Welfare and Competition in Expert Advice Markets*

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Abstract

We perform a controlled experiment to study the welfare effects of competition within a strategic communication environment. Two equally informed senders with conflicting interests can misreport information at a cost. We compare a treatment where only one sender communicates to a treatment where both senders privately communicate with a decision-maker, all else equal. Data show that competition fails to improve decision-making and harms senders' welfare. As a result, the overall market welfare is significantly lower under competition. In both treatments, senders reveal less information, and decision-makers obtain less than the most informative equilibria predict. However, they still reveal and get more information compared to other equilibria.

Keywords: experiment, welfare, multiple senders, competition, sender-receiver games.

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1 Introduction

Economic theory and intuition suggest that an effective way to obtain reliable information is to consult several well-informed experts with conflicting interests.[1] Indeed, competition between experts may spur information transmission and allows for comparing their recommendations. However, competitive pressures may also drive experts to dissipate a considerable amount of resources to influence decision-makers. The trade-off between decision-makers' accuracy and the wasteful use of resources for persuasion is central in, e.g., lobbying, legal systems (Posner, 1999; Tullock, 1975), and the efficient design of organizations (Milgrom, 1988). This paper uses a controlled experiment to study how competition between experts affects this trade-off.

The main goal of this paper is to study the welfare effects of competition in information provision. To this end, we present a novel experimental design that builds upon canonical sender-receiver environments. There are three players: two senders and one decision-maker. The two senders have state-independent payoffs and conflicting interests. They observe the realization of a random variable, which we refer to as the *drawn value*. The drawn value can be either a positive or a negative integer. Then, depending on the treatment, one or both senders privately deliver a report to the decision-maker. The decision-maker is fully aware of the senders' preferences and cares about learning the sign of the drawn value.[2] After observing the reports, the decision-maker selects one of two possible actions. We say that *persuasion* occurs when the decision-maker selects a sender's preferred action when, under complete information, she would have chosen the other action.

A key feature of our setup is that senders can misreport the drawn value at a cost proportional to the size of the lie: reports claiming that the drawn value is further away from its actual realization are more expensive. These "misreporting costs" have a broad interpretation. They can encapsulate direct costs for tampering with evidence, the time and effort required to credibly "cook the numbers," bribe witnesses, manipulate earnings,

[1] Consulting multiple senders proves beneficial both when information is fully verifiable (Milgrom & Roberts, 1986) and when it is not verifiable (Battaglini, 2002). The "wisdom of the crowd" literature suggests that obtaining diverse opinions is beneficial even without conflicts of interest (Galton, 1907; Kremer, Mansour, & Perry, 2014). By contrast, this paper considers a setting with partially verifiable information and with no scope for information aggregation and acquisition.

[2] The drawn value can be naturally interpreted as a quality dimension, valence score, or vertical differentiation parameter. For example, in a courtroom the state can represent the quality of a test, strength of evidence, or competence of a witness expert. To adjudicate, the judge needs to believe that the supporting evidence is strong enough, "beyond a reasonable doubt."

etc.[3] The explicit inclusion of misreporting costs makes our environment one of "costly talk" rather than cheap talk. This feature allows us to measure the resources senders use to influence decision-makers, a critical component of players' welfare currently unexplored in related experimental work. The presence of multiple senders and misreporting costs generates a framework that combines a communication game with an all-pay contest. This combination produces an interesting trade-off because competition is typically beneficial in the former and detrimental in the latter.[4]

The experiment performs a treatment manipulation by varying the number of senders allowed to make a report. In our baseline condition, we consider a monopolistic news market where only one of the two senders communicates with the decision-maker. Instead, the treatment variation mimics a competitive news market where both senders privately communicate with the decision-maker.[5] Senders are equally and perfectly informed, and thus they compete in the provision of the same piece of information. The absence of information aggregation problems allows us to isolate the effects of competition on the players' welfare. Senders' competition can benefit decision-makers even when there is no scope for information aggregation: cross-validating the senders' report allows decision-makers to extract more information from each report and to discipline senders by deterring misreporting. On the other hand, competitive pressures may promote misreporting, thus increasing senders' expenditures while simultaneously decreasing information transmission.

We say that a sender allowed to communicate is *active*. By contrast, a spectating sender is *inactive*. The only difference between the two experimental conditions is the number of active senders. This number determines the underlying strategic environment: the competitive treatment has an adversarial component absent in the monopolistic baseline. The decision-maker can compare and cross-validate the reports of two active senders, whereas she cannot make such comparisons when one sender spectates.

[3]Alternatively, they can incorporate more indirect and non-pecuniary costs such as reputation damages, perjury convictions, or moral concerns. Our underlying assumption is that misreporting more is—in expectation—more costly, as doing so requires the use of more resources or increases the probability of being caught in a lie (see e.g., Abeler, Nosenzo, & Raymond, 2019; Gneezy, Kajackaite, & Sobel, 2018; Kartik, Ottaviani, & Squintani, 2007). Thus, misreporting costs directly depend on how far from the truth a report is and not on how reports are interpreted by decision-makers.

[4]More specifically, our setup can be thought of as an all-pay contest where the success function is endogenous. In communication games, the presence of multiple senders with conflicting interests makes decision-makers better informed (Battaglini, 2002; Krishna & Morgan, 2001b). By contrast, contests are detrimental to welfare when outcomes are determined through an exogenous success function (Baye, Kovenock, & De Vries, 1999; Tullock, 1975).

[5]For a discussion about the role of competition in news markets, see Gentzkow and Shapiro (2008).

The main findings can be summarized as follows. The introduction of competition between senders significantly decreases the total welfare. The sum of individual payoffs is lower in competition than in the baseline condition. There are two determinants of this result. First, on average, competition does not make decision-makers better informed. Second, the total amount of resources devoted to misreporting information is about two times higher in the competitive condition than in the monopolistic one. The average cost incurred per active sender is similar across treatments.[6] However, the rate at which each active sender achieves persuasion is substantially lower in the competitive treatment. As a result, senders are worse off under competition, and the market's total welfare is lower.

In both treatments, the most informative equilibrium is fully revealing. This means that decision-makers acquire all the necessary knowledge to always make optimal choices. However, we observe a consistent pattern of information loss: at times, decision-makers err due to unwarranted skepticism or excessive trust. Nevertheless, the transmission of information remains higher than predicted by non-revealing equilibria in both treatments: decision-making accuracy is significantly better compared to worst-case scenarios. Coherently, senders reveal less information than predicted by the most informative equilibria, but more than in non-revealing ones. A comparison with the *cheap talk* benchmark shows that misreporting costs boost information transmission but make senders worse off.

Our results contribute to the debate concerning the effects of competition in communication environments. Conventional wisdom asserts that competition in news markets promotes truth and better informs decision-makers (Gentzkow & Shapiro, 2008). Informational theories support the view that the presence of multiple senders with conflicting interests spurs information revelation (Battaglini, 2002; Krishna & Morgan, 2001b). By contrast, Tullock's criticism of the common law (Tullock, 1975) suggests that adversary dispute resolution systems are informationally inefficient and socially wasteful. A central point of this criticism is that contending parties in adversarial systems dissipate substantial amounts of resources to influence decision-makers.[7] As a result, "decentralized self-interested behavior by litigants depresses overall social welfare" (Zywicki, 2008).

The rest of the paper is organized as follows. Section 2 discusses the related literature. Section 3 introduces the experimental design, and Section 4 discusses the theoretical

[6]One may think that the duplication of misreporting cost in the competitive treatment is natural given that there are two senders rather than one. However, the senders' reporting behavior is endogenous, and should be reasonably affected by increased competition and difficulty in achieving persuasion.

[7]See, e.g., Zywicki (2008) and references therein.

background. Results are in Section 5. Finally, Section 6 concludes. Other material is in the Online Appendix.

2 Related Literature

This paper contributes to the experimental literature on strategic communication. Most work in this literature builds on the theoretical framework of Crawford and Sobel (1982) by studying settings with one sender and payoff-irrelevant messages.[8] A recurrent finding is an over-communication effect, that is, more information is revealed in controlled experiments than in the most informative equilibria (Blume, DeJong, Kim, & Sprinkle, 1998, 2001; Cai & Wang, 2006; Dickhaut, McCabe, & Mukherji, 1995; Kawagoe & Takizawa, 2009; Lafky, Lai, & Lim, 2022; Sánchez-Pagés & Vorsatz, 2007; Wang, Spezio, & Camerer, 2010). In our experiment with payoff-relevant messages, we find that less information is revealed by senders than predicted by the most informative equilibria.

Differently from the above line of work, we consider an experimental condition with two competing senders. Theoretical work on strategic communication with multiple senders suggests that more information can be revealed with two senders than with one (Battaglini, 2002; Gilligan & Krehbiel, 1989; Krishna & Morgan, 2001a, 2001b; Milgrom & Roberts, 1986).[9] However, the empirical evidence is mixed. Lai, Lim, and Wang (2015) use a multidimensional state space to study fully revealing equilibria as in Battaglini (2002) and find that more information is transmitted with two senders than with one.[10] In experiments with a one-dimensional state space, Battaglini, Lai, Lim, and Wang (2019) and Minozzi and Woon (2019) find that decision-makers do not make more informed decisions when consulting an additional expert. In Battaglini et al. (2019) senders communicate simultaneously, while in Minozzi and Woon (2019) senders communicate sequentially. Both studies find over-communication with one sender but do not find full information revelation when the number of senders is two. In contrast, Minozzi and Woon (2016) show that when two senders communicate simultaneously and are privately informed about

[8] For a survey of the experimental literature on cheap talk, see Blume, Lai, and Lim (2020).

[9] Mullainathan and Shleifer (2005) show a channel through which competition does not necessarily improve decision-making. They consider news markets where readers hold biased views and like to receive information consistent with their prior beliefs. Similarly to our model and related work, their behavioral model shows that multi-homing "conscientious" readers benefit from competition.

[10] Vespa and Wilson (2016) show that fully revealing equilibria can be approximated in the laboratory by using a particular setting with a multidimensional state space.

their own preferences, there is over-communication, and the resulting outcome is close to being fully revealing. Bayindir, Gurdal, Ozdogan, and Saglam (2020) find that with two senders there is no statistically significant over-communication effect, independent of whether the timing of communication is simultaneous or sequential.

Our experiment differs from all the papers mentioned above as we introduce misreporting costs that are proportional to the size of the lie.[11] Messages impact directly on the senders' payoffs, and therefore "talk is not cheap." Instead, communication takes the form of costly signaling.[12] For this reason, our setting is more closely related to the theoretical work on communication with exogenous lying costs (Kartik, 2009; Kartik et al., 2007; Vaccari, 2023a, 2023b) than to that of cheap talk and verifiable disclosure.

A few experiments include communication costs in settings with multiple senders. As we consider senders that compete to persuade a decision-maker, our setting is related to experiments that study information in adversarial procedures. Block, Parker, Vyborna, and Dusek (2000) and Block and Parker (2004) compare the adversarial and the inquisitorial judicial systems in an experiment where auditors enforce an anti-perjury rule.[13] Boudreau and McCubbins (2008, 2009) analyze competition between senders that incur penalties for lying.[14] Differently from this body of work, our experiment focuses on the comparison between monopoly and competition in information provision, and studies the behavior and welfare of all market participants.

Agranov, Dasgupta, and Schotter (2023) analyze the impact of competition on the welfare of all players in a setting where senders suffer from induced lying costs.[15] Senders are sellers that are privately informed about the quality of their product and their

[11] A prominent explanation for the over-communication effect is the presence of pro-social preferences, and in particular of subjects' lying aversion (Hurkens & Kartik, 2009; Sánchez-Pagés & Vorsatz, 2007, 2009). In a setting with two senders, preference uncertainty, and a one-dimensional state space, Minozzi and Woon (2013) use priming and labeling to affect subjects' lying aversion indirectly. Regarding the causes of over-communication in cheap talk games, see Lafky et al. (2022).

[12] Experiments on signalling games (see, e.g., Kübler, Müller, and Normann (2008) and references therein) study settings with a different signalling structure than our paper, have a different scope, and feature a single sender only. An exception to the latter is Müller, Spiegel, and Yehezkel (2009), which studies oligopoly limit pricing with two informed senders.

[13] They define perjury as "embellishment as well as falsification" of information, which is punishable by the forfeiture of the offending party's full potential payoff. Unlike in our setting, in Block et al. (2000) and in Block and Parker (2004), the two contending parties are not equally and fully informed.

[14] The penalty consists of the deduction of a fixed sum of money from a sender's earnings for each time such a sender makes a false statement. In Boudreau and McCubbins (2008, 2009) the receivers have unobserved, uncontrolled, and potentially heterogeneous beliefs about the realized state.

[15] Agranov et al. (2023) also induce other belief-dependent psychological costs such as guilt and disappointment. Conversely, our misreporting costs are common knowledge, belief-independent, and map from larger state and message spaces, thus allowing senders to deliver lies of different magnitudes.

preferences, lying cost included. In their experiment, the welfare of all players is lower with competition than without it. This result is due to a twofold empirical effect of competition on players' behavior: it drives senders to lie more frequently and makes receivers more credulous. In Agranov et al. (2023), sellers use messages to compete in a product market, but they do not compete in the provision of information. By contrast, our experiment considers senders who are equally informed and whose preferences are common knowledge. In our environment, senders compete for the decision-maker's beliefs over the same state of nature.

Lastly, our paper is connected to the experimental literature on voluntary disclosure. Jin, Luca, and Martin (2021) study the unraveling effect, where all information is revealed to receivers (Milgrom & Roberts, 1986). They consider a one-sender one-receiver setting where the sender can either truthfully report the state to the receiver or make no report. Communication is costless, and senders cannot lie or misrepresent their private information. They find evidence in support of incomplete unraveling. In a similar setting, Sheth (2021) finds that senders' competition significantly increases unraveling and improves the receivers' welfare. Contrary to predictions, competition fails to yield complete information revelation. Similar to these papers, our setup admits equilibria where all information is revealed, but we find that inefficiencies persist and some information is lost.

3 Experimental Design

Game. In all sessions of our experiment, groups of three participants make decisions for 30 rounds of play. At the beginning of each session, subjects are randomly assigned to a fixed role: either Sender$_i$, with $i \in \{1, 2\}$, or decision-maker (from now on DM).[16] At the start of each round, and for each group, an integer number labeled as *drawn value* is randomly drawn from the interval [-100, +100] using a truncated discrete normal distribution with zero mean and a standard deviation of 25.[17] The state of the world is determined by this number. If the drawn number is negative, then the state of the world

[16] In the experiment we used neutral labels to not frame participants.

[17] We chose this distribution to increase the number of rounds where misreporting is more likely, i.e., when drawn values are around zero. Using a uniform distribution would instead lead to more extreme drawn values, where persuasion is prohibitively expensive and unlikely to occur. Although a uniform distribution is easier to understand, we wrote our instructions carefully, ensuring that the normal distribution's salient characteristics were clear enough (see Appendix A). A similar approach has been used by Enke and Zimmermann (2019).

is RED. If the number is positive, the state of the world is BLACK. The state is equally likely to be either RED or BLACK if the number is zero. Importantly, the drawn value is revealed to Sender_1 and Sender_2 only.

In our experiment, we exogenously vary the market configuration. For improved reading, we first describe our treatment variation (i.e., *COMP*), where we allow for competition between the two senders. In this treatment, upon receiving information about the drawn value, both senders must privately report to the DM an integer from the interval [-100, +100]. Having observed the two reports, the DM has to guess the state of the world by choosing either action *Red* or action *Black*. The decision-maker is always better off when such a guess is correct. Senders have conflicting incentives over decision-making: Sender_1 always prefers action *Black*, whereas Sender_2 always prefers action *Red*. Therefore, senders may gain by misreporting the drawn number to persuade the DM to choose their preferred action. However, misreporting comes at a cost c_i that is proportional to the difference between the drawn value and the report. Specifically, the larger the lie, the larger the misreporting cost. In the experiment, we used the following cost function:[18]

$$c_i = (25/3) \cdot |\text{Drawn Number - Report}_i|.$$

The design maintains a simple choice structure for the DM and allows senders to deliver lies of varying magnitudes, corresponding to different misreporting costs. This unique feature enables us to integrate a communication game with a contest-like framework whereby senders can achieve persuasion by misreporting relatively more than their competitors. Doing so allows us to analyze the trade-off between information transmission and rent-dissipation. Our configuration generates a tension that would not exist if the report space were limited to binary support, akin to the DM's action space. In our context, each Sender aims to either misreport to a greater extent than their competitor or refrain from doing so entirely. This type of strategic interaction creates a contest where the DM can still extract some information through cross-validation and comparison of the Senders' reports.[19] However, the incentive for Senders to marginally outperform their opponent in lying may lead to an escalation of inefficient misreporting, potentially diminishing both

[18] We calibrated the cost function to allow for the presence of fully revealing equilibria in both our treatments. Failures of full information transmission cannot be attributed to an absence of fully revealing equilibria.

[19] These behavioral patterns, so far just conjectured, are confirmed by the analysis of adversarial equilibria (see Appendix D.2.2).

information transmission and overall welfare.

Our baseline treatment (i.e., *MONO*) is similar to the game described above, with the only exception being that we allow Sender_1 to act as a monopolist in the market. Hence, we bar Sender_2 from reporting information to the DM. For this reason, in this treatment Sender_2 bears no misreporting costs. As Sender_2 is inactive and acts as a spectator, we elicit their beliefs about the choices of the other group members. First, we elicit the belief that Sender_1 reports the drawn value truthfully. Second, we ask for the probability of the DM choosing *Black* conditional on Sender_1's report. These beliefs were elicited through an incentive-compatible mechanism.[20] To keep incentives constant across treatments, we do not inform the other two players that Sender_2 can earn extra money from these two questions.[21] The monopolistic treatment is essential to isolate the effect of competition. It helps in removing differences in behavior across treatments that might be due to other-regarding preferences. Since the payoffs of the three group members in both treatments depend on the action chosen by the DM, we can compare their welfare among the different market configurations.

In all treatments, the expected payoffs and the cost are automatically displayed and updated on participants' screens to avoid cognitive strain and allow subjects to focus on the experimental game. Once the decision-maker selects an action, the payoffs of all group members are assigned accordingly. To promote learning, at the end of each round participants are provided with a summary of the current and previous rounds. Hence, they acquire information about the drawn value, the state, the report(s), the DM's action, and all individual payoffs. Table 1 summarises the experimental payoffs.

Additional variables. At the end of each session, we elicit a self-reported questionnaire. The answers allow us to check whether treatments were balanced with respect to individual characteristics and to control for personal traits in regression analysis. First, we elicit the gender and the age of the respondent. We then obtain a few individual attitudes toward risk, trust, and honesty. These three questions are answered using a Likert scale. The propensity to take risks is captured by the answer to the question "*Do you see yourself as a person ready to take risk or you try to avoid it?*". We allow for 11 possible levels going from "0: absolutely unwilling to take risks" to "10: absolutely willing

[20]Beliefs were incentivised using a quadratic scoring rule. Please see instructions for the spectator for more details (Appendix A).

[21]As the possibility of receiving money from the two beliefs is Sender_2's private information, this extra payment is not included in the analysis where we compare welfare across treatments.

	Payoff	DM's choice
Sender_1	$1200 - c_1$	*Black*
	$400 - c_1$	*Red*
Sender_2	$400 - c_2$	*Black*
	$1200 - c_2$	*Red*
DM	600	choice = state
	200	otherwise

Table 1 Experimental payoffs.

to take risks". Trust is elicited by the following question: "*In general, do you think people can be trusted?*". Answers can span from "0: No, you must always be cautious" to "2: Yes, you can almost always trust". Finally, answers to "*In general, do you think people try to take advantage of others if they get the chance?"* range from "0: No, people always behave correctly" to "3: Yes, they always try to take advantage of it". We use this question as a proxy for the honesty of others. See Appendix A for more details.

Procedures. The experiments took place between March 2021 and October 2021. In total, 192 students recruited from the subject pool of the Cognitive and Experimental Economics Laboratory (CEEL) at the University of Trento participated in our experiment. We implemented a between-subject design, where students were allocated to one session as well as one treatment only. Table C.1 in Appendix C provides basic randomization checks, showing treatments were balanced with respect to most of the key variables. The experiment was programmed and conducted using the oTree open-source platform (Chen, Schonger, & Wickens, 2016) and supervised online in a virtual laboratory setting.

Subjects connected remotely from their personal computer to a Zoom meeting that lasted the entire duration of the experiment. At the beginning of each session, we verified participants' identities, and instructions were displayed on screens and read aloud by one experimenter. Within treatment, each subject was thus presented with the same set of instructions. Subjects then answered control questions and participated in a trial round to familiarize themselves with the task and the graphic interface. Groups were randomly and anonymously formed at the beginning of each round. Hence, we shut down the channel of reputation.

Final payments in the experiment were based on the average earnings of two randomly selected rounds. In the event a participant made a loss (resulting from paying a very high cost of misreporting in the rounds selected for payments), the participation fee covered this loss. In case the fee was insufficient, we asked subjects to complete an additional task whose duration was proportional to their loss.[22] Eventually, no subject had to complete the additional task. Payoffs in each round were given in points and converted into cash at the end of the session using the following conversion rate: 100 points for 1 Euro.

A typical session lasted about 80 minutes, and the average payment was 11.93 Euros, including a 4 Euros participation fee. The experiment was preregistered at OSF Registries (https://doi.org/10.17605/OSF.IO/DXWT7).[23] Data and replication files can be found at: https://osf.io/9svpf.

4 Theoretical Background

This section studies the equilibria of the continuous approximation of our experimental conditions. The analysis performed here informs us of the players' expected payoffs and equilibrium behavior. Section 5.4 compares our theoretical predictions with the empirical payoffs and players' behavior. This comparison allows us to interpret our empirical findings better. We conclude by analyzing a few benchmark cases. The formal description of our model, equilibria characterization, and proofs are relegated to Appendix D.

An equilibrium or outcome is hereby said to be: *truthful*, if senders always report truthfully; *revealing*, if decision-makers obtain their complete-information payoff; *informative*, if decision-makers obtain a strictly higher expected payoff than they would absent communication; *babbling*, if the senders' strategies are state-independent and the decision-makers' strategy is report-independent.[24] Babbling equilibria are not informative, whereas truthful equilibria are informative and revealing. An equilibrium is *more informative* when decision-makers earn a higher expected payoff. We say that *persuasion* occurs in an informative equilibrium when decision-makers select *Black* and the state is RED, or when they select *Red* and the state is BLACK.[25]

[22]Subjects had to count the number of zeroes in a series of 7x10 matrices, the number of which was proportional to the participant's loss. We chose this task for two reasons: (i) it does not distort incentives of misreporting, and (ii) it allows us to provide a low participation fee, preventing the risk of decreasing the salience of the main experimental task.

[23]Our pre-registration plan mentions a third experimental condition where reports are made sequentially. Due to a lack of funding, we did not run this treatment.

[24]For this definition of babbling equilibrium, see Sobel (2020).

[25]This definition differs from that used in other papers. The term "persuasion" is often used to denote

Our first observation is that the setup studied here does not admit babbling or truthful equilibria (Proposition D.1 in Appendix D). Intuitively, babbling outcomes cannot occur because ignored senders best respond by reporting truthfully when misreporting is costly. Truthful equilibria do not exist because they make decision-makers credulous, thereby creating situations where senders can profit from lying. All equilibria of our conditions are informative, and some are revealing. Both *MONO* and *COMP* admit revealing and non-revealing equilibria. Persuasion occurs in all equilibria, except for the revealing ones.

The presence of multiple equilibria prevents us from ranking our conditions in terms of welfare. As we shall see, some equilibria of *MONO* give players a higher expected payoff than other equilibria of *COMP*, and vice-versa (see Table 2). Refinements are unhelpful because they are either ineffective or cannot be applied to both our conditions simultaneously. In contrast with related communication games, the setting considered here does not produce a clear-cut theoretical argument for or against senders' competition. This problem contributes to our motivation for the empirical investigation in Section 5.

4.1 Theoretical Expectations

To measure information transmission, we first look at the decision-maker's expected payoff. This score encapsulates how much information is revealed by senders and incorporated by decision-makers. The monopolistic setting's (*MONO*) most informative equilibrium (MIE) is revealing, meaning that decision-makers always select their preferred action. By contrast, some information is lost in the monopolistic setting's least informative equilibrium (LIE). As we shall see, information transmission is compromised in this condition by Sender_1's successful persuasion attempts via misreporting.

The competitive setting (*COMP*) also admits revealing equilibria. In these MIE, senders may obtain different payoffs depending on their reporting behavior. To study non-revealing equilibria of the competitive setting, we use the *adversarial equilibrium* (AE) solution concept (Vaccari, 2023a). In AE, some information is lost because of senders' misreporting behavior. It is not known whether AE are also the LIE of *COMP*. However, this is not a problem because we observe that information transmission is significantly

situations where decision-makers take an action that, absent information provided by the senders, she would not have taken. Such a term is often—but not exclusively—used in frameworks where information is fully verifiable, misreporting is not possible, and senders have commitment power (such as, e.g., in games of verifiable disclosure or Bayesian persuasion models). By contrast, in this paper information is partially verifiable, misreporting is possible, and senders have no commitment power.

higher than prescribed by the AE. Table 2 shows the players' expected payoffs and the market's total welfare in all these equilibria.

Setting – eqm	DM	Sender_1	Sender_2	Total
MONO – MIE	600	483.09	800	1883.09
MONO – LIE	410.96	800	421.92	1694.05
COMP – MIE	600	483.09 or 800	800 or 483.09	1883.09
COMP – AE	449.08	561.84	561.84	1572.76

Table 2 Players' expected payoffs in different equilibria of *MONO* and *COMP*. The senders' payoffs in *COMP* – MIE take two values because the competitive setting admits two most informative equilibria.

The decision-makers ex-ante payoffs tell us how their actions relate to the realized states in equilibrium. In revealing equilibria, decision-makers always select their preferred action conditional on the realized state. The correlation between actions and realized states would be zero in babbling or non-informative equilibria. Next, we further disentangle players' behavior by looking at the relationship between realized states and reports, and between reports and decision makers' actions.

Recall that the state is BLACK when the drawn value is positive and RED when the drawn value is negative. In all the equilibria we consider, Sender_1 delivers positive reports when the state is BLACK. Similarly, Sender_2 delivers negative reports when the state is RED. This observation is natural, given the senders' incentives. More formally, denote by τ_1 (τ_2) the ex-ante probability that, in a given equilibrium, Sender_1 (Sender_2) delivers a positive (negative) report conditional on the state being BLACK (RED). The scores τ_j represent senders' inclination to correctly report the state when it is convenient for them to do so. By no surprise, we always have $\tau_j = 1$ for $j \in \{1, 2\}$.

Next, we analyze senders' tendency to misreport the state in an attempt to persuade decision-makers. We say that Sender_1 (Sender_2) attempts persuasion by delivering a positive (negative) report when the state is RED (BLACK). Denote by μ_1 (μ_2) the ex-ante probability that, in a given equilibrium, Sender_1 (Sender_2) delivers a positive (negative) report conditional on the state being RED (BLACK). The scores μ_j represent the senders' inclination to misreport the state. In revealing equilibria, we have $\mu_j = 0$. By contrast, in non-revealing equilibria we have $\mu_j > 0$. Table 3 describes the senders' equilibrium behavior in the monopolistic and competitive settings.

Setting – eqm	Sender$_1$		Sender$_2$	
	μ_1	τ_1	μ_2	τ_2
MONO – MIE	0	1	–	–
MONO – LIE	0.95	1	–	–
COMP – MIE	0	1	0	1
COMP – AE	0.60	1	0.60	1

Table 3 Senders' ex-ante reporting behavior in different equilibria of *MONO* and *COMP*.

Finally, we examine decision-makers equilibrium behavior. The sequentially rational choice rule depends on the setting and equilibrium. In *MONO*, decision-makers select *Black* if and only if Sender$_1$'s report is sufficiently high. In the MIE of *COMP*, decision-makers base their choice solely on the report of one of the two senders. By contrast, their choice depends on both senders' reports in the AE of *COMP*. Specifically, decision-makers select *Black* if the average report is positive, and select *Red* otherwise. In every equilibrium, decision-makers employ a threshold choice rule whereby they select action *Black* if and only if reports are sufficiently high. Each equilibrium features a different threshold determining how reports should be to induce decision-makers to select *Black*. We summarize the thresholds for each equilibrium in Table 4.

Setting – eqm	DM
	$a = Black$ iff
MONO – MIE	$r_1 \geq 96$
MONO – LIE	$r_1 \geq 48$
COMP – MIE	$r_1 \geq 96$, $r_2 > -96$
COMP – AE	$\frac{r_1+r_2}{2} \geq 0$

Table 4 Decision-makers' threshold choice rule in different equilibria. The MIE of *COMP* features two different choice rules because there are two most informative equilibria of the competitive setting.

Denote by λ (φ) the ex-ante probability that, in a given equilibrium, the DM selects *Black* conditional on the senders' report being higher (lower) than the equilibrium's threshold. Clearly, we obtain that $\lambda = 1$ and $\varphi = 0$. In Section 5.4 we will confront these theoretical scores with empirical observations to see whether the decision-makers choice rule is consistent with that prescribed by some equilibrium. An analysis of λ and φ is instrumental in understanding the relationship between reports and actions.

Denote by β (ζ) the ex-ante probability that the DM selects *Black* (*Red*) conditional on the state being BLACK (RED). The scores β and ζ represent the probability that the DM takes the correct action conditional on the state. An equilibrium is revealing when $\beta = \zeta = 1$. Lower values of β and ζ indicate that some information is lost due to either persuasion or miscommunication. An analysis of β and ζ is instrumental in understanding the relationship between states and actions. Table 5 shows how the decision-makers' actions relate to the senders' reports in different equilibria of our settings, and how this reliance affects optimal decision-making in different states.

Setting – eqm	DM			
	λ	φ	β	ζ
MONO – MIE	1	0	1	1
MONO – LIE	1	0	1	0.05
COMP – MIE	1	0	1	1
COMP – AE	1	0	0.62	0.62

Table 5 Decision-makers' ex-ante behavior in different equilibria of *MONO* and *COMP*.

4.2 Benchmarks

We conclude this section by analyzing three important benchmarks. In the *Complete Information* benchmark, decision-makers know perfectly the realized state. There is no asymmetric information problem, and communication is not necessary. In the *No-Communication* benchmark, senders cannot deliver reports, and decision-makers must act based on their prior beliefs only. In the *Cheap Talk* benchmark, senders do not incur misreporting costs but can deliver any report for free.

The first two benchmarks are easier to scrutinize. Under complete information, decision-makers always take the best course of action. This first benchmark sets a best-case scenario: DMs cannot do better than when perfectly informed. When communication is not possible, decision-makers cannot do better than by randomizing actions.[26] This case describes an absence of information transmission and a worst-case scenario for decision-making. Unlike

[26]Since decision-makers are indifferent between the two actions under the prior, any randomization yields the same expected outcome.

in equilibria of our settings, in these two benchmarks senders are passive and do not or cannot misreport information.

In the cheap talk benchmark, senders can communicate and lie, but do not incur misreporting costs by default. This case is relevant because it helps to understand the equilibrium implications of introducing misreporting costs in an otherwise cheap talk framework. It is widely known that babbling equilibria of cheap talk games always exist. No information is transmitted when babbling occurs. A relevant question is whether the cheap talk benchmark of our setting can admit informative equilibria whereby some information is conveyed and decision-making is improved.

We find that all equilibria of the cheap talk benchmark are non-informative (see Proposition D.2 in Appendix D). Intuitively, this result is due to the stark conflict of interest between decision-makers and senders. The *Cheap Talk* and *No-Communication* benchmarks are outcome-equivalent. The introduction of misreporting costs generates informative outcomes in settings where no information transmission would otherwise occur. Table 6 shows the players' expected payoffs in the three benchmarks and both treatments.

Benchmark	DM	Sender_1	Sender_2	Total
Complete Info	600	800	800	2200
No Communication	400	800	800	2000
Cheap Talk	400	800	800	2000

Table 6 Players' expected payoffs under three benchmark cases and across both treatments.

5 Results

We start this section by describing the choices of senders (Sender_1 and Sender_2) and decision-makers (DM). Table 7 provides summary statistics for individual choices for each role. Then, we focus our analysis on welfare measured via individual payoffs (Net Payoffs). Finally, we present some additional results that help explain behavior in the experiment.[27]

[27] In Appendix B, we present further analysis of decision times and spectator beliefs. These results show how participants reacted to the different strategic incentives, and whether they had an overall correct representation of others' behavior.

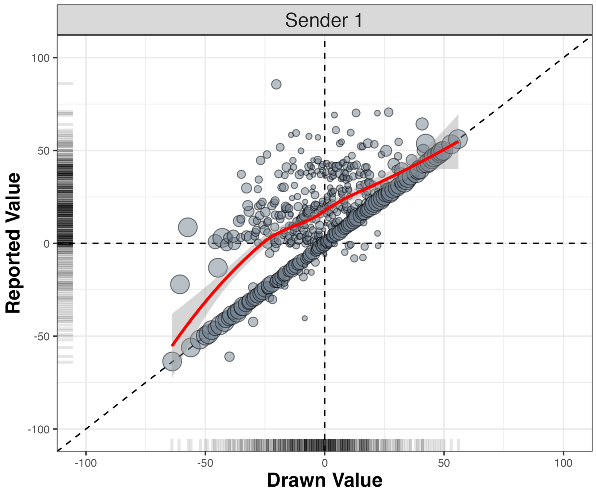
	Role	*MONO*		*COMP*		
Fraction of truthful reports	Sender_1	0.565		0.472		
	Sender_2	-		0.512		
Average deviation	Sender_1	9.634 (16.567)		8.961 (16.316)		
	Sender_2	-		10.267 (18.059)		
Fraction of mistakes	DM	0.278		0.260		
Sign of report(s)		$-$	$+$	$++$	$+-$	$--$
Fraction of chosen Red*	DM	0.860	0.205	0.014	0.513	0.979

Table 7 Summary statistics by role and experimental condition (individual observations).
Note: Deviations are computed as Report-*Drawn Value* (*Drawn Value*-Report) for Sender_1 (Sender_2). Standard deviations are in parentheses. *Fractions are conditional on the sign of the report(s), which are reported in columns; in *COMP*, the signs refer to the reports of Sender_1 and Sender_2, respectively.

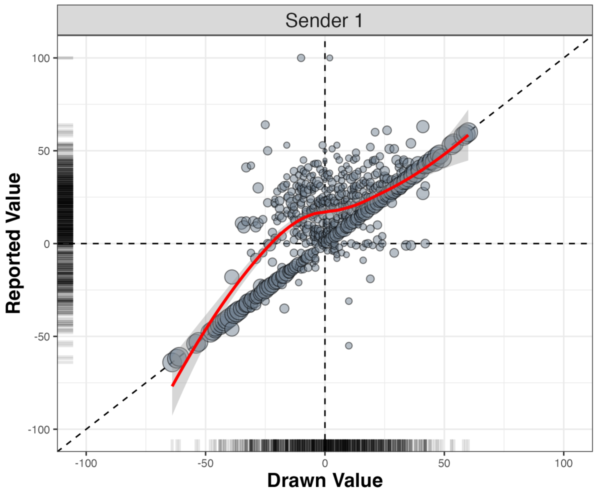
The upper panels of Table 7 show that truthful reports by senders are not ubiquitous and happen about half of the time, with substantial absolute level deviations from the *drawn value* in both conditions. Concerning the decision-makers, most guesses are correct, with the percentage of mistakes slightly above 25% in both treatments. The bottom panel illustrates the behavior of DMs as a reaction to the information received. In *MONO*, decision-makers seem to generally follow the report sent by the monopolist. In *COMP*, when the reports of Sender_1 and Sender_2 are consistent, DMs adamantly follow their messages. Differently, when reports conflict, they seem to disregard them and be indifferent between the two color options. Below, we elaborate on these pieces of evidence.

5.1 Senders

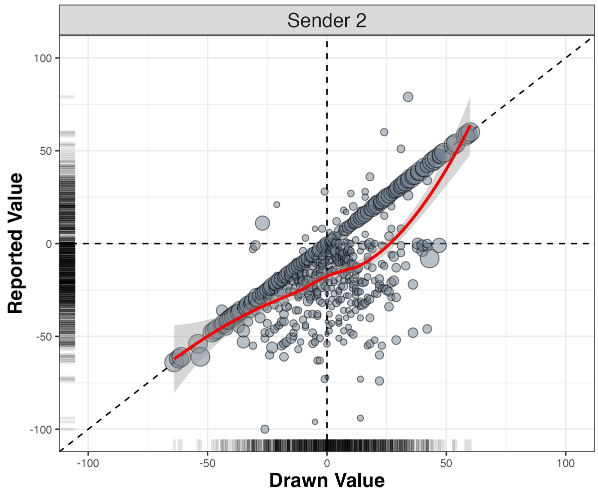
Figure 1 provides a representation of senders' behavior in terms of reported values conditional on drawn values. The upward panel (1a) portrays the senders' behavior in *MONO*, whereas the two downward panels (1b and 1c) depict their behavior in *COMP*. The circles' size captures the reports' joint frequency given the observed drawn value. The continuous line represents a polynomial fitting of the data. The gradient of bars on the side of the graph depicts the marginal distribution of drawn (x-axis) and reported values (y-axis).



(a) MONO: Sender 1



(b) COMP: Sender 1



(c) COMP: Sender 2

Figure 1 Drawn and reported values by treatment.
Panel 1a shows reports of Sender$_1$ conditional on the drawn value in *MONO*. Panels 1b and 1c show reports from Sender$_1$ and Sender$_2$ in *COMP*, respectively. Each circle captures the joint frequency of the reports given the realized drawn value. The red line represents a polynomial fitting of the data. The x-axis depicts the marginal distribution of the realized random draws. The y-axis shows the marginal distribution of reported values.

Deviations from truthful reporting are widespread: only 49.2% and 56.5% of reports are truthful in *COMP* and *MONO*, respectively. The figure shows that senders react to the monetary incentives in both experimental conditions and tend to misreport to their advantage. Sender$_1$ overreports the drawn value, while Sender$_2$ tends to send negative reports more frequently (see the marginal distribution of reports on the y-axis). The bubble plot suggests deviations are more frequent for drawn values closer to zero, as confirmed by the fitting curve. When computing deviations of reported values from drawn values,[28] the overall average deviation is 9.634 in the monopoly and 9.614 in the competition treatment. As the figure suggests, senders misreport to a larger extent when they have a conflict of interest with the DM. In these cases, the average deviation is 13.291 and 13.386 in *MONO* and *COMP*, respectively. Table 8 provides a summary description of misreporting costs sustained by senders in the two treatments.

Treatment	Role	N	Mean	SD	Median
MONO	Sender_1	960	85.859	134.664	0.000
COMP	Sender_1	960	88.533	127.372	16.667
	Sender_2	960	93.090	145.950	0.000

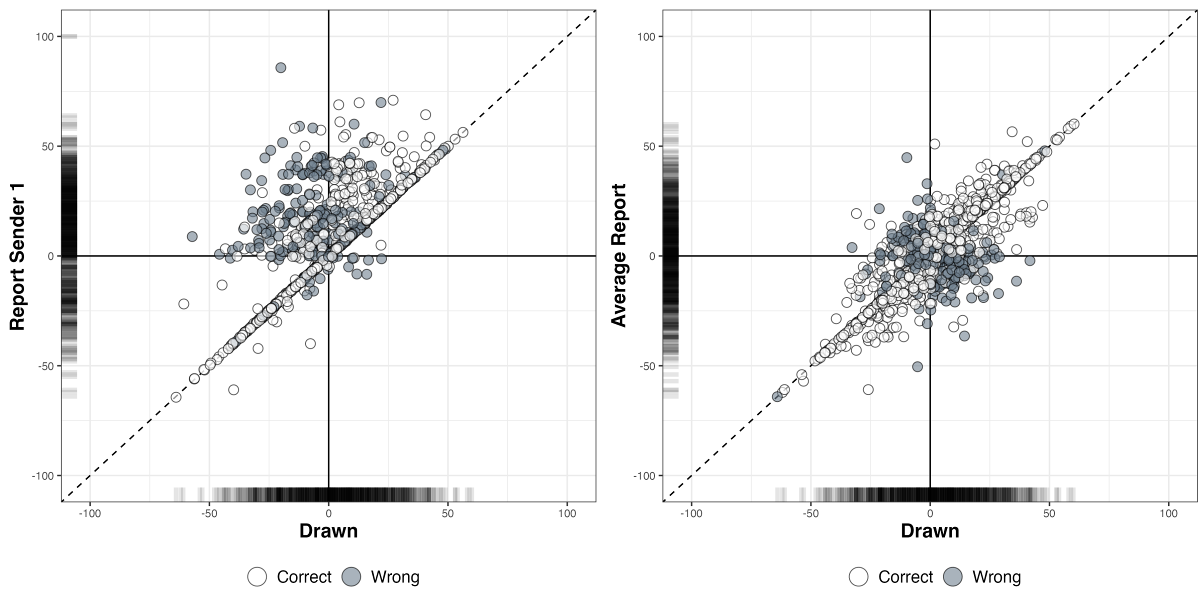
Table 8 Misreporting Costs (individual observations).

Individual average costs appear to be similar between the two treatment conditions, and no significant differences between the two conditions are identified (Wilcoxon Rank Sum Test on individual averages, p-value = 0.395) . However, as in *COMP* both senders are allowed to communicate, the average total costs per group are 181.623, more than twice that of those in *MONO*.

5.2 Decision-Makers

Figure 2 provides a representation of the correct and wrong choices of decision-makers. The leftward panel (2a) refers to the monopoly treatment and shows DMs' guesses conditional on Sender_1's report and the drawn value. The rightward panel (2b) represents DMs' choices in competition conditional on the average report of the two senders and the drawn value.

[28]The deviation is computed as the difference between the report and the drawn value for Sender_1 and the opposite (drawn value - report) for Sender_2.

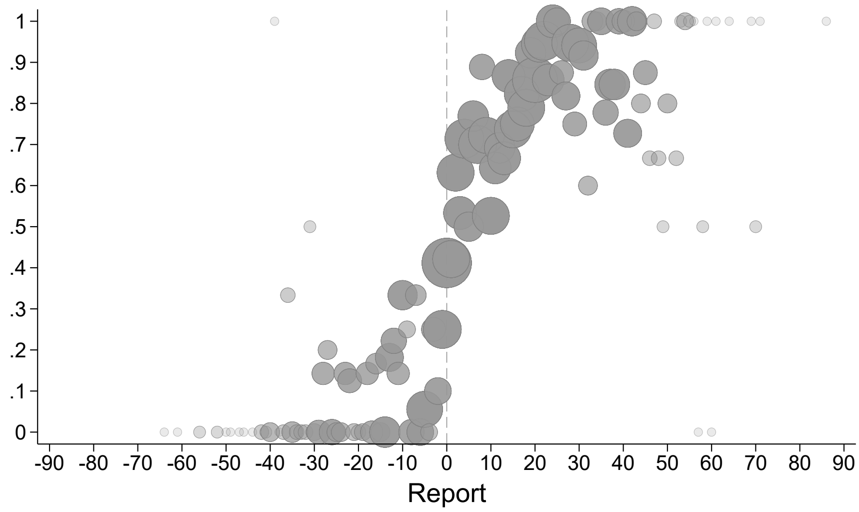


(a) *MONO* **(b)** *COMP*

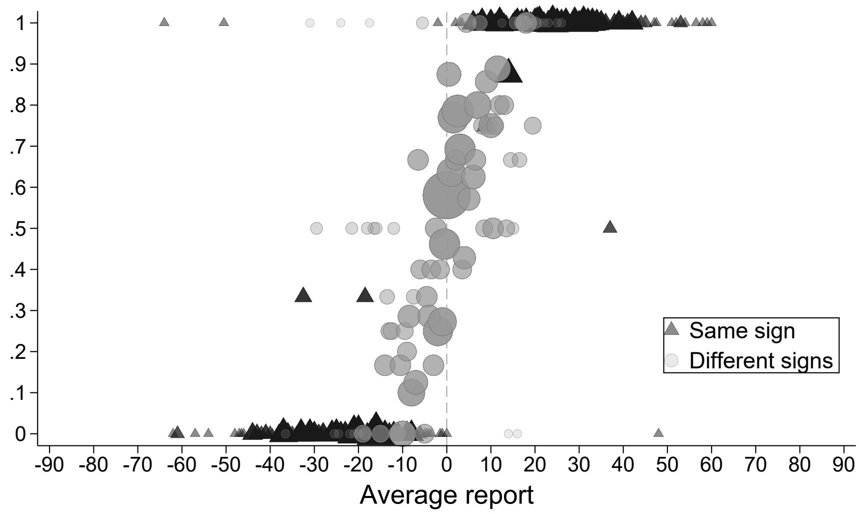
Figure 2 Decision-makers accuracy by treatment.
Note: The figure shows DMs accuracy in *MONO* (2a) and *COMP* (2b). The y-axis reports the unconditional frequency of Sender_1 reports (2a) and average reports by Sender_1 and Sender_2 (2b). The x-axis shows the unconditional frequency of drawn values.

In *MONO*, the overall frequency of correct guesses is 72.2%. As expected, the decision-maker is less likely to make a correct guess (29.3%) when Sender_1 misreports the state to her advantage. Instead, when a positive number is drawn and the monopolist reports a positive value, the percentage of correct guesses increases up to 83.2%. In *COMP*, the overall frequency of correct choices is 74.0%, very similar to *MONO*. However, this percentage depends on the signs of the average report and the drawn value, as shown by Figure 2b. When the average report has a different sign than the drawn value, the percentage of correct choices by DMs is only 31.4%. By contrast, DMs' accuracy significantly increases when the signs are the same: the percentage of correct choices increases to 91.2%, close to fully informed decision-making. This evidence might suggest that in our experiment, decision-makers struggle to interpret the reports from senders when at least one of them invests substantial resources in misreporting.

We visually investigate this possibility in Figure 3. The upper panel (3a) shows the fraction of *Black* choices conditional on the monopolist's reports. The bottom panel (3b), instead, represents the fraction of *Black* choices in *COMP* conditional on the senders' average report. In *MONO*, it seems that decision-makers do not always trust the sender as they choose action *Black* 14% of the time the report is non-positive. When the report is positive, the percentage of *Black* increases to 79.5%. In *COMP*, results are similar: when the average report has a positive (non-positive) sign, DMs choose action *Black* 88% (16%) of the time. However, the information acquired by the decision-makers appears to depend on their ability to cross-validate the two reports. When senders' reports have the same sign, *Black* (*Red*) is almost always selected if the average report is positive (non-positive). DMs appear to easily infer the true realized state as the percentage of correct choices is equal to 95%. In contrast, DMs show more uncertainty when senders deliver reports with different signs. The probability of taking the correct action drops to 49%, close to random guessing. In this last case, the cross-validation of reports appears to be more difficult.



(a) *MONO*



(b) *COMP*

Figure 3 Fraction of action *Black* conditional on report(s).
Note: Markers' size represent the joint frequency of action *Black* and report(s).

The results so far presented show that the introduction of competition directly translates into a wasteful use of resources as the decision-makers seem to not benefit, on average, from consulting an additional information source.

5.3 Welfare

The misreporting costs and the DMs' choices directly translate into participants' payoffs. We take the participants' net payoffs as a measure of their welfare and as our primary unit of analysis.[29]

In Table 9, we report a statistical analysis of the effect of competition on participants' welfare, taking into account the panel structure of our data and other relevant variables. Each column represents a linear mixed-effect model that controls for individual and session effects. The table provides an estimate for each type of player taken in isolation and for pooled data (*Group*).[30] The individual net payoff is regressed against a set of main explanatory variables: *COMP* is a dummy for the main treatment variable ($COMP$=1, $MONO$=0), *Drawn* represents the drawn value observed by senders, and *Round* is the progressive round number. For senders, we control for the drawn value, as we are interested in the impact of the randomly drawn number on senders' payoffs. Because the coefficient of *Drawn* has no clear meaning for either the DM nor groups, we focus on the impact of extreme drawn values instead. Hence, we report the estimated effect of the absolute value of *Drawn* (i.e., $|Drawn|$). The table also controls for individual characteristics and attitudes elicited in the final questionnaire.[31]

[29] In Table C.6 in Appendix C we report descriptive statistics of the net payoffs by treatment at the individual and group levels.

[30] As a robustness check, we also run a regression on the sum of net payoffs at the group level, which implies dropping individual controls. Results from this check further corroborate those in Table 9.

[31] The observations of one participant are missing from the regression for Sender_1 because they did not answer the questionnaire. The observations of one participant are missing from the regression for Sender_2 because they identified neither as a male nor as a female. However, results reported in Table 9 are confirmed when including all observations and omitting controls for individual characteristics.

Net payoff	Sender_1	Sender_2	DM	*Group*
COMP	−58.166 (22.831)*	−42.114 (18.838)*	−25.561 (16.365)	−59.807 (24.510)*
Drawn	10.456 (0.518)***	−8.765 (0.544)***		
COMP×*Drawn*	1.432 (0.734)	−3.200 (0.760)***		
|*Drawn*|			2.589 (0.452)***	1.118 (0.525)*
COMP×|*Drawn*|			2.090 (0.636)**	1.790 (0.739)*
Round	−0.017 (0.849)	−0.375 (0.887)	1.384 (0.444)**	0.481 (0.515)
Male (=1)	−2.442 (22.002)	−2.335 (16.808)	−12.974 (12.597)	−7.964 (20.593)
Age	1.375 (4.534)	6.762 (3.230)*	0.005 (3.148)	0.016 (3.580)
Risk	−4.285 (5.509)	8.078 (4.696)	0.742 (3.183)	0.663 (5.270)
Trust	−8.975 (12.549)	4.423 (10.901)	−4.570 (5.906)	−10.068 (11.359)
Honesty	28.465 (18.762)	−10.934 (16.220)	−6.104 (11.790)	−6.314 (17.994)
Constant	747.561 (103.270)***	554.838 (74.679)***	432.068 (50.382)***	661.643 (87.167)***
Observations	1890	1890	1920	5700
Subjects	63	63	64	190

Table 9 Net Payoffs.
Note: Linear mixed-effects model with net payoff as a dependent variable. The models include random intercepts at session and subject levels. Standard errors are in parentheses. Significance levels: $^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

The regression outputs for both senders show that competition significantly and negatively impacts their net payoffs. As expected, larger drawn values have a positive (negative) effect for Sender_1 (Sender_2). As a spectator, Sender_2 benefits from the occurrence of negative drawn values. This effect is more pronounced in the competitive treatment. For decision-makers, competition does not significantly impact net payoffs. In absolute terms, larger drawn values positively impact net payoffs, and the effect is stronger in competition. The estimated coefficient of *Round* suggests that the performances of DMs improve over time. This learning effect is also confirmed by a regression estimate showing a significant increase in net payoffs in the second half of the session. Finally, when considering all types of players together (*Group*), competition has a negative impact on welfare. In absolute terms, larger drawn values improve welfare, and this effect is stronger under competition. The outcomes of the table echo the results discussed previously: introducing a sender with conflicting goals decreases the total welfare.

5.4 Theoretical benchmarks

In Section 4, we derive some theoretical predictions about expected payoffs and players' behavior in different equilibria of the game. Although in our pre-registration we only mention comparison with the full information benchmark, we also compare data with the other theoretical predictions.

Table 10 shows the percentage deviations of empirical net payoffs from theoretical benchmarks outlined in Section 4. The two main columns identify the two experimental conditions and, nested within each column, the three possible roles. The rows identify alternative benchmarks. The upper panel presents deviations relative to the equilibria presented in Table 2: *Most Informative Equilibrium* (MIE), *Least Informative Equilibrium* (LIE), and *Adversarial Equilibrium* (AE). The lower panel focuses on the three information benchmarks presented in Table 6: *Complete Info*, *No Communication*, and *Cheap Talk*.

	MONO			*COMP*		
Benchmark	DM	Sender_1	Sender_2	DM	Sender_1	Sender_2
MIE	**−18.5**	**61.1**	−8.0	**−17.4**	**53.0**	**−15.1**
	/	/	/	/	**−7.6**	**40.6**
LIE	**18.9**	−2.7	**74.4**	/	/	/
AE	/	/	/	**10.4**	**31.5**	**20.9**
Complete Info	**−18.5**	−2.7	**−8.0**	**−17.4**	**−7.6**	**−15.1**
No Communic.	**22.2**	−2.7	**−8.0**	**24.0**	**−7.6**	**−15.1**
Cheap Talk	**22.2**	−2.7	**−8.0**	**24.0**	**−7.6**	**−15.1**

Table 10 Percentage deviations of net payoffs from theoretical benchmarks.
Note: the bold font identifies differences that are statistically significant at least at 5% level according to a Wilcoxon Signed Rank test on individual averages.

The upper panel of Table 10 displays percentage deviations from expected payoffs across different equilibria (see Table 2). The DM fares significantly worse than in the most informative equilibria (MIE) of either treatment, indicating some loss of information compared to theoretical possibilities. Nonetheless, the DM is significantly better off than in the least informative equilibria (LIE) of *MONO* and the adversarial equilibrium (AE) of *COMP*. Senders' net payoffs significantly diverge from what is expected according to the MIE, underscoring a divergence between observed player behavior and MIE predictions. In contrast, Sender_1 net payoff does not significantly deviate from that predicted by LIE in *MONO*. Yet, Sender_2's net payoff is notably higher, which is consistent with lower persuasion rates (see Table 11) and higher payoffs for the DM. Finally, all players achieve significantly higher payoffs than in the AE of *COMP*, suggesting that players perform better at individual and aggregate levels than in theoretical worst-case scenarios.

The lower panel of Table 10 focuses on the three information benchmarks outlined in Table 6 and discussed in Section 4.2. Senders are worse off than in all competitive benchmarks. In *MONO*, their negative deviations from the benchmarks are smaller than in *COMP*, and statistically significant only for Sender_2. This result suggests that Sender_1's informational rents are offset by their wasteful expenditures in misreporting. Furthermore, competition adversely affects both senders, implying that communication is detrimental to their outcomes. In both experimental conditions, the DM is better off than in the *No Communication* and *Cheap Talk* benchmarks but worse off than in the *Complete Info* one. This result testifies to partial information transmission taking place in the experiment. The presence of misreporting costs (vs. *Cheap Talk*) benefits the DM but harms senders. Additionally, information asymmetries (vs. *Complete Info*) harm all players.

Next, we focus on players' observed behavior. Table 11 compares senders' behavior with that prescribed by different equilibria of our two treatments. Specifically, we analyze how senders' reports relate to the realized state. Table 12 displays decision-makers' behavior, and compares it with theoretical predictions. In the first four main columns, we study how the DM's actions relate to the senders' reports. In the last four main columns, we study how the DM's actions relate to the realized state.

In reading Tables 11 and 12, it may be useful to recall some definitions from Section 4.1. We define several scores which summarize the players' behavior in some given equilibrium. The score τ_1 (τ_2) denotes the ex-ante probability that Sender_1 (Sender_2) delivers a positive (negative) report conditional on the state being BLACK (RED). The score μ_1 (μ_2) denotes the ex-ante probability that Sender_1 (Sender_2) delivers a positive (negative) report conditional on the state being RED (BLACK). Analyzing τ_j and μ_j informs us of how senders' behavior is related to the realized state. The score λ (φ) denotes the ex-ante probability that the DM selects *Black* conditional on the senders' report being higher (lower) than the equilibrium's threshold. An analysis of λ and φ shows us how the decision-makers' actions depend on the senders' reports. Finally, the score β (ζ) denotes the ex-ante probability that the DM selects *Black* (*Red*) conditional on the state being BLACK (RED). An analysis of β and ζ tells us how decision-making relates to the realized state.

Setting – eqm	Sender$_1$				Sender$_2$			
	μ_1	$\hat{\mu_1}$	τ_1	$\hat{\tau_1}$	μ_2	$\hat{\mu_2}$	τ_2	$\hat{\tau_2}$
MONO – MIE	0	0.39***	1	0.95	–	–	–	–
MONO – LIE	0.95	0.39***	1	0.95	–	–	–	–
COMP – MIE	0	0.46***	1	0.94	0	0.41***	1	0.95
COMP – AE	0.60	0.46***	1	0.94	0.60	0.41***	1	0.95

Table 11 Senders' reporting behavior in different equilibria of *MONO* and *COMP*.
Note: We report theoretical probabilities (μ_j, τ_j) from Section 4 along with their empirical estimations ($\hat{\mu_j}$, $\hat{\tau_j}$). Estimated coefficients and statistical significance are derived from mixed-effect linear probability models where we test the estimated conditional probabilities against their theoretical predictions. As estimates from mixed-effect models are less intuitive to interpret in terms of conditional probabilities, in Table C.4 in Appendix C we compare them with pooled OLS estimations. Point estimates between the two models are virtually identical. Significance levels: $^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table 11 shows that senders' τ_j are not significantly different from those predicted by all equilibria and in every treatment. As expected, senders report truthfully the state when they find it convenient to do so. By contrast, senders' attitude to persuasion is always significantly different from that predicted by the considered equilibria. In both our treatments, senders attempt persuasion more frequently than predicted by the MIE but less frequently than predicted by the LIE or AE.

Setting – eqm	DM							
	λ	$\hat{\lambda}$	φ	$\hat{\varphi}$	β	$\hat{\beta}$	ζ	$\hat{\zeta}$
MONO – MIE†	1	n/a	0	0.58***	1	0.81***	1	0.64***
MONO – LIE	1	0.75**	0	0.57***	1	0.81***	0.05	0.64***
COMP – MIE†	1	n/a, 0.53***	0	0.53***, n/a	1	0.75***	1	0.73***
COMP – AE	1	0.86***	0	0.13***	0.62	0.75***	0.62	0.73***

Table 12 Decision-makers' behavior in different equilibria of *MONO* and *COMP*.
Note: We report theoretical probabilities (λ, φ, β, ζ) from Section 4 along with their empirical estimations ($\hat{\lambda}$, $\hat{\varphi}$, $\hat{\beta}$, $\hat{\zeta}$). Estimated coefficients and statistical significance are derived from mixed-effect linear probability models where we test the estimated conditional probabilities against their theoretical predictions. As estimates from mixed-effect models are less intuitive to interpret in terms of conditional probabilities, in Table C.5 in Appendix C we compare them with pooled OLS estimations. Point estimates between the two models are virtually identical.
† Due to the lack of (or few) observations that meet the equilibrium criteria, some point estimates cannot be properly estimated. Significance levels: $^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

We conclude this section by focusing on observed decision-making. Table 12 indicates that decision-making significantly diverges from predictions across equilibria and in all treatments. In *MONO*, DMs display both unwarranted skepticism and excessive credulity with respect to predictions. Scores $\hat{\lambda} < \lambda$ suggest that DMs do not always select *Black* when Sender_1's reports are sufficiently high to signal that action *Black* is optimal. Scores $\hat{\varphi} > \varphi$ suggest that DMs sometimes select *Black* even though Sender_1's reports are insufficiently high and signal that action *Red* is optimal. The interpretation is slightly different when considering the AE of *COMP*. Scores $\hat{\lambda} < \lambda$ ($\hat{\varphi} > \varphi$) suggest that sometimes DMs display excessive skepticism toward Sender_1 (Sender_2) and credulity toward Sender_2 (Sender_1). These observations are coherent with the pattern displayed in Figure 3, which shows that decision-makers do not follow clear cut-off rules as prescribed by equilibria.

In both treatments, decision-makers make significantly less informed choices than those prescribed by MIE. These observations reflect and confirm the occurrence of partial information transmission. In *MONO*, DMs correctly select action *Red* in state *RED* more often than predicted by the LIE. This result can be attributed to lower persuasive behavior (see μ_1 in Table 11). However, DMs also select action *Black* in state BLACK less often than predicted by the LIE. Recall that there is no (interim) conflict of interest between

Sender_1 and the DM when the state is BLACK. Therefore, this result suggests that DMs are excessively skeptical or that senders fail to properly account for DM's skepticism (or both). In *COMP*, decision-making is significantly more informed than predicted by the AE. As before, this result can be attributed to a lower persuasive behavior.

6 Conclusion

We conducted a controlled experiment to study the welfare effects of competition between senders in a strategic communication environment. In contrast with related work, we introduce an exogenous cost that senders incur when misreporting information. This cost is increasing in the size of the lie. Our setup combines elements of standard communication games with those of all-pay contests. Typically, competition benefits decision-makers in the former, whereas it may harm contestants in the latter. This tension plays a central role in several applications, ranging from organizational design to judicial decision-making.[32]

We find that senders' competition fails to enhance decision-making. In both treatments, information transmission falls within the theoretical predictions for the least and most informative equilibria. Concurrently, competition adversely affects senders' welfare. When evaluating the collective welfare of the market, competition exerts a significantly negative impact. Subjects fail to realize the potential informational benefits of competition, resulting in an overall welfare decrease caused by wasteful misreporting costs.

In addition, we observe that senders are negatively impacted by both information asymmetries and their ability to communicate. By comparing our observations with the cheap talk benchmark, we find that the introduction of misreporting costs hurts senders but benefits decision-makers. In all treatments, senders reveal significantly less information than predicted by the most informative equilibria, but less than in other non-revealing equilibria. These results suggest that the most informative equilibria, which typically are focal in communication games, may not best describe the outcomes of settings with explicit and exogenous misreporting costs.[33]

[32] This is the case, for example, when firms internalize the inefficient and wasteful opportunity costs brought by influence activities (Milgrom, 1988). Consulting more employees may improve decision-making, but it can also increase opportunity costs. A similar trade-off is at the center of criticism of adversarial dispute resolution systems: competition between contending parties spurs information discovery and disclosure, but it can also prompt rent-seeking behavior leading to sub-optimal outcomes (Zywicki, 2008).

[33] By contrast, the observed differences with the least informative and adversarial equilibria can be more easily explained by the presence of additional and unobserved lying costs.

Our results have implications for settings with common information and limited scope for information aggregation. The findings suggest that improvements in decision-making are limited and may not justify the detrimental effects brought by competition. In our environment, the dissipation of resources caused by competitive pressures is not compensated by concurrent informational gains. Overall, our findings partially support and validate Tullock's criticism of adversarial communication systems.

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Part
Appendix for "Welfare and Competition in Expert Advice Makets"

Andrea Albertazzi, Matteo Ploner, Federico Vaccari

Table of Contents

A Experimental Instructions

In this section we report the on-screen experimental instructions shown to participants. We use different colours (*COMP*, *MONO*) to highlight differences among treatments.

General Information

Welcome and thank you for participating in this experiment. These instructions are identical for all participants. From now on, communication with other participants is not allowed. If you do not conform to these rules, we will have to exclude you from the experiment.

The Experiment This experiment studies decision making between three individuals. You will participate in 30 rounds of decision making. Please read all the instructions carefully; the payment that you will receive at the end of the experiment will depend on your decisions and those of other participants. At the end of the experiment, you will be asked to fill in a short questionnaire.

Your earnings For your participation you will receive a 4 EURO participation fee. Additional earnings that you can realize during the experiment will be expressed in terms of points with the following conversion rate: 100 points = 1 EURO.
At the end of the experiment the computer will randomly select two rounds of play. Your additional earnings from the experiment will be determined by the average of the points you earned in the two selected rounds. Because during the experiment you might incur losses, your payment can be negative. If this is the case, then we will deduct your negative profits from the participation fee. If the fee is not enough to cover your losses, then at end of the experiment you will be asked to complete an additional task whose duration is proportional to your losses.

Participation Your participation in this study is completely voluntary. Choosing not to take part will not disadvantage you in any way. You can withdraw from the experiment at any time without consequences.

Confidentiality All your answers will be treated confidentially and only used for research purposes only. Experimental data will be anonymized to ensure that no personal information can be linked to your answers. The data will be deposited in a completely confidential manner so that it can be used for future research and learning.

Should you have any questions, please contact the experimenter that will answer to your questions.

Please DO NOT click the NEXT button to read the rest of the instructions until you are told otherwise.

Role assignment

In each round you will be randomly and anonymously matched in groups of three participants.

The three group members will be referred to as Player A, B, and C. Each of you will be assigned to one of these three roles only. Thus, your role will remain fixed throughout the experiment.

Participants will be randomly rematched after each round to form new groups, for a total of 30 rounds. Each round is a separate decision task.

Decision

In each round, an integer number will be randomly selected from the interval $[-100, 100]$. We will refer to this number as the *Drawn Value*. The following figure (Figure 1) illustrates an example of how often each number is selected. You can see that the frequency with which a number is selected increases as one approaches the top of the bell curve. Thus, it is much more likely that the *Drawn Value* is closer to zero than further away from it.

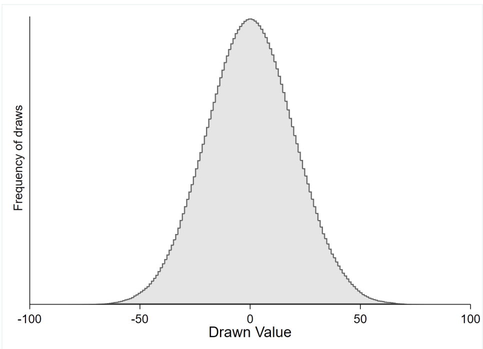

Figure 1: Frequency of draws for the random number *Drawn Value*.

The *Drawn Value* determines the state of the world. If this number is smaller than zero, we will say the state is **RED** and, if it is greater than zero, **BLACK**. If $Drawn\ Value = 0$, then the state is either **RED** or **BLACK** with equal probability. Hence, state **RED** and state **BLACK** are equally likely to occur.

COMP: The *Drawn Value* will be observed only by Players A and B, which in turn will have to privately report a number to Player C. Player C, after observing the reports delivered by the other two players (but without observing the *Drawn Value*), has to guess the state by selecting either action *Red* or *Black*.

MONO: The *Drawn Value* will be observed only by Players A and B. Player A will have to privately report a number to Player C while Player B will be a spectator. Hence, Player B does not send any report. However, Player B will be asked her/his beliefs about the actions of the other players. Details about the expression of beliefs will be provided on screen to Player B. These beliefs will not be known to either Player A or C, and will have no consequences on their earnings. Player C, after observing the report delivered by Player A (but without observing the *Drawn Value*), will have to guess the state by selecting either action *Red* or *Black*.

Players A and B's decisions (Players A's Decision)

You will be presented with three lines on your screen (Figure 2). All lines range from -100

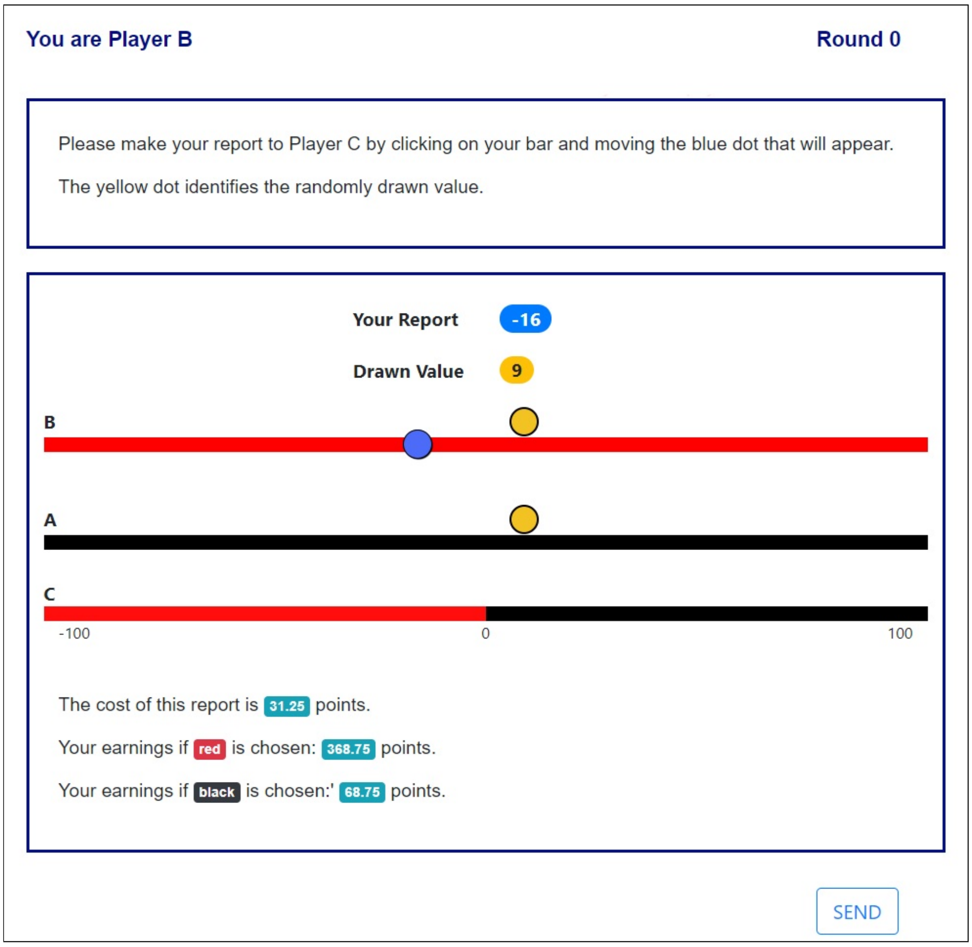

Figure 2: Example of decision screen for Player B. (In *MONO* we used a decision screen from Player A.)

to 100. The first line will be the line corresponding to your role. The lines corresponding to Players A and B (The line corresponding to Player A) will include a yellow circle representing the *Drawn Value*.

You will be asked to privately report to player C a number of your choice by clicking on the line corresponding to your role. You can click on the line as many times as you want until you reach the number you wish to report. Remember, you are free to choose any number between $[-100, 100]$. Once your choice is made, click the button "Send" on your screen.

Player C's decision

You will be presented with the same three lines on your screen. After seeing Player A's and Player B's reports represented by a circle on their respective lines, you will be asked to make your decision by choosing either *Red* or *Black*.

Your payoff

Each group member can obtain either a higher or a lower payoff that is determined by the choice made by Player C. You can see this in the previous figure. The colour of the segments illustrate for what *Drawn Values* each player obtains a higher payoff if the action of the same colour is chosen. To sum up:

- Player A always receives a higher payoff if *Black* is chosen.
- Player B always receives a higher payoff if *Red* is chosen.
- Player C receives a higher payoff if he/she chooses:
  - *Red* when the state is **RED** (*Drawn Value* $<= 0$),
  - *Black* when the state is **BLACK** (*Drawn Value* $>= 0$).

COMP :

Players A and B's payoffs

Player A receives 1200 points if Player C chooses action *Black*, 400 otherwise.

Player B receives 1200 points if Player C chooses action *Red*, 400 otherwise.

Moreover, there is a cost for sending your report: $cost = \frac{25}{3} \cdot |Drawn\ Value - report|$.

This cost increases with the distance between the *Drawn Value*, and the number you report. For your convenience, this cost will be automatically calculated and your expected earnings will be displayed on your screen while you are making your choice.

In summary,

$$\text{Payoff (Player \ A)} = \begin{cases} 1200 - cost & \text{if Player } C \text{ chooses } Black \\ 400 - cost & \text{otherwise.} \end{cases}$$

$$\text{Payoff (Player \ B)} = \begin{cases} 1200 - cost & \text{if Player } C \text{ chooses } Red \\ 400 - cost & \text{otherwise.} \end{cases}$$

MONO:

Players A's payoff

Player A receives 1200 points if Player C chooses action *Black*, 400 otherwise.

Moreover, there is a cost for sending your report: $cost = \frac{25}{3} \cdot |Drawn\ Value - report|$.

This cost increases with the distance between the $Drawn\ Value$, and the number you report. For your convenience, this cost will be automatically calculated and your expected earnings will be displayed on your screen while you are making your choice.

In summary,

$$\text{Payoff (Player \ A)} = \begin{cases} 1200 - cost & \text{if Player } C \text{ chooses } Black \\ 400 - cost & \text{otherwise.} \end{cases}$$

MONO:

Players B's payoff

Player B receives 1200 points if Player C chooses action *Red*, 400 otherwise.

Because Player B does not send any report, his/her payoff only depends from the action chosen by Player C.

$$\text{Payoff (Player \ B)} = \begin{cases} 1200 & \text{if Player } C \text{ chooses } Red \\ 400 & \text{otherwise.} \end{cases}$$

All treatments:

Player C's payoff

The amount of points you earn in a round depends on whether the colour of your choice matches with that of the state.

$$\text{Payoff per round} = \begin{cases} 600 & \text{if choice is } \textit{Red} \text{ and state is } \textbf{RED} \ (Drawn\ Value < 0) \\ 600 & \text{if choice is } \textit{Black} \text{ and state is } \textbf{BLACK} \ (Drawn\ Value > 0) \\ 200 & \text{otherwise} \end{cases}$$

Remember, when the $Drawn\ Value$ equals zero, the state is equally likely to be **RED** or **BLACK**.

Summary information

COMP:

At the end of each round, you will be provided with a summary of the round: what the $Drawn\ Value$ was, Player A's and Player B's reports, Player C's choice, and the points earned by each member of the group.

MONO:

At the end of each round, you will be provided with a summary of the round: what the $Drawn\ Value$ was, Player A's report, Player C's choice, and the points earned by each member of the group.

Payment

At the end of the experiment the computer will randomly select two rounds out of 30 to calculate your cash payment. Thus, it is in your best interest to take each round seriously. You will receive the average of the points that you earned in the two selected rounds. Your total payment will then be this average, converted in EURO, plus a 4 EURO participation fee. Note that during the experiment you might incur losses. Thus, your payment from the two selected rounds might be negative. If that happens, then your negative payment will be deducted from your participation fee. If this amount of money is not enough to cover your losses, then you will be asked to complete an additional task whose duration is proportional to your losses.

Instructions for Spectator (*MONO*)

Question 1: The panel above provides you with a description of Value Drawn and of the incentives of Player A and Player C: Player C earns more when he/she chooses Red and the Drawn Value is negative or when he/she chooses Black and the Drawn Value is positive; Player A earns more if Black is chosen.

In the panel below, you are asked to state your beliefs about the probability that Player A is going to report the value truthfully.

The table also reports the points you earn for each probability and the actual choice of A. As an example, if you estimate that the probability that the report is truthful is between 0% and 20%, you earn 50 points if the actual report is truthful and 250 otherwise. If you estimate that the probability that the report is truthful is between 81% and 100%, you earn 250 points if the actual report is truthful and 50 otherwise.

At the end of the experiment, one of the 30 beliefs about A will be randomly selected and paid to you.

Probability that Player A reports truthfully?

	0%-20%	21%-40%	41%-60%	61%-80%	81%-100%
Points if the report is truthful	50	100	150	200	250
Point if the report is not truthful	250	200	150	100	50

Question 2: The panel above provides you with a description of Value Drawn and of the incentives of Player A and Player C: Player C earns more when he/she chooses Red and the Drawn Value is negative or when he/she chooses Black and the Drawn Value is positive; Player A earns more if Black is chosen.

In the panel below, you are asked to state your beliefs about the probability that Player C is going to choose *Black*.

The table also reports the points you earn for each probability and the actual choice of C. As an example, if you estimate that the probability that Player C chooses *Black* is between 0% and 20%, you earn 50 points if the actual choice is *Black* and 250 otherwise. If you estimate that the probability that that Player C chooses *Black* is between 81% and 100%, you earn 250 points if the actual choice is *Black* and 50 otherwise.

At the end of the experiment, one of the 30 beliefs about C will be randomly selected and paid to you.

Probability that Player C chooses Black?

	0%-20%	21%-40%	41%-60%	61%-80%	81%-100%
Points if *Red* is chosen	50	100	150	200	250
Points if *Black* is chosen	250	200	150	100	50

Final Questionnaire

1. What is your gender?
2. What is your age?
3. What is your nationality?
4. What is your field of study?
5. Do you consider yourself a person who is completely ready to take risks or try to avoid taking risks? Mark one of the numbers below, where the value 0 means "absolutely not willing to take risks" and value 10 means "completely willing to take risks."
6. In general, do you think most people can be trusted?
   - No, you always have to be careful
   - No, you have to be careful in most cases
   - Yes, you can trust in most cases
   - Yes, you can always trust them
7. In general, do you think most people try to take advantage of others if they have the opportunity?
   - No, they always behave correctly
   - No, they behave correctly in most cases
   - Yes, they try to take advantage of it in most cases
   - Yes, they always try to take advantage of it
8. Do you have any comment about the experiment?

Bankruptcy Task

0	0	0	0	1	1	1	1	1	0
1	0	1	0	0	0	1	0	1	0
1	0	1	0	0	1	0	1	0	0
0	0	1	1	0	0	0	0	1	1
0	0	0	1	1	1	0	0	0	0
0	1	0	0	1	1	1	1	1	0
0	1	0	0	1	1	1	1	1	1

Please insert here your loss:

As an example, if your loss is 3 Euro and 20 cents write “3.20”.

To clear your loss, you must count the number of zeroes in a series of tables similar to the following.

Given your loss, you must count “X” tables (one table every 0.5 Euro).

In this specific example, the number of zeroes is equal to 37.

B Additional Analysis

B.1 Decision times

The time subjects spend making a decision might help us understand whether subjects react to the different strategic incentives of our treatments. In what follows, we present an exploratory analysis (not preregistered) of decision times for both senders and decision-makers. We take the individual average time to make a decision as a proxy for the degree of deliberation of choice. All times are measured in seconds. To send a report, senders take, on average, 20.3 and 20.5 seconds in *COMP* and *MONO*, respectively. The two averages are similar and not significantly different (WRT on individual averages, $p = 0.570$). Overall, misreporting requires significantly more time than telling the truth, 26.2 and 17.9 seconds, respectively (Wilcoxon Signed Rank Test (WST) on individual averages, $p < 0.001$). The same pattern also emerges when considering treatments separately. Hence, misreporting requires a longer time to deliberate, but no effect of the treatment variation on decision times is found for senders.

Decision-makers require slightly more time to choose in *COMP* (13.4) than in *MONO* (11.6). However, this difference is not statistically significant (WRT on individual averages, $p = 0.344$). Despite average times do not seem to differ between treatments, in *COMP* decision times depends on whether reports have the same sign. The time taken to choose when the two reports have different signs is about 60% more than when they are aligned (16.5 and 10.8, respectively; WST on individual averages, $p < 0.001$).

B.2 Spectator beliefs

In the monopolistic treatment, Sender_2 is not allowed to communicate. Instead, the spectator is asked to answer two belief elicitation questions using an incentive-compatible mechanism.[1] First, we ask the spectator how likely is Sender_1 to report truthfully given the realized drawn number. The average belief of a truthful report is equal to 67.3% for positive and 49.7% for negative drawn values. Hence, Sender_2 correctly anticipates that the likelihood of misreporting is higher for drawn values that conflict with the monopolist interest (WST on individual averages, $p < 0.001$). However, the spectator seems to fail to predict the behavior of the monopolist with whom they are matched. The average belief

[1] Beliefs are collected over five equally-spaced probability intervals. Here, we compute average beliefs by taking the median value of each interval as a reference.

when the matched sender tells the truth is higher (60.9%) than when the matched player lies (55.2%). However, this difference is not statistically significant (WST, $p = 0.304$), and the central tendency of both sets of beliefs is close to the 50% value, suggesting indecisiveness.

The second question asks how likely it is that the decision-maker chooses *Black* given the number reported by Sender_1. Data show that firmer beliefs that the decision-maker will choose *Black* are more associated with a positive than a negative report, 69.0%, and 31.5%, respectively (WST on individual averages, $p < 0.001$). Hence, the spectator correctly anticipates that DM will base their choice mainly on the observed reports. Regarding correctness relative to actual behavior, higher beliefs are observed when DM chooses *Black* compared to when they choose *Red*, 69.6% and 41.1%, respectively. The marked difference between the two sets of beliefs is statistically significant (WST, $p < 0.001$) and shows that observers maintain an overall correct representation of DM's choices.

C Tables

VARIABLES	(1) Age	(2) Gender	(3) Risk	(4) Trust	(5) Honesty
COMP	1.783***	-0.00526	-0.327	0.0834	0.0123
	(0.421)	(0.0742)	(0.282)	(0.0865)	(0.0851)
Constant	21.42***	1.500***	5.938***	3.927***	3.167***
	(0.297)	(0.0524)	(0.199)	(0.0610)	(0.0600)
Observations	191	191	191	191	191
R-squared	0.087	0.000	0.007	0.005	0.000

Table C.1 Balancing checks.
Note: The coefficients and statistical significance are obtained from linear regression models, wherein we regress our treatment variable ($COMP = 1$ if competition, $COMP = 0$ if monopoly) on the questionnaire variable of interest for each column. One subject in *COMP* did not complete the final questionnaire. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

	MONO	*COMP*
Subjects	96	96
Sessions	4	3

Table C.2 Number of participants by treatment.

	MONO	*COMP*
Mean (SD)		
Age	21.42	23.2
	(3.10)	(2.70)
Risk	5.93	5.61
	(1.81)	(2.08)
%		
Gender:		
Female	47.92	49.47
Male	51.04	50.53
Non-Binary	1.04	0
Trust:		
No, you always have to be careful	13.54	17.89
No, you have to be careful in most cases	66.67	65.26
Yes, you can trust in most cases	18.75	16.84
Yes, you can always trust them	1.04	0.00
Honesty:		
No, they always behave correctly	0.00	0.00
No, they behave correctly in most cases	27.08	27.37
Yes, they try to take advantage of it in most cases	62.50	63.16
Yes, they always try to take advantage of it	10.42	9.47
Observations	96	95

Table C.3 Questionnaire variables.
Note: One subject in *COMP* did not complete the final questionnaire.
Standard deviations in parenthesis.

Setting – eqm	Sender$_1$				Sender$_2$			
	$\hat{\mu}$	$\hat{\mu}_{OLS}$	$\hat{\tau}$	$\hat{\tau}_{OLS}$	$\hat{\mu}$	$\hat{\mu}_{OLS}$	$\hat{\tau}$	$\hat{\tau}_{OLS}$
MONO	0.39	0.39	0.95	0.95	–	–	–	–
COMP	0.46	0.46	0.94	0.94	0.41	0.40	0.95	0.96

Table C.4 Senders' reporting behavior in *MONO* and *COMP*.
Note: We report both estimates as in Table 11 in Section 5 along with pooled OLS estimations.

Setting – eqm	DM							
	$\hat{\lambda}$	$\hat{\lambda}_{OLS}$	$\hat{\varphi}$	$\hat{\varphi}_{OLS}$	$\hat{\beta}$	$\hat{\beta}_{OLS}$	$\hat{\zeta}$	$\hat{\zeta}_{OLS}$
MONO – MIE	n/a	n/a	0.58	0.58	0.81	0.81	0.64	0.64
MONO – LIE	0.75	0.76	0.57	0.57	0.81	0.81	0.64	0.64
COMP – MIE	1.02,0.53	1.00,0.53	0.53,0.50	0.53,0.50	0.75	0.75	0.73	0.73
COMP – AE	0.86	0.86	0.13	0.13	0.75	0.75	0.73	0.73

Table C.5 Decision-makers' behavior in *MONO* and *COMP*.
Note: We report both estimates as in Table 12 in Section 5 along with pooled OLS estimations.

Treatment	Role	N	Mean	SD	Median
MONO	Sender$_1$	960	778.307	386.615	900.000
	Sender$_2$	960	735.833	395.026	400.000
	DM	960	488.750	179.323	600.000
	Group	960	2002.891	263.205	2191.667
COMP	Sender$_1$	960	738.967	404.176	862.500
	Sender$_2$	960	679.410	397.577	400.000
	DM	960	495.833	175.636	600.000
	Group	960	1914.210	310.067	2033.333

Table C.6 Net Payoffs (individual observations).

D Theoretical Results

This appendix studies the continuous approximation of our experimental conditions. Some results are summarized in Section 4. The derivation of some proofs and equilibria characterization is in Vaccari (2023a, 2023b) and Appendix E.

Setup. There are two equally informed senders (Sender_1 and Sender_2), and an uninformed decision-maker (DM). There is a random variable with realization $\theta \in \Theta = [-\phi, \phi]$, with $\phi > 0$. We refer to θ as the *drawn value*.[2] This score is distributed according to the atomless pdf f, which has CDF F, full support in Θ, and is symmetric around zero. Senders perfectly observe θ. The state is BLACK when $\theta \geq 0$, and it is RED otherwise. Depending on the treatment, either one or both senders deliver a report $r_j \in \Theta$, $j \in \{1, 2\}$. In *COMP*, both senders deliver a report privately or simultaneously; in *MONO*, only sender 1 delivers a report, whereas sender 2 cannot. After observing the senders' reports, but not the drawn value, the decision-maker takes an action $a \in \{Red, Black\}$.

Payoffs. Player $i \in \{1, 2, DM\}$ gets utility $u_i(\theta, a)$ when the decision-maker selects action a and the drawn value is θ. In addition, Sender_j gets a total payoff of $w_j(r_j, \theta, a) = u_j(\theta, a) - C(r_j, \theta)$ from delivering report r_j when the drawn value is θ and the decision-maker selects action a. $C(\cdot, \cdot)$ is a misreporting cost function.[3]

Knowledge and equilibrium. Apart from senders having private information about the drawn value, every other aspect of the model is common knowledge. The solution concept we use is perfect Bayesian Equilibrium (PBE). We explicitly mention when we use refinements or focus on specific equilibria.

Parameters. The space Θ has $\phi = 100$, and therefore $\Theta = [-100, 100]$. The continuous probability distribution f has full support in Θ and is symmetric around zero.[4] The decision-maker's payoff is $u_{DM}(Black, \theta) = 600$ when $\theta > 0$ and $u_{DM}(Black, \theta) = 200$ when $\theta < 0$; it is $u_{DM}(Red, \theta) = 600$ when $\theta < 0$ and $u_{DM}(Red, \theta) = 200$ when $\theta > 0$.

[2] We use the term "drawn value" to remain coherent with the terminology used in the experimental design (Section 3) and in the instructions. Differently, related work typically refers to θ as the realized *state*. Our terminology is appropriate given the decision-maker's binary choice. Accordingly, terms like "full revelation" refer to the sign of the drawn value, and not to θ.

[3] We will focus on the cases where, as in the experimental conditions, players have step utility functions and misreporting costs are linear. However, the equilibria's structure remains similar under general preferences, such as non-linear misreporting costs and utilities.

[4] The monopolistic and competitive equilibria discussed in this section are not affected by the distribution, provided that f is an atomless pdf with full support in Θ and symmetric around zero. The actual experimental distribution is a discrete and truncated Normal distribution with support in $\{-100, \ldots, 100\}$, zero mean, and a standard deviation of 25.

When $\theta = 0$, the decision-maker is equally likely to obtain a payoff of 600 and 200 independently of her chosen action. Senders' payoffs are, for every $\theta \in \Theta$, $u_1(Black, \theta) = u_2(Red, \theta) = 1200$ and $u_1(Red, \theta) = u_2(Black, \theta) = 400$. Finally, misreporting costs are

$$C(r, \theta) = \tfrac{25}{3}|r - \theta|.$$

Reach. We define the reach of Sender$_j$ as the report whose associated misreporting costs offset Sender$_j$'s gains from having their own preferred alternative eventually selected. Reports that are more expensive than the reach are strictly dominated by truthful reporting. More formally, we define Sender$_1$'s reach when the drawn value is θ as the report $\bar{r}_1(\theta) > \theta$ such that $u_1(Red, \theta) = u_1(Black, \theta) - C(\bar{r}_1(\theta), \theta)$. We obtain that $\bar{r}_1(\theta) = \theta + 96$. Similarly, we define Sender$_2$'s reach when the drawn value is θ as the report $\bar{r}_2(\theta) < \theta$ such that $u_2(Black, \theta) = u_2(Red, \theta) - C(\bar{r}_2(\theta), \theta)$. We obtain that $\bar{r}_2(\theta) = \theta - 96$.

Since reports outside the reach at a given drawn value are strictly dominated, it follows that in every equilibrium senders must deliver reports that lie within their own reach.

Observation D.1. *In every equilibrium of MONO and COMP, senders do not deliver reports outside the set* $[\theta - 96, \theta + 96]$.

The next proposition asserts that our model does not admit babbling or truthful equilibria, independently of whether the setting is *MONO* or *COMP*. Consequently, in all equilibria we must have that the decision-maker's sequentially rational action rule is not independent of the senders' report, and that misreporting occurs in at least some state.

Proposition D.1. *There are neither babbling nor truthful equilibria of our settings.*

Proof. This result is proved in Vaccari (2023a, 2023b). □

D.1 Monopolistic Equilibria

We begin our analysis by studying the perfect Bayesian equilibria (PBE) of the monopolistic condition *MONO*. We focus on those PBE that survive the Intuitive Criterion (Cho & Kreps, 1987). Define,

$$\bar{\lambda} = \mathbb{E}_f[\theta \,|\, \theta \in (0, \bar{r}_1(0))],$$

$$\hat{r}(\lambda) = \{r \in \Theta \,|\, \mathbb{E}_f[\theta \,|\, \theta \in (\bar{r}_1^{-1}(r), r)] = \lambda\},$$

where $\bar{r}_1^{-1}(r) = r - 96$ is the inverse function of Sender$_1$'s reach. Equilibria of the monopolistic condition have the following structure: given a $\lambda \in [0, \bar{\lambda}]$, the monopolistic Sender$_1$'s reporting rule $\rho_1(\theta, \lambda)$ is,

$$\rho_1(\theta, \lambda) = \begin{cases} \hat{r}(\lambda) & \text{if } \theta \in \left(\bar{r}_1^{-1}\left(\hat{r}(\lambda)\right), \hat{r}(\lambda)\right) \\ \theta & \text{otherwise.} \end{cases} \tag{1}$$

The decision-maker sequentially rationally selects action *Black* when $r_1 \geq \hat{r}(\lambda)$, and selects *Red* otherwise. For the proofs and more details about the equilibrium strategies and beliefs, see Proposition E.1 in Appendix E.

Persuasion takes place when $\theta \in (\bar{r}_1^{-1}(\hat{r}(\lambda)), 0)$. We obtain an equilibrium that fully reveals the sign of the drawn value by setting $\lambda = \bar{\lambda}$. In this case, we have that $\hat{r}\left(\bar{\lambda}\right) = \bar{r}_1(0) = 96$ and $\bar{r}_1^{-1}\left(\hat{r}\left(\bar{\lambda}\right)\right) = 0$. Persuasion never occurs. By contrast, the least informative equilibrium has $\lambda = 0$. In this case, we have that $\hat{r}(0) = 48$, misreporting occurs when $\theta \in (-48, 48)$, and persuasion takes place when $\theta \in (-48, 0)$.

Observation D.2. *In the MIE of* MONO*,*

- *DM obtains an expected payoff of 600;*
- *Sender$_1$ obtains an expected payoff of 483.09;*
- *Sender$_2$ obtains an expected payoff of 800.*

Proof. The MIE of *MONO* is revealing. Decision-makers always select their preferred action, and thus earn an expected payoff of 600. Sender$_2$ is passive, and receives 1200 and 400 with ex-ante equal probability 1/2, respectively. The expected payoff of Sender$_2$ is 800. Sender$_1$ misreports to 96 all drawn values between 0 and 96, and reports truthfully otherwise. Given DM's action rule, Sender$_1$'s expected payoff in this equilibrium is

$$\begin{aligned} &400 \cdot \tfrac{1}{2} + 1200 \int_{96}^{100} f(\theta) d\theta + \int_{0}^{96} \left(1200 - \tfrac{25}{3}|96 - \theta|\right) f(\theta) d\theta \\ &= 1200 - 800F(96) + \frac{25}{3} \int_{0}^{96} \theta f(\theta) d\theta \approx 483.09, \end{aligned} \tag{2}$$

as $F(96) \approx 0.9999$ and $\int_0^{96} \theta f(\theta) d\theta \approx 9.9679$. □

Observation D.3. *In the LIE of* MONO*,*

- *DM obtains an expected payoff of 410.96;*
- *Sender$_1$ obtains an expected payoff of 800;*

- *Sender_2 obtains an expected payoff of 421.92.*

Proof. In this equilibrium, Sender_1 pools drawn values between -48 and 48 by misreporting to 48, and reports truthfully otherwise. DM selects *Black* if and only if $r_1 \geq 48$. When the drawn value is positive or lower than -48, DM chooses accurately and obtains 600. By contrast, Sender_1 persuades DM when the drawn value is between -48 and 0. As a result, DM's expected payoff in this equilibrium is

$$200\left(\tfrac{1}{2} - F(-48)\right) + 600\left(\tfrac{1}{2} + F(-48)\right) \approx 410.9596,$$

as $F(-48) \approx 0.027399$. Sender_2 is passive and receives an expected payoff of

$$1200F(-48) + 400(1 - F(-48)) \approx 421.9192,$$

whereas Sender_1 obtains an expected payoff of

$$F(-48)(400 + 1200) + \int_{-48}^{48} \left(1200 - \tfrac{25}{3}|48 - \theta|\right) f(\theta)d\theta = 800.$$

□

Observation D.4. *In every equilibrium of* MONO*, $\tau_1 = 1$. In the MIE of* MONO*, $\mu_1 = 0$. In the LIE of* MONO*, $\mu_1 = 0.9452$.*

Proof. From the equilibrium reporting rule ρ_1, we can see that Sender_1 always delivers a positive report when the drawn value is positive. As a result, $\tau_1 = 1$ in every equilibrium of *MONO*. In the MIE of *MONO*, Sender_1 never delivers a positive report when the drawn value is negative, and thus $\mu_1 = 0$. In the LIE of *MONO*, Sender_1 delivers a positive report ($r_1 = 48$) when $\theta \in (-48, 0)$. Conditional on the drawn value being positive, this event occurs with probability $2\left(\frac{1}{2} - F(-48)\right) = 1 - 2F(-48) \approx 0.9452$. □

Observation D.5. *In the MIE of* MONO*, $\beta = \zeta = 1$. In the LIE of* MONO*, $\beta = 1$ and $\zeta \approx 0.0548$.*

Proof. Since the MIE of *MONO* is revealing, it follows that $\beta = \zeta = 1$. Consider now the LIE of *MONO*. Decision-makers always selects *Black* when the state is positive, and thus $\beta = 1$. By contrast, decision-makers select *Red* only when $r_1 < 48$, which occurs when $\theta < -48$. As a result, $\zeta = 2 \cdot F(-48) \approx 0.0548$. □

D.2 Competitive Equilibria

We now turn our attention to the competitive condition, i.e., *COMP*. Equilibria of this condition are formally studied in Vaccari (2023a).

D.2.1 Revealing Equilibria

There are two equilibria that fully reveal the drawn value, and therefore are the most informative. In the first one, Sender_1's reporting rule is the same as in the most informative equilibrium of the monopolistic condition (see $\rho_1(\theta, \lambda)$ in (1) with $\lambda = \bar{\lambda}$), whereas Sender_2 always reports truthfully the state.

Sender_1's reporting rule $\rho_1(\theta)$ is,

$$\rho_1(\theta) = \begin{cases} \bar{r}_1(0) = 96 & \text{if } \ \theta \in (0, 96) \\ \theta & \text{otherwise,} \end{cases} \tag{3}$$

$$\rho_2(\theta) = \theta \ \text{ for every } \ \theta \in \Theta = [-100, 100]. \tag{4}$$

The decision-maker selects action *Black* if and only if the report delivered by Sender_1 is equal to or higher than $\bar{r}_1(0) = 96$, and selects action *Red* otherwise.

There is another revealing equilibrium where the senders' roles are inverted. That is, Sender_1 always report truthfully, whereas Sender_2 pools information in the following way,

$$\rho_1(\theta) = \theta \ \text{ for every } \ \theta \in \Theta = [-100, 100], \tag{5}$$

$$\rho_2(\theta) = \begin{cases} \bar{r}_2(0) = -96 & \text{if } \ \theta \in (-96, 0) \\ \theta & \text{otherwise.} \end{cases} \tag{6}$$

In this second revealing equilibrium, the decision-maker selects action *Red* if and only if the report delivered by Sender_2 is equal to or lower than $\bar{r}_2(0) = -96$, and selects action *Black* otherwise. On the equilibrium path of both these two revealing outcomes, the decision-maker's action rule depends on the report of one sender only.

Observation D.6. *In the MIE of* COMP*,*

- *DM obtains an expected payoff of 600;*
- *Either* Sender_1 *obtains an expected payoff of 483.09 and* Sender_2 *obtains an expected payoff of 800, or* Sender_1 *obtains an expected payoff of 800 and* Sender_2 *obtains an expected payoff of 483.09.*

Proof. The MIE of *COMP* is revealing. Decision-makers always select their preferred action, and earn an expected payoff of 600. In the first MIE, both senders obtain the same expected payoff as in the MIE of *MONO*. In the second MIE the senders' roles are inverted, and Sender_1 obtains an expected payoff of 800 and Sender_2 of 483.09. □

Observation D.7. *In the MIE of* COMP*,* $\tau_1 = \tau_2 = 1$ *and* $\mu_1 = \mu_2 = 0$*.*

Proof. The proof follows straightforwardly by observing that, in the MIE of *COMP*, both senders always deliver positive reports when the drawn value is positive and negative reports when the drawn value is negative. □

Observation D.8. *In the MIE of* COMP*,* $\beta = \zeta = 1$*.*

Proof. The proof follows from the observation that decision-makers always select their preferred alternative, the prior f is symmetric around zero, and from the senders' revealing strategies in the MIE. □

D.2.2 Non-revealing Equilibria

Vaccari (2023a) shows that there exist non-revealing equilibria of *COMP*. Specifically, there exist a class of equilibria, referred to as *adversarial*, that have several appealing properties. To characterize these adversarial equilibria in our setup, we draw from the main proposition in Vaccari (2023a). It is useful to represent the senders' strategies via a CDF. Denote by Φ_j the CDF of Sender_j's reporting strategy.

Senders report truthfully when the drawn value is extreme. Specifically, $r_1 = r_2 = \theta$ for every $\theta \notin [-48, 48]$. When the drawn value is positive but less than 48,

$$\Phi_1(r_1, \theta)|_{\theta \geq 0} = \begin{cases} 0 & \text{if } r_1 < \theta \\ \theta/48 & \text{if } r_1 = \theta \\ (r_1 + \theta)/96 & \text{if } r_1 \in (\theta, 96 - \theta] \\ 1 & \text{if } r_1 > 96 - \theta, \end{cases}$$

$$\Phi_2(r_2, \theta)|_{\theta \geq 0} = \begin{cases} 0 & \text{if } r_2 < \theta - 96 \\ 1 + (r_2 - \theta)/96 & \text{if } r_2 \in [\theta - 96, -\theta) \\ 1 - \theta/48 & \text{if } r_1 \in [-\theta, \theta) \\ 1 & \text{if } r_1 \geq \theta. \end{cases}$$

When the drawn value is negative but greater than -48,

$$\Phi_1(r_1,\theta)|_{\theta<0} = \begin{cases} 0 & \text{if } r_1 < \theta \\ -\theta/48 & \text{if } r_1 \in [\theta, -\theta) \\ (r_1-\theta)/96 & \text{if } r_1 \in [-\theta, \theta+96] \\ 1 & \text{if } r_1 > \theta+96, \end{cases}$$

$$\Phi_2(r_2,\theta)|_{\theta<0} = \begin{cases} 0 & \text{if } r_2 < -\theta-96 \\ 1+(r_2+\theta)/96 & \text{if } r_2 \in [-\theta-96, \theta) \\ 1 & \text{if } r_2 \geq \theta. \end{cases}$$

In adversarial equilibria of our condition, the decision-maker selects *Black* if $(r_1+r_2)/2 \geq 0$, and selects *Red* otherwise. The decision-maker assigns equal weights to the senders' reports.

Senders always report truthfully when $\theta \notin [-48, 48]$, and play mixed strategies otherwise. The set $[-48, 48]$ is obtained by finding the drawn values that satisfy $\bar{r}_j(\theta) = -\theta$ for $j \in \{1,2\}$. Consider a $\theta \in (-48, 48)$, and recall that $\bar{r}_1(\theta) = \theta + 96$ and $\bar{r}_2(\theta) = \theta - 96$. The support of Sender$_1$'s reporting strategy is $S_1(\theta) = [\theta, -\bar{r}_2(\theta)]$ when $\theta \in [0, 48)$, and it is $S_1(\theta) = \{\theta\} \cup [-\theta, \bar{r}_1(\theta)]$ when $\theta \in (-48, 0]$. The support of Sender$_2$'s reporting strategy is $S_2(\theta) = [\bar{r}_2(\theta), -\theta] \cup \{\theta\}$ when $\theta \in [0, 48)$, and it is $S_2(\theta) = [-\bar{r}_1(\theta), \theta]$ when $\theta \in (-48, 0]$. Senders report truthfully with probability $\alpha_j(\theta) = |\theta|/48$ when $\theta \in [-48, 48]$, for $j \in \{1,2\}$. When misreporting, Sender$_j$ delivers a report $r_j \in S_j(\theta) \setminus \{\theta\}$ with a state- and report-independent probability density $\psi_j(r_j, \theta) = 1/96$, with $j \in \{1,2\}$.

Observation D.9. *In the AE of* COMP*,*

- *DM obtains an expected payoff of* 449.08*;*
- *Sender$_1$ obtains an expected payoff of* 561.84*;*
- *Sender$_2$ obtains an expected payoff of* 561.84*.*

Proof. Given the AE's strategies and beliefs, decision-makers always select their preferred alternative when the drawn value is higher than 48 or lower than -48. When the drawn value is $\theta \in [0, 48]$, decision-makers select their least preferred alternative with probability

$$\gamma(\theta) = \int_{\bar{r}_2(\theta)}^{-\theta} \psi_2(r_2, \theta) \cdot \Phi_1(-r_2, \theta) dr_2.$$

That is, $\gamma(\theta)$ is the probability that $\frac{r_1+r_2}{2} < 0$ when the drawn value is positive but less than 48. We have that $\Phi_1(r_1, \theta) = \frac{r_1+\theta}{96}$ and $\psi_2(r_2, \theta) = 1/96$. Calculations give us

$$\gamma(\theta) = \frac{1}{2} - 2\left(\frac{\theta}{96}\right)^2.$$

By symmetry, $\gamma(\theta)$ describes the mistake rate also for negative states higher than -48. The expected payoff of DM in some $\theta \in [-48, 48]$ is $200\gamma(\theta) + 600(1 - \gamma(\theta))$. The DM's expected payoff in an adversarial equilibrium is

$$2 \cdot 600 \cdot F(-48) + \int_{-48}^{48} (600 - 400\gamma(\theta)) f(\theta) d\theta \approx 449.0820.$$

By solving the integral and recalling that $F(-48) \approx 0.0274$ and $\int_{-48}^{48} \theta^2 f(\theta) d\theta \approx 439.1659$, we obtain the result.

Consider now Sender$_1$ and a positive drawn value that is lower than 48. To calculate the expected payoff in equilibrium, we use senders' indifference between reports within the strategy's support. Recall that senders report truthfully with positive probability. Doing so gives Sender$_1$ an expected payoff of

$$1200\alpha_2(\theta) + 400(1 - \alpha_2(\theta)) = 400 + \frac{50}{3}\theta.$$

As $\alpha_1(\theta) = \alpha_2(\theta) = |\theta|/48$. By contrast, reporting truthfully when the drawn value is negative always yields Sender$_1$ a payoff of 400. Moreover, Sender$_1$ always get 1200 when the drawn value is higher than 48, and 400 when it is lower than -48. It follows that the expected payoff of Sender$_1$ in adversarial equilibria is

$$400 + 800F(-48) + \frac{50}{3} \int_0^{48} \theta f(\theta) d\theta \approx 561.8392.$$

The result follows from $\int_0^{48} \theta f(\theta) d\theta \approx 8.3952$. By symmetry, Sender$_2$ obtains the same expected payoff. □

Observation D.10. *In the AE of* COMP*,*

- *Conditional on the drawn value being positive, Sender$_1$ always delivers positive reports. That is, $\tau_1 = 1$. Conditional on the drawn value being negative, Sender$_1$ delivers a positive report with ex-ante probability* 0.60*. That is, $\mu_1 = 0.60$;*
- *Conditional on the drawn value being negative, Sender$_2$ always delivers negative reports. That is, $\tau_2 = 1$. Conditional on the drawn value being positive, Sender$_2$*

delivers a negative report with ex-ante probability 0.60. *That is,* $\mu_2 = 0.60$.

Proof. The proof for τ_1 and τ_2 follows straightforwardly from the senders' strategies in adversarial equilibria. For μ_j, condition on $\theta < 0$. In AE, Sender$_1$ delivers a positive report with probability 0 for $\theta \in [-100, -48]$, and with probability $1 - \alpha_1(\theta) = 1 - |\theta|/48$ for $\theta \in [-48, 0]$. Therefore,

$$\mu_1 = 2\int_{-48}^{0} \left(1 - \frac{-\theta}{48}\right) f(\theta) d\theta \approx 0.5954.$$

The result follows from $\int_{-48}^{0} \theta f(\theta) d\theta \approx -8.3952$. By symmetry, $\mu_2 = \mu_1$. □

Observation D.11. *In the AE of* COMP, $\beta = \zeta \approx 0.6227$.

Proof. Consider an AE and some positive drawn value. When $\theta > 48$, decision-makers always select their preferred alternative. When $\theta \in [0, 48]$, decision-makers select their preferred alternative with probability $1 - \gamma(\theta)$. The ex-ante probability that DM selects $a = Black$ conditional on the state being positive is thus

$$\beta = 2\left[\int_{0}^{48} (1 - \gamma(\theta)) f(\theta) d\theta + F(-48)\right] \approx 0.6227.$$

The result follows from solving the integral while noting that $\gamma(\theta) = \frac{1}{2} - 2\left(\frac{\theta}{96}\right)^2$ and $\int_0^{48} \theta^2 f(\theta) d\theta \approx 219.5829$. By symmetry, we obtain that $\zeta = \beta$. □

D.3 Cheap Talk Benchmark

Proposition D.2. *The cheap talk benchmark admits only non-informative equilibria. In particular,*

- *with a single sender, there are only babbling equilibria;*
- *with two senders, all equilibria are payoff-equivalent to babbling equilibria.*

Proof. Consider a version of the model where $C(r, \theta) = 0$ for every $(r, \theta) \in \Theta^2$. Sender$_j$ can deliver reports $r_j \in \mathcal{R}$, where $\mathcal{R}$ is an abstract set containing at least two reports. Communication is *influential* if the decision-maker's action is not constant along the equilibrium path. Otherwise, *babbling* occurs.

Consider the one-sender setting, and fix an equilibrium. Define by $\pi(r_1)$ the probability that the decision-maker selects $a(r_1) = Black$ after observing report r_1. Define by $\mathbf{r_1} \subseteq \mathcal{R}$

the set of reports maximizing π in such an equilibrium. That is, $\pi(r_1') \geq \pi(r_1)$ for every $r_1 \in \mathcal{R}$ and $r_1' \in \mathbf{r_1}$. It must be that π is constant along the equilibrium path and equal to $\pi(r_1')$ for some $r_1' \in \mathbf{r}$. Otherwise, Sender$_1$ would have a profitable deviation. Thus, only babbling equilibria exist in the one-sender cheap talk variant of the model.

Consider now an equilibrium of the two-sender setting. Define by $\pi(r_1, r_2)$ the probability that the decision-maker selects $a(r_1, r_2) = Black$ after observing the pair of reports $(r_1, r_2) \in \mathcal{R}^2$. Define by $\mathbf{r_j}$ the set of Sender$_j$'s reports that maximize Sender$_j$'s expected utility in this equilibrium. If the support of a sender's strategy is a singleton, then π would be constant on-path, and the equilibrium would be babbling. In influential equilibria, it must be that $\mathbf{r_j}$ contains at least two reports, $j \in \{1, 2\}$. By definition of influential equilibrium, we have that $\pi(r_1, r_2) \neq \pi(r_1', r_2')$ for some $r_1, r_1' \in \mathbf{r_1}$ and $r_2, r_2' \in \mathbf{r_2}$. Define by Π the ex-ante probability that the decision-maker selects *Black* in this influential equilibrium. There always exists a babbling equilibrium where $\pi(r_1, r_2) = \Pi$ for every $(r_1, r_2) \in \mathcal{R}^2$, as the decision-maker is indifferent under the prior. Therefore, all influential equilibria are payoff-equivalent to some babbling equilibrium. $\square$

E Equilibrium Characterization

E.1 The Monopolistic Communication Game

The proofs and the game studied in this Appendix are, with some minor modificatons, adapted from Vaccari (2023b).

There are two players: a sender (S) and a receiver (R). The sender privately observes the realization of a state $\theta \in \Theta \subseteq \mathbb{R}$, and then delivers a news report $r \in \Theta$. The receiver has to choose an action $a \in \{P, N\}$. Before taking an action, the receiver observes the sender's report r but not the state θ.

Denote player j's "threshold" with $\tau_j \in \mathbb{R}$. The utility $u_j(a, \theta)$ of player $j \in \{S, R\}$ is non-decreasing in θ and such that $u_j(P, \theta) > u_j(N, \theta)$ for all $\theta > \tau_j$ and $u_j(P, \theta) < u_j(N, \theta)$ for all $\theta < \tau_j$. We assume that $\tau_S < \tau_R$ and that the utilities $u_j(\cdot)$ are continuous for all θ greater and lower than τ_j, $j \in \{P, N\}$. This specification allows u_j to have a discontinuity at τ_j and be, e.g., a step utility function. In addition, the sender incurs misreporting costs $kC(r, \theta)$, where k is a strictly positive and finite scalar. Denote the sender's total utility as $v_S(r, a, \theta) = u_S(a, \theta) - kC(r, \theta)$. The misreporting cost function $C(r, \theta)$ is continuous on Θ^2 with $C(r, \theta) \geq 0$ for all $r \in \Theta$ and $\theta \in \Theta$, $C(x, x) = 0$ for all $x \in \Theta$. The cost function $C(\cdot)$ satisfies $C(r, \theta) > C(r', \theta)$ if $|r - \theta| > |r' - \theta|$ for all $\theta \in \Theta$, and $C(r, \theta) > C(r, \theta')$ if $|r - \theta| > |r - \theta'|$ for all $r \in \Theta$.

We assume that the set Θ is convex and that the state θ is randomly drawn from a common knowledge distribution f, which has full support in Θ, a continuous pdf, and is symmetric around τ_R. Given the sender's utility and misreporting costs, we define the functions $l(r)$ and $\bar{r}_S(\theta)$ as follows: for a $r > \tau_S$,

$$l(r) = \max\left\{\tau_S, \min\left\{\theta \in \Theta | kC(r, \theta) = u_S(P, \theta) - u_S(N, \theta)\right\}\right\},$$

while for a $\theta > \tau_S$,

$$\bar{r}_S(\theta) = \max\{r \in \Theta | kC(r, \theta) = u_S(P, \theta) - u_S(N, \theta)\}.$$

We further assume that the state space is large enough, that is, $\Theta \supseteq [l(\tau_R), \bar{r}_S(\tau_R)]$.

A reporting strategy for the sender is a function $\rho : \Theta \to \Theta$ that associates a report $r \in \Theta$ to every state $\theta \in \Theta$. We say that a report r is off-path if, given strategy $\rho(\cdot)$, r will not be observed by the voter. Otherwise, we say that r is on-path. A belief function for the receiver is a mapping $p : \Theta \to \Delta(\Theta)$ that, given any news report $r \in \Theta$, generates posterior beliefs $p(\theta|r)$, where $p(\cdot)$ is a probability density function. Given a report r and posterior beliefs $p(\theta|r)$, the receiver takes an action in the sequentially rational set $\beta(r) = \arg\max_{a\in\{P,N\}} \mathbb{E}_p[u_S(a, \theta) \,|\, r]$.

We use the term "generic equilibrium" to denote a perfect Bayesian equilibrium of this communication game $\hat{\Gamma}$ that is robust to the Intuitive Criterion (Cho & Kreps, 1987). A "sender-preferred equilibrium" of the communication game $\hat{\Gamma}$ is the generic equilibrium preferred by the sender.

Proposition E.1 builds on Lemmata E.1 to E.5 and shows all the generic equilibria of $\hat{\Gamma}$. A sufficient condition on the state space for the existence of all generic equilibria in Proposition E.1 is $\Theta \supseteq [\tau_s, \bar{r}_s(\tau_R)]$. We assume that such a condition is always satisfied.

The set of all the receiver's pure strategy best responses to a report r and posterior beliefs $p(\cdot|r)$ such that $\int_{\theta\in T} p(\theta|r)d\theta = 1$ is defined as[5]

$$B(T, r) = \bigcup_{p:\int_T p(\theta|r)d\theta=1} \arg\max_{a\in\{P,N\}} \int_{\theta\in\Theta} p(\theta|r)u_R(a, \theta)d\theta.$$

Fix an equilibrium outcome and let $v_S^*(\theta)$ denote the sender's expected equilibrium payoff in state θ. The set of states for which delivering report r is not equilibrium-dominated for the sender is

$$J(r) = \left\{ \theta \in \Theta \middle| v_S^*(\theta) \leq \max_{a\in B(\Theta,r)} v_S(r, a, \theta) \right\}.$$

An equilibrium does not survive the Intuitive Criterion refinement if there exists a state $\theta' \in \Theta$ such that, for some report r', $v_s^*(\theta') < \min_{a\in B(J(r'),r')} v_S(r', a, \theta')$.

In Lemma E.5, we use the following notation to denote the limits of the reporting rule $\rho(\cdot)$ as θ approaches state t from, respectively, above and below: $\rho^+(t) = \lim_{\theta\to t^+} \rho(\theta)$ and $\rho^-(t) = \lim_{\theta\to t^-} \rho(\theta)$.

Lemma E.1. *In a generic equilibrium of $\hat{\Gamma}$, $\rho(\theta)$ is non-decreasing in $\theta < \tau_S$ and $\theta > \tau_S$.*

Proof. Consider a generic equilibrium and suppose that there are two states $\theta'' > \theta' > \tau_S$ such that $\rho(\theta') > \rho(\theta'')$. We can rule out that $\beta(\rho(\theta')) = \beta(\rho(\theta'')) = N$, as in such case the equilibrium would prescribe $\rho(\theta') = \theta' < \theta'' = \rho(\theta'')$. If $\beta(\rho(\theta')) = \beta(\rho(\theta'')) = P$, then in at least one of the two states θ', θ'' the sender could profitably deviate by delivering the report prescribed in the other state. Consider the case where $\beta(\rho(\theta')) = P$ (N) and $\beta(\rho(\theta'')) = N$

[5]For $T = \varnothing$, we set $B(\varnothing, r) = B(\Theta, r)$.

(P). In equilibrium, it has to be that $\rho(\theta'') = \theta''$ ($\rho(\theta') = \theta'$). Given $\rho(\theta') > \rho(\theta'') = \theta'' > \theta'$ ($\theta'' > \theta' = \rho(\theta') > \rho(\theta'')$) and $C(\rho(\theta'), \theta'') < C(\rho(\theta'), \theta')$ ($C(\rho(\theta''), \theta'') > C(\rho(\theta''), \theta')$), the sender could profitably deviate in state θ'' (θ') by reporting $\rho(\theta')$ ($\rho(\theta'')$). A similar argument applies for any two states $\theta' < \theta'' < \tau_S$, completing the proof. □

Lemma E.2. *In a generic equilibrium of $\hat{\Gamma}$, if $\rho(\theta)$ is strictly monotonic and continuous in an open interval, then $\rho(\theta) = \theta$ for all θ in such an interval.*

Proof. Consider a generic equilibrium and suppose that the reporting rule $\rho(\cdot)$ is strictly increasing (decreasing) and continuous in an open interval (a, b), but $\rho(\theta) > \theta$ for some $\theta \in (a, b)$. There always exist an $\epsilon > 0$ such that the sender prefers the same alternative in both states θ and $\theta - \epsilon$, and $\theta < \rho(\theta - \epsilon) < \rho(\theta)$ (resp. $\rho(\theta - \epsilon) > \rho(\theta) > \theta$). The sender never pays misreporting costs to implement its least preferred alternative; therefore, it must be that $\beta(\rho(\theta)) = \beta(\rho(\theta - \epsilon))$. Since $C(\rho(\theta - \epsilon), \theta) < C(\rho(\theta), \theta)$ (resp. $C(\rho(\theta), \theta - \epsilon) < C(\rho(\theta - \epsilon), \theta - \epsilon)$), the sender has a profitable deviation in state θ (resp. $\theta - \epsilon$), contradicting that $\rho(\cdot)$ is in equilibrium. □

Lemma E.3. *In a generic equilibrium of $\hat{\Gamma}$, $\rho(\theta) = \theta$ for almost every $\theta \leq \tau_S$.*

Proof. Consider a generic equilibrium and suppose that $\rho(\theta) \neq \theta$ for all $\theta \in \hat{\Theta}$, where $\hat{\Theta}$ is an open set such that $\sup \hat{\Theta} \leq \tau_S$ and $\hat{\Theta} \subset \Theta$. Beliefs must be such that $\beta(r) = P$ for all $r \in \hat{\Theta}$. Suppose that a report $r' \in \hat{\Theta}$ is off-path. It must be that $v_S^*(\theta) \geq v_S(r', P, \theta)$ for all $\theta \geq \tau_S$. Since $\sup J(r') \leq \tau_S < \tau_R$ and $B(J(r'), r') = N$, the sender can profitably deviate by reporting truthfully when $\theta = r' \in \hat{\Theta}$. Hence, all reports $r \in \hat{\Theta}$ must be on-path. To have $\beta(r') = P$ for a $r' \in \hat{\Theta}$, it must be that $\rho(\theta') = r'$ for some $\theta' \geq \tau_R$. In all states $\theta > \tau_S$ such that $\rho(\theta) \in \hat{\Theta}$, the sender must deliver the same least expensive report $r' \in \hat{\Theta}$ such that $\beta(r') = P$. Thus, $\hat{\Theta}$ has measure zero and $\rho(\theta) = \theta$ for almost every $\theta \leq \tau_S$. □

Lemma E.4. *In a generic equilibrium of $\hat{\Gamma}$, $\rho(\cdot)$ is discontinuous at some $\theta \in \Theta$.*

Proof. Suppose by way of contradiction that there is a generic equilibrium where $\rho(\theta)$ is continuous in Θ. From Lemma E.3, we know that $\rho(\theta) = \theta$ for $\theta \leq \tau_S$. If $\rho(\theta) = \theta$ also for all $\theta > \tau_S$, then the equilibrium would be fully revealing. In such case, the sender could profitably deviate by reporting τ_R when the state is $\theta \in (\tau_R - \epsilon, \tau_R)$ for some $\epsilon > 0$. Therefore, it must be that $\rho(\theta') \neq \theta'$ for some state $\theta' > \tau_S$. By Lemma E.2, it has to be that $\rho(\theta') < \theta'$, or otherwise $\rho(\cdot)$ would be discontinuous; therefore Lemmata E.1 and

E.2 imply that $\rho(\theta) = \rho(\theta')$ for all $\theta \in (\max\{\rho(\theta'), \tau_S\}, \sup\Theta)$. There always exists a report $r' \geq \theta'$ such that $\inf J(r') \geq \max\{\rho(\theta'), \tau_S\}$. Since $\beta(\rho(\theta')) = P$, it must be that $B(J(r'), r') = P$. Therefore, there are states where the sender would have a profitable deviation, contradicting that a continuous $\rho(\cdot)$ can be part of a generic equilibrium. □

Lemma E.5. *In a generic equilibrium of* $\hat{\Gamma}$, $\rho(\cdot)$ *has a unique discontinuity in state* θ_δ, *where* $\theta_\delta \in [\tau_S, \tau_R]$. *The reporting rule*[6] *is such that* $\rho(\theta) = \rho^+(\theta_\delta) > \theta_\delta = l(\rho^+(\theta_\delta))$ *for* $\theta \in (\theta_\delta, \rho^+(\theta_\delta))$ *and* $\rho(\theta) = \theta$ *for all* $\theta \in (\inf\Theta, \theta_\delta) \cup [\rho^+(\theta_\delta), \sup\Theta)$.

Proof. I denote by θ_δ the lowest state in which a discontinuity of $\rho(\cdot)$ occurs. By Lemmata E.3 and E.4, we know that in equilibrium such a discontinuity exists and $\theta_\delta \geq \tau_S$.

Suppose that $\rho^-(\theta_\delta) \neq \theta_\delta$. If $\rho^-(\theta_\delta) < \theta_\delta$, then by Lemmata E.1 and E.2 we have that $\rho(\theta) = \rho^-(\theta_\delta)$ for all $\theta \in (\max\{\rho^-(\theta_\delta), \tau_S\}, \theta_\delta)$ and $\rho(\theta) = \theta$ for $\theta \leq \max\{\rho^-(\theta_\delta), \tau_S\}$. In equilibrium, it has to be that $\beta(\rho^-(\theta_\delta)) = P$ and $\beta(r') = N$ for every off-path $r' \in (\max\{\rho^-(\theta_\delta), \tau_S\}, \theta_\delta)$. Hence, every report $r' \in (\max\{\rho^-(\theta_\delta), \tau_S\}, \theta_\delta)$ is equilibrium dominated for all $\theta < \theta'$, where $\theta' = \{\theta \in \Theta \,|\, C(\rho^-(\theta_\delta), \theta) = C(r', \theta)\}$. Therefore, $B(J(r'), r') = P$, and the sender could profitably deviate by reporting r' instead of $\rho^-(\theta_\delta)$ when $\theta \in (\theta', \theta_\delta)$. Suppose now that $\rho^-(\theta_\delta) > \theta_\delta$. By Lemma E.1 we have $\rho^-(\tau_S) = \tau_S$, and thus it has to be that $\theta_\delta > \tau_S$. Similarly to the previous case, in equilibrium it must be that $\rho(\theta) = \rho^-(\theta_\delta)$ for all $\theta \in (\tau_S, \theta_\delta)$. This is in contradiction to θ_δ being the lowest discontinuity, as we would have $\rho^+(\tau_S) > \tau_S$. Therefore, in every generic equilibrium, $\rho^-(\theta_\delta) = \theta_\delta \geq \tau_S$ and $\rho(\theta) = \theta$ for $\theta < \theta_\delta$.

From Lemmata E.1 and E.2, it follows that $\rho^+(\theta_\delta) > \theta_\delta$ and $\rho(\theta) = \rho^+(\theta_\delta)$ for every $\theta \in (\theta_\delta, \rho^+(\theta_\delta)]$: since it must be that $\beta(\rho^+(\theta_\delta)) = P$, the sender would profitably deviate by reporting $\rho^+(\theta_\delta)$ in every state $\theta \in (\theta_\delta, \rho^+(\theta_\delta)]$ such that $\rho(\theta) > \rho^+(\theta_\delta)$. To prevent other profitable deviations, $\rho^+(\theta_\delta)$ must be such that $u_S(P, \theta) - u_S(N, \theta) \leq kC(\rho^+(\theta_\delta), \theta)$ for $\theta \in (\tau_S, \theta_\delta)$ and $u_S(P, \theta) - u_S(N, \theta) \geq kC(\rho^+(\theta_\delta), \theta)$ for all $\theta \in [\theta_\delta, \rho^+(\theta_\delta)]$. Together, these conditions imply that $\theta_\delta = l(\rho^+(\theta_\delta))$. Any off-path report $r' > \rho^+(\theta_\delta)$ would be equilibrium-dominated by all $\theta \leq \rho^+(\theta_\delta)$, yielding $B(J(r'), r') = P$. Therefore, it must be that $\rho(\theta) = \theta$ for all $\theta \geq \rho^+(\theta_\delta)$, and $\rho(\theta) = \rho^+(\theta_\delta)$ for $\theta \in (\theta_\delta, \rho^+(\theta_\delta))$.

Suppose now that $\theta_\delta > \tau_R$. Given the reporting rule, posterior beliefs p must be degenerate on $\theta = r$ for all $r \in [\tau_R, \theta_\delta)$. In this case, there always exists an $\epsilon > 0$ such that

[6] Recall that $\rho^+(t) = \lim_{\theta \to t^+} \rho(\theta)$ and $\rho^-(t) = \lim_{\theta \to t^-} \rho(\theta)$.

the sender can profitably deviate by reporting τ_R instead of θ in states $\theta \in (\tau_R - \epsilon, \tau_R)$. Therefore, $\theta_\delta \in [\tau_S, \tau_R]$. $\square$

Proposition E.1. *A pair $(\rho(\theta), p(\theta \mid r))$ is a generic equilibrium of $\hat{\Gamma}$ if and only if, for a given $\lambda \in [\tau_R, \mathbb{E}_f[\theta|\theta \in (\tau_R, \bar{r}_S(\tau_R))]]$,*

i) The reporting rule $\rho(\theta)$ is, for a $\lambda \in [\tau_R, \mathbb{E}_f[\theta|\theta \in (\tau_R, \bar{r}_S(\tau_R))])$,

$$\rho(\theta) = \begin{cases} \hat{r}(\lambda) = \min\left\{\{r \in \Theta | \mathbb{E}_f[\theta|\theta \in (l(r), r)] = \lambda\}, 2\lambda - \tau_S\right\} & \text{if } \theta \in (l(\hat{r}(\lambda)), \hat{r}(\lambda)) \\ \theta & \text{otherwise.} \end{cases}$$

When $\lambda = \mathbb{E}_f[\theta|\theta \in (\tau_R, \bar{r}_S(\tau_R))]$, $\rho(\theta) = \hat{r}(\lambda)$ for $\theta \in [l(\hat{r}(\lambda)), \hat{r}(\lambda))$, and $\rho(\theta) = \theta$ otherwise.[7]

ii) Posterior beliefs $p(\theta \mid r)$ are according to Bayes' rule whenever possible and such that $\mathbb{E}_p[\theta \,|\hat{r}(\lambda)] = \lambda$, $\mathbb{E}_p[\theta \,|r] < \tau_R$ for every off-path r, and $p(\theta \mid r)$ are degenerate on $\theta = r$ otherwise.

Proof. Given the reporting rule $\rho(\cdot)$ described in Lemma E.5, beliefs p must be such that $\beta(\rho^+(\theta_\delta)) = P$, and thus $\mathbb{E}_p[\theta \mid \rho^+(\theta_\delta)] = \mathbb{E}_f[\theta|\theta \in (\theta_\delta, \rho^+(\theta_\delta))] \geq \tau_R$, where $\theta_\delta = l(\rho^+(\theta_\delta)) \leq \tau_R$ and, similarly, $\rho^+(\theta_\delta) = \bar{r}_S(\theta_\delta) > \tau_R$. It follows that the expectation $\mathbb{E}_p[\theta \mid \rho^+(\theta_\delta)]$ induced by the report $\rho^+(\theta_\delta)$ has to be between τ_R and $\mathbb{E}_f[\theta|\theta \in (\tau_R, \bar{r}_S(\tau_R))]$. I define the pooling report $\hat{r}(\lambda)$ as

$$\hat{r}(\lambda) := \{r \in \mathbb{R} \mid \mathbb{E}_f[\theta \mid l(r) < \theta < r] = \lambda\}.$$

For a $\lambda \in [\tau_R, \mathbb{E}_f[\theta|\theta \in (\tau_R, \bar{r}_S(\tau_R))])$, we can rewrite the reporting rule described in Lemma E.5 as

$$\rho(\theta) = \begin{cases} \hat{r}(\lambda) & \text{if } \theta \in (l(\hat{r}(\lambda)), \hat{r}(\lambda)) \\ \theta & \text{otherwise.} \end{cases} \tag{7}$$

Alternatively, (7) can have $\rho(l(\hat{r}(\lambda)) = \hat{r}(\lambda)$ as long as $l(\hat{r}(\lambda)) > \tau_S$. If $\lambda = \mathbb{E}_f[\theta|\theta \in (\tau_R, \bar{r}_S(\tau_R))]$, then it must be that (7) has $\rho(l(\hat{r}(\lambda))) = \hat{r}(\lambda)$; otherwise the sender would profitably deviate by reporting τ_R when the state is $\theta \in (\tau_R - \epsilon, \tau_R + \epsilon)$ for some $\epsilon > 0$. Since θ is symmetrically distributed around τ_R, we have $\hat{r}(\lambda) = \{r \in \Theta | \mathbb{E}_f[\theta|\theta \in (l(r), r)] = \lambda\}$ if $l(\hat{r}(\lambda)) > \tau_S$ and $\hat{r}(\lambda) = 2\lambda - \tau_S$ otherwise.

[7] Up to changes of measure zero in $\rho(\theta)$ due to the sender being indifferent between reporting $l(\hat{r}(\lambda))$ and $\hat{r}(\lambda)$ when the state is $\theta = l(\hat{r}(\lambda)) > \tau_S$.

By applying Bayes' rule to (7), we obtain that posterior beliefs $p(\theta|r)$ are such that $\mathbb{E}_p[\theta \,|\, \hat{r}(\lambda)] = \lambda \in [\tau_R, \mathbb{E}_f[\theta|\theta \in (\tau_R, \bar{r}_S(\tau_R))]]$, and are degenerate on $\theta = r$ for all $r \notin [l\left(\hat{r}\left(\lambda\right)\right), \hat{r}\left(\lambda\right))$. For every off-path report $r' \in (l\left(\hat{r}\left(\lambda\right)\right), \hat{r}\left(\lambda\right))$ it must be that $\mathbb{E}_p[\theta \,|\, r'] < \tau_R$ to have $\beta(r') = N$. These off-path beliefs are consistent with the Intuitive Criterion since for every $r' \in (l\left(\hat{r}\left(\lambda\right)\right), \hat{r}\left(\lambda\right))$ we have that $\inf J(r') < l(\hat{r}(\lambda)) \leq \tau_R$, and thus $N \in B(J(r'), r')$. The proof is completed by the observation that the pair $(\rho(\theta), p(\theta|r))$ described in Proposition E.1 is indeed a generic equilibrium of $\hat{\Gamma}$ for every $\lambda \in [\tau_R, \mathbb{E}_f[\theta|\theta \in (\tau_R, \bar{r}_S(\tau_R))]]$. $\square$

E.2 The Competitive Communication Game

The equilibria of the competitive game with two active senders are studied in Vaccari (2023a). Two types of equilibria are considered: revealing and *adversarial*. The latter are not revealing.

First, consider the revealing equilibria with two active senders as discussed in Appendix D.2.1. In the first revealing equilibrium, Sender_2 always reports truthfully, whereas Sender_1 reports truthfully only negative drawn values. On-path beliefs are pinned down by the senders' reporting strategies, which are revealing because of Sender_2's truthful strategy. The decision-maker's beliefs after observing an off-path pair of reports are such that DM selects action *Black* only if $r_1 \geq \bar{r}_1(0) = 96$, and selects *Red* otherwise. There are no individual profitable deviations from the prescribed strategies, and beliefs are according Bayes' rule whenever possible. Therefore, this is a perfect Bayesian equilibrium. There exists another revealing equilibrium where senders' roles are reversed: Sender_1 always reports truthfully, whereas Sender_2 reports truthfully only positive states. As before, it is easy to check that this is also an equilibrium.

Second, consider the *adversarial* equilibrium strategies as discussed in Appendix D.2.2. The players' strategies and beliefs are drawn from the main proposition in Vaccari (2023a). Denote by $U_{dm}(r_1, r_2)$ the decision-maker's expected difference in utility from selecting *Black* rather than *Red* in an adversarial equilibrium given the pair of reports (r_1, r_2). Suppose that the decision-maker's posterior beliefs satisfy three properties: (i) for every $r_j \geq r'_j$ and $j \in \{1, 2\}$, we have $U_{dm}(r_1, r_2) \geq U_{dm}(r'_1, r'_2)$; (ii) for every pair of reports (r_1, r_2) such that $r_2 \leq 0 \leq r_1$, and for $j \in \{1, 2\}$, we have $dU_{dm}(r_1, r_2)/dr_j > 0$; (iii) $U_{dm}(\bar{r}_1(0), \bar{r}_2(0)) = U_{dm}(0, 0) = 0$. Vaccari (2023a) shows that, under these assumptions and given the players' symmetric features, posterior beliefs are such that the decision-maker follows the recommendation of the sender delivering the report that is highest in absolute value. That is, given $r_1 \geq 0 \geq r_2$, the decision maker selects *Black* if $r_1 \geq |r_2|$, and selects *Red* otherwise. The posterior beliefs are coherent with the senders' reporting strategies and according Bayes' rule whenever possible. Given these beliefs, no sender has an individual profitable deviation. Therefore, this is an perfect Bayesian equilibrium.