \theta_{\tau+1}). \tag{21}$$

We use the notation $\mathbf{1}_\tau$ to denote an indicator function that takes the value 1 if A_τ conducts autonomous research at time τ, and 0 otherwise. Let denote by $\gamma_{\tau+1}(j)$ and $\pi_{\tau+1}(j)$ the values of, respectively, $\gamma_{\tau+1}$ and $\pi_{\tau+1}$ if at time τ we had $\mathbf{1}_\tau = j$, with $j = 0, 1$. For instance, $\gamma_{\tau+1}(1)$ denotes the precision of Nature's signal at time $\tau + 1$ if at time τ individual A_τ conducted autonomous research. We suppose that γ_τ and π_τ, the state variables of our model, evolve over time as follows.

Assumption 1: *Assume that* (i) $\pi_\tau(1) > \pi_\tau(0)$ *and* $\gamma_\tau(1) \geq \gamma_\tau(0)$; (ii) *If* $\mathbf{1}_{\tau-1} = 0$, *we have that* $\gamma_\tau = \gamma_{\tau-1}$ *and* $\pi_\tau = \pi_{\tau-1}$; (iii) $\lim\limits_{\tau\to\infty} \gamma_\tau(1) = 1$.

The first part of Condition (i) of Assumption 1 is crucial for our dynamics. It requires that if a young student conducts autonomous research at time $\tau - 1$ the

[21] The assumption that the horizon is infinite is not essential, but will be used for some limiting results.

[22] Individual $B_{\tau-1}$ is alive at time τ but, as in the previous sections, he is not an active player because B_τ does not need to be informed.

effectiveness of research at time τ strictly increases. The underlying assumption is that the act of doing research increases the stock of research instruments (such as, libraries, books, theorems, oral traditions) available to future generations, thereby making future research more effective.[23] The second part of Condition (i) requires that if a young student does autonomous research when is young, he becomes (weakly) more capable of extracting precise signals when he becomes a preacher. According to Condition (ii), $\gamma_{\tau+1}$ and $\pi_{\tau+1}$ stay constant if A_τ does not conduct research. To some extent, this amounts to assuming no depreciation of the stock of research instruments. Condition (iii), which is only needed for a limiting result, requires that Nature's signals become fully informative in the limit as individuals keep conducting research.

The assumption that Nature's draws of the state are i.i.d. across time allows us to avoid the possible complexities of introducing learning into our model: at each τ the prior probability of being in a state of disagreement is constant and equal to $P(\theta_D)$. Moreover, for tractability, we also assume that individuals at time τ do not take into account the consequences of their decisions on $\gamma_{\tau+1}$ and $\pi_{\tau+1}$. This implies that the problem of a young individual at time τ is essentially a static problem. Consequently, in each period, the message strategies and the effort decisions are exactly the ones described in Proposition 6. However, since by Assumption 1 the state variables evolve, the preacher's incentives change over time.

Given our modeling assumptions, solving for the dynamics is straightforward. First, it is easy to show that dogmatic attitudes are persistent. Suppose in fact that at time $\tau = 1$ the parameters of the model (i.e., β, $P(\theta_D)$, γ_1 and π_1) are such that A_0 induces dogmatic attitudes in A_1. Then, no autonomous research is conducted at time $\tau = 1$ and by Assumption 1 all parameters stay constant. Then, A_1 will also induce dogmatic attitudes in A_2; and so on for all τ. This result suggests that societies may be trapped in a dogmatic equilibrium.

Suppose instead that the initial parameters are such that A_0 is truthful. It is equally easy to show that truthful reporting is also an absorbing state. Two cases must be considered. First, suppose that $s_1 = s_{CAU}$. In this case, A_1 truthfully reports s_{CAU} and no research is conducted. Since parameters do not change (see Assumption 1), in the next period A_1 will still be truthful. Second, suppose that $s_1 = s_{IDY}$. In this case, research will be conducted. By Assumption 1, this implies that $\pi_2 > \pi_1$ and $\gamma_2 \geq \gamma_1$. From Corollary 1 and Proposition 6 we know that an increase of π and γ

[23] Note that this is independent of whether the research was successful.

will reinforce A_1's incentives to be truthful at $\tau = 2$. Following a similar argument, we obtain that for all $\tau > 2$ preachers will also be truthful.

Finally, suppose that at $\tau = 1$ the parameters are such that A_0 always sends message s_{IDY}. In particular, from Proposition 2 we know that this occurs if $\beta \geq 1/2$ and

$$P(\theta_D) > \frac{1}{2\beta(1-\gamma_1)+\gamma_1}. \tag{22}$$

In what follows, we will show that at $\tau = 2$ we may observe either truthful reporting or, as it occurred at $\tau = 1$, skeptical attitudes. To see this, notice that since A_1 conducts research at $\tau = 1$, by Condition (i) we have that $\gamma_2 \geq \gamma_1$. Two cases are possible. First, at $\tau = 2$ it could be that

$$P(\theta_D) \leq \frac{1}{2\beta(1-\gamma_2)+\gamma_2}. \tag{23}$$

In this case, from Proposition 2 we know that A_1 sends truthful reports. From the discussion above we also know that truthful reports will be observed for all $\tau > 2$. The other possibility is that (23) is not satisfied. In this case, A_1 induces skeptical attitudes, A_2 conducts research and $\gamma_3 \geq \gamma_2$. This increases the cutoff at time 3, thereby making the transition to truthful reporting more likely. If Condition (iii) is also satisfied, γ_τ goes eventually to 1. Then, at some date τ in the future the prior $P(\theta_D)$ of our economy will necessarily lie below the corresponding τ-cutoff, thereby implying that after observing skeptical attitudes for several periods preachers will start being truthful. The above discussion is summarized in the following proposition.

PROPOSITION 7: *Suppose that γ_τ and π_τ evolve according to Conditions (i) and (ii) of Assumption 1. Then, truthful reporting and dogmatism are two absorbing states. That is, if the parameters are such that at time τ dogmatism (resp. truthful reporting) is observed, at time $\tau+1$ dogmatism (resp. truthful reporting) will also be observed. If instead at time τ preacher $A_{\tau-1}$ induces skeptical attitudes in A_τ, at time $\tau+1$ preacher A_τ may either keep inducing skeptical attitudes in $A_{\tau+1}$ or be truthful. If Condition (iii) is also satisfied, we obtain that as $\tau \to \infty$ skepticism will eventually be replaced by truthful reporting.*

An implication of Proposition 7 is that societies will be able to escape from a dogmatic-trap only if a large shock occurs, such as an increase of π_τ due, for example, to the opening of the society, which would provide access to more research instruments.

3. Interdependent Beliefs' Manipulation.

This section considers a slightly different setup from the one analyzed in Section 2. Take the basic (static) model analyzed in Section 2.1 without autonomous research and assume that $\Omega = \{\theta_1, \theta_2, \theta_D\}$, where θ_2 is another state of agreement. The following matrix summarizes the preferred policies by each individual in each state:

	A's optimal policy	B's *optimal policy*
θ_1	b	b
θ_2	a	a
θ_D	a	b

The payoffs to A and B in states θ_1 and θ_D are as before. In state θ_2, policy a is optimal for both individuals:

$$\begin{aligned} u_A(a, \theta_2) &= u_B(a, \theta_2) = 1 \\ u_A(b, \theta_2) &= u_B(b, \theta_2) = 0 \end{aligned}$$

Assume that ex-ante states θ_2 and θ_1 are equally likely: that is, $P(\theta_1) = P(\theta_2)$. As before, $P(\theta_D) \in (1/2, 1)$. Notice that in contrast to before, individual B is not ex-ante certain that policy b is the right policy for him. In this section, we assume that B is also associated to a preacher, $\widehat{B}$, whose role is to advice B. The utility of $\widehat{B}$ is

$$U^{\widehat{B}}(c_B, x, \theta) = -\beta c_B + u_B(x, \theta). \tag{24}$$

Nature sends a common signal to both preachers and both preachers will send a message to their respective students. This implies that besides the strategic interdependence in the game of conflict, there will be strategic interdependence between the advisors' message strategies.

The timeline is as follows. At $t = 0$, Nature sends to both preachers a *common* signal $s \in \{s_{CAU}, s_{IDY}\}$ which is (not necessarily fully) informative about the current state $\theta \in \{\theta_1, \theta_2, \theta_D\}$. To keep the model as tractable as possible, we maintained the assumption that there are only two possible signals. The information structure is as follows:

$$P(s_{CAU} \mid \theta_1) = 0 \text{ and } P(s_{IDY} \mid \theta_1) = 1,$$

$$P(s_{CAU} \mid \theta_2) = 0 \text{ and } P(s_{IDY} \mid \theta_2) = 1,$$

$$P(s_{CAU} \mid \theta_D) = \gamma \text{ and } P(s_{IDY} \mid \theta_D) = 1 - \gamma.$$

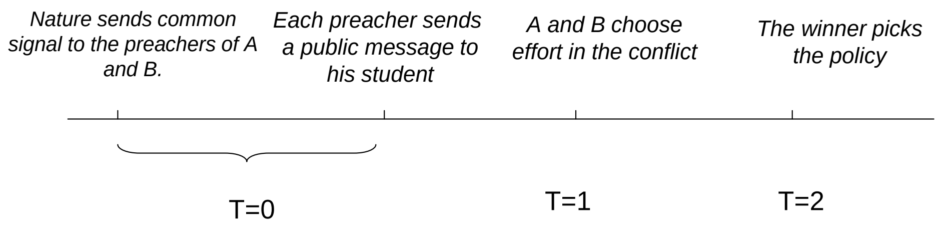

Figure 5: Timeline in the Model with two "Preachers"

Notice that upon receiving signal s_{IDY} the posterior probability of being in the state of conflict decreases. However, signal s_{IDY} does not favor one state of agreement relatively to the other. As a result, the posterior probabilities of being in state θ_1 and θ_2 will be equal. After receiving a signal from Nature, each preacher $\widehat{i}$ sends a message $m_{\widehat{i}} \in \{s_{CAU}, s_{IDY}\}$. As before, we assume that messages are public and that each student is naive *vis-à-vis* his own preacher. At the same time, we assume that each individual knows that his opponent is naive and that the other preacher may not tell the truth. In other words, each individual believes that the relationship with his own preacher is unique: in a student's mind only the other preacher, not his own, may misreport the facts. This perception bias implies that the two individuals will, in general, end up with different posteriors and "agree to disagree" about the probability of the current state. After receiving the message of his preacher each individual forms his posterior belief. The message of the other preacher is also observed. The posterior probability of individual i of being in state θ_D after receiving $m_{\widehat{i}}$ is denoted by $\mu^i\left(m_{\widehat{i}}\right).$ At this point, it is practical to introduce some further notation. Let $\chi^A(m_{\widehat{A}})$ denote the posterior probability of individual A that policy a is the correct policy to adopt when $\widehat{A}$'s message is $m_{\widehat{A}}$. This is given by

$$\chi^A(m_{\widehat{A}}) = \mu^A(m_{\widehat{A}}) + \frac{1-\mu^A(m_{\widehat{A}})}{2}.$$

The first term is the posterior probability that the state is θ_D while the second term is the posterior probability that the state is θ_2. Further, let $\chi^B\left(m_{\widehat{B}}\right)$ denote the posterior probability of individual B that policy b is the correct policy. Similarly, one obtains

$$\chi^B\left(m_{\widehat{B}}\right) = \mu^B\left(m_{\widehat{B}}\right) + \frac{1-\mu^B\left(m_{\widehat{B}}\right)}{2}.$$

The first term is the posterior probability that the state is θ_D while the second term is the posterior probability that the state is θ_1.

It is obvious that upon receiving message s_{CAU}, for individual $i = A, B$ we have that $\chi^i(s_{CAU}) = 1$. If instead i receives message s_{IDY},

$$\chi^i(s_{IDY}) = \frac{2P(\theta_D)(1-\gamma) + 1 - P(\theta_D)}{2\left(1 - P(\theta_D)\right) + 2P(\theta_D)(1-\gamma)}. \tag{25}$$

It is important to notice that since $P(\theta_D) > 1/2$, we have that $\chi^A(m_{\widehat{A}})$ and $\chi^B\left(m_{\widehat{B}}\right)$ are both greater than 1/2. This implies that the conditionally optimal policy (i.e., the policy that an individual picks in the final period) does *not* depend on the message he has received. In other words, receiving either message s_{CAU} or s_{IDY} only affects the confidence that A (resp. B) has in the optimality of policy a (resp. b). However, no message can ever induce A to choose policy b or B to choose policy a.

3.1 Equilibrium Characterization

3.1.1 Policy Decisions

We solve the game backwards; we start by finding the policy decisions at $t = 2$. As discussed above, since $\chi^A(m_{\widehat{A}})$ and $\chi^B\left(m_{\widehat{B}}\right)$ are both greater than 1/2, regardless of the messages:

$$D_A(m_{\widehat{A}}) = a \text{ for all } m_{\widehat{A}},$$

$$D_B(m_{\widehat{B}}) = b \text{ for all } m_{\widehat{B}}.$$

Notice that since each individual expects the opponent to choose a different policy from the one that he prefers, a conflict always arises.

3.1.2 The Game of Conflict

We now move to the game of conflict. The characterization of the effort decisions is provided by the following proposition. Without any loss of generality suppose that $\chi^A(m_{\widehat{A}}) \leq \chi^B\left(m_{\widehat{B}}\right)$. That is, A is the lower-valuing individual.

PROPOSITION 8: *(Hillman and Riley, 1988) The equilibrium cumulative distribution functions of effort levels of A and B are, respectively,*

$$G_B(c_A) = \frac{c_A}{2\chi^A(m_{\widehat{A}}) - 1},$$

and

$$G_A(c_B) = 1 - \frac{2\chi^A(m_{\widehat{A}}) - 1}{2\chi^B\left(m_{\widehat{B}}\right) - 1} + \frac{c_B}{2\chi^B\left(m_{\widehat{B}}\right) - 1}.$$

This implies that for individual B the mixed strategy is a uniform distribution over the interval $\left[0, 2\chi^A(m_{\widehat{A}}) - 1\right]$. For A there is a positive probability equal to

$$1 - \frac{2\chi^A(m_{\widehat{A}}) - 1}{2\chi^B\left(m_{\widehat{B}}\right) - 1}$$

of exerting zero effort. Thereafter, A's mixed strategy is a uniform distribution over the interval $\left[0, 2\chi^A(m_{\widehat{A}}) - 1\right]$.

The proof of Proposition 8 is identical to the one of Proposition 1; it is therefore omitted. Similarly to Proposition 1, notice that for both individuals the maximum effort level is identical and equal to the valuation of the individual with higher stakes in the conflict. Moreover, the lower-valuing individual enters the conflict with probability less than one; this probability is equal to the ratio between his valuation and the valuation of the higher valuing individual. This implies that an increase of the valuation of the higher-valuing individual would not affect the effort level of that individual; it would only induce the other opponent to exert less effort. This suggests that inducing dogmatic attitudes, besides having a motivation effect, has here also a *preempting effect*. This effect was not present before because in Section 2 the valuation of the higher-valuing individual (i.e., B) was not manipulable and because A's valuation could not exceed B's valuation. In this section instead, the two players are ex-ante symmetric. This implies, as we will see, that one preacher may induce a dogmatic attitude to make his student the individual with the highest stakes in the conflict in order to preempt the other player.

3.1.3 Message Game

It is quite easy to show that it is not possible to have an equilibrium where both preachers send truthful reports. By way of contradiction, suppose for instance that Nature sends signal s_{IDY}. Do preachers report truthfully? If this were the case, by the assumed symmetry of our setting, both individuals would enter the conflict with the same amount of doubts. Notice, however, that one of the two preachers would have an incentive to remove doubts in his student so as to make his student the high-valuation individual in the conflict. In fact, from Proposition 8 we know that inducing dogmatism when the opponent has doubts induces the opponent to further decrease his effort level, without affecting the effort exerted by the dogmatic student. Contrary

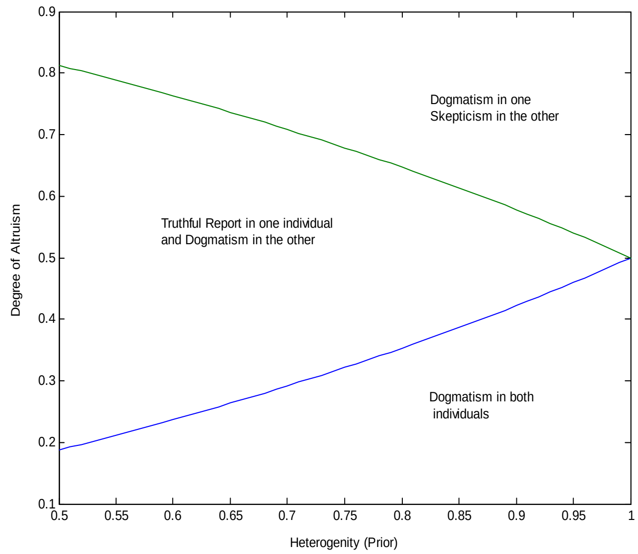

Figure 6: Equilibrium in the Model with two Advisors.

to the motivating effect discussed in Section 2, this effect is present regardless of the preacher's altruism parameter. After arguing that one of the two preachers always induces a dogmatic attitude, the incentives to manipulate information of the other preacher are practically identical to the ones discussed in Section 2. We now state Proposition 9.

PROPOSITION 9: *Suppose $0 \leq \beta < 1/2$. For all $P(\theta_D) \leq \widehat{C}$, where*

$$\widehat{C} = \frac{\beta}{1 - \gamma - \beta(1 - 2\gamma)},$$

one preacher reports truthfully while the other always reports s_{CAU}. When $P(\theta_D) > \widehat{C}$, both preachers always report s_{CAU} regardless of the signal. Suppose instead that $1/2 \leq \beta \leq 1$. For all $P(\theta_D) \leq \overline{C}$, where

$$\overline{C} = \frac{1 - \beta}{\gamma + \beta(1 - 2\gamma)},$$

one preacher reports truthfully while the other always reports s_{CAU}. When $P(\theta_D) > \overline{C}$, one preacher reports s_{IDY} regardless of the signal, while the other always reports s_{CAU}.

The proof of Proposition 9 is contained in the appendix. See Figure 6. Notice that dogmatic attitudes in both opponents can only be observed if preachers' altruism is low. When altruism is high, one of the two preachers will choose to always instill doubts. As a result, even if the starting game is symmetric, the distribution of payoffs is asymmetric: the dogmatic individual obtains, in expected terms, a higher payoff than the skeptical one.

4. Conclusions

Karl Popper (1963), who is cited at the beginning of the paper, argues that conflicts will be less violent if individuals entertain the possibility that their opponent may be right. Why is it so difficult to observe this attitude? To answer this question, this paper considered a model of indoctrination where altruistic advisors (such as, preachers or parents), after receiving signals from Nature, send (possibly distorted) messages to the participants in the conflict. In the context of our model, we have shown that there exist two possible deviations from an attitude of reasonableness. In some cases, as a result of indoctrination, individuals never doubt about the possibility of being wrong, although all available information suggests otherwise. In other cases, some individuals are excessively reasonable: they believe that their opponent may be right even when all the evidence indicates beyond any doubt that the policy preferred by the opponent is suboptimal. The common feature in both cases is that information is distorted, although in different directions.

A brief summary of our results is the following:

(i) Manipulation of information (in both directions) is more likely to occur in heterogenous societies, when Nature's signals are less informative, and when research is less likely to be successful.

(ii) Dogmatic attitudes in both opponents are observed if (and only if) advisors' altruism is low. In this case, advisors remove doubts in their students to motivate them and also to preempt the opponent. When instead altruism is perfect, we obtain that one of the two opponents is induced by his advisor to always doubt. Instilling doubts is a defence mechanism which moderates the escalation of violence in the conflict.

(iii) Conflicts are more likely in heterogenous societies. However, the intensity of conflict is not necessarily at its maximum in very heterogeneous societies.

(iv) Dogmatism and truthful reporting are persistent over time. On the contrary, skeptical attitudes are less likely to persist in the long-run.

An extension of this model seems particularly worthy: to look at the role of institutions in affecting beliefs' manipulation. Virtually all the extant literature on optimal institutions has taken as given the degree of ideological polarization in the society. It would be interesting to study optimal constitutional design by taking into account that institutions, by changing the way conflicts are resolved in a legislature or in the society, may also affect the degree of ideological polarization.

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PROOF OF PROPOSITION 1

Suppose $\mu^A\left(m_{\widehat{A}}\right) < 1$. We first show that the equilibrium expected payoff of B is strictly positive. To see this, notice that A will never exert an effort level higher than his valuation, $2\mu^A\left(m_{\widehat{A}}\right) - 1$. This implies that B can guarantee for himself a strictly positive payoff by exerting an effort level just above $2\mu^A\left(m_{\widehat{A}}\right) - 1$.

We now show that the effort strategies of both players are mixed, with no mass points for all $c_i > 0$. By way of contradiction, suppose that player j has a mass point at a particular bid c_j. Then, the payoff of the other player would increase discontinuously at c_j. It then follows that there is a $\varepsilon > 0$ such that the other player exerts effort on the interval $[c - \varepsilon, c]$ with zero probability. However, if this were the case, j would increase his payoff by bidding $c_j - \varepsilon$ instead of c_j.

We now show that the maximum effort level of the two players is the same. To see this, notice that since the effort strategies are mixed, if one individual has a maximum effort level, the other individual would win with probability one by just exerting that effort level.

We now show that the minimum effort level is zero. By way of contradiction, suppose that an individual has a minimum effort level $\underline{c} \in \left(0, 2\mu^A(m_{\widehat{A}}) - 1\right]$. Then the other player does not exert effort in the interval $[0, \underline{c})$ because by doing so he would lose with probability one. But this implies that the first individual would rather exert an effort level lower than $\underline{c}$.

Individual B's expected payoff from exerting effort c_B is

$$EU^B = G_A(c_B) - c_B,$$

while A's expected payoff from exerting effort c_A is

$$EU^A = \left(1 - \mu^A\left(m_{\widehat{A}}\right)\right) + G_B(c_A)\left(2\mu^A\left(m_{\widehat{A}}\right) - 1\right) - c_A.$$

Noticing that B must be indifferent among all the effort levels in the set and recalling that the equilibrium expected payoff for B is strictly positive, we evaluate EU^B when $c_B = 0$. It follows that $G_A(0) > 0$.

We now show that B cannot put positive mass at zero. If this were the case, there would be a tie with some positive probability. But B would be better off increasing his effort just above zero. This implies $G_B(0) = 0$ and A's expected payoff is $1 - \mu^A\left(m_{\widehat{A}}\right)$. Then,

$$G_B(c_A) = \frac{c_A}{2\mu^A\left(m_{\widehat{A}}\right) - 1}.$$

When B's effort is $2\mu^A\left(m_{\widehat{A}}\right)-1$,

$$EU^B = G_A(2\mu^A\left(m_{\widehat{A}}\right)-1)-(2\mu^A\left(m_{\widehat{A}}\right)-1),$$

or

$$EU^B = 1-(2\mu^A\left(m_{\widehat{A}}\right)-1).$$

Then,

$$G_A(c_B) = 1-(2\mu^A\left(m_{\widehat{A}}\right)-1)+c_B.$$

This concludes the proof of Proposition 1. $\square$

PROOF OF LEMMA 1: Recall that if $m_{\widehat{A}} = s_{CAU}$ a total conflict occurs. In this case, from Proposition 1 we know that the expected effort exerted by A is equal to $1/2$. To explain the first term of (10), recall that in $\widehat{A}$'s utility the effort exerted by A is multiplied by β. To explain the second term of (10), note that in a total conflict both players win with equal probabilities. Since $s = s_{CAU}$, $\widehat{A}$ obtains a payoff equal to one if A wins and zero if B wins.

To understand (11), recall from Proposition 1 that after receiving message s_{IDY}, A enters the conflict with probability $\left(2\mu^A\left(s_{IDY}\right)-1\right)$. Conditional on A exerting positive effort, his expected effort cost is

$$-\frac{2\mu^A\left(s_{IDY}\right)-1}{2}. \tag{26}$$

Conditional on A exerting a positive effort, both individuals have equal probabilities of victory and $\widehat{A}$'s expected gain from the conflict is $1/2$. With complementary probability $2\left(1-\mu^A\left(s_{IDY}\right)\right)$, individual A exerts no effort, B picks policy b, and, consequently, the payoff to $\widehat{A}$ is zero. $\square$

PROOF OF LEMMA 2: Compared to (11), expression (12) includes a second term. To understand this term, note that when A exits the conflict, B chooses policy b, which is optimal for A with probability $1-\mu^{\widehat{A}}\left(s_{IDY}\right)$.

We now explain (13). Suppose that $\widehat{A}$ induces A to start a total conflict by sending the false message s_{CAU} when $s = s_{IDY}$. The first term of (13) coincides with the first term of (10). To explain why the second terms of (10) and (13) also coincide, note that $\widehat{A}$'s expected gain from a total conflict when $s = s_{IDY}$ is

$$\frac{\mu^{\widehat{A}}\left(s_{IDY}\right)}{2}+\frac{1-\mu^{\widehat{A}}\left(s_{IDY}\right)}{2}, \tag{27}$$

which is equal to 1/2. To understand (27) note that with probability 1/2 player A wins and implements policy a, which gives $\widehat{A}$ an expected payoff equal to $\mu^{\widehat{A}}(s_{IDY})$. With probability 1/2 player B wins and implements policy b, which gives $\widehat{A}$ an expected payoff equal to $1-\mu^{\widehat{A}}(s_{IDY})$. $\square$

PROOF OF PROPOSITION 2

Step 1: *When*

$$P(\theta_D) \leq \frac{1}{2-\gamma},$$

$\widehat{A}$ is truthful.

Proof of Step 1: Two cases must be considered. First, suppose that $s = s_{IDY}$. Using Bayes' Rule, we obtain that

$$\mu^{\widehat{A}}(s_{IDY}) = \frac{P(\theta_D)(1-\gamma)}{1-P(\theta_D)+P(\theta_D)(1-\gamma)}.$$

If the condition in the statement of Step 1 is satisfied, this implies that $\mu^{\widehat{A}}(s_{IDY}) \leq 1/2$. Suppose that $\widehat{A}$ is truthful and sends message s_{IDY}. Then, it is also the case that

$$\mu^{A}(s_{IDY}) = \frac{P(\theta_D)(1-\gamma)}{1-P(\theta_D)+P(\theta_D)(1-\gamma)}.$$

Since $\mu^{A}(s_{IDY}) \leq 1/2$, A exerts no effort and B picks policy b. The expected payoff to the preacher is

$$1-\mu^{\widehat{A}}(s_{IDY}) \geq \frac{1}{2}.$$

Suppose instead the preacher sends message s_{CAU}. In this case, A starts a total conflict. Using (13), the preacher's expected payoff would be

$$-\frac{\beta}{2}+\frac{1}{2},$$

which is lower than 1/2. This implies that a deviation from a truthful report is not profitable when the actual signal is s_{IDY}.

Second, suppose that $s = s_{CAU}$. If the preacher sends message s_{CAU} his expected payoff is

$$-\frac{\beta}{2}+\frac{1}{2},$$

which is greater than zero, the payoff obtained by sending message s_{IDY}, which induces A to exert no effort. This implies that a deviation from a truthful report is also not profitable when the actual signal is s_{CAU}.

Step 2: *When*

$$\frac{1}{2-\gamma} < P(\theta_D) \leq \frac{1}{2\beta(1-\gamma)+\gamma},$$

$\widehat{A}$ is also truthful.

Proof of Step 2: First, suppose that $s = s_{IDY}$ and that the preacher is truthful. If the condition in the statement of Step 2 is met, $\mu^A(s_{IDY}) > 1/2$. Then, a conflict arises. By Lemma 2, the preacher's expected utility of sending a truthful message is given by (12). Since $\mu^{\widehat{A}}(s_{IDY}) = \mu^A(s_{IDY})$ when reporting is truthful, we can rewrite (12) as

$$\left(2\mu^A(s_{IDY}) - 1\right)\frac{1-\beta\left(2\mu^A(s_{IDY})-1\right)}{2} + 2\left(1-\mu^A(s_{IDY})\right)^2. \tag{28}$$

To see whether $\widehat{A}$ has an incentive to deviate and send message $m_{\widehat{A}} = s_{CAU}$ when the actual signal is s_{IDY}, we compare (28) to (13), the expected utility after the deviation. To show that (13) is lower than (28) when the condition in the statement of Step 2 is met, take the derivative of (28) with respect to $\mu^A(s_{IDY})$:

$$-2\beta(2\mu^A(s_{IDY}) - 1) + 1 - 4(1-\mu^A(s_{IDY})). \tag{29}$$

This derivative can be written as

$$(1-2\beta)(2\mu^A(s_{IDY}) - 1) + 2(\mu^A(s_{IDY}) - 1). \tag{30}$$

Knowing that $1 \geq \mu^A(s_{IDY}) > 1/2$ and that $1 \geq \beta \geq 1/2$, one can verify that the derivative is always negative. Since (13) is equal to (28) when $\mu^A(s_{IDY}) = 1$, we have proved that (13) is lower than (28). Therefore, $\widehat{A}$ has no incentive to send message s_{CAU} when $s = s_{IDY}$.

To conclude the proof of Step 2, we have to show that the preacher does not want to deviate even when $s = s_{CAU}$. The preacher utility from truthful reporting is (10) while the utility of sending message s_{IDY} is (11). One can show that when

$$\mu^A(s_{IDY}) \leq \frac{1}{2\beta}, \tag{31}$$

the preacher has no incentive to misreport. In fact, when $\mu^A(s_{IDY}) = 1/(2\beta)$ and $\mu^A(s_{IDY}) = 1$ expressions (10) and (11) coincide. Between the two roots, (10) is greater than (11). When $\mu^A(s_{IDY}) \leq 1/(2\beta)$ we have that (10) is lower than (11): $\widehat{A}$ has no incentive to misreport when $s = s_{CAU}$. Knowing that $\mu^A(s_{IDY})$ is given by (5), it is easy to show that $\mu^A(s_{IDY}) \leq 1/(2\beta)$ if and only if

$$P(\theta_D) \leq \frac{1}{2\beta(1-\gamma)+\gamma}.$$

Step 3: *When*

$$P(\theta_D) > \frac{1}{2\beta(1-\gamma)+\gamma},$$

$\widehat{A}$ sends message s_{IDY} regardless of Nature's signals.

Proof of Step 3: Following the algebra of Step 2, we obtain that when the condition in the statement of Step 3 is satisfied, $\widehat{A}$ has an incentive to send message s_{IDY} when the actual signal is s_{CAU}. When instead $s = s_{IDY}$ the report is truthful. It then follows that regardless of s, $\widehat{A}$ always sends message s_{IDY}.

This concludes the proof of Proposition 2. □

PROOF OF PROPOSITION 3

We proceed by steps.

Step 1: *When*

$$P(\theta_D) \leq \frac{1}{2-\gamma},$$

$\widehat{A}$ is truthful.

Proof of Step 1: The proof is identical to the proof of Step 1 of Proposition 2, since that proof did not use the fact that β was greater or equal than 1/2.

Step 2: *When*
$$\frac{1}{2-\gamma} < P(\theta_D) \leq \frac{1}{2(1-\beta)(1-\gamma)+\gamma},$$
$\widehat{A}$ is truthful.

Proof of Step 2: First, suppose that $s = s_{IDY}$. Since
$$\frac{1}{2-\gamma} < P(\theta_D),$$
we have that $\mu^A(s_{IDY}) > 1/2$. Then, a conflict arises. The preacher's expected utility of sending a truthful message is (28). To see whether $\widehat{A}$ has an incentive to deviate and send message $m_{\widehat{A}} = s_{CAU}$ when the actual signal is s_{IDY}, we compute his utility after this deviation. This is given by (13). In comparing (28) to (13), one can show that when $\beta < 1/2$ it may be the case that (13) is greater than (28). However, when
$$\mu^A(s_{IDY}) \leq \frac{1}{2(1-\beta)}, \tag{32}$$
(13) is lower than (28). Then, $\widehat{A}$ has no incentive to send message s_{CAU} when he receives signal s_{IDY}. Knowing that $\mu^A(s_{IDY})$ is given by (5), it is easy to verify that (32) is satisfied if and only if
$$P(\theta_D) \leq \frac{1}{2(1-\beta)(1-\gamma)+\gamma}.$$
Finally, suppose that the actual signal is $s = s_{CAU}$. The preacher utility from truthful reporting is (10), while the utility of sending message s_{IDY} is (11). One can show that when $\beta < 1/2$ the preacher has no incentive to misreport.

Step 3: *When*
$$P(\theta_D) > \frac{1}{2(1-\beta)(1-\gamma)+\gamma},$$
$\widehat{A}$ sends message s_{CAU} regardless of Nature's signals.

Proof of Step 3: This follows from the algebra in the previous step.

This conclude the proof of Proposition 3. $\square$

PROOF OF LEMMA 3: To understand (19), notice that with probability $(1-\pi)$ research is not successful. Since the probability of success is independent from θ, A does not update his beliefs in case of failure: the expected payoff to the preacher is then given by (11). With probability π research is successful and A perfectly observes the state. Since $s = s_{CAU}$, A can only discover that $\theta = \theta_D$. In this case, a total conflict arises and the preacher's payoff is (18). To understand (20), note that with probability $(1-\pi)$ research is not successful and individual A does not change his beliefs: the expected payoff to the preacher is then given by (12). The preacher's expected payoff in case research is successful is as follows. With probability $\mu^{\widehat{A}}(s_{IDY})$, $\widehat{A}$ expects A to discover that the true state is θ_D. In this case, the payoff would be the one from a total conflict. With complementary probability $\widehat{A}$ expects A to discover that the true state is θ_1. In this case, $\widehat{A}$'s payoff would be equal to one. $\square$

PROOF OF PROPOSITION 5

First, knowing the conditional probabilities (3) and (4), we derive the probabilities of the two signals.

$$\phi(s_{IDY}) = 1 - \gamma P(\theta_D) \text{ and } \phi(s_{CAU}) = \gamma P(\theta_D).$$

From (15), (9), and the results of Proposition 3, we write the expression for $E(c_A + c_B)$ when $\beta < 1/2$:

$$E(c_A + c_B) = \begin{cases} \gamma P(\theta_D) \text{ if } P(\theta_D) \leq \frac{1}{2-\gamma}, \\ \gamma P(\theta_D) + (1-\gamma P(\theta_D))(2\mu^A(s_{IDY}) - 1)\mu^A(s_{IDY}) \quad \text{if } \frac{1}{2-\gamma} < P(\theta_D) \leq \widehat{P}, \\ 1 \text{ if } P(\theta_D) > \widehat{P}. \end{cases}$$

Using the results of Proposition 2, we write the expression for $E(c_A + c_B)$ when $\beta \geq 1/2$:

$$E(c_A + c_B) = \begin{cases} \gamma P(\theta_D) \text{ if } P(\theta_D) \leq \frac{1}{2-\gamma}, \\ \gamma P(\theta_D) + (1-\gamma P(\theta_D))(2\mu^A(s_{IDY}) - 1)\mu^A(s_{IDY}) \quad \text{if } \frac{1}{2-\gamma} < P(\theta_D) \leq \overline{P}, \\ (2\mu^A(s_{IDY}) - 1)\mu^A(s_{IDY}) \text{ if } P(\theta_D) > \overline{P}. \end{cases}$$

Step 1: *We show that $E(c_A + c_B)$ is weakly increasing in $P(\theta_D)$ when $\beta < 1/2$.*

Proof of Step 1: To see this, we first show that

$$\gamma P(\theta_D) + (1 - \gamma P(\theta_D))(2\mu^A(s_{IDY}) - 1)\mu^A(s_{IDY}) \tag{33}$$

is increasing in $P(\theta_D)$. Knowing (5), we find the derivative of (33) with respect to $P(\theta_D)$:

$$\gamma + (1-\gamma)(2\mu^A(s_{IDY}) - 1) + P(\theta_D)\frac{2(1-\gamma)^2}{(1-\gamma P(\theta_D))^2} \tag{34}$$

which is positive since $(2\mu^A(s_{IDY}) - 1)$ is positive, $P(\theta_D) \in (1/2, 1)$, and $0 \le \gamma \le 1$. Moreover, note that (33) is equal to $\gamma P(\theta_D)$ when $P(\theta_D) = 1/(2-\gamma)$, and that (34) is greater than γ, the slope of $E(c_A + c_B)$ when $P(\theta_D) \le 1/(2-\gamma)$. Finally, note that (33) is lower than one: that is, right after $P(\theta_D) = \widehat{P}$, total effort jumps.

Step 2: *We show that $E(c_A + c_B)$ is not monotone in $P(\theta_D)$ when $\beta > 1/2$.*

Proof of Step 2: It is enough to show that right after $P(\theta_D) = \overline{P}$, total effort drops. This is obvious since

$$(2\mu^A(s_{IDY}) - 1)\mu^A(s_{IDY}) < 1.$$

Step 3: *We show that $E(c_A + c_B)$ is decreasing in β.*

Proof of Step 3: Note that β only affects the location of the point of discontinuity where total effort jumps (if $\beta < 1/2$) or drops (if $\beta \ge 1/2$). To show that $E(c_A + c_B)$ is decreasing in β when $\beta < 1/2$ is straightforward, since $\widehat{P}$ is increasing in β, thereby implying that the cutoff where total effort jumps to 1 shifts further to the right. Suppose instead that $\beta > 1/2$. In this case, it can be shown that

$$\gamma P(\theta_D) + (1 - \gamma P(\theta_D))(2\mu^A(s_{IDY}) - 1)\mu^A(s_{IDY}) \ge (2\mu^A(s_{IDY}) - 1)\mu^A(s_{IDY}).$$

Given that $\overline{P}$ is decreasing in β, we have that an increase of β shifts to the left the cutoff where the drop occurs.

Step 4: *Suppose that γ increases from $\underline{\gamma}$ to $\overline{\gamma}$, with $0 \le \underline{\gamma} < \overline{\gamma} \le 1$. Then, the intensity of conflict strictly increases when $P(\theta_D) \le 1/(2 - \underline{\gamma})$ and weakly decreases when $P(\theta_D)$ is close to one.*

Proof of Step 4: Showing that for all $\beta \in [0,1]$ we have that $E(c_A + c_B)$ increases when $P(\theta_D) \leq 1/(2-\underline{\gamma})$ is trivial. We now show that when $P(\theta_D)$ is close to 1, $E(c_A + c_B)$ is decreasing in γ. Two cases must be considered. First, suppose $\beta \geq 1/2$. In this case, we compute the derivative of

$$(2\mu^A(s_{IDY}) - 1)\mu^A(s_{IDY}) \tag{35}$$

with respect to γ. Noting that (35) is increasing in $\mu^A(s_{IDY})$ and that $\mu^A(s_{IDY})$ is decreasing in γ, we have that (35) is decreasing in γ. This implies that when $P(\theta_D)$ is close to one and $\beta \geq 1/2$ an increase of the precision of Nature's signals lowers total effort. The second case is when $\beta < 1/2$. In this case, total effort is constant in γ around 1. $\square$

PROOF OF PROPOSITION 6

Step 1: *We show that upon receiving message s_{IDY}, A is indifferent between conducting and not conducting research.*

Proof of Step 1: Suppose that A receives message s_{IDY}. If A engages in a conflict without conducting research, his expected utility is equal to

$$\left(2\mu^A(s_{IDY}) - 1\right)\frac{1 - \left(2\mu^A(s_{IDY}) - 1\right)}{2} + 2\left(1 - \mu^A(s_{IDY})\right)^2, \tag{36}$$

which is equal to $1 - \mu^A(s_{IDY})$.

If instead he conducts research, A expects to obtain

$$(1-\pi)\left[\left(2\mu^A(s_{IDY}, NS) - 1\right)\frac{1 - (2\mu^A(s_{IDY}, NS) - 1)}{2} + 2(1 - \mu^A(s_{IDY}, NS))^2\right] + \\ +\pi\left[1 - \mu^A(s_{IDY})\right], \tag{37}$$

which is also equal to $1 - \mu^A(s_{IDY})$.

Step 2: *We show that if $\widehat{A}$ always sends message s_{IDY} when $\pi = 0$, he will follow the same strategy when $\pi > 0$.*

Proof of Step 2: Suppose that $\widehat{A}$ always sends message s_{IDY} when $\pi = 0$. This implies that (11) $\geq$ (10) and (12) $\geq$ (13). When $\pi > 0$, (19) replaces (11) and (20) replaces (12). It is easy to show that (11) $\geq$ (10) if and only if (19) $\geq$ (10). Moreover, it is also simple to verify that if (12) $\geq$ (13) we also have (20) $\geq$ (13).

Step 3: *We show that if $\widehat{A}$ always sends message s_{CAU} when $\pi = 0$, there exists a cutoff $\widetilde{\pi}$, with $\widetilde{\pi} < 1$, such that for all $\pi > \widetilde{\pi}$ preacher $\widehat{A}$ is truthful.*

Proof of Step 3: Suppose that $\widehat{A}$ always sends message s_{CAU} when $\pi = 0$. This implies that (10) $\geq$ (11) and (13) $\geq$ (12). Suppose now that $\pi > 0$. It is easy to see that if (10) $\geq$ (11) we also have that (10) $\geq$ (19). Note however that (13) $\geq$ (12) does not necessarily imply that (13) $\geq$ (20). One can easily verify that we have that (13) $\geq$ (20) if and only if

$$\mu^A(s_{IDY}) \geq \frac{2 - \pi(1-\beta)}{4(1-\pi)(1-\beta)}. \tag{38}$$

Notice that when $\beta \geq 1/2$ inequality (38) is never satisfied. Suppose instead $\beta < 1/2$. When $\pi = 1$, the RHS of inequality (38) goes to infinity, thereby implying that inequality (38) is never satisfied. When $\pi = 0$ inequality (38) is sometimes satisfied when $\beta < 1/2$. This implies that exists a cutoff $\widetilde{\pi}$, which depends on the parameters of the economy, such that for all $\pi \leq \widetilde{\pi}$ inequality (38) is satisfied. When instead $\pi > \widetilde{\pi}$ the preacher reports truthfully.

Step 4: *We show that if $\widehat{A}$ is truthful when $\pi = 0$, he will follow the same strategy when $\pi > 0$.*

Proof of Step 4: Suppose that $\widehat{A}$ is truthful when $\pi = 0$. This implies that (10) $\geq$ (11) and (12) $\geq$ (13). Suppose $\pi > 0$. It is easy to see that if (10) $\geq$ (11) we also have that (10) $\geq$ (19) and that if (12) $\geq$ (13) we also have (20) $\geq$ (13). $\square$

PROOF OF PROPOSITION 9

Step 1: *We show that if the opponent has doubts ($\chi^{-i}(m_{\widehat{-i}}) < 1$), preacher $\widehat{i}$ sends message s_{CAU} to individual i regardless of s.*

Proof of Step 1: To see this, first notice that the posterior of individual $-i$ is, by assumption, not affected by $m_{\widehat{i}}$. Second, notice that $\chi^{-i}(m_{\widehat{-i}}) < 1$ only if $m_{\widehat{-i}} = s_{IDY}$. Two cases must be considered. First, suppose $s = s_{CAU}$. From Proposition 8, we know that if $\widehat{i}$ sends message s_{CAU}, the payoff to $\widehat{i}$ is

$$\left(2\chi^{-i}(s_{IDY})-1\right)\frac{1-\beta\left(2\chi^{-i}(s_{IDY})-1\right)}{2}+2(1-\chi^{-i}(s_{IDY}))\left(1-\frac{\beta\left(2\chi^{-i}(s_{IDY})-1\right)}{2}\right). \tag{39}$$

If instead $\widehat{i}$ sends message s_{IDY}, the payoff to $\widehat{i}$ is

$$\frac{1-\beta\left(2\chi^{-i}(s_{IDY})-1\right)}{2}. \tag{40}$$

Clearly, by comparing (40) and (39), one can see that sending message s_{CAU} is preferable for $\widehat{i}$. Second, suppose $s = s_{IDY}$. By sending message s_{IDY} the payoff to $\widehat{i}$ is

$$\frac{1-\beta\left(2\chi^{-i}(s_{IDY})-1\right)}{2}. \tag{41}$$

By sending message s_{CAU} the payoff to $\widehat{i}$ is

$$\left(2\chi^{-i}(s_{IDY})-1\right)\frac{1-\beta\left(2\chi^{-i}(s_{IDY})-1\right)}{2}+2(1-\chi^{-i}(s_{IDY}))\left(\chi^{\widehat{i}}(s_{IDY})-\frac{\beta\left(2\chi^{-i}(s_{IDY})-1\right)}{2}\right). \tag{42}$$

Again, by comparing (42) and (41), and recalling that $\chi^{\widehat{i}}(s_{IDY}) \geq 1/2$, one can verify that sending message s_{CAU} is preferable for $\widehat{i}$.

Step 2: *Suppose* $\beta < 1/2$. *For all* $P(\theta_D) \leq \widehat{C}$, *where*

$$\widehat{C} = \frac{\beta}{1-\gamma-\beta(1-2\gamma)},$$

one preacher reports truthfully while the other always sends s_{CAU}. *If* $P(\theta_D) > \widehat{C}$, *both preachers always send message* s_{CAU}.

Proof of Step 2: First, suppose that $s = s_{IDY}$ and that $\widehat{-i}$ sends message s_{CAU}. It is possible to show that $\widehat{i}$ is truthful when $s = s_{IDY}$ if and only if

$$\left(2\chi^{i}(s_{IDY})-1\right)\frac{1-\beta\left(2\chi^{i}(s_{IDY})-1\right)}{2}+2(1-\chi^{i}(s_{IDY}))^2 \geq -\frac{\beta}{2}+\frac{1}{2}. \tag{43}$$

Inequality (43) can be written as

$$\chi^{i}(s_{IDY}) \leq \frac{1}{2(1-\beta)}. \tag{44}$$

Knowing (25), we rewrite (44) as

$$P(\theta_D) \leq \frac{\beta}{1-\gamma-\beta(1-2\gamma)}.$$

Second, suppose $s = s_{CAU}$ In this case, since $\beta < 1/2$, it is never the case that

$$\left(2\chi^i(s_{IDY}) - 1\right) \frac{1 - \beta \left(2\chi^i(s_{IDY}) - 1\right)}{2} \geq -\frac{\beta}{2} + \frac{1}{2}. \tag{45}$$

Finally, it is easy to check that if $\widehat{i}$ is truthful, $\widehat{-i}$ always sends message s_{CAU}. If instead $P(\theta_D) > \widehat{C}$ and $\widehat{i}$ always sends message s_{CAU}, it is also easy to show that by symmetry $\widehat{-i}$ always sends message s_{CAU}.

Step 3: *Suppose $\beta \geq 1/2$. For all $P(\theta_D) \leq \overline{C}$, where*

$$\overline{C} = \frac{1 - \beta}{\gamma + \beta(1 - 2\gamma)},$$

one preacher reports truthfully while the other always reports s_{CAU}. If $P(\theta_D) > \widehat{C}$, one preacher always sends message s_{IDY} while the other one always sends message s_{CAU}.

Proof of Step 3: First, suppose that $s = s_{CAU}$ and that $\widehat{-i}$ sends message s_{CAU}. Preacher $\widehat{i}$ sends message s_{CAU} if and only if

$$\left(2\chi^i(s_{IDY}) - 1\right) \frac{1 - \beta \left(2\chi^i(s_{IDY}) - 1\right)}{2} \leq -\frac{\beta}{2} + \frac{1}{2}, \tag{46}$$

which is equivalent to

$$\chi^i(s_{IDY}) \leq \frac{1}{2\beta} \tag{47}$$

By solving (47) we obtain

$$P(\theta_D) \leq \frac{1 - \beta}{\gamma + \beta(1 - 2\gamma)}.$$

Now suppose $s = s_{IDY.}$ In this case, since $\beta \geq 1/2$, it is never the case that

$$\left(2\chi^i(s_{IDY}) - 1\right) \frac{1 - \beta \left(2\chi^i(s_{IDY}) - 1\right)}{2} + 2(1 - \chi^i(s_{IDY}))^2 \leq -\frac{\beta}{2} + \frac{1}{2}. \tag{48}$$

Finally, it is easy to check that if $\widehat{i}$ is truthful, $\widehat{-i}$ always sends message s_{CAU}; if instead $P(\theta_D) > \overline{C}$ and $\widehat{i}$ always sends message s_{IDY}, it is also easy to show that $\widehat{-i}$ always sends message s_{CAU}.

This concludes the proof of Proposition 9. $\square$