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Modes of ambiguous communication ☆

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ABSTRACT

We study cheap talk communication in a simple two actions-two states model featuring an ambiguous state distribution. Equilibrium behavior of both sender (S) and receiver (R) features mixing and we relate each agent's randomization to a specific mode of ambiguous communication. For sufficiently high ambiguity, implementing the S-optimal decision rule with only two messages is impossible if R has aligned preferences. This may in contrast be possible if R has misaligned preferences. Adding a little ambiguity may generate influential communication that is unambiguously advantageous to S.

"*When I use a word,*" Humpty Dumpty said, in a rather scornful tone, "*it means just what I choose it to mean – nothing more nor less.*". "*The question is,*" said Alice, "*whether you can make words mean so many different things.*".

[Lewis Carroll, Through the looking glass]

1. Introduction

Many situations of advice feature uncertainty about the prior distribution of the state of the world. In medical advice, the distribution of a particular disease across ethnic groups may be unclear. In financial advice, the process governing the value of a given asset may be unknown. We examine a binary cheap talk model featuring Knightean prior uncertainty as well as ambiguity averse agents and we address the following questions. First, how does the addition of ambiguity change the predictions of the classical cheap talk model? Second, does the model generate features that are reminiscent of ambiguous language? We review our findings in what follows.

A preliminary standard result is that agents strictly favor randomization for intermediate (and thereby inconclusive) signal realizations, which allows to hedge in the face of ambiguity. We start by focusing on equilibria that implement the optimal decision rule of S (S-optimal equilibria). Our main objective is to establish the comparative statics of the set of S-optimal equilibria with respect to preference misalignment, message space cardinality and the ambiguity level. In our binary model, the natural measure of preference misalignment between sender (S) and receiver (R) is $\beta = q_S - q_R$, where $q_i \in (0, 1)$ describes i's relative sensitivity to type I and II errors ($\beta \geq 0$ as we assume $q_R \leq q_S$). The level of ambiguity is captured by a one dimensional parameter.

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Our first main finding is that it is without loss of generality to concentrate on so-called threshold equilibria. In the latter, S sends at most three messages and his communication strategy is described by three thresholds and mixing probabilities computed on the basis of q_S and q_R. In threshold equilibria S occasionally randomizes and his strategy cannot be described as a partitional strategy à la Crawford and Sobel (1982) (CS) but only as mixing over a set of partitional strategies. R also typically randomizes. We interpret randomization by respectively S and R as embodying two different modes of ambiguous communication.

Our next class of findings concerns the impact of the message space cardinality on the existence of S-optimal equilibria. If three messages are available, for any ambiguity level there is a maximal bias $\widetilde{\beta} \in (0, 1)$ such that an S-optimal equilibrium exists if and only if $\beta \leq \widetilde{\beta}$. Given high ambiguity, three messages are necessary for the existence of an S-optimal equilibrium independently of bias β. Given intermediate ambiguity there is always an interval of biases $\left[\underline{\beta}, \overline{\beta}\right]$ satisfying $\overline{\beta} < \widetilde{\beta}$ for which two messages suffice. It may furthermore be the case that $\underline{\beta} > 0$, meaning that a low bias renders three messages necessary. Finally, given low ambiguity two messages are always sufficient.

We add four remarks on the above class of findings. First, given intermediate ambiguity perfectly manipulating R thus requires more sophisticated language as β increases from $\beta \in \left[\underline{\beta}, \overline{\beta}\right]$ to $\beta' \in (\overline{\beta}, \widetilde{\beta}]$. In this case, if we pick the S-optimal equilibrium as our prediction for the game, more bias thus implies richer equilibrium language. This reverses the prediction of the CS cheap talk model if we pick the finest equilibrium as the salient prediction for the latter model. A second remark is that under high (resp. intermediate) ambiguity the S-optimal equilibrium for sure (resp. potentially) does not exist if S and R have identical preferences and only two messages are available. This is counterintuitive and we term this the *Doppelgänger Paradox*. A third remark is that under intermediate ambiguity the Doppelgänger Paradox, if arising, is compounded by the existence of an S-optimal equilibrium if R is moderately biased (i.e. $\beta \in \left[\underline{\beta}, \overline{\beta}\right]$). A misaligned R is thus preferable to S than a perfectly aligned R. We term this the *strong Doppelgänger Paradox*. A fourth and final remark is that the above features do not obtain in the absence of ambiguity. In a model featuring two actions, two messages always suffice to implement the (potentially mixed) S-optimal decision rule if S and R have identical preferences.

A third main finding is that there typically now also exist influential communication equilibria that do not implement the S-optimal decision rule, in contrast to the case of no ambiguity. A fourth main finding is that adding a little ambiguity, starting from no ambiguity, can generate the possibility of influential communication and additionally be unambiguously beneficial to S.

Literature review Ambiguous language arguably lacks a theoretical explanation: Existing models that explicitly purport to study ambiguous communication actually generate vagueness (see for example Alesina and Cukierman, 1990; Aragonès and Neeman, 2000; Callander and Wilson, 2008; Tomz and Van Houweling, 2009). In contrast, we find the forms of randomization (by S and R) featured in S-optimal equilibria of our game reminiscent of two common modes of ambiguous communication. In this light, we provide a simple account of ambiguous language as the equilibrium implication of ambiguity in priors.

Our contribution lies at the intersection of the literatures on respectively cheap talk communication and ambiguity. The first was initiated by the seminal model of Crawford and Sobel (1982). The endogenous randomization over messages inducing different beliefs featured in our model bears a relation to the exogenous randomization studied in Blume et al. (2007). In the latter model, an emitted message may be randomly swapped with another during the transmission process. The authors show that this exogenous randomization can be welfare beneficial. Note however that if the sender had access to non-noisy messages he would strictly favor these over noisy messages. Blume and Board (2013, 2014) as well as Gordon and Nöldeke (2015) offer a further exploration of the issues studied in Blume et al. (2007). Finally, Lipman (2009) examines communication with identical player preferences and concludes that vagueness can be efficient only if the informed party exhibits bounded rationality in the form of "vague views of the world". Some of our results are in line with this conjecture.

Our paper also relates to the literature of ambiguity. We model ambiguity based on the Max–Min model (Gilboa, 1987; Gilboa and Schmeidler, 1989). It is well-known that no common practice on updating of ambiguity averse preferences has yet emerged. We refer to Siniscalchi (2011) as well as Hanany and Klibanoff (2007, 2009) for a discussion of this issue. Recently, ambiguity has been brought to strategic settings by a number of authors. Bade (2010), Riedel and Sass (2014), Azrieli and Teper (2011) and Hanany et al. (2015) define general equilibrium concepts under ambiguity. A large array of papers study more specific applications to finance, tournaments or contract theory. Somewhat more related contributions include a number of studies of mechanism design under ambiguity (Bose and Renou, 2014; Di Tillio et al., 2017). The latter contributions, in applying the revelation principle, analyze a messaging game in the presence of ambiguity. Finally, Kellner and Le Quement (2017) analyze ambiguous (Ellsbergian) communication strategies within the CS model and find that for any standard influential equilibrium, there exists an Ellsbergian equilibrium ensuring both S and R a strictly higher ex ante expected payoff. Ambiguity, by triggering Max–Min decision making, acts as a beneficial commitment device for R.

2. The model

There are two agents, a sender S and a receiver R. The state of the world $\omega \in \{A, B\}$ has a subjectively uncertain distribution represented by a set $[P_l(B), P_h(B)]$ of prior probabilities of state B. We assume that $P_h(B) = \frac{1}{2} + e$ and $P_l(B) = \frac{1}{2} - e$, for some $e \in \left(0, \frac{1}{2}\right)$. R can choose among two actions a and b.