Understanding Ambiguity Attitudes - Ellsberg Choices Among Indian Students

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Abstract

Individuals have often displayed a preference for known risk over unknown prospects (Ellsberg, 1961). Different variants of Ellsberg paradox have been widely used by academicians to examine the phenomena of ambiguity aversion among diverse subjects. This study examined ambiguity attitudes through a survey based approach, among a set of Indian students by using a quantitative measurement of ambiguity attitude developed by Dimmock, Kouwenberg, and Wakker (2016). Supporting the ambiguity attitude results of developed markets, a majority of the students exhibited an aversion to ambiguity and risk. The relation between risk and ambiguity attitude is inconclusive and yet to be explored further. Empirical results showed certain demographic variables to be significant in explaining ambiguity attitudes in contrast to results from developed markets. These results can be due to cultural differences, which offer a promising area for future studies. Future studies can explore the impact of family responsibility and commitments on attitudes towards ambiguity. Testing factors determining ambiguity attitude can broaden understanding of ambiguity aversion and how it can be addressed in Asian countries like India, which are collectivist in nature. Role of family commitment and marital responsibilities can elicit ambiguity attitudes different from those of developed countries. Alternatively, the study proposed to explore ambiguity attitude in relation with financial decision making with a more representative sample of investors .

Keywords : **Ellsberg paradox, ambiguity aversion, matching probability, decision making**

JEL Classification : C90, D91, G40

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In decision making under certainty, an individual has direct access to the set of available actions and consequences with surety. The worth of his/her actions in such situations is equivalent to the worth of its outcome. Decision making under certainty is known as preference theory, which assumes the decision maker to be an economic man who is rational and completely informed (Edwards, 1954). In decision making under uncertainty, an individual does not have direct access to outcomes through his/her actions (Bryant, 2014). On account of what can be known, unknown, or unknowable, the set of outcomes might differ depending on possible unfolding of the states of the world (Machina, 1987). These are the situations involving risk, ignorance, and uncertainty. Under such situations, the assumption of an economic man does not hold completely. Scholars have questioned the rationality of decisions made under such situations as the decision maker might not be always completely informed (Edwards, 1954).

A decision-making process requires a decision maker to engage with abstraction at three levels :

- Defining the decision problem,
- Formalizing the decision problem,
- Representing the decision problem.

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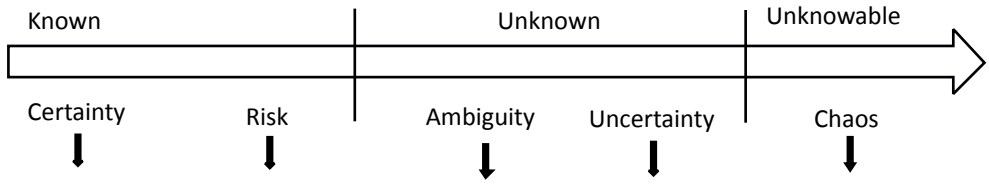
Figure 1. Formalization of Decision Problem in Different Situations



Actions	Defined	Defined	Conflicting Views	Not Defined
States	Defined	Defined		Not Defined
Outcomes	Defined	Known with probabilities		Not Defined

Defining the decision problem requires specifying the choice to be made. Formalization of the decision problem deals with the level of information available about the basic blocks of decision making, that is, action set, states, and outcomes (Peterson, 2009). On the spectrum of formalization of decision problem ranging from known to unknowable (Schoemaker, 2012), the situations under decision making and the information about its building blocks can be categorized as displayed in Figure 1.

The first formal distinction between risk and uncertainty dates back to 1921, when Frank Knight explicitly defined risky situations as those where both outcomes and probabilities of reaching those outcomes can be accurately assessed. When it cannot be done, such situations fall under the ambit of uncertainty (Knight, 1921). Knight mentioned in his seminal work that there is a subtle and important difference between risk, uncertainty, and ambiguity in individual decision making. Further examining individual choice behavior, Daniel Ellsberg in 1961 acknowledged Knight's work to formally define the concept of ambiguity and aversion to ambiguity (Rakow, 2010). Known as the Ellsberg Paradox, it has been subjected to a variety of scholarly tests to understand the decision-making process with respect to ambiguity attitudes.

Need for the Study

Scholars have consistently critiqued that choice under uncertainty is yet to find its Isaac Newton and is still considered to be in a state of flux (Machina, 1987). The field has lacked sufficient intellectual progress and many believe it has received less attention from economists (Zeckhauser, 2014). Ambiguity and attitudes of agents towards ambiguity is believed to be the most ill-defined in decision making under uncertainty. The phenomena of ambiguity suffers from a lack of unanimous definition and suffers from inexactness (Machina & Siniscalchi, 2014). The concept of ambiguity and ambiguity aversion are still ambiguous. Hence, understanding ambiguity attitudes among decision makers still continues to challenge academicians.

Objectives of the Study

This paper attempts to enhance understanding of ambiguity by empirically measuring ambiguity attitudes among subjects of a developing country. Ellsberg argued that individuals demonstrate aversion to ambiguity. However, it has been observed in past studies that subjects can be averse, neutral, or even prefer ambiguity in certain

situations. Through a survey based approach, it aims to elicit ambiguity attitudes using the Ellsberg two urn paradox. Empirically, it examines factors affecting ambiguity attitudes and relation of ambiguity attitudes with risk attitudes.

Choices Under Risk and Uncertainty

Decision making in finance originated from the standard consumer theory in economics, which involved choices among commodity bundles. It assumed the individuals have the ability to perform the mathematical operations to make a decision (Machina, 1987). With the emergence of the concept of probability in the 17th century, the decision to involve in a risky venture could be expressed mathematically. An individual was considered to be rational by taking a decision which results in the maximum expected value.

Decision making in finance deals with assets, which are different from standard commodity bundles meant to satiate current needs. The mathematical concept of expected value could not explain why a pauper perceived a gambling bet different from a wealthy individual. It was the Bernoulli paradox (Bernoulli, 1954) which challenged the concept of expected value and gave birth to the concept of expected utility. The attractiveness of a risky venture is dependent not upon the absolute value of an outcome, but the utility each outcome gives to the decision maker. An individual is considered to be rational when the decision process results in maximizing expected utility expressed as the sum of the product of utility of each outcome and the probability of occurrence of each outcome.

The probability of occurrence of each outcome and its utility is required by an individual to formalize a decision problem. Decision making becomes complex when the information available is not sufficient enough to come up with probabilities of occurrence of an outcome or even to specify the whole set of potential outcomes. Knight defined such a situation as unmeasurable uncertainty (Ellsberg, 1961).

(1) Defining Probability : If risk has a mathematical heart, it is the concept of probability. Originating in the 17th century, evolution of probability has followed a long journey (Hacking, 2006). Over the years, the concept of probability has been defined in two forms. One is the mathematical form which explains how probabilities behave and how they are calculated. The other is the philosophical form which deals with explaining what probabilities are (Lyon, 2009).

The philosophical school of thought diverged in two contrasting views on interpreting probabilities. One view interpreted probability as a tool to support the past and was based on evidence. It assumed that the nature of occurrence of an outcome will remain the same with probability as an intrinsic property of the process, defining it as objective probability. The classic example being that of a toss of an unbiased coin or spinning of an unbiased roulette wheel. The other view which came to be known as subjective probability interpreted probability as a tool to express the information known to an individual about the process. They assumed that the nature of occurrence of each outcome cannot be the same, and hence, probability in such cases needs to be formed on beliefs one forms about the occurrence of outcomes. The classic example being that of a result of a horse race or forecasting growth rate (Wenmackers, 2011). Based on the philosophical classification of probability, expected utility was classified as objective and subjective expected utility.

(2) Defining Utility and Utility Models : When an individual knows the probabilities of outcomes, theory of choice assumed, he/she will make a choice based on the highest expected utility values. Pioneering work in the field of theory of choice, when probabilities can be objectively defined, was the expected utility (EU) theory by von Neumann and Morgenstern in 1947. The expected utility theory became synonymous with theory of choice under risk and defined an individual to be rational if he/she observed a set of axioms (Gilboa, Postlewaite, & Schmeidler, 2008).

Savage in 1954 built up on the expected utility theory by defining situations when the individual is not able to objectively come up with the probability of outcome occurrence. In such situations, an individual conjectures the possible states of the world subjected to his/her beliefs and defines his/her desired set of outcomes (Weber & Camerer, 1987). Since the probability of outcome occurrence is subjected to beliefs, it led to formation of subjective expected utility (SEU). It became synonymous with the theory of choice under uncertainty. The axioms of rational behavior under EU were refined to build axioms for rational behavior under SEU by Savage. It is beyond the scope of this study to elaborate upon the nature of the axioms under EU and SEU.

SEU enabled individuals to define their preferences based upon their beliefs of realization of a particular state and their tastes of possible outcomes (Savage, 1954). While the states could be represented with a subjective probability distribution (Savage, 1954), the outcomes, synonymous with the tastes, could be represented with a utility function (Kelsey & Quiggin, 1992). SEU assumed that an individual will exhibit "probabilistic sophistication," that is, unique subjective probabilities will be assigned to states, which can be used to predict outcomes with consistency.

However, the most modern attack on SEU was the Ellsberg paradox, which challenged and still continues to challenge the SEU axioms for rational behavior for violation of "probabilistic sophistication" (Machina & Schmeidler, 1992). It showed that an individual is not always skilled to assign subjective probabilities to realization of events due to the presence of ambiguity (Ellsberg, 1961).

Choices Under Ambiguity

(1) Ellsberg Paradox : "Ellsberg choices are rational responses by decision-makers to a lack of reliable information that prevents them from forming beliefs with confidence" (Al-Najjar & Weinstein, 2009, p. 10). One of the primary examples used by Ellsberg to elicit decision choices was the two urn paradox. The two urn paradox still continues to be widely cited in empirical literature (Machina & Siniscalchi, 2014). It is also used in this study to design the experimental survey.

The two urn paradox (shown in Table 1) consists of two urns containing a total of 100 balls each, consisting of red and black color. While in Urn I, the proportion of 100 red and black color balls is unknown ; in Urn II, the proportion of both red and black color balls is exactly known to be 50 each. A decision maker is posited with four bets. Each bet requires the decision maker to draw a ball from an urn chosen by him/her. Bet B1 requires to draw a ball from Urn I and winning a certain amount of $X if it is red in color. Similarly, for the other bets, the decision maker wins a certain amount if the ball drawn is of the winning color from the chosen urn (Ellsberg, 1961).

Ellsberg argued and confirmed through experiments that a decision maker was indifferent in choosing between bets B1 and B3 or bets B2 and B4. However, most of the decision makers preferred to choose bets B2 and B4 over bets B1 and B3. Preference of bet B2 over B1 implied that probability of red in Urn 1 was less than ½. Similarly,

Table 1. The Two Urn Paradox

	Urn I		Urn II	
Balls	100 balls		50 balls	50 balls
Color	Red	Black	Red	Black
B1	$ X	$0		
B2			$ X	$0
B3	$0	$ X		
B4			$0	$ X

Source: Ellsberg Paradox

preference of Bet B4 over B3 implied that probability of black in Urn 1 was less than ½. Such preferences were paradoxical in nature and violated the properties of subjective probabilities as sum of both red and black probabilities should be equal to 1 and not less than 1 (Ellsberg, 2001). The Ellsberg choices hence, showed that SEU is not completely holistic to deal with true uncertainty.

When information about state realization is not known with certainty and cannot be even deduced through subjective beliefs, it leads to inconsistency in preferences (Ghirardato & Marinacci, 2002). Such a situation, considered as a type of uncertainty, was termed by Ellsberg as ambiguity, and a preference for known probability over unknown probability was defined as aversion to ambiguity. Hence, the nature of information regarding the realization of events affects decision making (Ellsberg, 2001).

(2) Defining Ambiguity : With the Ellsberg paradox, decision theory advanced to elicit preferences in situations of ambiguity. It questioned SEU and the role of nature of knowledge or information on attitudes towards ambiguity, leading to an extensive body of literature (Al-Najjar & Weinstein, 2009).

Scholars started defining the concept of ambiguity in both normative and descriptive approaches. Normative school of thought prescribed how decision makers ought to behave under situations of ambiguity. One could either banish ambiguity altogether by assuming all probabilities being expressed as subjective probabilities. Else, one could also follow a reductionist approach by expressing ambiguity through second order probabilities (Weber & Camerer, 1987). This field is progressing with the development of a variety of mathematical models as extensions of SEU formulating decision making under ambiguity (Ghirardato & Marinacci, 2002). The literature review on models on ambiguity aversion was captured well by Machina and Siniscalchi (2014). However, the normative approach is not completely exhaustive to deal with Ellsberg choices.

The descriptive school of thought developed the empirical psychological experimental approach by testing how decision makers behave under ambiguity. It focused on capturing the psychological essence of decision making under ambiguity by testing the Ellsberg paradox. The focus was on understanding the antecedents of ambiguity attitudes and their impact on various decision making problems (Etner, 2012).

Both schools of thought gave observations which have contributed in defining ambiguity. It is still unclear whether the models on ambiguity aversion cater to rational decision making or whether the descriptive experimental settings are an extension of misapplied heuristics (Al-Najjar & Weinstein, 2009). Hence, analyzing Ellsberg choices continues to challenge scholars, making it difficult for them to define it (Etner, 2012).

(3) Empirical Test on Ambiguity : Till date, Ellsberg paradox has been widely tested among subjects of developed countries. Empirical tests have been done to develop a broader understanding of ambiguity concept by focusing on the measurement tools of ambiguity aversion and on its determinants, which has taken the experimental route. These studies have enabled academicians to understand the psychological underpinnings behind ambiguity attitudes. Majority of the studies have used students as subjects and showed conformity with Ellsberg choices (Machina & Siniscalchi, 2014). Variation in Ellsberg paradox has been done by changing the proportion of objective and subjective uncertainty along with the variation in the quantum of gains and losses. Most of the studies gave mixed evidence, showing a heterogeneity of ambiguity attitudes (Etner, 2012). One can find a comprehensive review of an experimental survey on ambiguity attitudes in Weber and Camerer (1987) and Machina and Siniscalchi (2014).

To explore behavioral traits, ambiguity attitudes have also been examined with respect to the competence of the decision maker, perception of competence of other decision makers (Heath & Tversky, 1991) along with evaluation of ambiguous choices in isolation or in comparison with unambiguous choices (Fox & Tversky, 1995). They have been tested in other domains, including intertemporal choice (Weber & Tan, 2012) along with framing effects and fear of negative evaluation (Trautmann, Vieider, & Wakker, 2008). Behavioral and demographic traits

like individual feelings of optimism vs pessimism (Pulford & Gill, 2014), illusion of control (Charness & Gneezy, 2010), and gender differences (Borghans, Heckman, Golsteyn, & Meijers, 2009) have also been explored in context of ambiguity attitudes.

In this study, we contribute to the existing literature by empirically examining the antecedents of ambiguity attitudes among Indian students. We also aim to explore the relation between risk and ambiguity attitudes.

Experiment on Ambiguity Attitude

(1) Method

(i) Subjects : Sixty four (59 male and 5 female) students, currently enrolled in a post graduate general management program requiring each student to have a minimum work experience of 5 years, volunteered to participate in the survey experiment conducted in the month of July 2017. The subjects were not offered any real monetary incentives and based their decisions on hypothetical situations. The average age of the participants was 29 years ($SD = 2.2$) with an average work experience of 6.5 years. Among the 64 subjects, 19 were married. The average monthly salary of the students before joining the program was USD 1,076 (INR 73,126.6).

(ii) Survey Design : The participants were asked to respond to an online survey - experimental questionnaire developed using the Question Pro software. The survey was designed to gather demographic profile information and to elicit responses to questions on behavioral traits and ambiguity attitude measurement.

For demographic profile information, they responded to questions on age, gender, total years of work experience, marital status, number of dependent family members, and last drawn salary per month. Variables like financial literacy, risk attitude, level of trust, overconfidence, and self-assessed knowledge were measured through standard scales used in various studies. The text on the variables and measurement rules through scales is given in the Appendix.

Financial literacy was measured by asking a set of three questions used in multiple studies and in American Life Panel by Rand Corporation (Dimmock, Kouwenberg, Mitchell, & Peijnenburg, 2016). Risk attitudes were measured using standard DOSPERT scale index for gambling and investment propensity subscales. The scale is not mentioned in the appendix ; interested readers can refer to the work of Blais and Weber (2006) for the development of the scale.

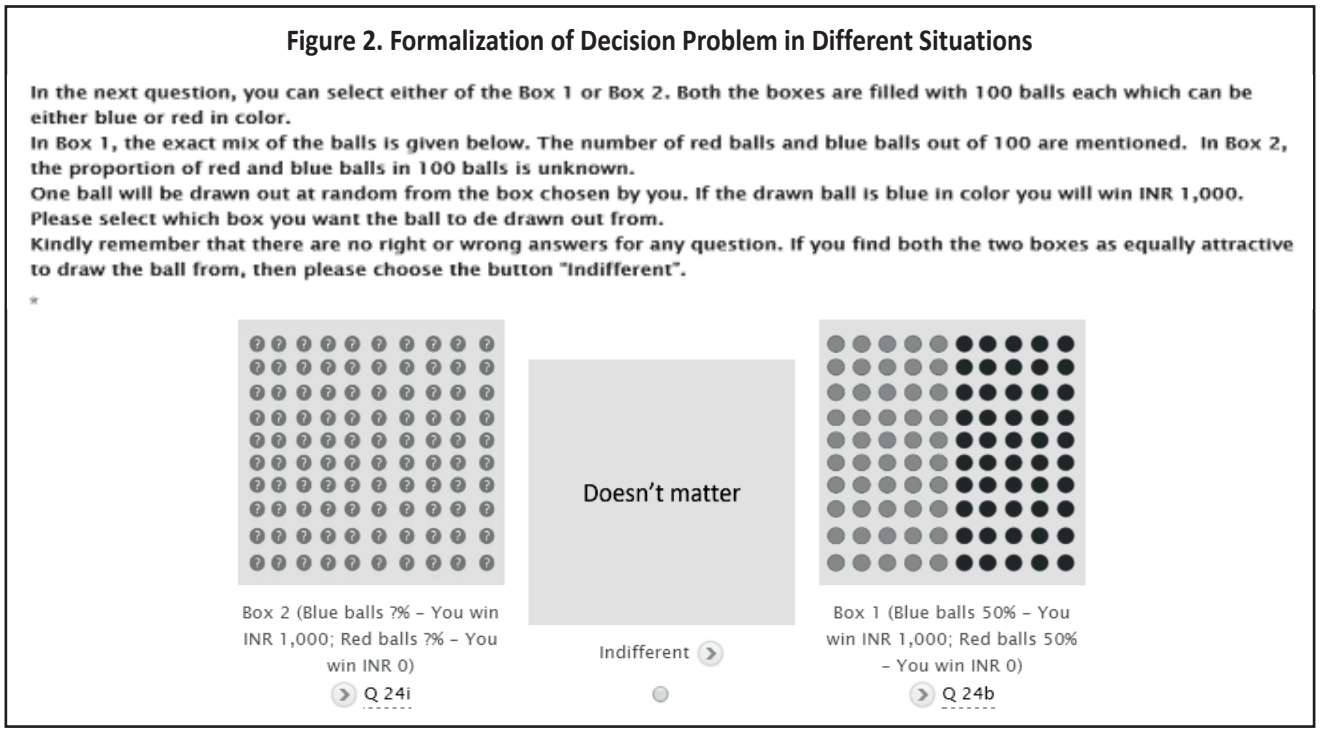
The level of trust was measured using the question from the World's value survey used in multiple studies (Dimmock, Kouwenberg, Mitchell, & Peijnenburg, 2016). Overconfidence was measured using better than average effect (Glaser & Weber, 2007). Self-assessed knowledge was measured using the Likert scale of 1 to 5 ranging from *very low* to *very high* on different financial products. The list of financial products was sourced from a financial literacy survey done among Indian students, employees, and retired persons (Agarwalla, Barua, Jacob, & Varma, 2012). The list is mentioned in the Appendix.

(2) Ambiguity Measurement

(i) Matching Probability : Ambiguity attitude was measured using the method based on matching probabilities (Dimmock, Kouwenberg, Mitchell, & Peijnenburg, 2016 ; Dimmock, Kouwenberg, & Wakker, 2016). The matching probability concept based on source method of ambiguity gives a quantitative measure for ambiguity attitude and is fairly easy in application.

Post gathering information on demographic and behavioral traits, the participants were asked a series of questions pertaining to Ellsberg two urn paradox. The questions required participants to choose between Box 1 (with known composition of red and blue balls), Box 2 (with unknown composition of red and blue balls), or be

Figure 2. Formalization of Decision Problem in Different Situations



indifferent to it. Hence, Box 1 was the unambiguous box with known risk and Box 2 was the ambiguous box, where subjects did not know the probability of drawing a certain color ball. All subjects were given a hypothetical situation of winning INR 1,000 if they were able to draw a blue ball from the box chosen by them.

Depending upon whether the subject chooses Box 1 (unambiguous), Box 2 (ambiguous), or indifferent, the pertaining ambiguity attitude to it was ambiguity averse, ambiguity seeking, or ambiguity neutral, respectively (Dimmock, Kouwenberg, Mitchell, & Peijnenburg, 2016).

The Figure 2 shows the survey question posed with known proportion of red and blue balls as 50 : 50. The text of the Ellsberg two urn paradox in the survey was kept similar to previous work of Dimmock, Kouwenberg, Mitchell, and Peijnenburg (2016). The probability of known risk, where the subject becomes indifferent between unambiguous and ambiguous urn is the matching probability defined as *"q"*.

(ii) Survey Procedure : If a subject chose unambiguous Box 1 in the first question, the probability of known risk was reduced in the question 2 and vice versa. This process was repeated till four times to elicit ambiguity attitude. The aim of the series of questions were to make the subjects come to a point where they became indifferent in selecting Box 1 or Box 2 (Dimmock, Kouwenberg, Mitchell, & Peijnenburg, 2016). Ambiguity aversion was calculated as 50% - *"q"* since the neutral probability was taken as 50% for known risk. For an ambiguity averse subject, the measure was less than 50%, making the ambiguity aversion measure a positive number and vice versa for an ambiguity seeking subject.

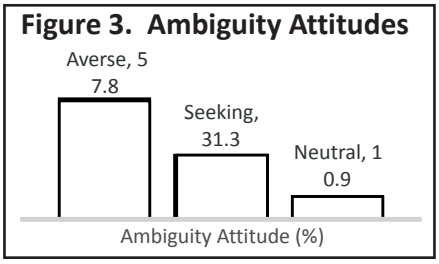
Analysis and Results

(1) Ambiguity Attitude and Risk Attitude Measure : The Figure 3 shows the ambiguity attitudes showed by subjects measured through matching probability concept with 50% as value of neutral probability. Majority of the subjects confirmed Ellsberg choices and showed an aversion to ambiguity. Approximately 57.8% of the students

chose to draw the ball from the unambiguous Box 1 in Round 1. The Figure 4 shows the risk attitudes exhibited by subjects using the investment and gambling sub scales of DOSPERT scale. Majority of the students also displayed an aversion to risk.

The Table 2 gives a cross tabulation frequency count of subjects showing risk and ambiguity attitudes. The percentage frequency count is calculated within risk attitude. A chi square test of independence was calculated to compare the frequency of aversion and non-aversion in risk and ambiguity attitudes. The relation came as insignificant χ^2 (2, $N = 64$), $p = 0.279 > 0.05$. Hence, the null hypothesis of no association between ambiguity and risk attitudes is not rejected. The relation between risk and ambiguity aversion is not fully established, but scholars have said that they have a positive correlation (Bossaerts, Ghirardato, Guarnaschelli, & Zame, 2007). The correlation between risk aversion and ambiguity aversion is - 0.006840. Whether risk and ambiguity attitudes have a causal relation, it still needs to be explored further.

When analyzed on behavioral parameters, the average level of trust exhibited by subjects was 3.1 out of 5. The mean better than average effect (for overconfidence) score was 0.6, indicating that most of the subjects thought



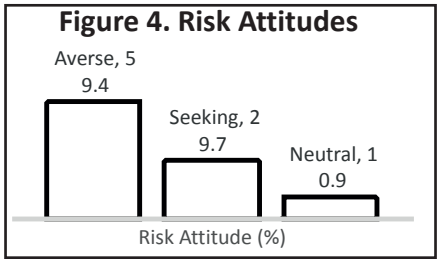


Table 2. Cross Tabulation of Frequency of Risk and Ambiguity Attitudes

			Risk Attitude			Total
Ambiguity Attitudes			**Averse**	**Neutral**	**Seeking**	
	Averse	Count	25	2	10	37
		% within risk attitude	66%	29%	53%	
	Neutral	Count	3	1	3	7
		% within risk attitude	8%	14%	16%	
	Seeking	Count	10	4	6	20
		% within risk attitude	26%	57%	32%	
Total		Count	38	7	19	64

Table 3. Descriptive Summary Statistics

Variable	Mean	Median	Min	Max	St.Dev
Age	29.2	29	26	41	2.2
Total Work Experience	6.5	6	4.9	19	2.1
Last Drawn Salary pm (INR'000)	73.1	66.0	17.0	225.0	30.0
Financial Literacy Score	2.7	3	0	3	0.5
Trust	3.2	3	0	5	1.2
Better than Average Effect	0.6	0.8	(0.2)	0.9	0.3
Self-Assessed Knowledge of Shares	2.8	3	1	5	1.2
Self-Assessed Knowledge of Financial Products	3.1	3	1.7	4.8	0.7

they were better than their batch mates. The Table 3 gives the summary statistics of the demographic and behavioral variables. One way analysis of variance (ANOVA) tests were done to understand variables having a significant impact on ambiguity attitudes.

(2) Antecedents of Ambiguity Attitude : One way ANOVA analysis was done to compare the effect of collected demographic and behavioral trait variables, treated as categorical independent variables (IV) on ambiguity attitude measurement, treated as a continuous dependent variable. The Table 4 gives the ANOVA results for different independent variable categories with their frequency counts. There was a significant effect of marital

Table 4. One Way ANOVA Results

IV	Categories	*F* (Between groups, within groups)	*F* value (*F* critical value)	*p* - value
Demographic				
Gender	• Male (59)	1,62	0.0599	
	• Female (5)		(3.9958)	0.8073
Age	• Below 30 (40)	1,62	0.9157	
	• Above 30 (24)		(3.9958)	0.3423
Marital Status	• Yes (19)	1,62	4.9316	
	• No (45)		(3.9958)	0.0300*
Dependent Members	• None (22)	2,61	3.2585	
	• Between 1 -2 (34)		(3.1477)	0.0452*
	• Above 2 (8)			
Work Experience	• 5 years (18),	2,61	2.3702	
	• Between 5 and 7 years (30)		(3.1477)	0.1020**
	• Above 7 years (16)			
Last Salary Drawn per	• Till 883 USD (24)	2,61	3.8271	
Month (USD)	• Between 883 - 1,176 USD (26)		(3.1477)	0.0271*
	• above 1,176 USD (14)			
Behavioral				
Risk Attitude	• Averse (38)	2,61	0.5484	
	• Neutral (7)		(3.1477)	0.5806
	• Seeking (19)			
Trust Score	• Below 3(19)	2,61	0.0699	
	• 3 (14)		(3.1477)	0.9325
	• Above 3 (31)			
Better than Average	• Below average (4)	2,61	1.2266	
	• average (5)		(3.1477)	0.3004
	• above average (55)			
Financial literacy score	• Below 2 (12)	2,62	2.0877	
	• Above 2 (52)		(3.9958)	0.1535

Note : * significant at 5%, ** significant at 10%.

status on ambiguity attitudes at $p < 0.05$ level for married and unmarried subjects. The same was the case for number of dependent members and last drawn salary per month under the conditions mentioned in Table 4. The remaining demographic variables like gender and age did not have a significant effect on ambiguity attitudes at $p < 0.05$. Effect of work experience on ambiguity attitudes came as significant at the 10% level of significance.

When one way ANOVA was done for variables : measuring risk attitude, trust, overconfidence, and financial literacy score, none of the variables had a significant effect on ambiguity attitudes at $p < 0.05$. These variables need to be explored further to understand their impact on ambiguity attitudes.

Conclusion

This experiment attempts to examine potential demographic and behavioral traits affecting ambiguity attitudes by using Ellsberg two urn paradox in an Indian context. In conformity with existing studies, the subjects in this experiment showed diverse ambiguity attitudes (Bossaerts et al., 2007 ; Dimmock, Kouwenberg, & Wakker, 2016 ; Stahl, 2014), though a majority of the subjects displayed an aversion to ambiguity.

Among the demographic variables, marital status, number of dependent members, and last drawn salary per month had a significant impact on ambiguity attitudes. Socio - demographic factors were found to be significant in previous studies that were conducted to determine the factors affecting financial behavior in developing countries (Gautam & Matta, 2016 ; Paramashivaiah & Ramya, 2014 ; Vadde, 2015) ; whereas, in studies done among subjects of developed markets, particularly the U.S. and Netherlands, these variables did not come as significant (Dimmock, Kouwenberg, Mitchell, & Peijnenburg, 2016 ; Dimmock, Kouwenberg, & Wakker, 2016). These results might be due to cultural differences as well. Testing factors determining ambiguity attitude can broaden understanding of ambiguity aversion and how it can be addressed.

Alternatively, I propose to explore ambiguity attitude in relation with financial decision making with a more representative sample of investors. The literature supports mixed evidence on how ambiguity aversion affects financial decision making (Charness & Gneezy, 2010).

Managerial Implications, Limitations of the Study, and Future Research Directions

The study has managerial implications with respect to the collectivist nature of our society. Hofstede's five major cultural dimensions has individualism vs collectivism as one of the dimensions. Significance of marital status and number of dependent children implies that while dealing with ambiguity, these aspects should be kept in mind in policy framing. It can help in identifying relevant factors while looking at portfolio formation for investors to gauge their appetite for ambiguity. Our conclusion with this experiment is that ambiguity aversion cannot be assumed in general for all. Culture specific and individual specific factors should be explored in depth to understand sources of ambiguity attitude. The two urn Ellsberg paradox can also be tested among subjects by modifying the context of winning or losing money. Future studies can explore the impact of family responsibility and financial strength on attitudes towards ambiguity. More studies are needed in different cultural settings to explore how ambiguity attitudes affect financial decision making. This can help scholars to explain different reaction of various financial markets in ambiguous situations.

This experiment, however, suffers from certain limitations in eliciting responses. Firstly, the decision making by subjects was done in a hypothetical scenario. Offering real incentives might give different results and offer new insights. Moreover, certain variables like gender and marital status are not fully represented due to extremely small sample size among 64 subjects. A much larger and representative sample can give better insights.

References

Agarwalla, S. K., Barua, S., Jacob, J., & Varma, J. R. (2012). *A survey of financial literacy among students, young employees and the retired in India*. Retrieved from https://faculty.iima.ac.in/~iffm/literacy/youngemployessandretired2012.pdf

Al-Najjar, N. I., & Weinstein, J. (2009). The ambiguity aversion literature : A critical assessment. *Economics and Philosophy, 25*(4), 249 - 284.

Bernoulli, D. (1954). Exposition of a new theory on the measurement of risk. *Econometrica, 22*(1), 23 - 36.

Blais, A. R., & Weber, E. U. (2006). A domain-specific risk-taking (DOSPERT) scale for adult populations. *Judgment and Decision Making, 1*(1), 10 - 29.

Borghans, L., Heckman, J. J., Golsteyn, B. H., & Meijers, H. (2009). Gender differences in risk aversion and ambiguity aversion. *Journal of the European Economic Association, 7* (2-3), 649 - 658.

Bossaerts, P., Ghirardato, P., Guarnaschelli, S., & Zame, W. (2007). Prices and allocations in asset markets with heterogeneous attitudes towards ambiguity. *Review of Financial Studies, 23* (4), 1325 - 1359.

Bryant, W. (2014). The microeconomics of choice under risk and uncertainty : Where are we? *Vikalpa, 39*(1), 21 - 40.

Charness, G., & Gneezy, U. (2010). Portfolio choice and risk attitudes : An experiment. *Economic Inquiry, 48*(1), 133 - 146.

Dimmock, S. G., Kouwenberg, R., & Wakker, P. P. (2016). Ambiguity attitudes in a large representative sample. *Management Science, 62* (5), 1363 - 1380.

Dimmock, S. G., Kouwenberg, R., Mitchell, O. S., & Peijnenburg, K. (2016). Ambiguity aversion and household portfolio choice puzzles: Empirical evidence. *Journal of Financial Economics, 119* (3), 559 - 577.

Edwards, W. (1954). The theory of decision making. *Psychological Bulletin, 51*(4), 380 - 401.

Ellsberg, D. (1961). Risk, ambiguity, and the savage axioms. *The Quarterly Journal of Economics, 75* (4), 643 - 669.

Ellsberg, D. (2001). *Risk, ambiguity and decision*. New York : Taylor & Francis.

Etner, J. J. (2012). Decision theory under ambiguity. *Journal of Economic Surveys, 26* (2), 234 -270.

Fox, C. R., & Tversky, A. (1995). Ambiguity aversion and comparative ignorance. *The Quarterly Journal of Economics, 110* (3), 585 - 603.

Gautam, S., & Matta, M. (2016). A study of socio-demographic and attitudinal factors on consumer behavior by individual investors in the Indian context. *Indian Journal of Finance, 10* (7), 48-59. doi:10.17010/ijf/2016/v10i7/97256

Ghirardato, P., & Marinacci, M. (2002). Ambiguity made precise: A comparative foundation. *Journal of Economic Theory, 102* (2) 251-289.

Gilboa, I., Postlewaite, A. W., & Schmeidler, D. (2008). Probability and uncertainty in economic modeling. *Journal of Economic Perspectives, 22* (3), 173 - 188.

Glaser, M., & Weber, M. (2007). Overconfidence and trading volume. *The Geneva Risk and Insurance Review, 32* (1), 1-36.

Hacking, I. (2006). *The emergence of probability* (2nd ed.). Cambridge: Cambridge University Press.

Heath, C., & Tversky, A. (1991). Preference and belief: Ambiguity and competence in choice under uncertainty. *Journal of Risk and Uncertainty, 4* (1), 5-28.

Kelsey, D., & Quiggin, J. (1992). Theories of choice under ignorance and uncertainty. *Journal of Economic Surveys, 6* (2), 133-153.

Knight, F. H. (1921). *Risk, uncertainty and profit*. Boston: Houghton Mifflin Co.

Lyon, A. (2009). Philosophy of probability. In A. Lyon, & F. Allhoff (Ed.), *Philosophies of the sciences* (Vol. 1st Edition, p. 368). London : Wiley-Blackwell.

Machina, M. (1987). Choice under uncertainty: Problems solved and unsolved. *The Journal of Economic Perspectives, 1* (1) , 121-154.

Machina, M. J., & Siniscalchi, M. (2014). Ambiguity and ambiguity aversion. In M. J. Machina & W. Viscusi (eds.), *Handbook of the economics of risk and uncertainty* (Vol. 1, pp. 729 - 807). North Holland : Elsevier.

Machina, M., & Schmeidler, D. (1992). A more robust definition of subjective probability. *Econometrica, 60* (4), 745-780.

Paramashivaiah, P., Puttaswamy, & Ramya, S. (2014). Changing risk perception of women investors : An empirical study. *Indian Journal of Finance, 8* (6), 22 - 33. doi:10.17010/ijf/2014/v8i6/71909

Peterson, M. (2009). *An introduction to decision theory*. University of California: Cambridge University Press.

Pulford, B. D., & Gill, P. (2014). Good luck, bad luck, and ambiguity aversion. *Judgement and Decision Making, 9* (2), 159-166.

Rakow, T. (2010). Risk, uncertainty and prophet: The psychological insights of Frank H. Knight. *Judgement and Decision Making, 5* (6), 458 - 466.

Savage, L. (1954). *The foundations of statistics*. New York: John Wiley.

Schoemaker, P. (2012). *Profiting from uncertainty: Strategies for succeeding no matter what the future brings*. USA : The Free Press, Simon and Schuster.

Stahl, D. O. (2014). Heterogeneity of ambiguity preferences. *Review of Economics and Statistics, 96* (4), 609 - 617.

Trautmann, S. T., Vieider, F. M., & Wakker, P. P. (2008). Causes of ambiguity aversion: Known versus unknown preferences. *Journal of Risk and Uncertainty, 36* (3), 225 - 243.

Vadde, S. (2015). Impact of socio-demographic and economic factors on households' savings behaviour: Empirical evidence from Ethiopia. *Indian Journal of Finance, 9* (3), 49 - 57. doi:10.17010/ijf/2015/v9i3/71514

Weber, B. J., & Tan, W. P. (2012). Ambiguity aversion in a delay analogue of the Ellsberg Paradox. *Judgment and Decision Making, 7*(4), 383 - 389.

Weber, M., & Camerer, C. (1987). Recent developments in modelling preferences under risk. *Operations - Research-Spektrum, 9* (3), 129-151.

Wenmackers, S. (2011). *Philosophy of probability: Foundations, epistemology, and computation.* The Netherlands: University of Groningen.

Zeckhauser, R. (2014). New frontiers beyond risk and uncertainty: Ignorance, group decision, and unanticipated themes. In W. K. Machina (ed.), *Handbook of the economics of risk and uncertainty*. UK: Elsevier, Oxford.

Appendix

Text for Variables Measures Through Standard Scale

(1) Financial Literacy : Please answer the below questions to the best of your knowledge :

Q1. Suppose you had INR 1,000 in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow ?

- More than INR 1020
- Exactly INR 1020
- Less than INR 1020
- Don't know

Q2. Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, would you be able to buy more than, exactly the same as, or less than today with the money in this account?

- More than today
- Exactly the same as today
- Less than today
- Don't know

Q3. Please tell us whether this statement is true or false. Buying a single company stock usually provides a safer return than a stock of mutual fund.

- True
- False
- Don't know

(2) Trust

On a score of 0 to 5, please kindly specify a number for the below question, with 0 indicating *strong agreement* and 5 indicating *strong disagreement*.

"Generally speaking, would you say that most people can be trusted and you do not need to be too careful in dealing with people?"

(3) Overconfidence

Q1. Of the people in your batch, what percentage do you think have better skills than you in identifying stocks that will give above average returns in the future (Do not write % symbol, mention the digits only, within 0 to 100).

Q2. Of the people in your batch, what percentage do you think will make more returns than you if they invest in stock markets (Do not write % symbol, mention the digits only, within 0 to 100).

Scoring Method :

(50 – Answer)/50 for each answer and the arithmetic average of the two scores.

These ratios yield 0 if respondents think they are average, 1 if they think they are better than everybody else, and -1 if they think to be worse than everybody else.

(4) Self-Assessed Knowledge : On a scale of 1 to 5, please mention your knowledge on the below financial products:

Savings account, fixed deposit, pension fund, housing loan, credit card, insurance, equity linked savings, shares, bonds/debentures, public provident fund, post office savings, and gold.

About the Author

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