

A Survey on Ambiguity of Talk

Masataka Iwata

Abstract

This paper is a survey on economic studies about the relationship between probabilistic ambiguity and cheap talk. Ambiguity has been a classical topic in the field of decision theory. Recently, the notion of the ambiguity is extensionally applied to a classical model of cheap talk. Ambiguity (or vagueness) of talk can be studied with the corresponding notion of ambiguity of probabilistic decision theory.

"Segnius irritant animos demissa per aurem,
Quam qua sunt oculis subjecta fidelibus."

— Horace.

1. Introduction: Decision Theory

Although not all economists might not be familiar with the term "decision theory," majority of them are actually using it by frequently referring to preference (relations) and expected utilities. From the point of view of contribution to economics, one of the most seminal study is Savage (1954), who axiomatized decision-making based on subjective expected utility (i.e. expected utility calculated with subjective probability measure). Expected utility theory based on additive (i.e. our familiar) probability measure is well-defined and easily tractable, and therefore has become a standard tool of economic theory. In that sense, modern economics as a whole has the decision theory as its foundation.

However, the Savage framework is not almighty. Ellsberg (1961) has shown a paradoxical case, in a form of thought experiment, which cannot be explained with the orthodox expected utility theory. Let me briefly introduce the case, "Ellsberg's urn." Suppose you are faced with two urns, named 1 and 2. The urn 1 has only 50 black balls and 50 red balls in it. The urn 2 also has black balls and red balls in it, though the numbers and proportions of the balls are totally unknown. You are required to bet on one of four events, which are 1B, 1R, 2B, and 2R. The choice 1B indicates that you are going to draw a ball from the urn 1 and the color of the drawn ball is black. 1R, 2B, and 2R are defined in the same way. If you win the bet, you get a prize. If you lose, you get nothing. Suppose that your preference relation over these four bets is $1A \sim 1B > 2A \sim 2B$. Such a preference is intuitively natural but never can be represented by any pair of (Von-Neumann-Morgenstern) utility function and belief.¹

1 For $2A \sim 2B$ to stand, the believed numbers of black balls and red balls in the urn 2 must be equal. However, that implies $1A \sim 1B \sim 2A \sim 2B$.

The Ellsberg paradox above has shown that the expected utility theory based on additive probability measure and unique prior distribution cannot deal with some ambiguous situations of decision making, specifically those in which frequencies of some events are unknown and not objectively describable.² Responding to it, Gilboa (1987) and Gilboa and Schmeidler (1989)³ have offered extended framework of expected utility theory, respectively, one with non (necessary) -additive measure and another with non-unique priors. Though mathematically they are distinct from each other, narratively their stories are similar; the decision - maker holds a reason to avert from those choices whose outcomes are probabilistically ambiguous. This characteristics is called "ambiguity aversion." With the ambiguity aversion, we can fully explain the Ellsberg paradox as a representation of a particular choice rule based on expected utility.

Recently, ambiguity is brought into various kinds of (applied) economic studies. Let me briefly introduce some of them. Siniscalchi (2011) as well as Hanany and Klibanoff (2007, 2009) has developed dynamic framework of choice under ambiguity; in other words, they have invented method of updating ambiguity-averse preferences. Bade (2010) has defined a general equilibrium concept under ambiguity. . Bose and Renou (2014) has investigated a mechanism design problem under ambiguity. Kellner and Le Quement (2017, 2018) have introduced some ambiguous distributions of private information into cheap talk models. This paper's focus is particularly on the last, that is, the studies of cheap talk among ambiguity averse agents.

2. Information Transmission by Cheap Talk Communication

Cheap talk is a field of game theory, in which how the use of costless messages (i.e. communication) affects the agents' behavior is investigated. Communication is in some way effective when any of the following three conditions is satisfied; according to the sent messages, (1) agents' belief on true state of the world changes (informative), (2) agents' action changes (influential), and (3) the agents' payoff profile is different from the case without messaging (payoff-relevant).⁴ Classic study by Crawford and Sobel (1982) (henceforth CS), solving a two-person message game, has shown the existence of equilibria wherein the communication is informative, influential, and payoff-relevant. Let me explains some more details. Agents are S and R, respectively the sender of the message and the receiver.⁵ At the beginning of the game, the state of the world ω is determined according to a known probabilistic distribution over $[0, 1]$. Only S observes the state. S sends a message m , which is chosen from a message set M , according to her strategy $q: [0, 1] \rightarrow$

2 This kind of acute lack of knowledge is often called "Knightian uncertainty," according to Knight (1921).

3 For newer study by the same authors, though they no longer belong to the expected utility theory, see Gilboa and Schmeidler (1995, 2001).

4 Definition of these characteristics is by Sobel (2013).

5 In subsequent literature, the sender and the receiver are often called respectively the expert and the decision - maker.

Δ_M (Δ_M is the set of distributions over the message set M). R determines her action a , according to her strategy $\delta : M \rightarrow \Delta_A$ (Δ_A is the set of distributions over the action set $A \equiv [0, 1]$). S's preference over R's actions is biased in the sense that S prefers higher a than R for each state ω , and therefore S has no incentive to honestly report the exact value of ω . In every equilibrium, essentially, S plays so-called partition communication strategy, in which the state space is partitioned into a finite number of intervals and S reports only which interval the true state belongs to.

Since in each equilibrium of the CS model the state of the world is blurred by the sender, the information transmission has been imperfect. Therefore, economists have been interested in how we can improve it and/or make it perfect. Such a topic of research interest is often verbalized as "generation of credibility." Many researches have been conducted in this line of interest;⁶ though we cannot survey all of them in this paper, Sobel (2013) offers a comprehensive introduction to the literature. CS is not just a classic work but also the basis of extensional studies of nowadays. Indeed, the model of CS reappears in the Section 4 and I am going to introduce its extensional studies which allow for the ambiguity averse agents.

Credibility foundation by cheap talk communication is enthusiastically studied also in the field of politics and political science. Well known is the works of Austen-Smith (1993, 2002), who have directly questioned the influence of cheap talk toward political procedures. Krishna (2001) has studied the relationship of various legislative rules and informational efficiency. Kartik and Van Weelden (2018) have analyzed politicians' cheap talks in the process of elections. Since politics is the very place where vagueness and ambiguity of talk play their part, this direction of research shall be substantially promising.

3. Ubiquity of Ambiguous Language

As a matter of fact, we use our language in an ambiguous way. More specifically, we need to know some key information to understand what a particular term exactly means. For example, the adverb "quite" exaggerates its subsequent adjective conspicuously when it is used in the United States, while it works like "rather" in England. Therefore, when a reader does not know the mother tongue of the writer, the meaning of the term "quite" stays ambiguous. Many adjectives also work ambiguously; we cannot exactly tell which one of "great" and "splendid" is better praise than the other; Such a sensitive order practically depends on the speaker's personal taste. Let me quote from Lipman (2009): "Consider, for example, the word 'tall.' There is no precise, known height which defines the line between a person who is tall and a person who is not. Why do we use a language in which such terms are so prevalent? Why don't we simply adopt as a definition that 'tall' will mean above, say, 6 foot 2?"

Given the disputes over the information transmission, which I have briefly introduced

6 For early works, see, for example, Sobel, 1985; Gilligan and Krehiel, 1989; Rabin, 1990; Benabou and Laroque, 1992; Austen-Smith, 1993; Farrell, 1993.

above, we have to face a natural and intuitive question; "On the face of it, the phenomenon of ambiguous language is puzzling because it appears to gratuitously decrease the precision of transmitted information." (Kellner and Le Quement 2018) And the question is already half answered; considering humans' rationality, we have to conclude that the ambiguous language shall pay more than strictly defined ones. Wright (1976) says, "the utility and point of the classifications expressed by many vague predicates would be frustrated if they were supplied with sharp boundaries."

Then how the use of ambiguous language contributes to human welfare, especially the economic efficiency? There is an interesting report by Serra-Garcia, van Damme, and Potters (2011); the leader of a production team (in an experiment) has often utilized vague messages in order to hide some inconvenient information about their product (a public good), while the other members have simply neglected such a message, which eventually reveals the inconvenient truth, and have kept working efficiently. It suggests a story; ambiguity of words may estrange the audience from the current (inconvenient) topic of conversation. In the following section, I would like to review some studies from the viewpoint of this idea.

4. Cheap Talk and Ambiguity

At the beginning of the 21st century, some studies have shown non-direct or noisy communication improves the efficiency by mediating conflicts among agents. Blume, Board, and Kawamura (2007) have studied a communication game wherein messages can include errors/noises in order to show that a small amount of noise raises the welfare. Goltsman, Hörner, Pavlov, and Squintani (2009) have extended the CS model to allow (among others) neutral third party to make a recommendation for negotiating pair. it is shown that mediation by the third party improves the welfare performance when the degree of conflict between the pair is high.

Subsequently, Blume and Board (2013) have studied a common-interest game and have shown that "indeterminacy of meaning, the confounding of payoff-relevant information with information about language competence, is optimal." In this study the authors evaluated the vagueness of language in an affirmative manner. Furthermore, Blume and Board (2014) have finally shown that strategic agents often deliberately choose to use a vague language, in order to avoid conflicts with others. Models of these studies are distinct from each other, though, the narrative of them can be summarized; when a party holds a risk of fierce conflict among them, noisy communication sometimes prevents it and keeps the peace. However, each of these studies has assumed no Knightian uncertainty nor ambiguity aversion.

Following the researches above, a marriage between the cheap talk study and the decision theory has been accomplished. First, Kellner and Le Quement (2017) introduced ambiguous distribution of the state of the world (mathematically, non-unique priors of it) into a simple two-action and two-states communication game. Among multiple qualitative results, noteworthy is that small increase of ambiguity generates influential communi-

cation whose outcome is better for the sender of message; that is, the conflict mitigation intuition reappears robustly. Subsequently, Kellner and Le Quement (2018), extending the classic CS model, have made inclusion of ambiguity into communication to be the sender's choice. The sender has the Ellsberg urn (the urn 2 in this paper) and make her message depend on the color of drawn ball. She can play also a strategy without ambiguity, by ignoring the urn. It is shown that there is likely to be those equilibria wherein the sender utilizes the urn; the ambiguity of talk can be endogenously created. Furthermore, such equilibria offers both the sender and the receiver higher ex-ante payoff than those without ambiguous message. That is, the ambiguity is advantageous to the parties involved in communication.

Let me note that Kellner and Le Quement (2018) is a qualitatively legitimate successor of CS. In the CS model, each equilibrium message strategy divides the state space $[0, 1]$ into multiple, say n , partitions and sends one message of $\{m_1, \dots, m_n\}$ according to which partition the state belongs to. The meaningful messages m_1, m_2, \dots, m_n can be any n numbers in $[0, 1]$. For example, whichever $m_k = 1/k$ ($k = 1, 2, \dots, n$) or $m_k = (0.5)^k$ ($k = 1, 2, \dots, n$) is true, as far as the receiver understands the indication of the messages correctly, informative communication stands. This property has already shown that the use of cheap talk bears the burden of ambiguity. If the receiver does not understand or simply ignore the meaning of the messages, there remains only bubbling equilibria, which lacks information transmission. If the sender tries to randomize over different profiles of messages, then the message becomes noisy. Furthermore, if the sender utilizes the ambiguous Ellsberg urn, then the message becomes ambiguous. The last "if" is the starting point of Kellner and Le Quement (2018).

5. Concluding Remark

"the issue of judicial interpretation rarely enters these economic analyses. In reality, however, there are numerous sources of ambiguity and vagueness in any statute, ranging from disputes concerning the meaning of simple statutory language to uncertainties about overall legislative intent."

— Rizzo and Arnold (1988)

Different people use language in different ways. Sometimes the same words happen to have quite opposite meanings to different people. This kind of ambiguity (or vagueness) of language is likely to be regarded just as some defect of our communication system. However, as we have seen above, the ambiguity of talk can be the result of our own choice. In the context of politics and jurisdiction, we can rather easily understand that point. People talk ambiguously in order to avoid (subjectively) unnecessary conflict with others. As we have also seen above, such an aversion from conflicts is frequently constructive because it enables potentially conflicting party to collaborate.

Given the existing studies introduced above, the research of ambiguous talk can be extended and applied to many fields of economics and even other academic fields, which

naturally include political science, law, education, management, and sociology. When you are interested in some people's interaction, it inevitably includes a kind of communication. In such a case, researchers come up against the ambiguity of talk as a tough barrier. Our (i.e. economist's) game-theoretic tool might help them overcome such a difficulty.

Research following this line is, of course, facing its own difficulties. First, analytical methods of computing ambiguity is not complete. Particularly studies on the methods for dynamic setting have just started recently. Second, rather technically, the assumption of non-unique priors offers way too much degree of liberty to the model. In applied researches, it might become a fertile ground of ad-hoc assumptions.

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