Experimental Evidences for Prospect Theory in Vietnam

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Abstract

In the context of growing literature about behavioral finance and experimental research, there is an urgent need to expand this contemporary branch in emerging markets in general and Vietnam in particular. Therefore, this paper aimed at finding evidence of prospect theory in Vietnam using a battery of experimental approach. The objective of experiment design is to understand the economic market and represent almost all risk suffering levels. The research outcomes strengthened arguments of prospect theory in terms of both slope and reference point. This research found evidence for the hypothesis that the utility curve reference point lies in the positive domain. This suggested that in the case of low profitability, investors could still prefer risk over certainty, but they shall be more risk averse as returns are increased. Besides, the relationship between loss aversion and other behavioral biases was also examined, and evidence of strong relation between loss aversion and anchoring and overreaction was found, while there existed no clear correlation between loss aversion and overconfidence. The findings of this paper shed light on current research about behavioral finance, especially about prospect theory in Vietnam, suggesting a pilot approach to find evidence of various behavioral biases that might affect stock market investors' decisions.

Keywords : **behavioral finance, experimental research, loss aversion, prospect theory, Vietnam**

JEL Classification Codes : G10, G11, G41

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Behavioral finance is one of the essential aspects of finance, which has been repeatedly researched and research in this area has been expanding over the past 50 years, both globally and in Vietnam. Prospect theory, one of the most critical discoveries in behavioral finance, generally studies the investors' decision with risk involved. First demonstrated by Kahneman and Tversky (1979), prospect theory is now applied to portfolio management, quantitative finance, and the study of investor decision-making. Not only in finance, but prospect theory is also widely used in the field of medicine, marketing, or law studies. Essentially, compared to the theory of expected utility, one of the classical financial theories supports the view that human beings always act rationally to maximize expected utility under risky circumstances, and probability demonstrates that human beings have systematic biases. Prospect theory has contributed to explain the apparent differences in the way people value profits and losses.

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With the emergence of artificial intelligence, behavioral finance applications for stock market trading are becoming more prevalent in the European and American markets. However, applications of behavioral finance are still limited in the Vietnam stock market. Part of the reason is that each investor has his/her own strategy and is greatly affected by cognitive issues, so investment strategies applied in developed countries are unlikely to be appropriate for Vietnamese investors and vice versa. A study incorporating behavioral finance concepts must be conducted with Vietnamese investors to shed light in developing new strategies.

Experimental research was applied in this paper to measure loss aversion in the context of emerging markets, which is our main research objective. Experiments are crucial to measure reactions of market participants regarding behavioral aspects. Compared with other methods, including primary survey method, experimental research has higher accuracy and is customized for its purpose. Experimental research applied in behavioral finance, in the Vietnamese context, therefore, is expected to bring about accurate results and contribute to the current literature about prospect theory.

Literature Review

Behavioral finance, in general, is attracting more attention from scholars, especially in recent years. Costa et al. (2019) provided a bibliometric analysis of behavioral finance and behavioral economics in general. Meanwhile, the outcomes of Alquraan et al. (2016) explored the behavioral finance factors influencing the stock investment decision of individual investors in the Saudi stock market.

Isidore and Christie (2018) observed eight types of behavioral biases – overconfidence, regret aversion, anchoring biases, loss aversion, anchoring, representativeness, gambler's fallacy, and mental accounting – by obtaining responses from 436 secondary equity investors residing in Chennai. The results showed that there was a relationship between mental accounting, available biases, and loss aversion.

According to Raghuram and Erickson (2017), the application of behavioral economic research was demonstrated in the asset pricing aspect. The value factors were researched through six independent portfolios. The results showed that the behavior aspect had a high correlation with asset pricing activities. This paper also showed that the Fama - French three-factor model was a good descriptor of returns in the Indian context. The discovery of the structural break in the asset pricing behavior was also consistent with the adaptive market hypothesis (AMH).

Regarding prospect theory, besides Kahneman and Tversky's (1979) outstanding work, there are other empirical studies of this branch. Barberis et al. (2001) demonstrated the relationship between prospect theory and property values. Thaler (1980) studied the effect of the prospect theory on customer choices. Camerer et al. (2004) showed the influence of the prospects in some economic sectors, for example, labor supply and demand in the market.

The most critical part of prospect theory's assumptions is the value function that describes the relationship between expected utility and the value of profits - losses. Besides, another concept associated with the value function is loss aversion. This theory was first introduced by Kahneman and Tversky (1979) and is thought to be one of the three cognitive traits in the prospect theory. It can be defined as a mechanism in which people relatively translate the results in terms of profit and loss to a reference point, and they are more susceptible to losses than those of similar magnitude gains. The disproportion between the weights of positive and negative expectations or experiences formed during evolution as humans reacted to threats in a more aggressive manner than to opportunities. There are many methods of measuring the degree of hesitation (or loss of confidence) such as those given by Benartzi and Thaler (1993) and Abdellaoui (2000).

The quantification of the loss aversion level is complicated, significantly when the weight of the options can differ between profit and loss. To solve this problem, many studies have suggested the simplification of the issue

of the utility function and probability, such as assuming the linear utility function, ignoring the weight of possibility, or considering the importance of the probability between the profits and losses is the same. This makes inaccurate measurements out of the actual results that can be drawn from the data. On the other hand, our method to measure utility and loss of interest, a development of the trade-off method (Wakker & Deneffe, 1996), did not use any simplifications. It allowed the expression of a utility function even if the probabilities are ambiguous or indeterminate. In other words, it is significant in probability while maintaining the value of the theory of probability.

In addition to the measure of utility, the application of any definition of impedance theory or method to measure the degree of loss of consciousness has a definite impact on the study results. There are many different definitions of loss aversion theory, which hinder the comparison of previous studies' results. Thus, in addition to the application of loss aversion theory to analyze the value function's convexity, this study also presents the coefficients of loss theory using different definitions of loss aversion theory. One of the most commonly used measurements first appeared in the study of Kahneman and Tversky (1979). The authors defined the loss aversion theory as : $-U(-x) > U(x)$ with $x > 0$ and determined the coefficient of loss aversion as the mean or median of $-U(-x) / U(x)$, while $U(x)$ is value of event.

There is evidence about the relationship between loss aversion theory and other theories of behavioral finance. Overconfidence is defined as an unsuspecting belief in an individual's visual reasoning, assessment, and cognitive ability. Herd behavior is the tendency of an individual to mimic a larger group of individuals (logical or unreasonable). Overreaction bias results in how individuals react systematically to new information, creating a more substantial price effect than is reasonably expected. Anchoring is a bias that investors hold on to their beliefs without proper analysis of adequate information. If these relationships exist, we can estimate explanatory variables that affect loss aversion theory and vice versa. Raut and Das (2015) observed that social factors like herding, emotional contagion, imitation, and information cascades and psychological patterns like representativeness availability and anchoring heuristics were essential factors that determined individual decisions. This paper highlighted the common decisional errors made by investors. Mehta and Chander (2010) examined the impact of behavior finance on January and December effects on the Indian stock market. Dangi and Kohli (2018) used another approach in quantitative ways to divide investors into five groups, including the stereotypical investor, the nervous investor, the imitator, the naive investor, the cautious investor, and the passive investor. An initial inventory of 24 items about 21 biases was assessed for validity, was subjected to pilot tests, and subsequently to various rounds of modification. Final data were collected from 389 respondents using a questionnaire that captured the biases. The archetypes were created using principal component analysis.

In recent times, with the development of markets and financial institutions, behavioral finance studies have become necessary to provide a different perspective on investors' behavior in the financial markets. Dzung and Quang (2019) employed many tests and found that the Vietnamese stock market fit into the definition of adaptivity of stock market efficiency. Vo and Thao (2013) found no clear evidence of anomalies in Vietnam, applying ARCH and GARCH (1, 1). Phan et al. (2020) used time-series analyses to assess a comparative basis between different Asian markets ; the research results showed that investors in Vietnam and Singapore tended to have overconfidence, while Thai investors tended to have underconfidence in their investment decisions.

Nguyen et al. (2012) used field experiments in Vietnam to find that while probability sensitivity or risk aversion did not affect trust, loss aversion influenced trust indirectly by lowering return expectations. Another research by Vo et al. (2020), in contrast, found the IVOL (idiosyncratic volatility) effect, which is considered as an IVOL puzzle in positive alpha sub-samples. However, these findings are not consistent with prospect theory.

Trang and Nguyen (2019) reviewed experimental approaches to manager's risk and time preferences in Vietnam, mainly EU models and non-EU models. This paper found and drew important conclusions regarding the Vietnamese financial environment.

As can be seen from the literature review, a research on the reference point with connection to loss aversion and the other behavioral biases as linked to prospect theory in Vietnam is still missing. This paper proposes a theoretical framework and, correspondingly, research questions related to prospect theory, loss theory related to other behavioral biases in Vietnam, with the utilization of experimental method to get closer to the best evidences.

Theoretical Framework

The first objective of this study is to find the disposition effect by exploiting the utility function. According to Kahneman and Tversky (1979), the utility function is concave in the loss area and is convex in the profit area ; it also means that the point at which the portfolio moves from the gain to the loss and the point at which convexity is converted into concavity is precisely the same. The point where the value function changes from concave to convex lies within the gains side, that is, investors may be risk-taking even if they have gained a small amount of profit, explained by the fact that risk-taking could not be so painful if the tradeoff is not too much. If further empirical results reinforce this assumption, it can help draw models and patterns that characterize investors' behavior in practice and contribute to prospect theory's existing literature. Put in a different way, this is the most critical research question of this study.

The theory of expected utility, the root for disposition effect, originated in the early twentieth century and was perfected by Von Neumann and Morgenstern (1945). This theory can be summarized as follows :

Suppose an event L has n results (u_1, u_2, ..., u_n). $L(p_1, p_2, ... p_n)$ is a set of probabilities corresponding to the results, with $p_1 + p_2 + ... + p_n = 1$. Then, the expected utility of the event L is equal to $p_1.u_1 + p_2.u_2 + ... + p_n.u_n$.

According to this theory, Von Neumann and Morgenstern (1945) proposed the following important model : For each value $L > L'$ (L is the preferred result over L') of the investor, there are numerical values for the utility degree u_i, where $L > L'$ when and only if $U(L) > U(L')$, with

$$U(p_1, p_2, ..., p_n) = p_1 . u_1 + p_2.u_2 + ... + p_n.u_n \quad (1)$$

However, contrary to the utility theory of expectations, Tversky and Kahneman (1979) offered the prospect theory. Accordingly, we argue that the hypothesis that two individuals make the same decision at the same level of expectancy is inaccurate because individuals are not dependent on their decisions. Absolute consumption value, instead, depends on the position of the asset when compared to a reference point (which is considered a gain and a loss).

The Value Function

The centre of prospects is a function of the value of the psychological effect of change in consumption on the absolute value of consumption. When new research on the prospect theory emerged, Tversky and Kahneman (1979) developed a simple outlook consisting of two outcomes : (x, p, y, q), in which the potential for x is given by the probability p ; on the other hand, we get the y value with the probability q. A prospect is considered positive if its results are positive and are assumed to be negative if its effects are adverse. If this prospect is not pure positive or pure negative, it is called a regular prospect. Two measures define the value function (denoted by V), π and v. The first measure, π, is a weight that affects the decision of probability associated with each result. This measure reflects the effect of possibility on the overall value of the prospect. The second measure, v, represents the subjective estimate for each result of the prospect.

The value of pure positive or pure negative prospect differs from that of a normal prospect. For ordinary probabilities (occurring when $p + q < 1$, or $x \geq 0 \geq y$, "or" $x \leq 0 \leq y$), the function is as follows :

$$V(x,p,y,q)=\pi(p)\,v(x)+\pi \quad (2)$$

where : $v(0)=0$, $\pi(0)=0$, $\pi(1)=1$

On the other hand, the function of the positive net potential (occurring when $p + q = 1$ and either $x > y > 0$ or $x < y < 0$), which is calculated as :

$$V(x,p,y,q)=v(y)+\pi(p) \quad (3)$$

There are three conclusions about the value function :

(i) The value function is determined by comparing the results with the reference point

(ii) The concave value function in the loss domain (above the reference point and can be expressed as : $v''^{(x)} \leq 0$, $x \geq 0$) and normally convex in the gain domain (below the reference point leads to : $v''^{(x)} \leq 0$, $x \geq 0$).

(iii) The value function is often steeper in the gain than in the loss domain, this finding also confirms the existence of the loss aversion theory and shall be discussed in the section : The Loss Aversion Theory.

However, to adhere to randomness, in order to apply to the prospects of more significant numbers of results, and by the convenience of symbolism, Abdellaoui et al. (2011) used the model of order dependence, first published by Quiggin (1982). We assume the probability of the form (x, p, y), where the expectation of receiving the result is x with the probability p and obtaining the result y with the probability $1– p$. Suppose an unmixed prospect contains only the profit (or loss) result. In that case, we assume that $x \geq y \geq 0$ ($x \leq y \leq 0$) ; in other words, the first result in an unmixed prospect is always the boundary value (maximum or minimum). With a mixed prospect, it is assumed that $x > y > 0$.

With this expression, the value function of a normal prospect is :

$$w^{+}(p)U(x)+(1-w^{-}(1-p))\,U(y) \quad (4)$$

And with positive or negative potential, the value function is as follows :

$$w^{i}(p)U(x)+(1-w^{i}(p))\,U(y) \quad (5)$$

where, $i = +$ "with the result of gain and" $i = –$with the result of loss. W represents the weighted probability function of the gains or losses and is described in more detail in the next section.

The Weight Function

In the original theoretical outlook, the decision weight is expressed as a function of probability. This is only true in cases where events are determined solely by possibilities. However, in reality, there are many other influencing factors, such as ambiguity. Regardless of whether these factors are involved, it should be noted that $\pi(p)$ differs from p itself.

Normally, the decisive weight $\pi(p)$ is an incremental function of p, with $\pi(0) = 0$ "and" $\pi(1) = 1$. However, unlike the original study using the weights described for each of the probabilities described above, Tversky and Kahneman (1992) proposed a different approach to the weight function, called the weight function continuity.

More specifically, the decision gravity of a result can be interpreted as the marginal impact of a related event.

The weight function is defined using w^+ "and" w^-, where the weight function is the probability function of a probability distribution, with $w(0) = 0$ and $w(1) = 1$. The weight of the decision can be interpreted as follows :

$$\pi^+_n = w^+(p_n), \pi^-_{-m} = w^-(p_{-m}),$$
$$\pi^+_i = w^+(p_i + ... + p_n) - w^+(p_{i+1} + ... + p_n), 0 \le i \le n-1,$$
$$\pi^-_i = w^-(p_{-m} + ... + p_i) - w^-(p_{-m} + ... + p_{i-1}), 1-m \le i \le 0. \quad (6)$$

Kahneman and Tversky (1979) continued to have new findings on weighting. First of all, the decisive weight also diminishes the same sensitivity as the utility function. Second, it can be seen that individuals are often confined to estimating probabilities at the boundary. They overestimate small probabilities while underestimating medium and high possibilities, but very high possibilities are considered to be certain.

The Loss Aversion Theory

There are various definitions of loss aversion theory, which lead to the difference between quantitative methods as well as coefficients of loss aversion theory in both quantitative and empirical studies on the subject. According to Kahneman and Tversky (1979), loss aversion theory is defined as $-U(-x) > U(x)$ with every $x > 0$ and is represented by the loss aversion coefficient as the mean or median of $-\frac{U(-x)}{U(x)}$ with the appropriate values of x. Neilson (2002) defined loss aversion as $\frac{U(-x)}{x} \ge \frac{U(-y)}{y}$ for all $x, y > 0$. Wakker and Tversky (1993) provided another concept of the loss aversion theory $U'(-x) \ge U'(x)$ for all $x > 0$, which is equivalent to the loss aversion factor $\frac{U'(-x)}{U'(x)}$. Köbberling and Wakker (2005) gave a completely different representation of loss aversion theory : $\frac{U'_{\uparrow}(0)}{U'_{\downarrow}(0)}$, where $U'_{\uparrow}(0)$ is the left and $U'_{\downarrow}(0)$ is the right derivative of U at the reference point.

Abdellaoui et al. (2007) compared the different definitions of loss aversion theory and came to the conclusion that the two definitions given by Kahneman and Tversky (1979) and Köbberling and Wakker (2005) were the best of all.

Methodology

Assumptions

This paper gives some assumptions about the variables and their meanings as follows :

$V(x, p, y)$ is the value of a potential, equal to the product of the function of the value and the weight function. In the analysis of $V(x_1, p_1, y_1) = V(x_2, p_2, y_2)$, the participant considers that the following two choices are equivalent :

- **Choice A :** Choosing between x_1 with probability p_1 and y_1 with probability $(1-p_1)$.
- **Choice B :** Choosing between x_2 with probability p_2 and y_2 with probability $(1-p_2)$.

Prospect functions $V(x, p, y)$ are valid only when uncertainty exists (p is different from 0 and 1). $W(p)$ is the weight function, which means that the influence of the probability changes on the choice of the participant, p and

$w(p)$ is in the range (0 ; 1). Weighting will lose its meaning if standing alone. In this paper, we assume that each participant's weight function with the same probability is the same at all times. The $w(p)^-$ denotes the weight function in the loss domain, and $w(p)^+$ represents the gain domain's weight function.

$U(x)$ is the value function, meaning the effect of the value on the participant's choice. This study assumes that all participant values are the same for the same initial value. To facilitate the calculation, assume $U(-100) = -100$; $U(0) = 0$; $U(100) = 100$.

Coding of Variables

Table 1 depicts the variable codes for $U(X)$.

Table 1. *Coding of Variables*

Step	Variable	Equilibrium Pair	Given Variable(s)
1	X_1	$V(X_1, p, Y^*) = V(X_0, p, Y_0)$	$p = 0.33$
	X_2	$V(X_2, p, Y^*) = V(X_1, p, Y_0)$	$Y^* = -100$
	p^-	$X_1 = V(X_2, P_t, X_0)$	$X_0 = -1000$
			$Y_0 = -600$
	X_1	$V(X_1, p, Y^*) = V(X_0, p, Y_0)$	$p = 0.33$
	X_2	$V(X_2, p, Y^*) = V(X_1, p, Y_0)$	$Y^* = 100$
	p^+	$X_1 = V(X_2, P_t, X_0)$	$X_0 = 1000$
			$Y_0 = 600$
2	X_1^-	$V(0, P_t, X_1^-) = -100$	P_t
	X_2^-	$V(0, P_t, X_2^-) = V(-100, P_t, X_1^-)$	P_t ; $U(X_1^-)$; $U(-100)$
	X_n^-	$V(0, P_t, X_2^-) = V(-100, P_t, X_{n-1}^-)$	P_t ; $U(X_{n-1}^-)$; $U(-100)$
	X_1^+	$V(0, P_t, X_1^+) = 100$	P_t
	X_2^+	$V(0, P_t, X_2^+) = V(100, P_t, X_1^+)$	P_t ; $U(X_1^+)$; $U(100)$
	X_n^+	$V(0, P_t, X_n^+) = V(100, P_t, X_{n-1}^+)$	P_t ; $U(X_{n-1}^+)$; $U(100)$

The first step of the study is similar to that of Abdellaoui et al. (2007). The participants were asked to choose the equilibrium pairs :

$$V(X_1, p, Y^*) = V(X_0, p, Y_0) \quad (7)$$

and from this we derive :

$$U(X_1) - U(X_0) = U(X_2) - U(X_1) \quad (8)$$

from there :

$$U(X_1) = ½ * U(X_0) + ½ * U(X_2) \quad (9)$$

Select p_t so that a participant sees no difference between the definite choice X_1 and $V(X_2, p, X_0)$, then :

$$U(X_1) = w(p) * U(X_0) + w(1-p)\, U(X_2) \quad (10)$$

According to the model of Abdellaoui et al. (2007), $w(p)^- = 0.5$. Similarly, we find $w(p)^+ = 0.5$. This is an important variable in the next expansion. In Table 1, P_t is interpreted as the value satisfies $w(P_t)^- = w(P_t)^+ = 0.5$.

Step two of the study is to determine the value function for survey and verification. From $w(p) = 0.5$, the participants choose X_1^- to $V(0, P_t, X_1^-) = -100$. We obtained :

$$w(1-p)*U(0) + w(p)*U(X_1^-) = -100 \Leftrightarrow 1/2*U(X_1^-) = -100 \Leftrightarrow U(X_1^-) = -200 \quad (11)$$

To narrow the value function, reverse :

$$w(1-p)*U(0) + w(p)*U(X_1^-) = U(X_2^-) \Leftrightarrow U(X_2^-) = -50 \quad (12)$$

The construction of the regression function $U(X_n^-)$ by knowing $U(X_{n-1})$ defines the value functions on the gain and loss with construction of the data setup to test for convexity and concavity.

For the identification of other behavioral biases, questionnaires were used. Each behavioral bias was measured by three to five multiple-choice tests, which were then scaled to assess the participants' sensitivity. Output data included a value function and a behavioral bias rating scale, from which the test hypotheses are tested.

Hypotheses

As stated, the main research question of the study is whether there is a case where the investor acts unreasonably at small gains or losses. Specifically, investors tend to speculate in the verbal and cautious domain of the loss, which will test the hypothesis that there is a point at the loss where the participant is more likely to speculate. Hypothesis 1 verifies the existence of point X such that :

- **$H0_1$:** $abs(U(-X)'/U(X)') > 1 \quad (13)$
- **Ha_1 :** $abs(U(-X)'/U(X)') < 1$

Hypothesis 2 studies the loss aversion theory. According to previous studies, the value of "loss aversion" is calculated in different ways, LA (Loss aversion) = mean ($U(-X) / U(X)$) or mean ($U(-X)'/U(X)'$). LA is between 1.5 and 2.5. The participants will review the topic. This leads us to conclude that the ratio between Vietnamese participants' risk fears and profit expectations is higher than that of international ones.

- **$H0_2$:** LA (Loss aversion) = mean $(U(-X)/U(X)) < 2.5 \quad (14)$
- **Ha_2 :** LA (Loss aversion) = mean $(U(-X)/U(X)) > 2.5$

Hypothesis 3 studies the correlation between loss aversion and three behavioral biases : overreaction, overconfidence, and past association across two subjects with a financial background and econometric background. Based on subjective judgment, we argue that the behavioral biases will have a more significant impact on the financial performance of the participants with a financial background, which means that the correlation between behavioral biases and loss aversion is higher in the students having financial background than in students with a mathematics background.

↳ **$H0_3$:** Correlation between behavioral biases and loss aversion of those with finance background is weaker than correlation between behavioral biases and loss aversion of those with economical mathematics background.

↳ **Ha_3 :** Correlation between behavioral biases and loss aversion of those with finance background is stronger than correlation between behavioral biases and loss aversion of those with economical mathematics background.

Data Collection

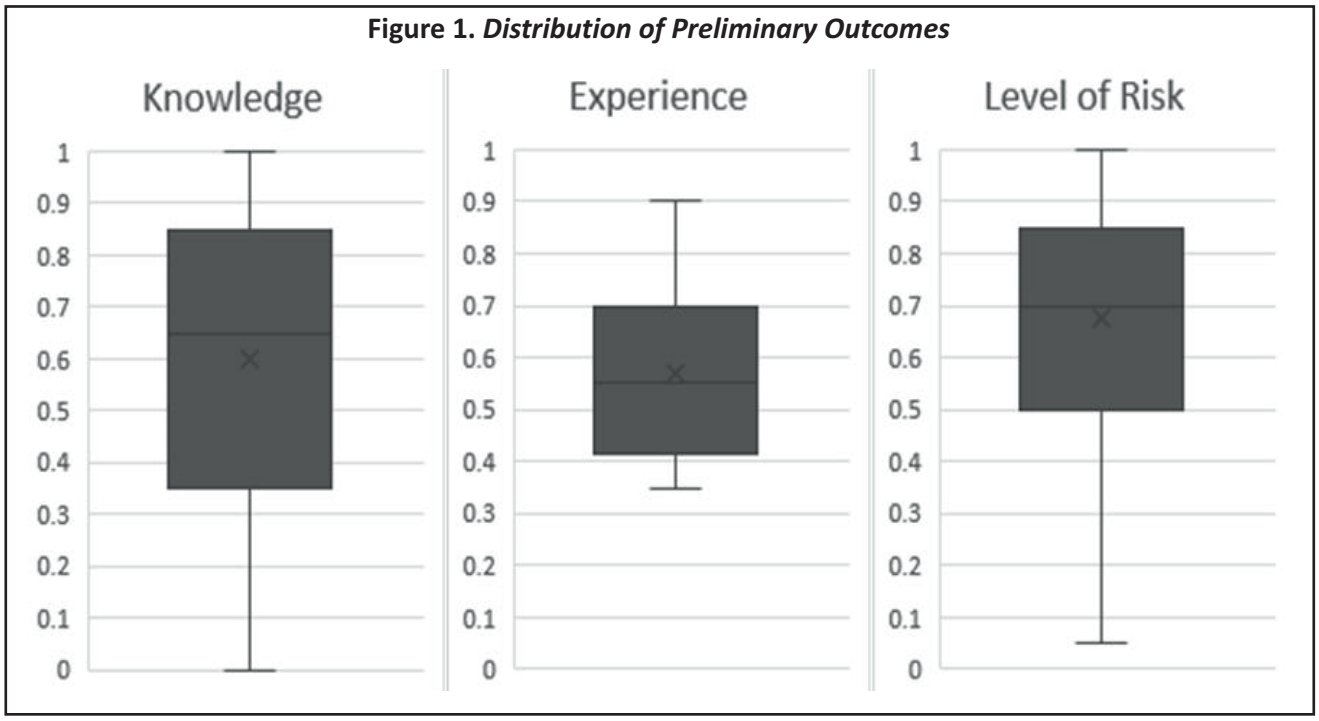
Our objective for experience design is to understand the economic market and represent almost all risk suffering levels. A preliminary questionnaire was designed to filter 300 students. Only participants who matched our selection criteria, both on demographic and scoring benchmarks, were chosen.

To adapt both knowledge and diversify characteristics, questions in the survey were divided into three groups : Knowledge about the financial institution, experience in the financial market, and level of risk.

Based on the questionnaire results, participants whose performance was not in the bottom quartile in knowledge and experience were chosen. Simultaneously, in the level of risk, we divided the distribution into 10 groups from minimum to maximum score and got 10% of each group participants. This process guaranteed both knowledge and diversification of participants who joined the experiment, as shown in Figure 1.

Finally, the experiments were conducted in 2018, with 24 participants, including 10 men and 14 women, aged between 20 – 25 years, of which half of the participants had a background in finance and the other half specialized in economical mathematics. Based on the participants' selection, we analyzed the data to conclude their behavior regarding risky gains and losses. Then we used the hypothesis tests with a confidence level of 1 – 5% to find evidence of the proposed hypotheses. The experimental method's strength is that there are no missing values. However, participants created many extraneous matters, which were processed by removing the most distant extraterrestrial values.

Figure 1. ***Distribution of Preliminary Outcomes***



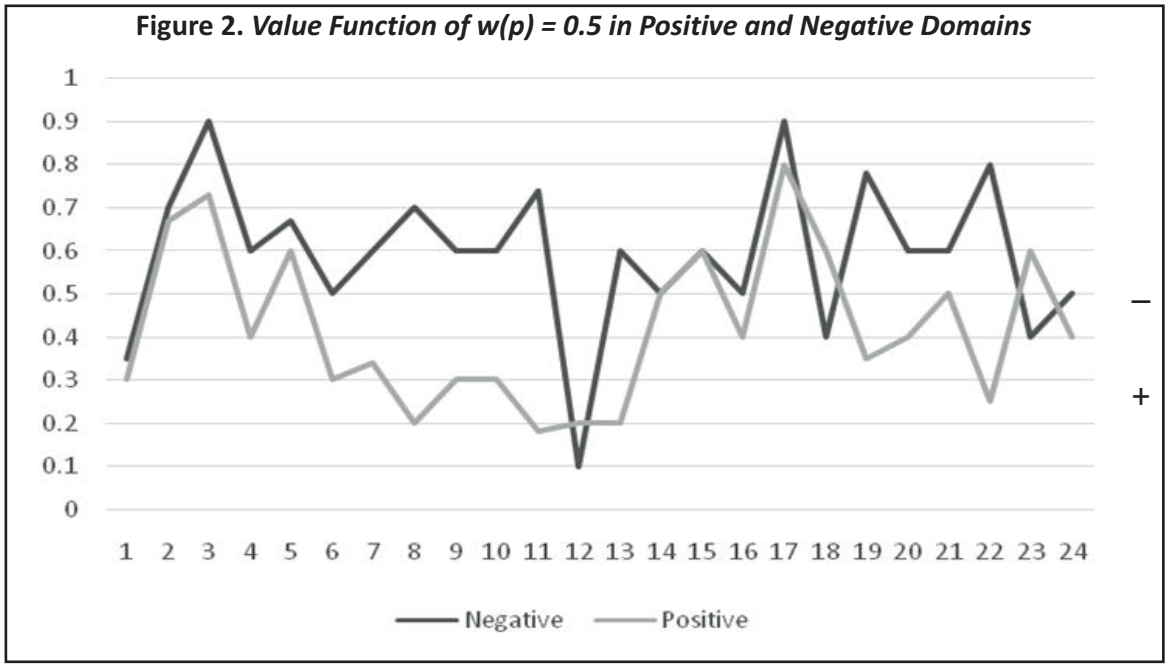
Experimental Findings

General Findings

Based on the analysis of the study, the following findings are obtained. Figure 2 depicts the p value of the weight function: $U(X, p, Y) = [U(X) + U(Y)]/2$ with abs $(X) <$ abs (Y) or p value to $w(p) = 0.5$, where p is the probability of the variable nearer to point 0.

It can be seen that almost all p values in the loss domain are more significant than in the profit domain, or $w(P_G) = w(P_L) = 0.5$, with $P_G < P_L$. P_G is the probability in the gain domain, and P_L is the probability in the loss domain. The statement is given: With the same magnitude required by the weight function, in the loss domain, participants tend to choose the probability value of the event nearer to the point of safety (point 0) than in the gain domain. This is in line with the theory of loss aversion in assuming that people tend to defend in the loss and speculate in the profit domain.

Figure 2. ***Value Function of w(p) = 0.5 in Positive and Negative Domains***



Figures 3 and 4 illustrate the value function of the two groups of students participating in the experiment; the student groups had a financial background and a mathematical economics background.

In general, it can be inferred from Figures 3 and 4, that both groups of students yield a slope value in the negative domain than the positive domain. However, the point of change in slope (the reference point) does not point 0, but deflects the positive. This is in line with our research question on the dot-and-dense division. The test section will verify the position of the change between convex and concave above.

Statistical Tests

(1) Convexity of the Value Function : The main research question of the paper is about the location of the reference point. We claim that the "zero" point belongs to the positive domain instead of point 0. To test the construction of

Figure 3. ***Value Function for Participants with a Finance Background***

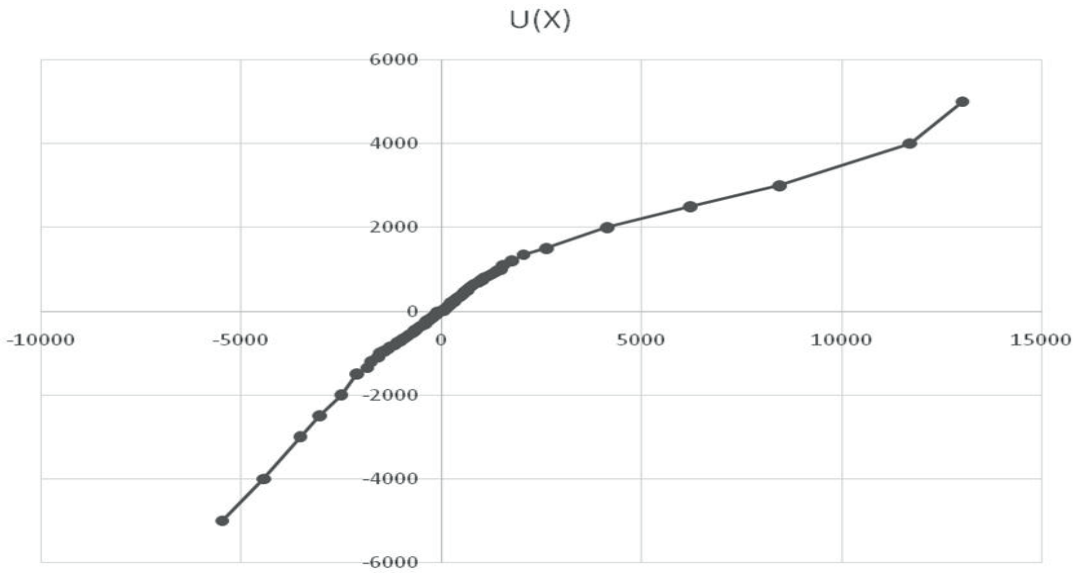
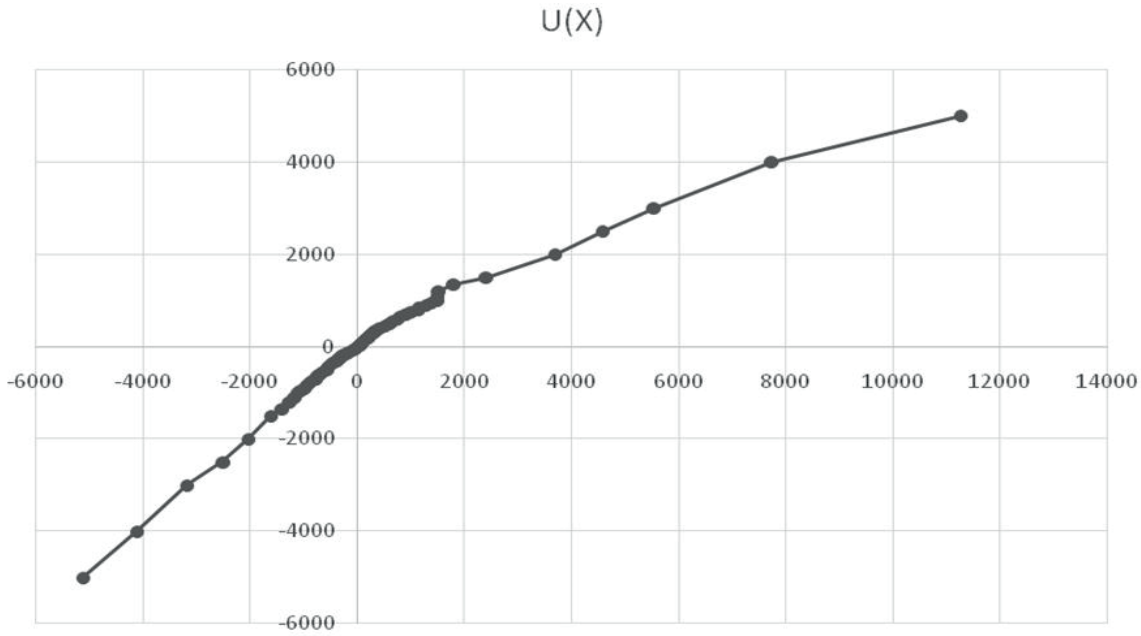


Figure 4. ***10 Value Functions for Participants with an Economical Mathematics Background***



the variable $D(X) = Abs(U(-X) / U(X))$. The test is conducted for the hypothesis that $D(X) > 1$ against $D(X) < 1$ (H_{01} and H_{a1}). If it is successfully rejected, it shows that $D(X) < 1$ and the change in positive function is positive. Table 2 shows the p - value for the hypothesis $D(X) > 1$.

With X ranges from 200 to 2000 (with high frequency of value functions in Figures 3 and 4), $D(X)$ represents

Table 2. ***Hypotheses Testing for D(X) > 1***

D(X)	*p* - value
D(200)	0.0048
D(400)	0.0434
D(600)	0.7303
D(1000)	0.8925
D(2000)	0.9983

convexity of value functions. With a confidence level of 1%, we can reject the hypothesis $D(X) < 1$ with $D(200)$ so that there exists a point $U(200)$ where the slope is steeper than $[U(-200), 0]$, supporting H_{01}. From this argument, it can be concluded that the change in the slope of the deviation function lies in the positive domain, not the negative one.

(2) Loss Aversion Average Values : The summarization in Table 3 concludes that the mean value of loss aversion (LA) is similar to what was obtained in previous studies. The calculation of $LA = Abs(U(-x)/U(x))$ shows the comparison of risk and return in absolute terms, while $LA = Abs(U'(-x)/U'(x))$ illustrates the comparison risks and profits when there is an increase compared to the original level. The higher the score, the more likely it is that a participant will be afraid of losing when they have an initial amount of money than a score of zero.

To compare the loss aversion level between Vietnam investors and others, LA is calculated, and H_{02} and H_{a2} are tested. From the regression result, the p_value is 0% in the sample with 168 cases, which shows that this test cannot reject H_{02}. Based on the analysis, we conclude that Vietnam investors are more careful than investors elsewhere.

(3) Correlation Between Loss Aversion and Other Behavioral Biases : In Table 4, the correlations between loss aversion and other biases, including overconfidence, overreaction, and anchoring are depicted.

From Table 4, the following inferences are found :

↳ In general, participants with high levels of loss aversion will have a lasting impression of a past event, even if it does not affect the present, and react calmly with sudden fluctuations in financial control.

↳ Students with a financial background had a higher degree of association between risk tolerance and association from past losses than the rest of the respondents, indicating a greater degree of caution and not being affected by behavioral factors.

Table 3. ***Findings About Loss Aversion Values***

Author	Method	Result
Fishburn & Kochenberger (1979)	*Abs(U'(−x)/U'(x))*	4.8
Bleichrodt et al. (2001)	*Abs(U(−x)/U(x))*	2.17
Pennings & Smidts (2003)	*Abs(U'(−x)/U'(x))*	1.81
Schmidt & Traub (2002)	*Abs(U'(−x)/U'(x))*	1.43
This Research*	*Abs(U(−x)/U(x))*	1.29
	Abs(U'(−x)/U'(x))	2.14

Note. * - Raw data are presented in the Appendix.

Table 4. ***Results of Participants with (a) Finance Background and (b) Economical Mathematics Background***

	Overconfidence	Overreaction	Anchoring
U(200)	0.2315	−0.2511	−0.0352
U(400)	0.0672	−0.1878	0.2971
U(600)	0.1205	−0.0845	0.4236
U(1000)	0.2571	−0.2177	0.3872
U(2000)	0.1849	−0.4804	0.3786

Note. Above are results of students with a finance background.

	Overconfidence	Overreaction	Anchoring
U(200)	0.1172	−0.0032	0.3658
U(400)	0.1978	0.0770	0.4592
U(600)	0.1744	0.1182	0.4844
U(1000)	−0.0287	0.0047	0.8128
U(2000)	−0.4848	−0.4541	0.5562

Note. Above are results of students with an economical mathematics background.

- There is no clear connection between overconfidence and risk aversion.
- The *p*_value of hypothesis H_{03} is 11.41%, which means we cannot reject the null hypothesis H_{03}.

Conclusion and Implications

Experimental results have contributed in providing evidences for the initial research questions: the reference point of utility curve is in the positive domain, the value of loss aversion is estimated, and the relationship between loss aversion and other behavioral biases is found.

Research results show that when profitability is low, participants should favor more concrete expectations than riskiness, expressed by the reference point lying in the positive domain. This only exists at low-profit expectations ; as expectations increase, participants expected higher risk and profit opportunities. It is in line with the fact that in Vietnam, individual investors are willing to take the risk even in the case of positive returns, provided that the amount of investment is small enough.

The estimated loss aversion rate for Vietnamese applicants is 1.29 and 2.14, corresponding to the two methods described. This is consistent with previous theoretical studies. The study also shows that applicants showed a higher degree of risk aversion if starting from a positive-sum of money than a starting point of an empty account. This is in line with behavioral finance's theoretical assumptions that people become more loss-averse if they have more to lose.

There is a correlation between the risk aversion of a participant and the behavioral bias from anchoring and overreacting, while overconfidence bias is not strongly correlated with risk aversion. This can be explained by the fear of risk being the result of past action, and affecting investor psychology when deciding on pressure, creating the overreaction needed. Meanwhile, confidence does not positively or negatively impact a participant, which is not really in line with previous studies about the Vietnamese market condition.

One important contribution of the study is the usage of experimental approach. This is the most advanced method for studying behavioral finance but has not yet been properly employed in Vietnam. This research has

been designed experimentally to measure the behavioral variables in the study of the disposition effect and the extension of the correlation of prospect theory with other behavioral biases, which makes prospect theory closer and more explanatory to the psychology of investors.

Limitations of the Study and Scope for Further Research

Besides the above advantages, the research has some shortcomings, such as :

- Limited number of respondents participated in the study due to the nature of research method and selection process.
- A full study of the relationship between behavioral bias and loss aversion has not yet been studied.
- The impact of the weight function on risk aversion effect has not been studied extensively.

Future research orientations can expand the advantages and overcome the disadvantages so that prospect theory can be more extensively examined and bring out practical implications in the Vietnamese investment environment in the coming time.

Authors' Contribution

The following tasks were assigned to each of the authors :

Dzung conducted the following parts : Started the idea and methodology for the whole project as well as guided and reviewed the final reports ; Literature review ; Methodology ; and Host experiment session.

Tung contributed to the project as follows. Methodology : Built the environment for examining the participants (in VBA Excel) and built fomular to measure value function ; conducted statistical tests for the Findings and Conclusion.

Van was in charge of the Introduction section, General Findings, and report preparation.

Thanh improved the literature review. She also proofread and contributed to finalizing the manuscript.

Conflict of Interest

The authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest, or non-financial interest in the subject matter, or materials discussed in this manuscript.

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Appendix

***Y* value of value function, *U*(*Y*) = *X*.**

From Students Who Had a Background in Finance						
	1	**2**	**3**	**4**	**5**	**6**
–4000	–1400	–5000	–8000	–2400	–6000	–2500
–3000	–1000	–4200	–6000	–1850	–4600	–1900
–2000	–600	–3000	–3000	–1550	–3200	–1150
–1000	–285	–950	–1150	–775	–1250	–580
–600	–200	–620	–710	–540	–730	–375
–400	–180	–470	–400	–375	–430	–210
–200	–110	–130	–123	–120	–140	–110
0	0	0	0	0	0	0
200	228	137	198	140	100	140
400	490	325	550	345	225	290
600	680	610	650	525	295	420
1000	940	900	1190	825	550	630
2000	1400	1700	1550	1400	1010	1180
3000	1700	1900	1950	1750	1600	1450
4000	1990	2150	2200	2100	1800	1700
	7	8	9	10	11	12
–4000	–2200	–5400	–2500	–5500	–2400	–6000
–3000	–1550	–3900	–2000	–3950	–1700	–4200
–2000	–940	–2600	–1200	–2500	–1200	–3030
–1000	–610	–870	–650	–670	–650	–1150
–600	–510	–525	–450	–370	–450	–630
–400	–260	–348	–225	–250	–325	–350
–200	–130	–115	–120	–120	–110	–90
0	0	0	0	0	0	0
200	60	195	200	275	200	220
400	190	470	300	490	400	420
600	240	670	400	690	600	580
1000	340	930	600	1050	1000	840
2000	690	1600	1000	1650	1990	1500
3000	970	1800	1500	1900	3000	1800
4000	11150	2200	1800	2200	3900	2200
From Students Who Had a Background in Economical Mathematics						
	1	**2**	**3**	**4**	**5**	**6**
–4000	–3840	–4840	–3800	–4840	–4240	–4840
–3000	–2840	–3440	–2800	–3640	–2720	–3440
–2000	–1920	–2120	–1960	–2520	–1790	–2320
–1000	–900	–920	–872	–1080	–840	–920
–600	–500	–526	–495	–550	–516	–520
–400	–320	–345	–315	–340	–340	–330
–200	–140	–145	–132	–140	–156	–140

0	0	0	0	0	0	0
200	220	245	220	230	184	220
400	400	436	388	410	350	410
600	520	552	505	540	450	550
1000	800	870	770	900	680	840
2000	1600	1720	1420	2320	1340	1940
3000	2560	2560	1860	2960	1680	2380
4000	3400	3400	2200	3600	1960	2800
	7	8	9	10	11	12
–4000	–3500	–3640	–4840	–5240	–3640	–4840
–3000	–2580	–2740	–3440	–3840	–2680	–3440
–2000	–1800	–1920	–2320	–2520	–1860	–2720
–1000	–880	–874	–1120	–910	–980	–840
–600	–540	–540	–540	–520	–540	–480
–400	–320	–346	–328	–332	–330	–314
–200	–140	–160	–140	–145	–155	–142
0	0	0	0	0	0	0
200	212	200	220	230	215	225
400	380	365	408	412	410	400
600	484	465	560	530	540	540
1000	728	690	1080	1080	870	774
2000	1360	1250	1920	2920	1980	1660
3000	1660	1520	2560	4160	2760	2200
4000	2160	1790	3400	5600	3600	2800

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