Doubts and Dogmatism in Conflict Behavior

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June 7, 2010

Abstract

We consider a game of conflict where two individuals fight in order to choose a policy. Intuitively, we expect conflicts to 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 studies information transmission from an informed principal (the parent) to a naive agent (the son). After being informed, the agent partecipates in a game of conflict. The parent wants to motivate his son, but he also cares that his son has the right incentives to acquire information and that he selects the correct policy. We find conditions under which dogmatic attitudes are observed and conditions under which skeptical attitudes are instead observed. We also study how beliefs manipulation evolves over time.

JEL Classification: D74, D83

Key Words: Dogmatism, Skepticism, Ideology, Conflict, Information Transmission, Dogmatic Trap.

*This research was partly carried out while visiting the Einaudi Institute for Economics and Finance (EIEF) in Rome. Its generous hospitality is gratefully acknowledged. I benefitted from comments by Vincent Boucher, Jorge Fernandez, Mike Golosov, Frederic Koessler, Massimo Morelli, Andy Skrzypacz, Jörgen Weibull and audiences at the 2009 SCSE meetings in Sainte-Adèle, Universidad de Alicante, EIEF, and Georgetown. *Correspondence:* Alessandro Riboni, Département de sciences économiques, Université de Montréal, C.P. 6128, succursale Centre-ville, Montréal (Québec) H3C 3J7, Canada. alessandro.riboni@umontreal.ca

"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

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.[1] Other evidence from the psychological literature, however, seems to suggest that reality is sometimes distorted in the opposite direction: some individuals seem to overestimate the possibility that the opponent may be right.[2]

We believe that this subject matter has implications of first-order economic importance. Consider, for instance, the negative consequences of dogmatism on the economy. First, we expect individuals with dogmatic attitudes to engage in violent conflicts, which are obviously detrimental to development.[3] Second, individuals whose minds are closed to questioning likely abstain from conducting research and from learning. As a result, we expect bad policy decisions to be made. One further problem with dogmatic attitudes is that they prove to be persistent: societies that are initially dogmatic may find it difficult to adopt more reasonable attitudes.

In this paper, we build a model where two individuals play a game of conflict over an ideological dimension. The main goal of our analysis is to understand whether and in which direction beliefs in conflict behavior are distorted.

[1] 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.

[2] This other type of reality distortion has been pointed out by Ferenczi (1932) and Freud (1937), who 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.

[3] For instance, see Collier *et al.* (2003).

Our first point of departure is to assume that one participant in the conflict has preference rankings over policy alternatives that depend on the current state of the world. Moreover, we assume that the current state is not observable by the two participants in the conflict. This implies that the individual with state-dependent preferences cannot be ex-ante certain about the optimality of the policy that he is trying to impose. In our model, this individual relies on the information provided by an altruistic advisor (for instance, a parent) who is assumed to be better (although not necessarily perfectly) informed about the current state.

More specifically, we consider a model with three players: a son, an opponent and a parent. The parent is (more or less) altruistic *vis-à-vis* his son. 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 son's preferences are state-dependent. More specifically, in one state of the world, the optimal policy of the son 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 son. Moreover, assume that the initial prior of all players is that the state where preferences are not aligned is more likely. The timing of our basic model is as follows. Nature privately sends to the parent a signal that is (not necessarily fully) informative about the current state; the parent updates his prior and decides which message to send to his son. Upon receiving a message from his parent, the son 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 analyze how information is transmitted from parent to son and study the subsequent game of conflict between the son and the opponent. The first questions that we intend to answer are the following. When facing an opponent that has no doubt, does the parent have an incentive to manipulate information? If so, does the parent have an incentive to remove or instill doubts in his son?

A preview of our results is the following. Whether or not the parent 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 parent's altruism, which measures how much does the parent internalize the effort cost exerted by the son.

When altruism is low, we find that the parent induces a dogmatic attitude in his son by removing any doubt that the son may have had about the possibility that the opponent's preferred policy is optimal for him. This occurs even when the signal that the parent receives from Nature indicates that the opponent may be right. As a result, the dogmatic son 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 parent induces a skeptical attitude by always instilling in his son the doubt that opponent may be right. The parent does so even when the evidence that he has received indicates that the policy that the opponent would choose is certainly not optimal for the son. As a result, the skeptical son exerts little effort because he incorrectly entertains the possibility that the policy that the opponent is trying to impose may be optimal. 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 son.

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).[4] In this model, the parent manipulates information in order to affect his son'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 son to exert higher effort. Clearly, this effect is more valuable to the parent, the lower his altruism parameter. But, why would a parent ever want to instill doubts in his son after learning that the opponent's preferred policy is not optimal? Instilling doubts decreases the probability that the son enters the conflict and, consequently, increases the probability that the suboptimal

[4]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).

policy is implemented. This is clearly welfare reducing for both the parent and the son. However, instilling doubts has a also *moderating effect* on the conflict: it decreases the average effort exerted by *both* opponents and reduces the conflict's Pareto inefficiency. This effect is valuable because effort in the conflict is wasteful and because the two opponents cannot credibly commit to low effort levels. Instilling doubts is then a (costly) *commitment* device for the parent. In contrast to the motivating effect, the moderating effect is more valuable to the parent, the higher his altruism parameter. One can then show that if the parent is sufficiently altruistic, the moderating effect dominates and, consequently, skeptical attitudes may be observed.

In Section 3.3, we extend the model and suppose that the son can acquire precise information on his own. More specifically, upon receiving a message that is not fully informative, the son can conduct autonomous research. With some positive probability autonomous research is successful and the son is assumed to perfectly observe the current state of the world. We show that the higher is the probability of successful research, the weaker are the parent's incentives to induce dogmatic attitudes. This result is obtained because dogmatism reduces the son's incentive to acquire information and because the value of information obtained from successful autonomous research is positive for the parent. On the other hand, we also show that the possibility of autonomous research does not alter the parent's incentives to induce skeptical attitudes. This suggests that in societies that have access to efficient ways of doing research (such as, internet and a developed educational system) truthtelling and systematic doubts are more likely to be observed than dogmatic attitudes.

It is also apparent that the effectiveness of research (which is treated as an exogenous parameter in Section 3.3) is endogenous to the economy. Societies have well-supplied libraries, good schools and high human capital only if previous generations conducted research. In Section 3.4, we consider a dynamic model where the probability of research's success increases over time if in the previous period research was conducted. This suggests that having doubts generates a positive externality on future generations because it induces current individuals to search and learn, thereby increasing the stock of research instruments available to future generations. 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 *reinforces* the incentives of future generations to report truthfully. In other words, there exists a virtuous circle in which the incentives to truthtelling becomes stronger over time. 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.

The remainder of the paper is as follows. In Section 2, we analyze the related literature. Section 3 presents the basic setup with one parent, one son and one opponent. Section 3.3 considers a different setup where the son can obtain precise information on his own, while Section 3.4 analyzes the evolution of indoctrination strategies over time. Section 4 concludes.

2. Review of the Literature

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 parents.[5] Contrary to Guiso *et al.* (2008), where parents can perfectly choose the beliefs of their children, indoctrination possibilities are more limited here because parents can affect sons' 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 parent may decide to misreport the truth for a different set of reasons: to motivate his own son (a similar motive is also present in, for instance, Bénabou and Tirole, 2002, 2006) and also, because of the existence of

[5] 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.

strategic interdependence between agents' effort decisions, to affect the strategy of the opponent.[6] Notice that the latter, but not the former, motive is also present if parents are perfectly altruistic. This implies that in our model misreporting may occur also when the utility of the parent coincides with the one of the son.[7]

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.[8] Recently, Caselli and Coleman (2006) and Esteban and Ray (2008, 2009) have focused on the role 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.

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

[7] 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.

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

3. 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 "parent" and to A as the "son". Alternatively, one could think of $\widehat{A}$ and A as, respectively, a preacher and a student or as two multiple selves that exist at different times within the same individual.[9]

It is important to emphasize that the game of conflict analyzed here does not concern the division of a given amount of resources.[10] 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 $\theta \in \Omega$. We assume that there are only two possible states of the world: $\Omega = \{\theta_A, \theta_C\}$. The state is randomly drawn by Nature. In state θ_A 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_C 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_A as the *state of alignment* and θ_C as the *state of conflict*. 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.

[9] On the latter possibility, see footnote 5 above. 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-creating stories against poor (or rich) minorities in order to block (or pass) redistribution policies.

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

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.[11]

More specifically, we will assume that in the state of alignment θ_A policy b is optimal for both individuals. Conversely, in the state of conflict θ_C 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:

	A's optimal policy	*B's optimal policy*
θ_A	b	b
θ_C	a	b

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.[12]

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,

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

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 parent is not fully altruistic *vis-à-vis* his son: $\widehat{A}$ does not fully internalize

[11] 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.

[12] In a previous draft of this paper, we also considered an extension where both opponents have state-dependent preferences and they are informed by their respective parents. The resulting game resembles a game of chicken: one of the two parents always removes doubts in his son in order to preempt the opponent, while the other parent selects his message strategy depending on parameters.

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 parent does not disagree with his son 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 conflict is denoted by $P(\theta_C)$. We will assume that $P(\theta_C) \in (1/2, 1)$: that is, the two individuals are (ex-ante) more likely to be in a state of conflict than in a state of alignment. To some extent, $P(\theta_C)$ 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 $P(\theta_C)$.

3.1 Timing and Information Structure

The period is divided in three sub-periods: $t = 0, 1, 2$. At $t = 0$, the *information transmission* from $\widehat{A}$ to 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 $s \in \{s_{ND}, s_D\}$ 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_{ND} is perfectly informative and reveals that there are no doubts that the state is θ_C. Conversely, signal s_D is not perfectly informative. The subscript D stands for "doubt" because this signal suggests that the state *may* not be θ_C.[13]

The conditional probabilities of receiving signals s_{ND} and s_D in state θ_A are

$$P(s_{ND} \mid \theta_A) = 0 \text{ and } P(s_D \mid \theta_A) = 1. \tag{3}$$

In state θ_C, they are

$$P(s_{ND} \mid \theta_C) = \gamma \text{ and } P(s_D \mid \theta_C) = 1 - \gamma, \tag{4}$$

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

[13] The thrust of most of our results would not change with a more general information structure. What is important is to have a signal that goes against the prior and another one that favors the prior. The fact that s_{ND} is perfectly informative, however, simplifies the algebra.

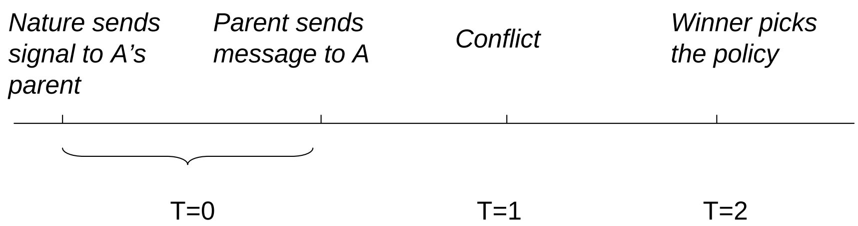

Figure 1: Timeline

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

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

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

The parameter γ can be viewed as a measure of the precision of Nature's signals. In fact, when $\gamma = 1$ both signals are perfectly informative. Instead, when $\gamma = 0$ the parent's posteriors upon receiving s_D coincide with his initial priors.

Upon receiving a signal from Nature, $\widehat{A}$ decides which messages $m_{\widehat{A}}$ to send, where $m_{\widehat{A}} \in \{s_{ND}, s_D\}$. 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 parent 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 $m_{\widehat{A}} = s_D$ and is equal to (6) when $m_{\widehat{A}} = s_{ND}$. The naivete assumption is somewhat justified because of the particular relationship between parent and son and on the assumption that $\widehat{A}$ is altruistic *vis-à-vis* A.[14] Finally, it is important to notice that the parent cannot fabricate new evidence that would allow him to perfectly choose the posterior of his son. Instead, we assume here that $\widehat{A}$ can affect A's beliefs only by misreporting the signal received from Nature.[15]

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

[14] We briefly discuss what happens when A is not naive at the end of Section 3.2.3.

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

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.[16] An effort strategy for i specifies an effort level for any message $m_{\widehat{A}}$.[17]

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 $\widehat{A}$.

3.2 Equilibrium Characterization

We solve the model by backward induction.

3.2.1 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 $1/2$, which constitutes the threshold of indifference between the two policy decisions. 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] 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).

[17] 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.

This threshold plays an important role in this paper. As we will see in the next sections, if the posterior belief of the parent conditional on the true signal is on one side of the threshold, $\widehat{A}$ will not send a message that shifts the posterior belief of the son to the other side. To understand this result, recall that $\widehat{A}$ does not disagree with A on the correct policy to adopt in each state.

3.2.2 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_C. 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

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

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

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

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: *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, which follows closely Hillman and Riley (1988), 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 son the parent 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 parent'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.

3.2.3 Message Strategies

Depending on the underlying parameters (namely, β, γ and the initial prior of being in state θ_C) we will show (see Propositions 2 and 3) that three message strategies may occur. First, there exists a region of parameter values where the parent reports Nature's signals in a *truthful* manner. Second, for other parameters values we obtain that $\widehat{A}$ always sends message s_{ND} regardless of the actual signal received from Nature. In this case, we say that $\widehat{A}$ induces a *dogmatic attitude* in his son.[18] 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_D regardless of the actual signal. In this other case, we say that $\widehat{A}$ induces a *skeptical attitude* in his son.[19] 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.

[18] 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."

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

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

LEMMA 1: *Let $s = s_{ND}$. 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_D, his expected payoff is

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

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

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

If instead $\widehat{A}$ sends the false message s_{ND}, 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 $2\mu^{A}\left(s_D\right) - 1$ individual A enters the conflict upon receiving message s_D. 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 $s = s_D$ but not when $s = s_{ND}$. Finally, expressions (10) and (13) are the parent's utilities of inducing A to play a total conflict. Note that the lower β, the higher the parent'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_D 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_{ND}. 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 parent 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 because the equilibrium effort levels of *both* players decrease. This effect is valuable because effort in the conflict is wasteful and because the two opponents cannot credibly commit to low effort levels. Instilling doubts is then a *commitment* device for the parent. This device, however, is not without cost for the parent: instilling doubts when doubts are not justified by evidence (that is, when $s = s_{ND}$) is that A exits the conflict with higher probability and b, which is suboptimal for A in state θ_C, is more often implemented. The parent 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 parent 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 parent would rather increase the expected payoff of a conflict than maximize the probability that A exerts positive effort. The converse holds true for a parent 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 $P(\theta_C) \leq \overline{P}$, where*

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

information transmission is truthful. When instead $P(\theta_C) > \overline{P}$, parent $\widehat{A}$ reports s_D 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_D 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 $P(\theta_C)$ 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_{ND}. Then, $\mu^{\widehat{A}}(s_{ND}) = 1$. If $P(\theta_C)$ is low, sending the false message s_D would instill a great amount of doubt in A since $\mu^A(s_D)$ is increasing in $P(\theta_C)$. In this case, the difference between the parent's posterior after the true signal and the son'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 parent'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_D when $s = s_{ND}$ and $P(\theta_C)$ is low is not a profitable strategy for $\widehat{A}$.

It is important to notice that these considerations would not arise in a model where conflict is over a given amount of resources. In that case, the parent would likely want to maximize the probability that his son wins the conflict. When instead the conflict is over the choice of a policy, he also cares that the son makes the correct decision.

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

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

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

information transmission is truthful. When instead $P(\theta_C) > \widehat{P}$, parent $\widehat{A}$ always reports s_{ND} 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_{ND} after all signals s. The parent's message confirms the son'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 $P(\theta_C)$ is sufficiently large (i.e., above the cutoff $\widehat{P}$). To see this, suppose that $P(\theta_C)$ is just above 1/2. After receiving signal s_D, parent $\widehat{A}$ would change his view

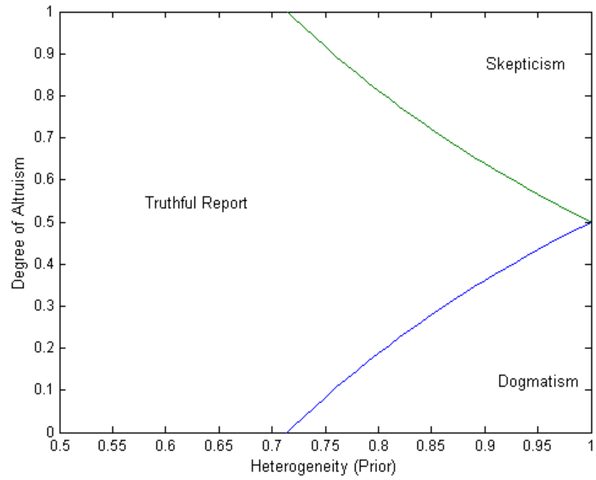

Figure 2: Beliefs Manipulation in the $(P(\theta_C), \beta)$ space with $\gamma = 0.6$

about the optimality of a and start to believe that b is the correct decision. Then, he has no incentive to send message s_{ND}, 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 $(P(\theta_C), \beta)$ space where beliefs' manipulation occurs. As stated in Propositions 2 and 3, $\widehat{A}$ sends truthful reports when $P(\theta_C)$ is sufficiently low. When instead $P(\theta_C)$ 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, 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. Graphically, this can be appreciated by noticing that the two curves drawn in Figure 2 shift to the right when γ increases. However, the shift is not parallel: both curves pivot around point $(1, 1/2)$.

To understand why beliefs manipulation is less likely when signals are more precise, suppose that γ is close to 1. After a false message, the posteriors of the parent and of the son would likely lie on different sides of $1/2$, the threshold of indifference discussed in Section 3.2.1. Therefore, when signals are very precise, the parent tells the truth in order to avoid wrong policy decisions. We state without proof the following Corollary.

Corollary 1: *The higher $P(\theta_C)$ 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.*

Using the results of Propositions 2 and 3, the next Corollary establishes how the likelihood that a conflict occurs (or incidence of conflict) and the total effort levels exerted in the conflict depend on the degree of societal heterogeneity.

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

The proof of Corollary 2 is contained in the Appendix. To understand the first part of Corollary 2, notice that when $P(\theta_C)$ is low (resp. high) conflicts occur only when the parent receives s_{ND} (resp. always occur). Since $P(\theta_D)$ is likely to be high in heterogeneous societies, this suggests that (not surprisingly) conflicts are less likely in uniform societies.[20] More surprisingly, the second part of Corollary 2 establishes that when $\beta \geq 1/2$ the intensity of conflict may not be monotone in the degree of ex-ante heterogeneity. The latter result occurs because, as described in Proposition 2, in more divided societies individuals may be induced to have a skeptical attitude. This causes a discontinuous drop of the total effort levels exerted in the conflict precisely when $P(\theta_C)$ is equal to $\overline{P}$.[21]

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

[20] This result is supported by the empirical findings of Montalvo and Reynal-Querol (2005), who show that ethnic polarization (which can viewed as a proxy of ex-ante heterogeneity) is positively correlated with the incidence of conflict.

[21] This 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.

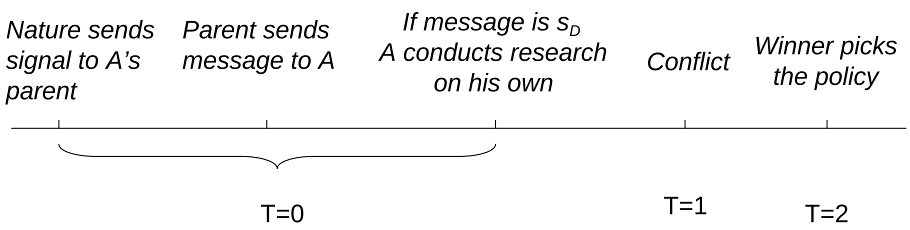

Figure 3: Timeline when A can conduct autonomous research

naive.[22] Instead, if we are in the parameter region where the parent has an incentive to misrepresent the facts, A would ignore the message of his parent: A's probability assessment of being in state θ_C would then coincide with his prior.

3.3 Dogmatism and Inefficient Decision-Making

At the beginning of the Introduction we pointed out that the cost of dogmatism is twofold: excessive violence and inefficient decision-making. The model presented in Section 3 captures only the first cost. In fact, in Proposition 3 we obtained that dogmatism does not lead to inefficient decision-making: that is, 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 son 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 allows us to capture this cost as well. In this section, we suppose that A is able to conduct research on his own in order to find out the current state of the world. This possibility will be used only when A receives message s_D. This assumption seems quite natural. In fact, after receiving message s_{ND}, A has no doubts that the state is θ_C. Therefore, from A's perspective, autonomous research is not needed.

More precisely, the timing is now as follows (see Figure 3). As before, at $t = 0$ parent $\widehat{A}$ observes evidence $s \in \{s_{ND}, s_D\}$ and sends a message to A. If $\widehat{A}$ sends message s_{ND}, the game unfolds exactly as before. If instead $\widehat{A}$ sends message s_D, we now assume that individual A is able, if he decides so, to conduct costless research in

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

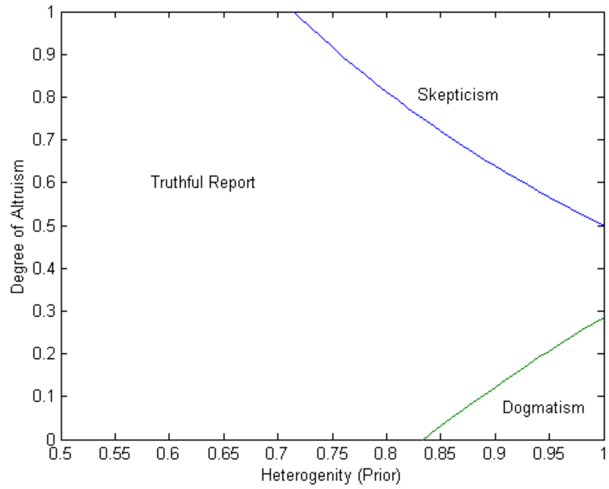

Figure 4: Beliefs Manipulation with Autonomous Research ($\pi = 0.4, \gamma = 0.6$)

order to discover the current state. 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 $\mu^A(s_D, NS)$ denotes the posterior probability of individual A after receiving message s_D 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 parent. First, it is easy to see that regardless of the true signal, the expected utility of the parent after sending message s_{ND} is, as in Lemmas 1 and 2, equal to

$$-\frac{\beta}{2} + \frac{1}{2}. \tag{14}$$

(Recall that after message s_{ND} we assumed that the son does not do research.) In Lemma 3, we compute the payoffs to $\widehat{A}$ of sending message s_D. Does A decide to conduct autonomous research after receiving s_D? It turns out (see the proof of Proposition 4) that A is indifferent between conducting and not conducting research; in what follows we will assume that A, upon receiving message s_D, does indeed conduct autonomous research.

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

$$(1-\pi)\left(2\mu^A(s_D, NS) - 1\right)\frac{1-\beta(2\mu^A(s_D, NS)-1)}{2} + \pi\frac{1-\beta}{2}. \quad (15)$$

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

$$(1-\pi)\left[\left(2\mu^A(s_D, NS) - 1\right)\frac{1-\beta(2\mu^A(s_D, NS)-1)}{2} + 2(1-\mu^A(s_D, NS))^2\right] + \\ +\pi\left[\mu^A(s_D)\frac{(1-\beta)}{2} + 1 - \mu^A(s_D)\right]. \quad (16)$$

The proof of Lemma 3 is contained in the Appendix. To find out the equilibrium message strategy of the parent, 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_{ND} when $s = s_D$? It is easy to see, by comparing (16) to (14), that when $\pi = 1$ the answer is negative: inducing A to conduct research when $s = s_D$ is strictly preferable to sending message s_{ND}. To understand this result, notice that if the son discovers that the state is θ_A, the parent obtains a payoff equal to 1, which is strictly greater than the payoff of sending message s_{ND}. If instead A discovers that the current state is θ_C, the parent obtains the same payoff that he would have obtained by sending the false message s_{ND}. Therefore, dogmatism never arises when $\pi = 1$. Another way of understanding this result is to notice that when $\pi = 1$ the value of information obtained from research is positive for the parent. As a result, the parent does not prevent his son from conducting autonomous research. Figure 4 draws the message strategies in the $(\beta, P(\theta_C))$ space for an intermediate value of π. One can see that dogmatism is still observed when β is sufficiently low and $P(\theta_C)$ sufficiently large, but that the region of parameter values where dogmatism occurs has shrunk compared to Figure 2.

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 (15) is greater than (14) 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.

Overall, this suggests that societies that have access to efficient ways of doing research (such as, well-supplied libraries, internet and an advanced educational system) are more prone to either truthtelling or systematic doubts and are less prone to dogmatic attitudes.

Proposition 4 describes the message strategies when A is allowed to conduct autonomous research.

PROPOSITION 4: *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* $\beta, P(\theta_C)$ *and* γ, *such that for all* $\pi > \widetilde{\pi}$ *the parent is truthful.*

The proof of Proposition 4 is contained in the Appendix. Since dogmatism sometimes prevents A from conducting potentially successful research, Proposition 4 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.

3.4 Dynamics

In Section 3.3, we supposed that the effectiveness of research (summarized by the parameter π) was exogenous. However, this parameter is likely to evolve over time depending on individuals' decisions. In this section, we posit the following mechanism behind the evolution of π: we suppose that the act of doing research (independently of whether this is successful) increases the stock of research instruments (such as, libraries, books, theorems, oral traditions) available to future generations, thereby making research in the future more effective. In other words, our view here is that having doubts, by inducing individuals to initiate autonomous research, generates a positive externality on future generations.[23]

To analyze the evolution of biased beliefs over time, we consider a simple dynamic extension to the model with autonomous research that we analyzed in the previous section. To understand the results of this section, it helps to remind the reader that in our static model the incentives to misrepresent (in either way) the facts are decreasing

[23]This captures the intuitive idea (of, among others, Descartes) that doubt is an instrument and also a necessary condition to secure knowledge.

in γ and that the incentives to induce dogmatic attitudes are decreasing in π (see Corollary 1 and Proposition 4, respectively).

Let τ denote the time, where $\tau = 1, 2, ..., \infty$.[24] 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 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.[25] Individual A_τ is associated to $A_{\tau-1}$, a parent 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. This assumption 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 conflict is constant and equal to $P(\theta_C)$. The parent $A_{\tau-1}$ observes evidence $s_\tau \in \{s_{ND}, s_D\}$ (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 3.3, after message s_D 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, where $x_\tau \in \{a, b\}$. We assume that individual A_τ is naive when he is young; when he is old, he becomes aware that his son 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

$$U^{i,\tau} = -c_{i,\tau} + u_i(x_\tau, \theta_\tau) - \beta c_{i,\tau+1} + u_i(x_{\tau+1}, \theta_{\tau+1}). \tag{17}$$

We suppose that γ_τ and π_τ, the state variables of our model, evolve over time as follows.

Assumption 1: *(i) If research is conducted at time τ we have that $\pi_{\tau+1} > \pi_\tau$ and $\gamma_{\tau+1} \geq \gamma_\tau$; (ii) If research is not conducted at time τ, we have that $\gamma_{\tau+1} = \gamma_\tau$ and $\pi_{\tau+1} = \pi_\tau$.*

The first part of Condition (i) of Assumption 1 is crucial for our dynamics. It requires that if a young son conducts autonomous research at time $\tau - 1$ the effectiveness of research at time τ strictly increases. The underlying intuition was discussed at the beginning of this subsection. The second part of Condition (i) requires that if the

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

[25] 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.

son does autonomous research when is young, he becomes (weakly) more capable of extracting precise signals when he becomes a parent. 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.

We now introduce the following notation. Let $\mathbf{1}_\tau$ denote an indicator function that takes the value 1 if A_τ conducts autonomous research at time τ, and 0 otherwise. We denote by $\gamma_{\tau+1}(j)$ the value of $\gamma_{\tau+1}$ 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 now state the following assumption.

Assumption 2: $\lim\limits_{\tau\to\infty} \gamma_\tau(1) = 1.$

This assumption, which is only needed for a limiting result, requires that Nature's signals become fully informative in the limit as individuals keep conducting research. It is then stronger than Assumption 1, since in order to satisfy Assumption 1 the signal's precision does not have to strictly increase.

Throughout our analysis, we assume that individuals at time τ do not take into account the external effect of their decisions on $\gamma_{\tau+1}$ and $\pi_{\tau+1}$.[26] 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 4. However, since by Assumptions 1 and 2 the state variables evolve, the parent'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, $P(\theta_C)$, γ_1 and π_1) are such that A_0 induces dogmatic attitudes in A_1. That is, the economy is characterized by a combination of parameters that lie in the lower-right region of Figure 4. 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 $s_1 = s_{ND}$. In this case, A_0 truthfully reports

[26] To justify this assumption, think of A and B as two representative agents in the economy. Similarly, in a growth model with human capital (for instance, Lucas, 1988) each representative consumer does not take into account the external effect of his decision on others' productivities.

s_{ND} 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 $s_1 = s_D$. 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 4 we know that both curves in Figure 4 shift to the right. In other words, an increase of π and γ *reinforces* A_1's incentives to be truthful at $\tau = 2$. Following a similar argument, we obtain that for all $\tau > 2$ parents will also be truthful.

Finally, suppose that at $\tau = 1$ the parameters are such that A_0 always sends message s_D. That is, suppose that the economy is characterized by a combination of parameters that lie in the upper-right region of Figure 4. In particular, from Proposition 2 we know that skeptical attitudes occur if $\beta \geq 1/2$ and

$$P(\theta_C) > \frac{1}{2\beta(1-\gamma_1)+\gamma_1}. \tag{18}$$

In this case, the son conducts autonomous research at $\tau = 1$. By Assumption 1, this increases the future value of π. From Proposition 4 we know that this does not alter the incentives of future parents to change their message strategies. However, if current research also increases the precision of future signal (that is, if it increases future values of γ), we know from Corollary 1 that this will indeed have an affect on future message strategies. 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) of Assumption 1 we have that $\gamma_2 \geq \gamma_1$. Two cases are possible. First, at $\tau = 2$ it could be that

$$P(\theta_C) \leq \frac{1}{2\beta(1-\gamma_2)+\gamma_2}. \tag{19}$$

In this case, from Proposition 2 we know that A_1 uses a different message strategy from his parent and sends truthful reports to his own son. In other words, the shift to the right of the blue (negatively-sloped) curve of Figure 4 is sufficiently large that the economy now finds itself in the truthful region. From the discussion above we also know that the switch to truthtelling is permanent. The other possibility is that (19) 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 Assumption 2 is also satisfied, γ_τ goes eventually to 1 and the negatively-sloped curve of Figure 4 keeps shifting to the right. Then, at some date τ in the future the prior $P(\theta_C)$ of our economy will necessarily lie below the corresponding

τ-cutoff, thereby implying that after observing skeptical attitudes for several periods parents will start being truthful. The above discussion is summarized in the following proposition.

PROPOSITION 5: *Suppose that γ_τ and π_τ evolve according to 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 parent $A_{\tau-1}$ induces skeptical attitudes in A_τ, at time $\tau+1$ parent A_τ may either keep inducing skeptical attitudes in $A_{\tau+1}$ or be truthful. If Assumption 2 is also satisfied, we obtain that as $\tau \to \infty$ skepticism will eventually be replaced by truthful reporting.*

The intuition explaining why truthtelling is persistent is (once again) as follows. Since under truthtelling individuals have doubts when Nature sends signal s_D, we obtain that individuals are sometimes induced to conduct autonomous research in order to acquire information. This produces a positive externality on the effectiveness of future research and (by Corollary 1) strengthens the incentives of future parents to tell the truth. This virtuous circle simply does not get started when a society is initially dogmatic and, as a result, no research is conducted. This is why dogmatic attitudes are difficult to eradicate. An implication of Proposition 5 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 effective research instruments. Finally, suppose that at $\tau = 1$ some parents in the society induce skeptical attitudes in their sons and encourage them to conduct research. In the context of our model (Assumptions 1 and 2), this increases the stock of knowledge in the society and makes future signals by Nature more precise. Eventually, manipulation of beliefs stops being profitable and truthtelling replaces skepticism. This result seems to suggest that societies are more likely to make correct decisions over time but that the intensity of conflicts does not necessarily decrease with time.

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 studies information transmission from an informed principal (a parent) to a naive agent (a son). In our model, the parent wants to motivate his son to exert effort in the conflict, but he also cares that the son has the right incentives to acquire information and that he selects the correct policy.

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. This leads to excessive violence and inefficient decision-making. 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. Instilling doubts is a defence mechanism which moderates the escalation of violence in the conflict. However, the skeptical individual obtains, in expected terms, a lower payoff than the opponent.

A brief summary of our results is the following:

(i) Manipulation of information (in both directions) is more likely to occur in heterogenous societies and when Nature's signals are less informative. Dogmatic attitudes are less likely to be observed when the agent is able to conduct autonomous and successful research.

(ii) Dogmatic attitudes are observed if the parent's altruism is low. When instead altruism is high, we obtain that the son is induced by his parent to always doubt.

(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 $[c_j - \varepsilon, c_j]$ 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 $m_{\widehat{A}} = s_{ND}$ 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 $s = s_{ND}$, $\widehat{A}$ 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_D, A enters the conflict with probability $\left(2\mu^A\left(s_D\right)-1\right)$. Conditional on A exerting positive effort, his expected effort cost is

$$-\frac{2\mu^A\left(s_D\right)-1}{2}. \tag{20}$$

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 $2\left(1-\mu^A\left(s_D\right)\right)$, 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 $1-\mu^{\widehat{A}}\left(s_D\right)$.

We now explain (13). Suppose that $\widehat{A}$ induces A to start a total conflict by sending the false message s_{ND} when $s = s_D$. 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 $s = s_D$ is

$$\frac{\mu^{\widehat{A}}\left(s_D\right)}{2}+\frac{1-\mu^{\widehat{A}}\left(s_D\right)}{2}, \tag{21}$$

which is equal to $1/2$. To understand (21) note that with probability $1/2$ player A wins and implements policy a, which gives $\widehat{A}$ an expected payoff equal to $\mu^{\widehat{A}}(s_D)$. With probability $1/2$ player B wins and implements policy b, which gives $\widehat{A}$ an expected payoff equal to $1-\mu^{\widehat{A}}(s_D)$. $\square$

PROOF OF PROPOSITION 2

Step 1: *When*

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

$\widehat{A}$ is truthful.

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

$$\mu^{\widehat{A}}(s_D) = \frac{P(\theta_C)(1-\gamma)}{1-P(\theta_C)+P(\theta_C)(1-\gamma)}.$$

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

$$\mu^{A}(s_D) = \frac{P(\theta_C)(1-\gamma)}{1-P(\theta_C)+P(\theta_C)(1-\gamma)}.$$

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

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

Suppose instead the parent sends message s_{ND}. In this case, A starts a total conflict. Using (13), the parent'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_D.

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

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

which is greater than zero, the payoff obtained by sending message s_D, 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_{ND}.

Step 2: *When*

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

$\widehat{A}$ is also truthful.

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

$$\left(2\mu^A(s_D)-1\right)\frac{1-\beta\left(2\mu^A(s_D)-1\right)}{2}+2\left(1-\mu^A(s_D)\right)^2. \tag{22}$$

To see whether $\widehat{A}$ has an incentive to deviate and send message $m_{\widehat{A}} = s_{ND}$ when the actual signal is s_D, we compare (22) to (13), the expected utility after the deviation. To show that (13) is lower than (22) when the condition in the statement of Step 2 is met, take the derivative of (22) with respect to $\mu^A(s_D)$:

$$-2\beta(2\mu^A(s_D)-1)+1-4(1-\mu^A(s_D)). \tag{23}$$

This derivative can be written as

$$(1-2\beta)(2\mu^A(s_D)-1)+2(\mu^A(s_D)-1). \tag{24}$$

Knowing that $1 \geq \mu^A(s_D) > 1/2$ and that $1 \geq \beta \geq 1/2$, one can verify that the derivative is always negative. Since (13) is equal to (22) when $\mu^A(s_D) = 1$, we have proved that (13) is lower than (22). Therefore, $\widehat{A}$ has no incentive to send message s_{ND} when $s = s_D$.

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

$$\mu^A(s_D) \leq \frac{1}{2\beta}, \tag{25}$$

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

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

Step 3: *When*

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

$\widehat{A}$ sends message s_D 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_D when the actual signal is s_{ND}. When instead $s = s_D$ the report is truthful. It then follows that regardless of s, $\widehat{A}$ always sends message s_D.

This concludes the proof of Proposition 2. $\square$

PROOF OF PROPOSITION 3

We proceed by steps.

Step 1: *When*

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

$\widehat{A}$ 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*

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

$\widehat{A}$ is truthful.

Proof of Step 2: First, suppose that $s = s_D$. Since

$$\frac{1}{2-\gamma} < P(\theta_C),$$

we have that $\mu^A(s_D) > 1/2$. Then, a conflict arises. The parent's expected utility of sending a truthful message is (22). To see whether $\widehat{A}$ has an incentive to deviate and send message $m_{\widehat{A}} = s_{ND}$ when the actual signal is s_D, we compute his utility after this deviation. This is given by (13). In comparing (22) to (13), one can show that when $\beta < 1/2$ it may be the case that (13) is greater than (22). However, when

$$\mu^A(s_D) \leq \frac{1}{2(1-\beta)}, \tag{26}$$

(13) is lower than (22). Then, $\widehat{A}$ has no incentive to send message s_{ND} when he receives signal s_D. Knowing that $\mu^A(s_D)$ is given by (5), it is easy to verify that (26) is satisfied if and only if

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

Finally, suppose that the actual signal is $s = s_{ND}$. The parent utility from truthful reporting is (10), while the utility of sending message s_D is (11). One can show that when $\beta < 1/2$ the parent has no incentive to misreport.

Step 3: *When*

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

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

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

This concludes the proof of Proposition 3. □

PROOF OF COROLLARY 2:

Step 1: *We show that the incidence of conflict is increasing in* $P(\theta_C)$.

Proof of Step 1: First, we compute the probability that a conflict occurs:

$$\Pr(\text{conflict}) = \begin{cases} \gamma P(\theta_C) \text{ if } P(\theta_C) \leq \frac{1}{2-\gamma}, \\ 1 \text{ if } P(\theta_C) > \frac{1}{2-\gamma}. \end{cases} \tag{27}$$

To understand (27), notice that for all $m_{\widehat{A}}$ we have that $\mu^A(m_{\widehat{A}}) > 1/2$ when $P(\theta_C) > 1/(2-\gamma)$. This implies that regardless of $\widehat{A}$'s message strategy, conflicts always occur when $P(\theta_C) > 1/(2-\gamma)$. When instead $P(\theta_C) \leq 1/(2-\gamma)$, one can verify from Propositions 2 and 3 that $\widehat{A}$ is truthful. Since $\mu^A(s_D) \leq 1/2$, a conflict arises only when $\widehat{A}$ sends message s_{ND}, an event occurring with probability $\gamma P(\theta_C)$.

Note that the probability of observing a conflict is obviously increasing in $P(\theta_C)$.

We now move to the proof of the second part of Corollary 2. 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

$$E(c_A + c_B) = \phi(s_D)E(c_A + c_B; s_D) + \phi(s_{ND})E(c_A + c_B; s_{ND}). \tag{28}$$

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

$$\phi(s_D) = 1 - \gamma P(\theta_C) \text{ and } \phi(s_{ND}) = \gamma P(\theta_C).$$

From (28), (9), and the results of Proposition 3, we write the expression for $E(c_A + c_B)$ when $\beta < 1/2$:

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

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

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

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

Proof of Step 2: To see this, we first show that

$$\gamma P(\theta_C) + (1 - \gamma P(\theta_C))(2\mu^A(s_D) - 1)\mu^A(s_D) \tag{29}$$

is increasing in $P(\theta_C)$. Knowing (5), we find the derivative of (29) with respect to $P(\theta_C)$:

$$\gamma + (1-\gamma)(2\mu^A(s_D) - 1) + P(\theta_C)\frac{2(1-\gamma)^2}{(1-\gamma P(\theta_C))^2} \tag{30}$$

which is positive since $(2\mu^A(s_D) - 1)$ is positive, $P(\theta_C) \in (1/2, 1)$, and $0 \leq \gamma \leq 1$. Moreover, note that (29) is equal to $\gamma P(\theta_C)$ when $P(\theta_C) = 1/(2-\gamma)$, and that (30) is greater than γ, the slope of $E(c_A + c_B)$ when $P(\theta_C) \leq 1/(2-\gamma)$. Finally, note that (29) is lower than one: that is, right after $P(\theta_C) = \widehat{P}$, total effort jumps.

Step 3: *We show that $E(c_A + c_B)$ is not monotone in $P(\theta_C)$ when $\beta > 1/2$.*

Proof of Step 3: It is enough to show that right after $P(\theta_C) = \overline{P}$, total effort drops. This is obvious since

$$(2\mu^A(s_D) - 1)\mu^A(s_D) < 1.$$

This concludes the proof of Corollary 2. □

PROOF OF LEMMA 3: To understand (15), 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 parent is then given by (11). With probability π research is successful and A perfectly observes the state. Since $s = s_{ND}$, A can only discover that $\theta = \theta_C$. In this case, a total conflict arises and the parent's payoff is (14). To understand (16), note that with probability $(1-\pi)$ research is not successful and individual A does not change his beliefs: the expected payoff to the parent is then given by (12). The parent's expected payoff in case research is successful is as follows. With probability $\mu^{\widehat{A}}(s_D)$, $\widehat{A}$ expects A to discover that the true state is θ_C. 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_A. In this case, $\widehat{A}$'s payoff would be equal to one. □

PROOF OF PROPOSITION 4

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

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

$$\left(2\mu^A(s_D)-1\right)\frac{1-\left(2\mu^A(s_D)-1\right)}{2}+2\left(1-\mu^A(s_D)\right)^2, \tag{31}$$

which is equal to $1-\mu^A(s_D)$.

If instead he conducts research, A expects to obtain

$$(1-\pi)\left[\left(2\mu^A(s_D,NS)-1\right)\frac{1-(2\mu^A(s_D,NS)-1)}{2}+2(1-\mu^A(s_D,NS))^2\right]+ \\ +\pi\left[1-\mu^A(s_D)\right], \tag{32}$$

which is also equal to $1-\mu^A(s_D)$.

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

Proof of Step 2: Suppose that $\widehat{A}$ always sends message s_D when $\pi=0$. This implies that (11) $\geq$ (10) and (12) $\geq$ (13). When $\pi>0$, (15) replaces (11) and (16) replaces (12). It is easy to show that (11) $\geq$ (10) if and only if (15) $\geq$ (10). Moreover, it is also simple to verify that if (12) $\geq$ (13) we also have (16) $\geq$ (13).

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

Proof of Step 3: Suppose that $\widehat{A}$ always sends message s_{ND} 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) $\geq$ (15). Note however that (13) $\geq$ (12) does not necessarily imply that (13) $\geq$ (16). One can easily verify that we have that (13) $\geq$ (16) if and only if

$$\mu^A(s_D)\geq\frac{2-\pi(1-\beta)}{4(1-\pi)(1-\beta)}. \tag{33}$$

Notice that when $\beta\geq 1/2$ inequality (33) is never satisfied. Suppose instead $\beta<1/2$. When $\pi=1$, the RHS of inequality (33) goes to infinity, thereby implying that inequality (33) is never satisfied. When $\pi = 0$ inequality (33) 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 (33) is satisfied. When instead $\pi > \widetilde{\pi}$ the parent 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) $\geq$ (15) and that if (12) $\geq$ (13) we also have (16) $\geq$ (13). $\square$