Investigation of variation between risk attitude and investment biases

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Biography

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Biography

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Abstract

There is a palpable link between financial investment decision making and investors' behaviour. Research into investors' behaviour may prove useful in increasing our understanding of the extremely complex financial marketplace. In many cases, investors are unaware of their predisposition for error. And more often, an irrational investor is a dissatisfied investor, because biases usually undermine financial goals. By adopting an experimental approach, the researchers try to correlate established investor biases with the psychographic profiles of investors, to see whether specific risk personality profiles correlate with susceptibility to four biases: herding, endowment, loss aversion and framing.

Many studies have focused on exploring the demographics of investment behavioural flaws, but very little attention has been paid to the risk attitude of investors and their actual investment behaviour. The findings of this study bridge two aspects of literature, being attitude to financial risk and behavioural investment biases.

Key words: Behavioural finance, Risk tolerance score, investment biases, framing, loss aversion, herding, endowment

1 Introduction

There is now a large body of evidence acquired as a result of individual decision making experiments showing 'anomalies' – that is, departures from precepts of economists' predictions - which appear to be substantial, systematic and easily replicable (see e.g. Camerer, 1995 and Starmer, 2000). Behavioural finance is a science that strives to explain and improve insight into the overall judgment processes of investors. This includes cognitive biases and affective (emotional) aspects of the decision making process of both novice and expert investors. As noted by Baker and Nofsinger (2002), cognitive and emotional weaknesses affect all. Shefrin (2000) notes that investors are prone to committing specific errors of which some are minor and others are grave. By allowing psychological bias and emotion to affect their investment decisions, investors can do serious harm to their wealth.

This work aims to explain four biases on the basis of investors' risk profile and so concentrates on those biases that could be more directly linked to risk profile: framing, loss aversion, herding and endowment. After identifying the risk profile of the subjects, the objective is to analyse whether this profile is responsible for investors' biased behaviour. By adopting an experimental approach, the researchers try to correlate established investor biases with the psychographic profiles of specific investors, to see if specific personality profiles correlate with susceptibility to four of the biases - herding, endowment, loss aversion and framing - which are identified in behavioural finance literature. The research questions in this study are outlined as follows:

Question 1 - To investigate whether framing, loss aversion, herding and endowment biases exist among the subjects groups in the experimental setting.

Question 2 - To establish whether risk tolerance score is a determinant factor in investment decision-making.

Question 3 - To establish whether there is a link between risk tolerance score and the effects of framing, loss aversion, herding and endowment biases.

The outline of this paper is organised as follows: Section 2 explains the theoretical motivation of the research study, Section 3 presents the methodology and procedure flow to be employed,

Section 4 reports the results and discusses the findings and Section 5 draws conclusions from the research, outlines the limitations and sketches possible extensions for further study.

2 The Theoretical Motivation of the Research Study

Cognitive limitation on decision making

To fully appreciate the behaviourists' theoretical propositions, we need to first understand the nature of a decision-making process under the homo economicus assumption, whose foundations are based on the principle of conditional probabilities as was mathematically established in 1763 by the mathematician Thomas Bayes. Bayes' rule represents a fundamental principle of rational decision making. Bayesian theory argues that the probability of an event can be viewed as the degree of belief of an "ideal" person. Bayes' theorem provides the probabilistic framework within which rational investment decisions should be made on the basis of all relevant, available information. It gives a highly structured procedure for rational decision making, which was also adopted in the case of homo economicus and the pursuit of its rational self-interest objectives, and this is exactly the point from which the behaviourists' main arguments are derived. Behavioural Finance argues that people often fail to respond rationally to new information as they completely fail to follow the above idealistic mathematical framework. This is caused by the inability of humans to differentiate information that requires probabilistic judgement from that which requires value judgement. Despite the fact that the above statement derives from psychology, it can be considered central to the principles of behavioural finance.

Psychological heuristics

Ricciardi (2004) noted that people utilise specific mental mechanisms for processing and problem solving regarding decision making, known as cognitive processes. Cognitive processes are the mental skills that permit individuals to comprehend and recognise the things around them. This is taken a step further in the case of cognitive factors and mental errors committed by investors, which includes factors known as cognitive bias or mental mistakes (errors) as reported by Ricciardi and Simon (2000); Ricciardi and Simon (October, 2000), and Ricciardi (2003).

Camerer (1997, p. 179) summarises anomalies in decisions and errors in judgments

and calls this the ‘‘exploration of procedural (bounded) rationality of individuals.’’ Todd and Gigerenzer (2003) commented that this view has spread from psychology into economics and law, shaping new research areas such as behavioural economics (e.g., Camerer, 1995) and law and economics (e.g., Jolls, et al., 1998). Conlisk (1996, p. 672) outlines the strong connection between this vision of bounded rationality and economic thinking by saying ‘‘the bias evidence suggests that people are capable of a wide variety of substantial and systematic reasoning errors relevant to economic decisions.’’ The evidence in question has led to a list of well-known cognitive biases such as base rate neglect, overconfidence bias and the sunk-cost effect (Kahneman, et at., 1982).

Heuristics, or rules of thumb, seem to be very common in all types of situations and can be thought of as a cognitive tool for reducing the time of the decision making (judgment) process for both novice investors and expert investment professionals, as noted in Ricciardi and Simon (2001). In essence, heuristics are mental shortcuts or strategies derived from our past experience that get us where we need to go quickly, but at the risk of potentially sending us in the wrong direction (Ricciardi and Simon, 2001, p. 19) or introducing biases that lead to over- or under-shooting.

Extension of risk tolerance

Scholars have long been interested in the factors that influence individuals' decision making behaviour in risky contexts (e.g. Hogarth, 1987 and Kahneman and Tversky, 1979), which is referred to as risk behaviour. Risk behaviour may be characterised by the degree of risk associated with the decisions made. As noted by Dohmen, et al. (2009), risk and uncertainty play a role in almost every important economic decision. Therefore, the continued study of individual attitudes towards risk will help us to understand and predict economic behaviour. Progress has been made on growing literature to develop empirical measures of individual risk attitudes, with the aim of capturing this important component of individual heterogeneity (see e.g., Bruhin, et al., 2007). Irwin (1993:11) defined financial risk tolerance as the willingness to engage in "behaviours in which the outcomes remain uncertain with the possibility of an identifiable negative outcome".

Yip (2000:2) observed that financial risk tolerance has attracted the attention of researchers in various disciplines including behavioural economists (e.g. Roszkowski and

Snelbecker, 1990); consumer research (e.g. Grable and Joo, 1999); cognitive psychologists (e.g. Holtgrave and Weber, 1993; Kahneman and Tversky, 1984 and Liverant and Scodel, 1960); social psychologists (e.g. Carducci and Wong, 1998; Wong and Carducci, 1991 and Zuckerman, 1983); and financial analysts and financial planners (e.g. Riley and Chow, 1992 and Quattlebaum, 1988). The prediction of a positive relationship between a person's financial risk tolerance and risk-taking behaviour is well established in the literature.

It is important to note that risk tolerance is a complex attitude and, like any attitude, it has multiple levels of interpretation. A measure of risk tolerance is an attitudinal instrument that reveals the client's perception of the trade -off between risk and the compensation required for bearing risk (see Blume and Friend, 1978 and Harlow and Brown, 1990). Prior studies in the form of risk tolerance questionnaires have provided some evidence that risk tolerance scores reflect the actual investment behaviour of individuals (Grable and Schumm, 2007). However, there are very few studies that have established behavioural validity of risk tolerance in relation to behavioural finance, which would provide a new perspective and meaningful implications to both of the questions under study.

3 Experimental Design and Procedural Flow

Response options

Of the 19 scenario questions, seven used a dichotomous option, eight provided subjects with a multiple choice selection and four required open-ended answers. Thus, 15 (79%) of the scenario questions provided subjects with limited, closed- ended response options. These closed ended responses are appropriate to acquire the decision making results and allow the researcher to collect data without requiring overwhelming effort from subjects and exceptional demand upon subjects' time committed to the experiments.

Familiarity and relevancy of the scenarios

Freeman and Giebink (1979) found significant differences in their subjects' responses to a variety of non-business scenarios depending upon the subject's familiarity with the issue presented. In this sense, when developing the context of the scenarios, the main concern was to design scenarios which are familiar and relevant to the student population, in the hope of eliciting a more realistic response from participating subjects. Furthermore, there were multiple scenarios to measure one bias to enhance the creditability on the variety of testable

factor; and to avoid order effect, changing the order of the information presented in the scenario.

Source of scenarios

As discussed in Weber (1992:153), it is important to avoid the "reinventing the wheel" syndrome. Although scenario-based research in the business ethics field began in 1961 with Baumhart's study of managers' values and ethics, much of the work has been published since 1985. While this indicates that the field is relatively young, researchers should begin to build upon and extend previous work, as shown by Arlow and Ulrich's (1980) and Stevens' (1984) use of Clark's (1966) set of scenarios. Various sets of scenarios have been developed with promising relevancy; focus and flexibility (see Dubinsky and Ingram, 1984; Fritzsche and Becker, 1983, 1984 and Weber, 1990). Since the questions aim to measure behaviour biases through decision making, it is essential to allow the participants to individually act according to their own dispositions; therefore, it is appropriate to construct the questions in the form of relatively simple, well-specified money payoffs which conform to the way of prior studies configured.

Data processing and analysis – statistical measures

The first part of the experiment comprised scenario based questions to test biases. Independent t-tests of significance were used to measure framing, loss aversion and herding to calculate the contrast between the paired scenarios by using paired t-test statistics. Chi-square tests were used to test the associations between variables and the Chi- square analysis procedure was implemented to determine if there was a significant relationship between the four biases. A repeated measure analysis of variance - ANOVA - was utilised to test the lottery choice for loss aversion, to assess the respondent's consistency across the seven responses to the scenarios. Pearson correlations were used to test endowment. For the second part of the experiment – the risk tolerance questionnaire –frequency reports were used to analyse the demographical characteristics of the subject population.

The appropriate use of Frequency report, Pearson correlation, analysis of variance, paired t-tests or Chi square analysis depends upon the research design and data collected. Although sophisticated statistical analysis should not be used inappropriately or unnecessarily, there are instances in previous scenario research where additional data analysis could have been used to increase the power of the research findings. Researchers should be cautioned against using sophisticated statistical analysis for its own sake, avoiding a "statistic

technique" race in competition with other researchers (Weber, 1992:152).

The result of the data analysis is discussed in the subsequent section.

4 Summary of Main Findings

Normal Distribution Test on Sample Population in Risk Tolerance Scores

In order to determine which statistical tool is more appropriate for data analysis, the researchers firstly test the assumption of normal distribution of the risk tolerance scores. On examining the distribution of risk tolerance scores visually at **Figure 1.** It can be seen that the histogram is nicely symmetrical in a bell-shaped curve. Note that the data points mostly fall very close to the diagonal line. To quantify the shape of the normality with numbers, a further examination of the characteristics of data is described in Table 1, where measure of central tendency, mean = 52.84, median = 53.50, measure of variability, range = 64, standard deviation = 13.349, variance = 178.203, measure of shape, kurtosis (pointyness) is 0.126 skewness (symmetry) is 0.126, both are positive and not far from 0. Another check is to run a K-S test to compare the risk scores in the sample to a normally distributed set of scores with the same means and standard deviation. The result of the K-S test is shown in Table 2**,** in which P value >0.05, indicating that the distribution of the sample is not significantly different from a normal distribution. All the tests confirm the normal distribution assumption on the risk tolerance scores. Moving forward, it is appropriate to take a parametric test to run statistical analysis. An independent t-test, Pearson correlation, one way ANOVA and Chi square were adopted to perform the statistical analysis on various biases. A detail analysis of data and results will be outlined in the next section.

Figure 1 Histogram of risk tolerance score distribution of sample population

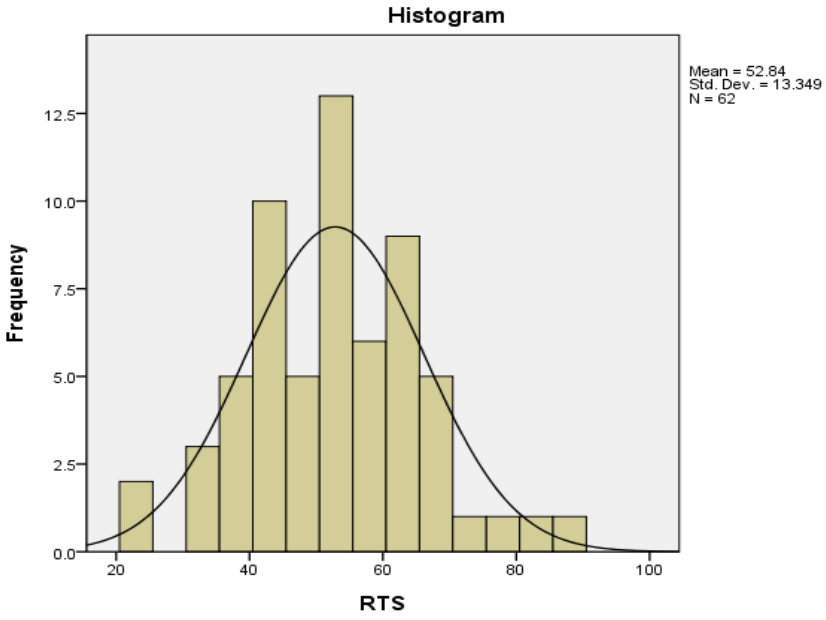

Table 1 Descriptive analysis of risk tolerance scores

Descriptive Statistics

	N	Range	Minimum	Maximum	Mean		Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
RTS	62	64	23	87	52.84	1.695	13.349	178.203	.126	.304	.126	.599
Valid N (listwise)	62											

Table 2 Normality test of risk tolerance score on sample population

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
RTS	.053	62	.200*	.991	62	.927

a. Lilliefors Significance Correction

*. This is a lower bound of the true significance.

Each of the biases represented in the data was tested for significance against mean risk between different groups, so as to provide results of various statistical analyses between each of the biases measured and risk tolerance scores. The objective is to investigate the proposition that investment biases individually may be linked significantly with risk tolerance

score. At the end, the researcher also tested to establish a link (if any) among various biases in this study.

Endowment

Subjects were randomly assigned to two different groups; one group (hereby named Group A) represented sellers while the other group (hereby named Group B) were buyers. The researchers firstly examined the mean risk scores of these two groups, to ensure a similar distribution pattern between the two groups in terms of risk tolerance scores. Given a random distribution of the two groups and a similar pattern of distribution of risk tolerance scores after examination, this excluded the possibility of pre-existing mystifications before further analysis.

Preliminary analysis of the data sought to identify any significant statistical relationship between WTA (Willing to Accept) and WTP (Willing to Pay). The experiment had four treatments, which observed the behaviour of subjects involving various amounts of money and within different contexts. The disparity between WTA and WTP indicated a persistent phenomenon throughout the experimental sessions (see Figure 2). However, the strength of the effect was less than in the prior study and also slightly differed between treatments (see Table 3).

Figure 2 Disparities between WTA and WTP

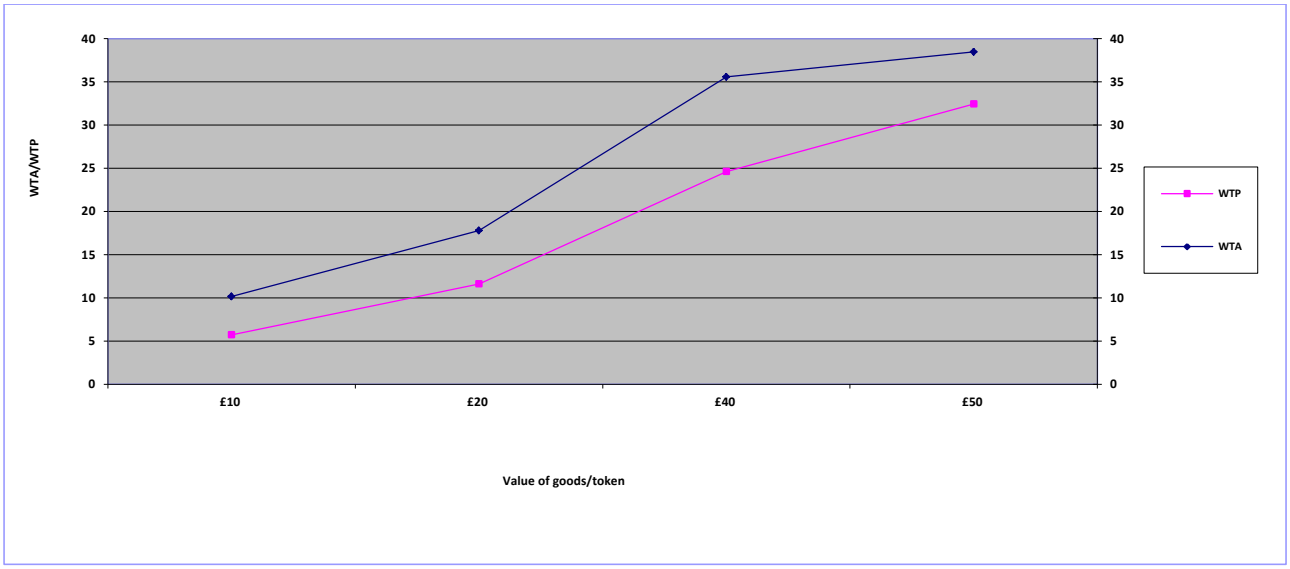

Table 3 WTA/WTP Ratio

		£10 Amazon voucher	£20 Cineworld gift card	£40 John Lewis voucher	£50 Used textbook
Group A	Mean RTS	Mean WTA	Mean WTA	Mean WTA	Mean WTA
	52.03	10.15	17.783	35.57	38.47
Group B	Mean RTS	Mean WTP	Mean WTP	Mean WTP	Mean WTP
	53.5938	5.734	11.63	24.63	32.44
Difference	-1.5638	4.416	6.153	10.94	6.03
WTA/WTP Ratio		1.770143	1.529063	1.444174	1.185882

Remarks: Group A represents sellers, Group B represents buyers

This study explores the linkage between risk tolerance score and endowment effect, the key finding being that risk tolerance scores and endowment are positively related. The evidence is presented from two aspects. In the WTA groups, the correlation between the WTA and RTS throughout the four treatments was all positive, and the significant values were less than 0.05. The two-tailed t-test significance level and Pearson Correlation for WTA are as illustrated in Table 4. However in the WTP group, the correlation between the WTP and RTS was negative throughout the 4 treatments and the significant values were all less than 0.05 also. The two-tailed t-test significance level and Pearson Correlation for WTP are as illustrated in Table 5.

.

Table 4 Correlation between RTS and WTA

Correlations

		RTS_A	Q16_A	Q17_A	Q18_A	Q19_A
RTS_A	Pearson Correlation	1	.435*	.365*	.372*	.375*
	Sig. (2-tailed)		.016	.048	.043	.041
	N	30	30	30	30	30
Q16_A	Pearson Correlation	.435*	1	.746**	.660**	.422*
	Sig. (2-tailed)	.016		.000	.000	.020
	N	30	30	30	30	30
Q17_A	Pearson Correlation	.365*	.746**	1	.940**	.697**
	Sig. (2-tailed)	.048	.000		.000	.000
	N	30	30	30	30	30
Q18_A	Pearson Correlation	.372*	.660**	.940**	1	.634**
	Sig. (2-tailed)	.043	.000	.000		.000
	N	30	30	30	30	30
Q19_A	Pearson Correlation	.375*	.422*	.697**	.634**	1
	Sig. (2-tailed)	.041	.020	.000	.000	
	N	30	30	30	30	30

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table 5 Correlation between RTS and WTP

Correlations

		RTS_B	Q16_B	Q17_B	Q18_B	Q19_B
RTS_B	Pearson Correlation	1	-.427*	-.545**	-.377*	-.372*
	Sig. (2-tailed)		.015	.001	.034	.036
	N	32	32	32	32	32
Q16_B	Pearson Correlation	-.427*	1	.657**	.787**	.280
	Sig. (2-tailed)	.015		.000	.000	.120
	N	32	32	32	32	32
Q17_B	Pearson Correlation	-.545**	.657**	1	.648**	.381*
	Sig. (2-tailed)	.001	.000		.000	.031
	N	32	32	32	32	32
Q18_B	Pearson Correlation	-.377*	.787**	.648**	1	.327
	Sig. (2-tailed)	.034	.000	.000		.068
	N	32	32	32	32	32
Q19_B	Pearson Correlation	-.372*	.280	.381*	.327	1
	Sig. (2-tailed)	.036	.120	.031	.068	
	N	32	32	32	32	32

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Kahneman et al. (1990) reported that several factors probably contribute to the discrepancies between the evaluations of buyers and sellers. The perceived illegitimacy of the transaction may, for example, contribute to the extraordinarily high demand for personal compensation for agreeing to the loss of a public good (e.g., Rowe, et al., 1980). Standard bargaining habits may also contribute to a discrepancy between the stated prices of buyers and sellers. Sellers are often rewarded for overstating their true value, and buyers for understating theirs (Knez, et al., 1985). By force of habit they may misrepresent their true valuations even when such misrepresentation confers no advantage, as in answering hypothetical questions or one-shot or single transactions. In such situations the buying-selling discrepancy is simply a strategic mistake, which experienced traders will learn to avoid (Brookshire and Coursey, 1987).

Actually many discrepancies between WTA and WTP are not mistakes but rather reflect the genuine effect of reference positions on preferences. Thaler (1980) labeled the increased value of a good to an individual when the good becomes part of the individual's endowment – the "endowment effect." This effect is a manifestation of "loss aversion", the

generalisation that losses are weighted substantially more than objectively commensurate gains in the evaluation of prospects and trades (Kahneman and Tversky, 1979). An implication of this asymmetry is that if a good is evaluated as a loss when it is given up and as a gain when it is acquired, loss aversion will, on average, induce a higher dollar value for owners than for potential buyers, reducing the set of mutually acceptable trades. There are some cases in which no endowment effect would be expected, such as when goods are purchased for resale rather than for utilisation.

As in most previous experiments using inexpensive market goods, WTA was roughly twice WTP. The most commonly indicated reason for the disparity is that subjects base WTP on what the good is worth to them personally and WTA on what the good is worth in a sale situation. That is, in deciding on WTA, most subjects referred to what the good would be worth to others and often appeared to rely on store price as a starting point.

A possible explanation for these results is that the endowment effect relies on the idea that selling creates a loss whereas buying creates a gain, which focuses on the good rather on the net result of the transaction. The subjects who have a higher risk tolerance score tend to ask for higher acceptance prices and tender lower bidding prices, which could be a reflection of the fact that an individual with a higher risk tolerance score would avoid selling too cheaply and paying too much to result in a less favourable scenario. By raising WTA and lowering WTP, the inevitable risk is that they might not be able to sell or buy the goods at their desirable level or price range. However, they prefer to take the risk of not being able to close the deal to ensure they get a good deal at the end. In this sense, the willingness to take more risk in order to secure a good deal is the nature of less risk aversion.

As pointed out by Kahneman et al. (1990)**,** the search for profit is a central aspect of many real world transactions. Because many of the goods for which evaluations are required do not have well-defined prices, but instead are characterised by a range of possible values, it is likely that buyers will look to the lower end of this range and that sellers will look to the higher end. This behaviour is both rational and predictable; it is the essence of getting a good deal, as long as expectations do not exceed what the market will bear. This behaviour will result in a difference in WTP and WTA evaluations of the worth of a good. The disparity will be larger to the extent that both external data (about what others may be willing to sell a good for or to pay for it) and internal data (about one's own values) show a larger possible range.

Market experience should tend to lower a disparity induced solely by the profit motive (Brown, 1999). To pursue profit is at the heart of every investor when making financial decisions; however, people with a higher tolerance score might tend to be more aggressive in profit searching than those with lower scores and this would help to decipher the positive relationship between endowment and risk tolerance attitudes.

From this perspective, the finding is coherent with the intuitive appeal observation. The study of Brown (2003) suggested that if loss aversion is separated from the good per se and instead refers to the net result of the transaction, loss aversion may certainly play a role in the disparity. The endowment effect argues for a change in preference upon a change in endowment, leading to a change in value for the good, but loss aversion - the notion that losses are weighted more than objectively commensurate gains - does not require a change in preference for the good once it becomes part of an individual's endowment. If the loss is of asset value, rather than of the good per se, no change in preference is needed for loss aversion to cause or enhance a disparity.

This finding confirmed all the three research questions and revealed the linkage between risk tolerance score and endowment effect. The key finding is that risk tolerance scores and endowment are ***positively*** related.

Framing

This experimental procedure is similar to the way framing effects were originally studied by Tversky and Kahneman (1981). The subjects were presented with scenarios in which a hypothetical decision problem was framed in terms of "gains" or "losses." However, different from some of the earlier studies, the researchers intentionally designed questions where the expected values of the two option choices are identical in each question. Subjects were asked to choose between (1) sure gain and probable gain; and (2) sure loss and probable loss so that the behavioural patterns surrounding gain and loss scenarios could be observed.

The subjects were asked to choose from the two questions independently: the first question was framed within a gain scenario and the second question was framed within a loss scenario. There were 41 (66%) subjects with a mean risk of 48.9 out of 62 who chose sure gain and 21 (34%) subjects with a mean risk of 60.52 who chose probable gain in the gain

scenario question. The result suggested risk averse, which is a common pattern as, when choices involving gains are involved, people are usually risk averse. The standard deviations were 12.932 and 10.736 as shown in Table 6 and the significant level between these two measures was 0.001 as shown in Table 7.

Table 6 Descriptive analysis for gain framed question

Group Statistics

Q1		N	Mean	Std. Deviation	Std. Error Mean
RTS	1	41	48.90	12.932	2.020
	2	21	60.52	10.736	2.343

Remarks: 1 represents sure gain, 2 represents probable gain

Table 7 Independent T test for gain framed question

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
RTS	Equal variances assumed	.725	.398	-3.537	60	.001	-11.621	3.286	-18.194	-5.049
	Equal variances not assumed			-3.757	47.622	.000	-11.621	3.093	-17.842	-5.401

For the second question which was framed in the loss scenario, there were 12 (19%) subjects with mean risk = 62.3 out of 62 who chose sure loss and 50 (81%) with mean risk = 50.56 who chose probable loss, showing that the majority are risk taking in this setting. The standard deviations were 14.834 and 12.044 as shown in Table 8 and the significant level between these two measures was 0.005 as show in Table 9. This result coincides with the previous finding of Fishburn, 1983 and Kahneman and Tversky, 1979, that when gains are involved, individuals are usually risk averse whereas choices involving losses are often risk seeking.

Table 8 Descriptive analysis for loss framed question

Group Statistics

Q2		N	Mean	Std. Deviation	Std. Error Mean
RTS	1	12	62.33	14.834	4.282
	2	50	50.56	12.044	1.703

Remarks: 1 represents sure loss, 2 represents probable loss

Table 9 Independent t-test for loss framed question

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
RTS	Equal variances assumed	1.038	.312	2.906	60	.005	11.773	4.051	3.670	19.877
	Equal variances not assumed			2.555	14.674	.022	11.773	4.609	1.931	21.616

These two questions were presented to subjects independently. The expected values are actually identical in both questions; however the majority chose sure gain and probable loss over probable gain and sure loss, confirming the existence of the framing effect. Results from the two questions were assessed using risk mean comparison between the groups given different option choices. The risk means are derived by calculating for each set of questions the risk mean of the subjects in that group. Risk score and number of people for the four questions are depicted respectively in the earlier contents. The risk mean suggested a significant difference between groups, which confirms the correlation between framing biases and risk tolerance scores.

The existence of the framing effect supports the violation of invariance. The principle of invariance is an essential condition for a theory of choice that claims normative status; different representations of the same choice problem should yield the same preference. However, as discussed by Tversky and Kahneman (1986), people do not spontaneously aggregate concurrent prospects or transform all outcomes into a common frame. From the results of this experiment, it is also evident that preference between options is not independent of their description and the variation of form does affect the actual choice. The preferences in this pair of questions illustrate a common pattern: choices involving gains are

often risk averse and choices involving losses are often risk taking. The inconsistent responses arise from the conjunction of a framing effect with contradictory attitudes toward risks involving gains and losses and this reversal has been observed in prior studies. The researchers then turned to an analysis of these attitudes.

Next, of great interest, in order to examine what type of relation existed between framing biases and risk tolerance scores, the research then took the combination of two preferences that subjects chose - sure gain in the gain scenario and probable loss in the loss scenario (called the framing group) - the rest of the subjects who chose otherwise than the framing pattern were categorised as the non framing group. On examination of these two groups, there were 36 (58%) subjects with a risk mean of 48.08 in the framing group and 26 (42%) subjects with a risk mean of 59.42 in the non-framing group. The standard deviation between two measures was 12.353 and 11.981 as shown in Table 10.

Table 10 Descriptive analysis between framing and non framing groups

Group Statistics

	Framing1	N	Mean	Std. Deviation	Std. Error Mean
RTS	1.00	36	48.08	12.353	2.059
	2.00	26	59.42	11.981	2.350

Remarks: 1.00 represents the framing group, 2.00 represents the non-framing group

Table 11 Independent t-test between the framing and non framing groups

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
RTS	Equal variances assumed	.069	.793	-3.612	60	.001	-11.340	3.140	-17.620	-5.059
	Equal variances not assumed			-3.630	54.978	.001	-11.340	3.124	-17.600	-5.079

As illustrated in Table 11, the variation of risk mean between framing and non framing group posed a significant level of difference, where the P value is 0.001. The finding from these two questions suggested that there is an inverse relationship between risk score and framing, i.e. the people with higher risk tolerance scores are more susceptible to framing bias than people with lower risk tolerance scores. The findings from the first pair of questions

answered all the three research questions and suggested that there is an ***inverse*** relationship between risk score and framing.

Unfortunately, the results from the second pair of questions only supported the existence of the framing effect and the determinant role of financial risk tolerance scores in behaviour but did not support a strong linkage between risk tolerance scores and framing bias. There are several possible explanations for this incoherent finding. The lack of correlation between the complicated managerial decision question set (as in the second pair of questions in this experiment) and risk tolerance score highlights the power of wording in altering subjects' behaviour when facing complicated scenarios. Although the straight forward question suggested a correlation with risk tolerance score, increasing the level of sophistication in the question set completely eliminated this association. This implies that studies which attempt to validate biases test using more than one set question and need to pay careful attention to the wording of each of the measures in terms of a consistent level of sophistication.

Risk-taking has also been a focus of interest in behaviour decision theory. In that tradition, risk-taking is viewed as context-dependent and susceptible to framing effects in which the description of the situation can alter participant choices (see Harrison, 2005). One of the best known lines of research in decision making comes from ''Prospect Theory'' (Kahneman and Tversky, 1979) which states in part that an individual's willingness to make a risky choice will depend on whether the decision outcomes are framed as gains or losses. Individuals will make riskier choices to avoid losses than they will to produce gains. Numerous studies have documented such framing effects (see Levin, et al., 1998 for a review).

The general tendency to be risk seeking would suggest a higher risk tolerance score; however, the existing studies do not suggest, if people are risky in loss scenarios and risk averse in gain scenario, what would be a possible risk tolerance score tendency. There is no existing data or study to support this question and the findings of this work would fill this gap in study.

Herding

This session aimed to analyse the presence of herding among the investors. The researchers designed the experiment to give the subjects supplemental information after their initial decision was made and allow them to make the decisions again on the same questions. In these two treatments, information regarding the previous decision made by the subject group was provided by the experimenter and the result was manipulated. The information was not generated from the system like other results in previous questions. To the contrary, it was pre-planted in the slide and showed to the subjects. Using this design, the researcher aimed to observe subject behaviour and identify who herds after the manipulated results are revealed. The subjects received no feedback on their actions to avoid influencing our results with learning experience.

With the identical tenures, providing the benchmark rate from Central Bank in the UK and Brazil as a reference point, the UK's government bond (5%-0.5%) is more favourable than Brazil's government bond (10%-8.5%) in terms of spread between the coupon rate and interest rate of Central bank, furthermore, the UK is more favourable than Brazil in sovereign risk. The question posed an extreme scenario that the UK's government bond is of lower risk and higher return, which is not the likely case in reality, but to observe herding behaviour, the researchers aim to provide an extreme and obviously favourable choice between two set choices. A manipulated group result showed that a majority (83%) of group subjects chose the unfavourable option, the Brazil government bond in this case. With the extreme contrast of the manipulated result shown to the subjects, the subjects were then asked again to choose the two products.

Out of a total of 62 subjects, in the first set of choices the number of people who chose the UK's government bond was 38 (61%) and the number of people who chose Brazil's government bond was 24 (39%) - mean risks for each group were 49.24 and 58.54 respectively. The standard deviations were 11.906 and 13.756 as shown in Table 12. The independent t-test results indicate a significant level of difference of mean risk between these two groups, p value = 0.006 as shown in Table 13. This result suggested that subjects who chose the UK's government bond had a lower mean risk than those who chose the Brazilian government bond.

Table 12 Descriptive analysis between two government bonds chooser

Group Statistics

Q14		N	Mean	Std. Deviation	Std. Error Mean
RTS	1	38	49.24	11.906	1.931
	2	24	58.54	13.756	2.808

Remarks: 1 represents the UK's government bond, 2 represents the Brazilian government bond

Table 13 Independent t-test between two government bonds chooser

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
RTS	Equal variances assumed	.638	.427	-2.822	60	.006	-9.305	3.298	-15.901	-2.709
	Equal variances not assumed			-2.730	43.817	.009	-9.305	3.408	-16.174	-2.436

After revealing to the subjects the manipulated results which posed an extreme contrast with actual results, subjects were asked to choose again between two government bonds. This time the number of people who chose the UK's government bond was 32 (52%) and the number of people who chose the Brazilian government bond was 30 (48%). The risk means were 51.38 for people who chose the UK's government bond and 54.40 for people who chose the Brazilian government bond. Standard deviations were 10.536 and 15.852 as shown in Table 14. The P value of mean risk between two groups was 0.377, which unfortunately did not show a significant level as shown in Table 15 The result from this session also suggested that subjects who chose the UK's government bond have a lower mean risk than those who chose the Brazilian government bond; however this was not statistically significant in the correlation. Both sessions indicate the same trends in mean risk tolerance score between subjects who chose the UK's and those who chose the Brazilian government bonds.

Table 14 Descriptive analysis for 2nd choice between two government bonds

Group Statistics

Q15		N	Mean	Std. Deviation	Std. Error Mean
RTS	1	32	51.38	10.536	1.863
	2	30	54.40	15.852	2.894

Remarks: 1 represents the UK's government bond, 2 represents the Brazilian government bond

Table 15 Independent t-test for 2nd choice between two government bonds

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
RTS	Equal variances assumed	4.629	.035	-.890	60	.377	-3.025	3.398	-9.823	3.773
	Equal variances not assumed			-.879	49.977	.384	-3.025	3.442	-9.938	3.888

This study is more interested in the risk characteristics between subjects who change their decision and those hold still. A further investigation was undertaken into how many subjects change their decision after being shown the manipulated result implanted by the research, and the mean risk comparison between those who had made the change (herding), and those who stuck to their original option or switch to the other direction (non-herding). Twelve (19%) subjects changed their decision from UK to Brazil government bonds after being shown the manipulated result and 50 (81%) held onto their original decision or changed from Brazil to UK to avoid herding. Mean risk for the herding group is 46.08 and 54.46 for non-herding and the standard deviations were 13.8 and 12.854 as shown in Table 16 The independent t-test showed the P value for the difference of mean risk from these herding and non herding groups was 0.05 as shown in Table 17.

Table 16 Descriptive analysis between herding and non herding groups

Group Statistics

	Herding	N	Mean	Std. Deviation	Std. Error Mean
RTS	1.00	12	46.08	13.800	3.984
	2.00	50	54.46	12.854	1.818

Remarks: 1 represents herding group, 2 represents non-herding group

Table 17 Independent t-test between herding and non-herding groups

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
RTS	Equal variances assumed	.172	.680	-1.999	60	.050	-8.377	4.189	-16.757	.004
	Equal variances not assumed			-1.913	15.903	.074	-8.377	4.379	-17.664	.911

The result of this study confirmed all three research questions and suggested that the risk tolerance score extrapolates the level of herding for individuals. The fall of risk tolerance score increases the intensity of the herding effect and vice versa, i.e. there is an ***inverse*** relationship between risk score and herding.

Further analysis was conducted to compare the mean risk between the herding group and those who stuck to the UK bond throughout the two questions among the non-herding group. The result suggested that the people who tend to overrule their own decision by herding to others' majority decision (herding group) exhibited a lower risk tolerance score than those who did not change their decision (non herding group) but excluded those subjects with inherently higher risk tolerance score subjects (non herding group who chose the Brazil bond). However the difference was not statistically significant but still confirmed an inverse relation between risk tolerance score and herding bias. The result from the above data is probably not sufficient to draw a definite conclusion but is rather suggestive of a possible negative correlation between herding and risk tolerance. Meanwhile, the statistical power of the test was unexpectedly weakened by the unexpectedly low number of people who changed their decision to the Brazilian bond, which reduced the relevant sample size.

Another observation from this result is that there were three subjects who changed from Brazilian to UK government bonds to avoid herding. Although the number of the sample is too small to have statistical significance, it is a possible area for future research to discuss "lone wolf" investors who choose not to follow the crowd (e.g. de Haan, and Kakes, 2011).

People are making decisions oftentimes under uncertainty; the uncertainty is not only about the ambiguity of the market or product but also the quality of information available. Because people are averse to uncertainty, they will tend to imitate other investors' decisions. Investors who imitate do not know the quality of other investors' information, financial market trends thus being based on the mood of investors and not on rational responses (Parker and Prechter, 2005). Thus, for example, in the same informational context investors who are more insecure and less confident about their sources of information will have a greater propensity to herd. This feeling of uncertainty is a characteristic of each individual, since it will depend on each individual's attitudes, their more or less intuitive character, their risk propensity, their excess or lack of confidence, their illusion of control, their degree of tolerance for ambiguity, and so on.

In the study of Fernandez et. al (2009), the analysis of herding gradually diminishes as uncertainty falls. The results from the Wilcoxon signed-rank test also confirm these results, since they show a statistically significant difference in herding between the high and low uncertainty treatments. The postulation of both of the studies that herding behaviour is more frequent in contexts of higher levels of uncertainty is consequently accepted.

The results of the experiment show that uncertainty is more important than the individual cognitive profile in explaining herding among investors. However, as the level of uncertainty diminishes, the investors' cognitive profile can explain why individuals show different imitation propensities in identical informational contexts. The above remarks made by Fernandez, et al. (2009) could help to explain the low herding ratio in this experiment. 12 people out of 62 subjects had changed their decision after being shown the group result; the low percentage of herding might be as a result of low uncertainty between these two option choices.

Along with uncertainty in financial decision making, the individuals are also affected by risk attitude in arriving at financial decisions. Thus, individuals are not always going to

behave as homogenous and perfectly rational agents. Consequently, responses to market signals vary considerably from one investor to the next. This makes it necessary to study how investors' individual risk profiles affect their herding behaviour.

Loss aversion

In this study, subjects played a range of gambling choice games with hypothetical payoffs, which mirrored the Holt and Laury (2002) design. Each question is presented with gain versus loss scenarios, which involves a choice between one positive payoff and one negative payoff at the equal probability. The series of questions comprise seven pair-wise lottery choice questions, each question involving acceptance or rejection of the gambling choices. The set started with the safest gamble, with a maximum loss of £10; the amount of loss for the following sets increased incrementally by £10 until £70 was reached, at which point the negative expected value of return was certain (order effect was addressed in the experiment).

The researchers found that the number of people to accept the gambling choice decreased as the payout increased while the mean risk increased in the same direction of the payout pattern. Mean risk across seven questions between acceptance and rejection groups all indicated a significant level. The pattern in both the acceptance and rejection groups throughout all rounds are exhibited in Figure 3. Please also refer to Figure 4 which indicates the trend pattern of mean risk in both the acceptance and rejection groups from question 7 to question 13. The standard deviations between two measures are displayed round by round and the significant test between two mean risks for the rejection and acceptance groups are shown in Table 18-31. The independent t-test between the two mean risks for the rejection and acceptance groups all showed a significant level of difference throughout all the rounds.

Figure 3 Number of people in each choice option - loss aversion lottery choice

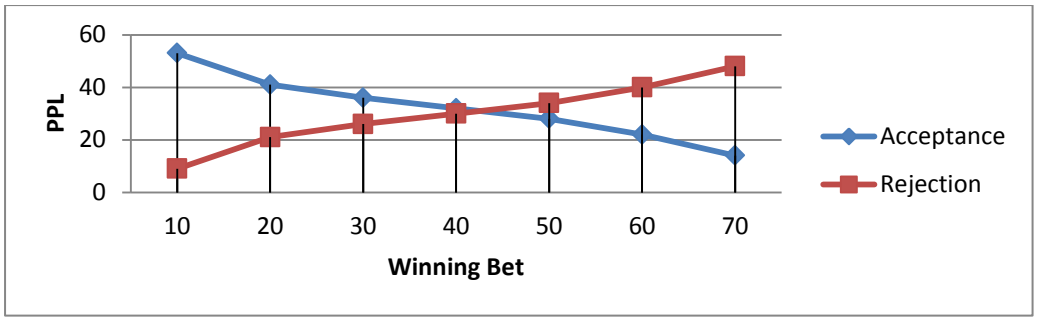

Figure 4 Mean risk in each round - loss aversion lottery choice

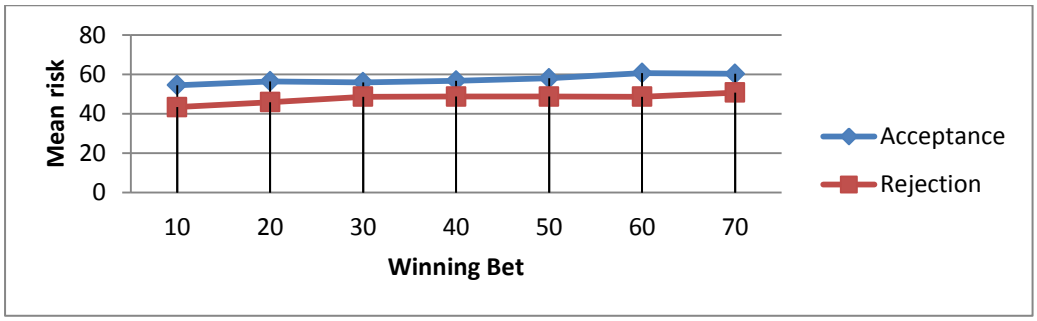

Table 18 Descriptive analysis on round 1 - loss aversion lottery choice

Group Statistics

Q7		N	Mean	Std. Deviation	Std. Error Mean
RTS	1	53	54.45	12.846	1.765
	2	9	43.33	12.933	4.311

Remarks: 1 represents accept, 2 represents reject

Table 19 Independent t-test on round 1 – loss aversion lottery choice

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
RTS	Equal variances assumed	.170	.682	2.399	60	.020	11.119	4.636	1.847	20.392
	Equal variances not assumed			2.387	10.858	.036	11.119	4.658	.851	21.388

Table 20 Descriptive analysis on round 2 - loss aversion lottery choice

Group Statistics

Q8		N	Mean	Std. Deviation	Std. Error Mean
RTS	1	41	56.44	12.207	1.906
	2	21	45.81	12.925	2.821

Remarks: 1 represents accept, 2 represents reject

Table 21 Independent t-test on round 2 – loss aversion lottery choice

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
RTS	Equal variances assumed	.215	.644	3.181	60	.002	10.630	3.341	3.946	17.313
	Equal variances not assumed			3.122	38.436	.003	10.630	3.404	3.740	17.519

Table 22 Descriptive analysis on round 3 – loss aversion lottery choice

Group Statistics

Q9		N	Mean	Std. Deviation	Std. Error Mean
RTS	1	36	55.92	13.727	2.288
	2	26	48.58	11.768	2.308

Remarks: 1 represents accept, 2 represents reject

Table 23 Independent t-test on round 3 – loss aversion lottery choice

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
RTS	Equal variances assumed	.208	.650	2.203	60	.031	7.340	3.332	.675	14.005
	Equal variances not assumed			2.259	58.159	.028	7.340	3.250	.835	13.844

Table 24 Descriptive analysis on round 4 - loss aversion lottery choice

Group Statistics

Q10		N	Mean	Std. Deviation	Std. Error Mean
RTS	1	32	56.75	12.485	2.207
	2	30	48.67	13.166	2.404

Remarks: 1 represents accept, 2 represents reject

Table 25 Independent t-test on round 4 – loss aversion lottery choice

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
RTS	Equal variances assumed	.425	.517	2.481	60	.016	8.083	3.258	1.567	14.599
	Equal variances not assumed			2.477	59.168	.016	8.083	3.263	1.554	14.613

Table 26 Descriptive analysis on round 5 - loss aversion lottery choice

Group Statistics

Q11		N	Mean	Std. Deviation	Std. Error Mean
RTS	1	28	57.89	12.723	2.404
	2	34	48.68	12.547	2.152

Remarks: 1 represents accept, 2 represents reject

Table 27 Independent t-test on round 5 – loss aversion lottery choice

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
RTS	Equal variances assumed	.044	.835	2.860	60	.006	9.216	3.222	2.771	15.662
	Equal variances not assumed			2.856	57.429	.006	9.216	3.227	2.756	15.677

Table 28 Descriptive analysis on round 6 - loss aversion lottery choice

Group Statistics

Q12		N	Mean	Std. Deviation	Std. Error Mean
RTS	1	22	60.59	12.304	2.623
	2	40	48.58	12.028	1.902

Remarks: 1 represents accept, 2 represents reject

Table 19 Independent t-test on round 6 – loss aversion lottery choice

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
RTS	Equal variances assumed	.064	.802	3.734	60	.000	12.016	3.218	5.578	18.454
	Equal variances not assumed			3.709	42.545	.001	12.016	3.240	5.480	18.552

Table 30 Descriptive analysis on round 7 - loss aversion lottery choice

Group Statistics

Q13		N	Mean	Std. Deviation	Std. Error Mean
RTS	1	14	60.21	14.143	3.780
	2	48	50.69	12.451	1.797

Remarks: 1 represents accept, 2 represents reject

Table 31 Independent t-test on round 7 – loss aversion lottery choice

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
RTS	Equal variances assumed	.190	.665	2.443	60	.018	9.527	3.899	1.727	17.326
	Equal variances not assumed			2.276	19.269	.034	9.527	4.185	.775	18.279

The results confirm that mean risk in the acceptance group is statistically significant higher than those in the rejection group in each round of lottery choice question. Furthermore, the researcher regroups the subjects based on the number of acceptances in the series of seven questions. In Table 32, the researchers report a summary of descriptive statistics classified by number of acceptances in the series of seven games. The researchers examined the number of acceptance option choice selected by each subject in the sequential seven questions and calculated the risk mean for each group. There are in total eight groups with a number of acceptance choices ranging from 0 to 7. The risk mean forms an irregular pattern as shown in the table. However, following further analysis from ANOVA, the P value is found to be 0.005 in between and within subjects as shown in Table 33.

Table 32 Descriptive analysis by numbers of acceptance in loss aversion lottery choice

Descriptives

RTS

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
.00	7	42.00	14.606	5.521	28.49	55.51	23	58
1.00	8	50.63	10.364	3.664	41.96	59.29	41	70
2.00	10	47.00	14.757	4.667	36.44	57.56	24	69
3.00	6	56.67	7.501	3.062	48.79	64.54	49	69
4.00	5	48.00	6.083	2.720	40.45	55.55	40	55
5.00	5	53.20	10.330	4.620	40.37	66.03	42	65
6.00	12	54.67	11.835	3.416	47.15	62.19	37	78
7.00	9	67.22	12.101	4.034	57.92	76.52	53	87
Total	62	52.84	13.349	1.695	49.45	56.23	23	87

Table 33 ANOVA analysis on significant level

ANOVA

RTS

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3310.157	7	472.880	3.378	.005
Within Groups	7560.231	54	140.004		
Total	10870.387	61			

The result of this study answers all three research questions and suggests that the risk tolerance score extrapolates the level of loss aversion for individuals; namely there is an ***inverse*** relationship between risk score and loss aversion.

Furthermore, with the aim of looking further at the relationships among the variables of the behavioural biases, the researchers first carried out an analysis of variance using Pearson's Chi square test. The researchers examined whether cognitive variables are mutually exclusive, and for this reason the latter analysis allows us to consider the interrelations between the cognitive variables chosen in the present study. The Pearson's Chi square test confirms there is no significant dependence between herding, loss aversion, endowment and framing. The results show no interactive relations between the variables measuring behavioural bias and risk tolerance score in the different treatments.

To sum up, the correlation between the four biases and risk tolerance scores has been established and documented through the results of the experiment, which is discussed in the later chapters. The findings are hereby summarised as follows:

- Risk tolerance score is ***positively*** correlated with endowment bias
- Risk tolerance score is ***inversely*** correlated with framing bias
- Risk tolerance score is ***inversely*** correlated with loss aversion
- Risk tolerance score is ***inversely*** correlated with herding

5 Implications, limitation and future research

The findings of this study offer general implications for the following areas:

Implications for financial advising

As pointed out by Kahneman and Riepe (1998), financial advising is a prescriptive activity whose main objective should be to guide investors to make decisions that best serve their interests. To advise effectively, advisors must be guided by an accurate picture of the cognitive and emotional weaknesses of investors that relate to making investment decisions:

their occasionally faulty assessment of their own interests and true wishes, the relevant facts that they tend to ignore and the limits of their ability to accept advice and to live with the decisions they make. Providing timely warnings about the pitfalls of intuition should be one of the responsibilities of financial advisors. Risk tolerance scoring provides a gauge on how an individual perceives risk; this investigation of the linkage between risk tolerance score and investment biases would further provide an understanding on how the level of risk tolerance correlates to the various biases in test. Financial services professionals would do well to recognise such differences when dealing with clients, due to the implications for the marketing of financial products and for financial service providers. Those providing advice to individual investors need to understand client attitudes to investment in general and risk in particular. Failure to grasp such differences may make it extremely difficult to provide appropriate advice and to gratify clients over the long term.

Implications for studying investment biases

Firstly, this finding further extends the range of situations in which the four biases can be found. The present experiment demonstrated bias effects in a behavioural task which were tested in a laboratory environment across different group sessions. Secondly, the lack of correlation between complicated managerial decision question set and risk tolerance score highlights the power of wording in altering subjects' behaviour when facing a complicated scenario. Although the straightforward question suggested the correlation with risk tolerance score, increasing the level of sophistication in the question set completely eliminated this association. This implies that studies which attempt to validate biases test using more than one question set need to pay careful attention to the wording of each of the measures in terms of a consistent level of sophistication. Thirdly, results from this study highlight the need for greater interdisciplinary contact between researchers interested in risk attitude and those studying behavioural decision making. This study suggested that the risk tolerance score inherent in individuals determines the level of framing, loss aversion, endowment and herding biases.

Implications for investors

There is a palpable link between financial investment decision and investors' behaviour. Research into investors' behaviour may prove useful in increasing our understanding of the extremely complex financial marketplace. In many cases, investors are unaware of their predisposition for error. And more often than not, an irrational investor is a

dissatisfied investor, because biases usually undermine financial goals (Barberis, et al., 1998). As Kahneman and Riepe (1998, p. 53) note, "Investors who are prone to these biases will take risks that they do not acknowledge, experience outcomes that they did not anticipate, will be prone to unjustified trading, and may end up blaming themselves or others when outcomes are bad". Understanding the psychological basis for investor errors and taking appropriate actions to correct such errors may reduce their effects on investment decisions and potentially lead to improved investment results. This does not necessarily mean, however, that taking such actions will lead to excess returns (Baker and Nofsinger, 2002).

Implications for methodological approach

Different from prior studies, the research aims to study linkage between risk tolerance score and the four investment biases which has been identified in behavioural literature. The method adopted in this study assesses choices in an experimental setting, which the researchers consider either hypothetical scenarios or where decisions have financial consequences (e.g., Holt and Laury 2002). In the experimental setting, the researchers observed actual decision making, assessing choices in an experimental setting and creating scores from survey questionnaires.

This study of the correlation between psychological traits and cognitive biases is related to the insightful analyses of Camerer (1987), and Barber and Odean (2002 a and b). Probably the most significant methodological difference between their works and this is that the researchers endeavour to directly measure psychological traits and cognitive biases. It is hoped that this direct confrontation of psychological data and economic actions can provide information useful to ascertain the impact of psychological aspects on economic phenomena.

Implications for RTQ

This study supports the reliability of a risk tolerance questionnaire (RTQ) using hypothetical questions. This may encourage a wider adoption of RTQ in future studies and more biases could be tested in a similar fashion.

Limitations

As discussed by Eisenberg (1996), rationalising behaviour through experimentation does not account for the process of thought, making outcomes of that process fallible. Human behaviour is dependent on individual responses which can be difficult to measure. As a result, a common concern arises as to the validity of experimental research.

However, experimentation can be combined with other research methods to ensure validity. Other qualitative methods such as case study, ethnography, observational research and interviews can function as preconditions for experimentation or conducted simultaneously to add validity to a study.

Also, as the findings presented here represent a convenient sample of respondents from the student population who volunteered to take part in the experiment, there may be certain groups of individuals who are excluded from the sample; for example, the demographic profile of the subjects tends to be younger and more technologically proficient than might be expected in the general population. Human behaviour often involves a trade off of several complex and interrelated concepts. Therefore it may be difficult to accurately test the cognitive biases with only a few questions. In this sense, the conclusion made from this study is more appropriate to be perceived as suggestion rather than affirmation.

Future Research

There are a number of promising extensions that can be made from the findings of this study. The study has focused on the individual level of analysis and has derived the propositions from individual-level theories and empirical research. However, many of the arguments developed here may be equally applicable to organisational level as to decision making entities. Much of the work to date on individual risk behaviour has focused on how individuals respond to uncertain conditions (e.g., Fischhoff et al., 1981 and Kahneman and Tversky, 1984). However, this substantial body of work has focused attention on the role of individual perceptions and preferences, with only limited consideration of the potentially

important impact of organisational context (e.g., Douglas and Wildavsky, 1982) and personal and organisational risk history (Osborn and Jackson, 1988). The analysis proposed here could easily be applied to understanding the degree of biases to which organisational decision makers are posed depending upon their risk attitude.

This study serves as an initial study which involved controlled laboratory experiments; however, since the pattern of relationship has been established, future study can extend to field tests. The result of this study confirms that herding, loss aversion, framing and endowment exist. There are many more investment biases that have been identified by prior studies but are yet to be examined in the same fashion. This would provide a starting point for future research to measure the individual's cognitive profile and its relationship with their respective risk tolerance score. Meanwhile, the study is conducted within campus using Business School students due to resources constraints, in order to reach a wider range of subjects with more heterogeneity; a web-based approach could be replicated to repeat the study. For future study, it would also be interesting to test the hypothesis on real investors; the individual investors' data exist in the files of private firms. It is hoped that some firms will see the benefit of sharing such data with researchers. For sharing to become a reality, confidentiality will have to be adequately protected - confidentiality of the source of the data and of the identities of the individual investors.

Besides contributing to the understanding of financial decision making, this research verifies the indications of people's information-processing limitations. The next phase of research could emphasise the development of techniques to help decision makers overcome their cognitive biases. Will informing an individual about his/her biases make him/her less susceptible to them or will it lead him/her to overcompensate, perhaps with even greater error? The past decades of research has uncovered some fascinating questions and stirred the discussion on the impact of cognitive biases to decision making process; future studies could attempt to answer how to tackle the biases and quantify the impact level.

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