

Paper:

# A Study on How Investors Decide on Socially Responsible Investments: Classification of Investment Behavior According to Companies' Environmental Activities

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**Environmental problems must be solved urgently, and sustainable production activities are desired. This study focuses on environmental finance, which is a method of promoting sustainable corporation activities. Environmental finance allows socially responsible investment to directly contribute to corporate activities and sustainable production activities. To clarify the mechanism of eco-friendly investment decision making, 4,843 respondents took a questionnaire survey on investment decision making, based on the framework of prospect theory. The results showed that prospect theory did not always work for environment issues and that people's attitudes when they decide on eco-friendly investments could be classified to four clusters.**

**Keywords:** socially responsible investment, questionnaire survey, cluster analysis, prospect theory, cognitive bias

## 1. Introduction

Global warming, the loss of biological diversity, the use of exhaustible resources, and other environmental problems should be solved urgently. To do this, design and production activities which focus on sustainability are needed, not only with technological approaches (e.g. Fargnoli et al. [1], Masui [2]) but also with socioeconomic ones. Studies focusing on the socioeconomic aspects include scenario analyses of product life-cycles (Kishita et al. [3], Fukushige et al. [4]), analyses with simulators (Hiraoka et al. [5]), case studies of eco-business (Kondoh et al. [6]), business model planning studies (Nakamura et al. [7]), and various other studies. At the same time, the aspect of the finance market also needs to be considered. In general, technological development and business that emphasize the environment often

require larger amounts of capital. Sustainable production activities are therefore difficult without the efficient securing of capital.

Environmental finance has received attention as a way of encouraging investors that consider the environment to voluntarily make investments and internalize the environmental problems in the finance market. Environmental finance is an approach to utilizing the examination and evaluation process of finance to handle various environmental problems in an efficient, rational, and smooth way and to find appropriate solutions. So it encompasses various market-based instruments that internalize environmental quality or risk [8]. This approach has the advantage of directly influencing corporations since it does not always need international agreement on a regulation framework. If the corporations that actively conduct technological development and production activities that target environmental problems can attract investment through environmental finance, this can directly contribute to these activities.

One of the practical applications of environmental finance is Socially Responsible Investment (SRI), which is investment based on the evaluation of not only ordinary financial data, such as yield and stability, but also on the investment destination and its relation to environmental and social problems [9]. According to Reneboog et al. [10], the assets under management in SRI portfolios have reached 2.3 trillion dollars in the US and 1.4 trillion dollars in Europe. According to the Socially Responsible Investment Forum [11], the SRI market in Japan reached 900 billion yen in 2007, more than 75% of which was environment-related SRI. The UNEP Statement by Financial Institutions on Environment & Sustainable Development [12] states, "Identifying and quantifying environmental risks should be part of the normal process of risk assessment and management." It goes on to say, "We encourage the financial services sector to develop products and services which will promote environmental protection," emphasizing that the financial busi-

ness needs to involve environmental risks in products and services (as a part of credit risk).

The motivation of SRI early on was an ethical one, and a corporation or business field unacceptable from the concept of values or a sense of ethics was excluded as an investment destination. Later, SRI was linked to environmental and social problems, and the motivation changed to the thought that one reward of investment should be the realization of a better society [9]. Studies on SRI include one by Geczy et al. [13], who used traditional finance theory CAPM for demonstration and analysis. They found that an SRI fund achieved a higher Sharpe ratio, or the proportion of the return of the portfolio to the risk, than a non-SRI fund. So the study implies the possibility of effective asset management. Bollen [14] compared investors' cash flow into SRI funds and into traditional funds. It was found that the utility function of the investors had two attributes, economic reward and social reward. Consolandi et al. [15] used an economics experiment method to find what portfolio allocation people chose when given information on the social responsibility of corporations. They found that examinees focused not only on economic performance but also other factors. There have been many studies on how economic performance affects investors' decision making, but there have been few on how corporations' social achievements affect investors' decision making. What investors prefer or how they make decisions in terms of the economic and social aspects of SRI is still not fully understood. If this issue were clarified, production activities that contribute to social sustainability would receive financial support, and guidelines for related social systems would be established.

This study aimed to clarify the investment decision making mechanism of environmental finance by applying the prospect theory framework, a theory of decision making under risk and uncertain circumstances, to SRI decision making problems with particular attention to environmental issues. Details of the prospect theory will be given in the next section. We designed and conducted a questionnaire survey asking about investment decision making designed within the framework of the theory, analyzed people's investment decision making with the environmental factors taken into account, and classified their investment activities by clustering. By analyzing the results obtained, we investigated what kind of financial products were preferred by investors in the SRI market.

This paper is organized as follows. Section 2 explains the prospect theory, the theory on which this study is based. The questionnaire survey designed within the framework of the theory is explained in section 3. Section 4 is devoted to a discussion of our analysis of the survey results. Conclusions are given in section 5.

## 2. Prospect Theory

Since Kahneman and Tversky [16] proposed the prospect theory as a theory of decision making in risk and

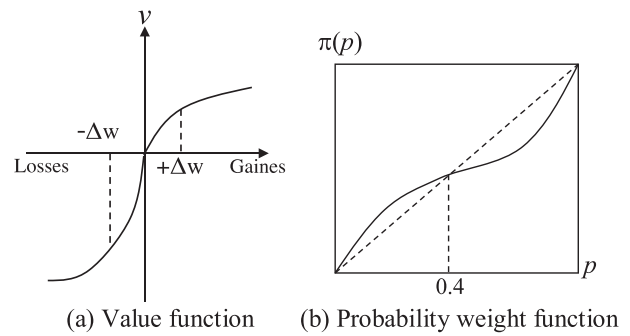


Fig. 1. Prospect theory.

uncertain circumstances, it has become widely known and considered to be able to explain various decision making phenomena. It can be applied in many situations in financial markets in particular [17, 18]. There is also a field of study called behavioral finance [19], where the theory is applied to finance. In this study, the prospect theory was used to design a questionnaire on decision making with attention to SRI. In what follows, we first explain the prospect theory briefly.

The prospect theory [16] is a theory of decision making under risk and uncertain circumstances. It can clearly explain human behaviors that are treated as counterexamples in the traditional expected utility hypothesis [20]. For example, suppose we can draw lots to receive 500 yen at a probability of 0.5 or lose 500 yen at a probability of 0.5. In the expected utility hypothesis, drawing lots (expected payoff of 0) and not drawing lots (payoff of 0) are considered to be indifferent. However, many people decide not to draw lots in this case. In the prospect theory, the decision is made based on a value function, which expresses subjective value as a function of the gains or losses of the decision maker. Fig. 1(a) shows the value function with the horizontal axis representing gains/losses and the vertical axis representing the value  $v$ . One can see in the figure that if the amount of possible gain and that of possible loss are the same, the loss will receive more emphasis, as the function has a steeper slope on the loss side. The above example of the lots can be explained by this function. The value function also represents people's tendency to avoid risks for gains (concave function on the positive side) and emphasize risks for losses (convex function on the negative side). Another important point is that people's probability evaluation is weighted with the curve given in Fig. 1(b). The figure means that people tend to overestimate small probability events and to underestimate high probability events. This curve is called the probability weight function.

Later, Tversky et al. [21] generalized the paper [16] they published in 1979, in which qualitative discussions were given. They formulated a cumulative prospect theory so that the value function and the probability weight function could be simultaneously expressed in a theoretical framework. The formulation was given in the following form. Let  $S$  be a finite set of possible states and  $X$  be a set of results. For simplicity,  $x \in X$  is considered as

monetary gain/loss. Uncertain event  $f$  is a mapping from a state  $S$  to a result  $X$ , and  $f$  is presented as  $(x_i, A_i)$ , where  $A_i$  is one of the parts partitioned from the set  $S$ . In other words,  $(x_i, A_i)$  means that when  $A_i$  arises,  $x_i \in X$  arises as a result.  $x_i$  is defined so that it always satisfies  $x_i > x_j$  when  $i > j$ . Now,  $f$  is classified as  $f^+$ , which yields a positive result, or  $f^-$ , which yields a negative result. If an uncertain event  $f = (x_i, A_i)$  lies in the range  $-m \leq i \leq n$ , the evaluation value  $V(f)$  of  $f$  is given by the following formula.

$$V(f) = V(f^+) + V(f^-), \quad \dots \dots \dots (1)$$

$$V(f^+) = \sum_{i=0}^n \pi_i^+ v(x_i), \quad V(f^-) = \sum_{i=-m}^0 \pi_i^- v(x_i),$$

where  $v$  is a mapping  $v: X \rightarrow \mathbf{R}$  and  $\pi_i^+$  and  $\pi_i^-$  are defined by the following.

$$\pi_n^+ = W^+(A_n), \quad \pi_{-m}^- = W^-(A_{-m}), \quad \dots \dots (2)$$

$$\pi_i^+ = W^+(A_i \cup \dots \cup A_n) - W^+(A_{i+1} \cup \dots \cup A_n),$$

$$0 \leq i \leq n - 1,$$

$$\pi_i^- = W^-(A_{-m} \cup \dots \cup A_i) - W^-(A_{-m} \cup \dots \cup A_{i-1}),$$

$$1 - m \leq i \leq 0.$$

Here,  $W$  is an extended concept of the capacity by Choquet [22] and defines a mapping from  $A \subset X$  to a real value in the range  $[0, 1]$ , satisfying  $W(\phi) = 0$  and  $W(S) = 1$ . It also satisfies  $W(A) \geq W(B)$  when  $A \supset B$ .  $W^+$  and  $W^-$  are  $W$ s classified according to  $f^+$  and  $f^-$ . For simple random events such as lots, where the probability of the occurrence of  $A_i$  is  $p_i$ , the above equations can be rewritten by setting  $A_i = p_i$ .

Tversky et al. [21] proposed in a paper specific function forms such as

$$v(x) = \begin{cases} x^\alpha & (\text{if } x \geq 0) \\ -\lambda(-x)^\beta & (\text{if } x < 0) \end{cases} \quad \dots \dots (3)$$

$$W^+(p) = \frac{p^\gamma}{(p^\gamma + (1-p)^\gamma)^{\frac{1}{\gamma}}}, \quad W^-(p) = \frac{p^\delta}{(p^\delta + (1-p)^\delta)^{\frac{1}{\delta}}} \quad \dots \dots \dots (4)$$

and estimated the parameters of the above equations to be  $\alpha = \beta = 0.88$ ,  $\lambda = 2.25$ ,  $\gamma = 0.61$ , and  $\delta = 0.69$ , based on several experiments with examinees.

It was shown that the prospect theory could be applied not only to the financial markets but also to various uncertain situations in actual society [23]. For example, the theory was actually applied to a taxi driver's labor problem [24], health and insurance [25, 26], and bets at a horse race [27, 28]. On the other hand, it has been applied less to environmental problems. Spence et al. [29] presented actual instances of environment deterioration and conducted a questionnaire survey to evaluate psychological risks, indicating some inconsistencies between their results and the prospect theory.

### 3. Questionnaire Survey

For our analysis of decision making in SRI, we conducted a questionnaire survey. The questions were designed within the framework of the prospect theory. An abstract situation involving investment decision making was assumed, and questions related to virtual stock investment and environmental awareness were asked.

In the questions on virtual stock investment, the environmental performance of a corporation was presented in terms of annual CO<sub>2</sub> emissions, as shown in Fig. 2, and its CO<sub>2</sub> emission forecast for the next year gave the amount as a probability event. Not only monetary gains and losses but also the CO<sub>2</sub> reduction were treated as probability events, so the prospect theory framework could be applied to the environmental awareness aspect. There were a total of 24 questions with different probabilities, gains, losses, and CO<sub>2</sub> reduction amounts. In this paper, we analyze the answers to 8 questions that assumed that both companies A and B provided the same yield. The parameter setting and answers to these questions are summarized in Table 1.

The questions on the environmental awareness include the following.

- EC1: I always try to take eco-friendly actions.
- EC2: I am not particularly interested in environmental problems.
- EC3: I think I am a rather eco-friendly person, but I do not want to pay money to solve environmental problems.
- EC4: I think corporations should reduce CO<sub>2</sub> emissions proactively.

Each respondent selected one of the following four choices as the answer to each question: "true for me," "slightly true for me," "slightly untrue for me," and "untrue for me."

The questionnaire survey was outsourced to an external survey company and conducted on the Internet from December 18 to 24, 2009. The survey targeted ordinary people in their 20 s to 60 s, and it was answered by 2,961 males and 1,882 females. 3,335 of the respondents had investment experience.

## 4. Results

### 4.1. Comparison to Prospect Theory

First, we checked the applicability of the prospect theory to making decisions about environmental issues. Table 1 presents the results of the questionnaire survey and Table 2 shows the forecast that prospect theory yields applied to CO<sub>2</sub> reduction and the actual results of the questionnaire survey. The second column of Table 2

You are thinking to invest 1 million yen to the stocks of company A or company B. Both companies emitted 10 million tons of CO<sub>2</sub> this year. Their investment yields and environmental efforts are shown below. To which do you want to invest your money? Choose one. There is no choice of not choosing any.

© Company A

Yield of investment

It is expected that investment of 1 million yen will produce a profit of 100,000 yen.

Environmental effort

The CO<sub>2</sub> emission in the next term is expected to be 8 million tons with 2 million tons reduced at 60% probability and 12 million tons with 2 million tons increased at 40% probability.

© Company B

Yield of investment

It is expected that investment of 1 million yen will produce a profit of 100,000 yen.

Environmental effort

In the next term, the company will keep the current performance, emitting 10 million tons of CO<sub>2</sub> with no increase or decrease.

(a) Actual questions

Q	A	B	Yield	Env. Effort
Q1	At 100% 100,000 yen	At 100% 100,000 yen	At 60% Minus 2 million t	At 40% Plus 2 million t
	At 100% 100,000 yen	At 100% 100,000 yen	At 100% ±0	
Q2	At 100% 100,000 yen	At 100% 100,000 yen	At 60% Minus 2 million t	At 40% Minus 4 million t
	At 100% 100,000 yen	At 100% 100,000 yen	At 100% Minus 2.5 million t	
Q5	At 100% 100,000 yen	At 100% 100,000 yen	At 40% Minus 2 million t	At 60% ±0
	At 100% 100,000 yen	At 100% 100,000 yen	At 30% Minus 3 million t	At 70% ±0
Q6	At 100% 100,000 yen	At 100% 100,000 yen	At 100% Minus 2 million t	
	At 100% 100,000 yen	At 100% 100,000 yen	At 75% Minus 3 million t	At 25% ±0
Q10	At 100% 100,000 yen	At 100% 100,000 yen	At 60% Plus 2 million t	At 40% Plus 4 million t
	At 100% 100,000 yen	At 100% 100,000 yen	At 100% Plus 2.5 million t	
Q15	At 100% -100,000 yen	At 100% -100,000 yen	At 60% Minus 2 million t	At 40% Plus 2 million t
	At 100% -100,000 yen	At 100% -100,000 yen	At 100% ±0	
Q16	At 100% -100,000 yen	At 100% -100,000 yen	At 60% Minus 2 million t	At 40% Minus 4 million t
	At 100% -100,000 yen	At 100% -100,000 yen	At 100% Minus 2.5 million t	
Q22	At 100% -100,000 yen	At 100% -100,000 yen	At 60% Plus 2 million t	At 40% Plus 4 million t
	At 100% -100,000 yen	At 100% -100,000 yen	At 100% Plus 2.5 million t	

(b) List of parameters in the questions

Fig. 2. Question examples and parameter setting.

Table 1. Conditions assumed in the questions and list of answers. (\* indicates a significance level of 5%, and \*\* indicates 1%.)

Q	Company	Economic performance	Environmental performance	Answer result <sup>3</sup>	p-value	Expected value of CO <sub>2</sub> reduction <sup>2</sup>
		Yield <sup>1</sup>	Prob CO <sub>2</sub> abilit y <sup>2</sup>			
1	A	100	0.6 2 0.4 -2	58.8%**	0.937%	0.4
	B	100	1 0	41.2%		
2	A	100	0.6 2 0.4 4	47.7%*	4.33%	2.8
	B	100	1 2.5	52.3%		
5	A	100	0.4 2 0.6 0	49.2%	56.4%	0.8
	B	100	0.3 3 0.7 0	50.8%		
6	A	100	1 2	62.7%	14.9%	2
	B	100	0.75 3 0.25 0	38.3%		
10	A	100	0.6 -2 0.4 -4	34.8%**	0.00%	-2.8
	B	100	1 -2.5	65.2%		
15	A	-100	0.6 2 0.4 -2	59.1%**	0.15%	0.4
	B	-100	1 0	40.9%		
16	A	-100	0.6 2 0.4 4	48.9%**	0.389%	2.8
	B	-100	1 2.5	51.1%		
22	A	-100	0.6 -2 0.4 -4	34.4%**	0.00%	-2.8
	B	-100	1 -2.5	66.6%		

<sup>1</sup> Unit: 1,000 yen

<sup>2</sup> Unit: 1 million ton

<sup>3</sup> Percentage of respondents who chose the same answer.

presents the values calculated using Eq. (1), the cumulative prospect theory, with Eqs. (3) and (4). The choice that yields the higher evaluation value is given in the third column. The fourth column of the table shows which company, A or B, respondents chose more with a significant difference in a chi-squared test. For example, for question 1 in Table 2, the prospect theory indicates that the respondents tend to have a stronger awareness of damage by the CO<sub>2</sub> emission increase than of benefit by the decrease, and they would therefore choose company B. However, the survey shows the opposite: company A was chosen by more respondents, and the difference was statistically significant. Although some of the answers to the questions matched the theory's forecast, the results of the questionnaire did not coincide with those predicted by the theory in many cases. It has been said that the prospect theory could be also applied to decision making events unrelated to money in an uncertain situation, but the present study shows that the prospect theory cannot fully explain people's attitudes toward environmental problems, including the CO<sub>2</sub> emission risk.

**Table 2.** Forecast from prospect theory applied to CO<sub>2</sub> reduction and actual questionnaire result. (chi-squared test result)

Question number	Calculation result of Eq. (1)	Prediction by prospect theory	Questionnaire results
1	V(A)=-0.750 V(B)=0	B	A
2	V(A)=2.41 V(B)=2.24	A	B
5	V(A)=0.681 V(B)=0.837	B	No significant difference
6	V(A)=1.84 V(B)=1.40	A	A
10	V(A)=-5.50 V(B)=-5.04	B	B
15	V(A)=-0.750 V(B)=0	B	A
16	V(A)=2.41 V(B)=2.24	A	No significant difference
22	V(A)=-5.50 V(B)=-5.04	B	B

**Table 3.** Percentage of selected choices in each cluster. (\* indicates a significant difference under the significance level condition of 5%.)

Question number	Cluster 1		Cluster 2		Cluster 3		Cluster 4	
	A	B	A	B	A	B	A	B
1	92.6%*	7.4%*	1.9%*	98.1%*	84.8%*	15.2%*	11.0%*	89.0%*
2	25.5%*	74.5%*	29.5%*	70.5%*	86.3%*	13.7%*	64.9%*	35.1%*
5	56.2%*	43.8%*	45.8%*	54.2%*	48.3%*	51.7%*	31.4%*	68.6%*
6	66.3%*	33.7%*	77.1%*	22.9%*	52.8%*	47.2%*	24.7%*	75.3%*
10	34.2%*	65.8%*	15.5%*	84.5%*	48.5%*	51.5%*	59.9%*	40.1%*
15	76.1%*	23.9%*	20.4%*	79.6%*	84.1%*	15.9%*	23.4%*	76.6%*
16	22.8%*	77.2%*	22.6%*	77.4%*	94.9%*	5.1%*	88.0%*	12.0%*
22	40.9%*	59.1%*	19.0%*	81.0%*	41.5%*	58.5%*	35.8%*	64.2%*

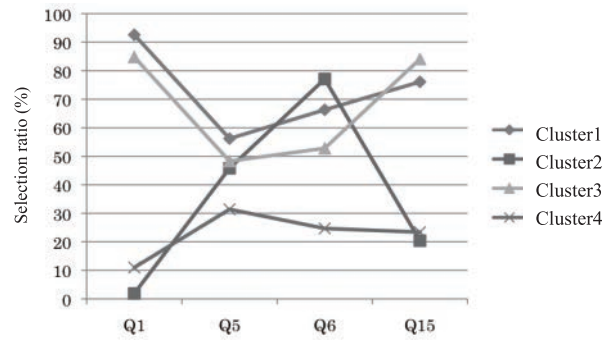
## 4.2. Cluster Analysis of Investment Activities of Investors

As shown in the previous section, it is difficult to explain people's actual evaluations of the environment in a unified form. However, there are a certain number of respondents who show the same decision-making pattern. Therefore, we use a cluster analysis to determine decision-making pattern clusters. The answers to the eight questions in **Table 1** are used as variables for the cluster analysis with a group average method.

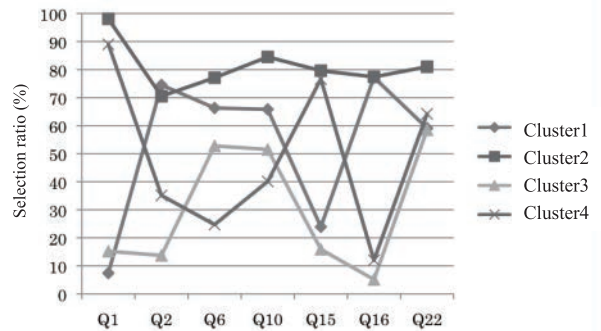
### 4.2.1. Decision Making Tendency of Each Cluster

**Table 3** shows the answers classified into four clusters. The eight questions in **Table 1** are classified into the following three groups according to their characteristics.

- Question group judging the zero-avoidance type of



**Fig. 3.** Percentage of respondents who chose to avoid zero deduction in the question group of judging zero-avoidance type.

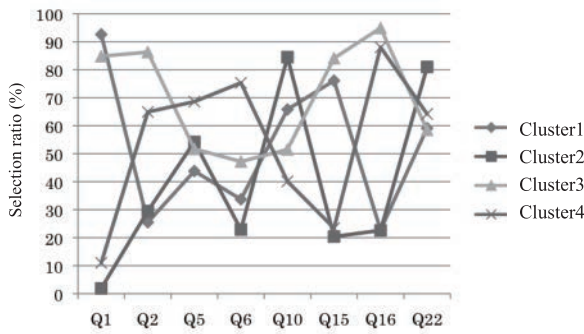


**Fig. 4.** Percentage of respondents who chose to pursue certainty in the question group of judging certainty pursuing type.

respondent (Q1,5,6,15): This is a group of questions that provide both the choice that would yield no CO<sub>2</sub> reduction and the choice that would yield a CO<sub>2</sub> reduction. By examining the decision making results based on these questions, one can judge whether a respondent chose to avoid zero reduction.

- Question group judging the certainty-pursuing type of respondent (Q1,2,6,10,15,16,22): This is a group of the questions that provide both the choice that would leave CO<sub>2</sub> reduction uncertain and the choice that would leave no uncertainty. By examining the results of decision making based on these questions, one can judge whether or not a respondent chose to avoid uncertainty.
- Question group judging rationality (Q1,2,5,6,10,15,16,22): The two choices in this group of questions have different expected values for CO<sub>2</sub> reduction. All eight questions belong to this group. By examining the decision making based on these questions, one can judge whether or not a respondent has made a rational decision according to the expected values.

**Figures 3 to 5** present the answers to the question groups. **Fig. 3** shows the percentage of respondents who avoided the zero CO<sub>2</sub> emission choice in the group of



**Fig. 5.** Percentage of respondents who chose to pursue rationality in the question group of judging rationality.

questions that judged if the respondent was of the zero-avoidance type. Specifically, it shows the percentage of respondents who chose company B in these four questions. Similarly, **Fig. 4** shows the percentage of the respondents who chose the answers (company B, B, A, B, B, B, B, respectively) with higher certainty in the CO<sub>2</sub> emission reduction in the question group that indicated the certainty-pursuing type of respondents. **Fig. 5** shows the percentage of respondents who chose the answers (company A, A, B, B, B, A, A, B, respectively) with a higher expected value of CO<sub>2</sub> reduction in the question group that indicates rationality. It was found by comparing these results that each of the four clusters has the following tendency.

- Cluster 1: Certainty-pursuing and zero-avoidance type (1651 respondents)  
In cluster 1, the number of respondents who took the zero-CO<sub>2</sub>-reduction choice was significantly large for any questions in the question group that indicated the zero-avoidance type. Also, the number of respondents who selected the high-certainty choice was significantly large in five out of the seven questions in the question group that indicated the certainty-pursuing type of respondents. More respondents selected the zero-CO<sub>2</sub>-reduction response to the other two questions. In the question group that indicated rationality, the choices of higher expected values were selected only in four out of the eight questions. These results indicate that many respondents in cluster 1 made their decisions taking into consideration not only the avoidance of the possible zero CO<sub>2</sub> reduction but also the certainty of the CO<sub>2</sub> reduction.
- Cluster 2: Certainty-pursuing type of respondents (1409 respondents)  
In cluster 2, the number of the respondents who avoided the zero-CO<sub>2</sub>-reduction choice was significantly large for only one of the four questions in the question group that indicated the zero-avoidance type of respondents. On the other hand, the number of the respondents who selected the high-certainty choice was significantly large for all seven questions in the question group that indicated the certainty-

pursuing type of respondents. However, the number of respondents who selected the rational choice was significantly high only for three out of the eight questions. These results indicate that many respondents in cluster 2 made decisions taking into consideration the certainty of the CO<sub>2</sub> reduction.

- Cluster 3: Rational selection and zero-avoidance type (1486 respondents)  
In cluster 3, the number of respondents who avoided the zero-CO<sub>2</sub>-reduction choice was significantly large for three out of four questions in the question group indicating the zero-avoidance type of respondent. The number of respondents who selected the high-certainty choice was significantly large for two out of seven questions in the question group indicating the certainty-pursuing type of respondent. The respondents made decisions according to the expected values in five out of the eight questions in the question group indicating rationality. To one (Q6) of the other three questions, the respondents put priority on the avoidance of zero CO<sub>2</sub> reduction. These results indicate that many respondents in cluster 3 made decisions not only taking into consideration the avoidance of the possible zero CO<sub>2</sub> reduction but also made decisions in a rational manner according to the expected values.
- Cluster 4: Rational selection type (299 respondents)  
In cluster 4, the number of respondents who avoided the zero-CO<sub>2</sub>-reduction choice was not significantly large for any questions in the question group indicating zero-avoidance-type respondents. The number of respondents who selected the high-certainty choice was significantly large only for three out of the seven questions in the question group indicating the certainty-pursuing-type of respondents. On the other hand, the number of residents who selected the choices of higher expected values for five out of eight questions in the question group indicating rationality was significantly large. These results indicate that many respondents in cluster 4 made decisions in a rational manner according to the expected values.

The applicability of the prospect theory to each of the above four clusters was checked. Comparing the questionnaire survey results in **Table 2** and the results for each cluster in **Table 3**, one can find that the answers to three out of the eight questions in cluster 1 were the same as those predicted by the theory while the answers to six out of the eight questions in other clusters were the same as the answers predicted by the theory (although Q10 in cluster 3 had no significant difference). However, the questions to which the respondents answered just as predicted by the prospect theory varied from cluster to cluster, so the prospect theory could not explain the answers of the respondents in a comprehensive manner, as seen in **Table 2**.

**Table 4.** Change in the ratio of choosing A when the yield changes from positive to negative under the same CO<sub>2</sub> reduction condition. (\* indicates a significant difference under the significance level condition of 5% and \*\* under the condition of 1%.)

	Cluster 1	Cluster 2	Cluster 3	Cluster 4
Q2→Q16	-3%	-7%**	+9%**	+23%**
Q1→Q15	-16%**	+18%**	-1%	+12%**
Q10→Q22	+7%**	+3%*	-7%**	-2%**

#### 4.2.2. Changes in Yield Conditions and Changes in Investment Decision Making

For three pairs in the eight questions, i.e. Q2 and Q16, Q1 and Q15, and Q10 and Q22, the difference in the decision making in each of the pairs was examined.

In each of the pairs of questions, company A had risk and company B did not, and this condition did not change from one question to the other. In each pair, the yield was assumed to be 100,000 yen at 100% in one question and -100,000 yen at 100% in the other. In other words, except for the sign of yields, the other conditions are equivalent between the two in each pair. Rational consideration would reach the conclusion that the preference for A or B should not change between the two questions. Actual change of the decision making under these conditions is shown in **Table 4**.

- Q2 and Q16  
Companies A and B had different levels of risk, but CO<sub>2</sub> emissions could surely be reduced in either case. In cluster 2, there were more answers related to avoiding risk (by choosing B), and in clusters 3 and 4 there were more answers related to preferring the risk (by choosing A). In cluster 1, there was no significant difference.
- Q1 and Q15  
Company A had the risk of increasing CO<sub>2</sub> emissions in these questions. In cluster 1, there were more answers related to avoiding risk (by choosing B), and in clusters 2 and 4, there were more answers related to preferring the risks (by choosing A). In cluster 3, there was no significant difference.
- Q10 and Q22  
CO<sub>2</sub> emissions are assumed to increase in these questions. In clusters 1 and 2, there were more answers related to preferring the risks (by choosing A), and in clusters 3 and 4, there were more answers related to avoiding the risks (by choosing B).

The results indicate that when the yield changes from positive to negative, the decisions of the investors about the risk of CO<sub>2</sub> reduction also change. The affect on their decisions varies from cluster to cluster, which is classified in section 4.2.1 and summarized in **Table 5**. For example, look at the column "Negative" in the table. Clusters 1 and

**Table 5.** Characteristics shown when yield changed from gain to loss under the same CO<sub>2</sub> reduction condition.

Environmental performance	Positive	Neutral	Negative
Cluster 1		+	-
Cluster 2	+	-	-
Cluster 3	-		+
Cluster 4	-	-	+

+: More risk averse answers

-: Less risk averse answers

(Empty): No significant difference

2 gave negative results and the clusters 3 and 4 gave positive ones. This means that, when the yield changes from gain to loss, more answers in clusters 1 and 2 preferred taking on risk but more answers in clusters 3 and 4 preferred avoiding risk. In other words, the clusters showed the decisions of the investors in terms of reducing CO<sub>2</sub> changed when the yield changed.

#### 4.3. Respondents' Environmental Awareness and Investment Decision Making

For the examination from a different viewpoint from that taken in the previous section, the respondents were asked about their awareness of the environment, and the results were used to analyze the above results related to investment decision making. Most of the socially responsible investments in Japan are eco funds [11], and most of the customers of the eco-friendly financial products can be considered to have a great awareness of environmental issues. It is therefore important to study whether investors with different levels of environmental awareness make different investment decisions.

Questions EC1 to 4 targeted the respondents' level of awareness of the environment. Those who chose the answers "true" or "slightly true" were put into the affirmative group, and those who chose the answers "untrue" or "slightly untrue" were put into the negative group. The answers to the eight questions in **Table 1** were then classified by the ECs, and the groups and the percentage difference between the two groups were examined using a test. In Q1, Q6, Q10, and Q15, the two groups in at least one of the ECs showed a significant difference in how they selected companies.

**Figures 6 to 9** show the ratio of the respondents who chose company A in Q1, Q6, Q10, and Q15. The respondents were classified by the groups which were defined by questions EC1 to 4. EC1 and 4 ask environmental awareness in the positive framework, so "true" or "slightly true" means the positive attitude. Accordingly, EC1 and 4 were given a plus (+). EC2 and 3 are opposite, so that a minus (-) was assigned to them.

**Figure 6** shows that company A in Q1 was chosen by the affirmative group at a higher rate in the ECs with a plus and by the negative group at a higher rate in the ECs with a minus. The difference between the groups was

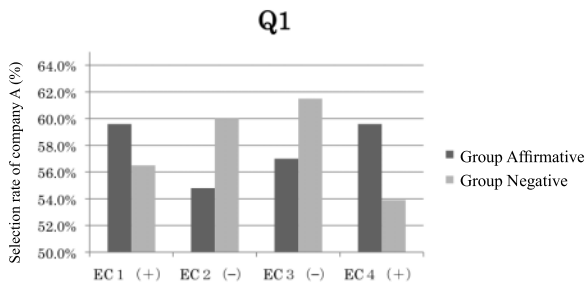


Fig. 6. Difference in selection rate of company A in Q1 between affirmative group and negative group in EC1 to 4.

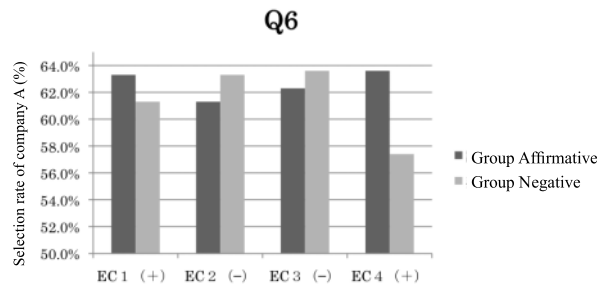


Fig. 7. Difference in selection rate of company A in Q6 between affirmative group and negative group in EC1 to 4.

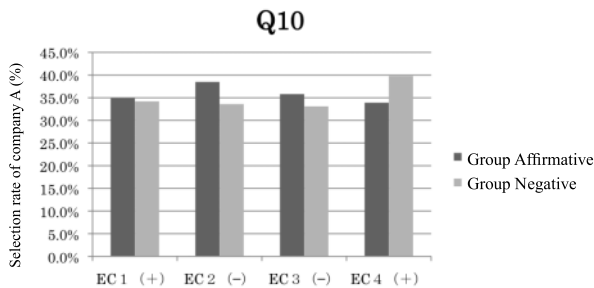


Fig. 8. Difference in selection rate of company A in Q10 between affirmative group and negative group in EC1 to 4.

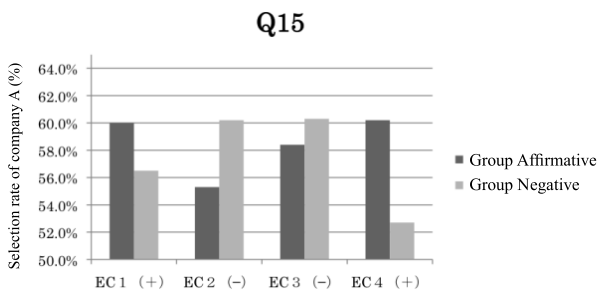


Fig. 9. Difference in selection rate of company A in Q15 between affirmative group and negative group in EC1 to 4.

significant under the significance level criterion of 5% in EC2, 3, and 4. This indicates that the group with a greater awareness of the environment chose company A in Q1 at a higher rate. Similarly, Fig. 7 shows that the group with the greater awareness of the environment chose company

A in Q6 at a higher rate, and the difference between the groups was significant under the significance level criterion of 5% in EC4. Fig. 8 shows that the group with the greater awareness of the environment chose company A in Q10 at a lower rate, and the difference between the groups was significant under the significance level criterion of 5% in EC2 and 4. Lastly, Fig. 9 shows that the group with the greater awareness of the environment chose company A in Q15 at a higher rate, and the difference between the groups was significant under the significance level criterion of 5% in EC1, 2, and 4.

A common characteristic of Q1, Q6, and Q15 was that corporation B would not reduce CO<sub>2</sub>. Therefore, the respondents who had high environment preservation awareness had a slightly stronger tendency to avoid choices that could result in no CO<sub>2</sub> reduction than did other groups. Also, in Q10, corporation B was a “less uncertain” choice than corporation A, and the respondents who were highly aware of environmental issues tended to avoid the uncertainty of CO<sub>2</sub> reduction.

The above discussion shows that the respondents who had a high level of environmental awareness showed a tendency to avoid zero CO<sub>2</sub> reduction or uncertainty in the CO<sub>2</sub> reduction in some questions, but they showed no significant difference from the other groups in many other questions. In other words, there was no sufficient evidence that clearly demonstrated the difference.

### 5. Discussion

The results in section 4.1 indicated that the prospect theory could not be applied to environmental problems. Spence et al. [29] studied the influence of environmental damage and its reduction in different frames (gain frame and loss frame) and used a questionnaire survey to investigate psychological risk evaluation, which was close to our way of thinking in this study. The survey contained questions related to the influence, and examinees were asked to answer using a psychological scale of five levels, from very positive to very negative. This was different from the decision making under risk and uncertain conditions assumed in the present study. However, in this preceding study, a more positive result was also obtained for the gain frame. Although it was not direct evidence, their result was partially different from what the prospect theory indicated. Our result thus replicates the result of this preceding study.

In section 4.2, it was found that the attitude of investors towards the uncertainty of the environmental load could be classified into four clusters. This was mostly due to the question design within the prospect theory framework. This result confirms that investors also focus on the social contributions of companies, as stated by Bollen [14] and Consolandi et al. [15]. Therefore, the present method is a kind of new way of making questionnaires, one based on the prospect theory applied to environmental issues. In addition, the result in section 4.2.2 indicates that economic performance and environmental performance are



interdependently related in the utility function of the investors. This had not been pointed out in previous studies and should be new knowledge.

In the clustering results, attention should be paid to the fact that the cluster that tended to make a rational selection according to the expected values was the smallest in scale (6.2% of all) and that there were a good number of investors who pursued higher certainty or tried to avoid companies which did not improve their contribution to the environment over the previous year. Investors would prefer an eco-friendly financial product if it were designed emphasizing the certainty to contain the shares of many companies that had tried to contribute to environmental solutions in the previous years. This viewpoint focusing on the continuity of environmental activities was quite interesting and was not taken in related studies by Bollen [14] or Consolandi et al. [15]. In section 4.2.2, it was found that the attitude of the investors toward the uncertainty of the environmental load when the yield changed from gain to loss varied depending on the clusters in section 4.2.1. In clusters 1 and 2, the respondents tended to put emphasize the certainty of reducing environmental load. When yield increased, they tended to pick choices with higher uncertainty if those choices reduced the environmental load. When the yield decreased, they tended to avoid choices with high uncertainty. In designing an eco-friendly financial product, companies that produce less environmental load would be selected through environmental screening. Therefore, the results in section 4.2.2 mean that one can assume that investors would prefer a fund designed to contain companies with lower uncertainty of environmental load reduction if the yield of eco-friendly financial products got worse or if the yield of the fund were worse than that of the others.

As stated above, environmentally friendly funds, called eco funds, are the most popular SRI in Japan. Most customers of environmentally-friendly financial products such as eco funds are those who pay great attention to environmental preservation. In section 4.3, it was not fully confirmed that the eco-minded investors had a different tendency from others in making investment decisions with emphasis on the uncertainty of environmental load. However, in some cases, the eco-minded investors tended to avoid investment destinations that would not result in any change in CO<sub>2</sub> emissions.

Compared to the certainty-pursuing behaviors or rationality-pursuing behaviors, it is more difficult to theoretically explain the tendencies of the eco-minded investors, or, in clusters 1 and 3, that the companies that had not reduced their CO<sub>2</sub> emissions in the past year were avoided as investment destinations (zero-emission-reduction avoidance). However, the tendency for respondents to consider "0" as a special number can be thought of as one of the recognition biases that have been studied in the prospect theory and behavioral finance [16]. These results indicate that people make environmental performance decisions based on heuristic evaluation. On the other hand, the companies that emitted only a small amount of CO<sub>2</sub> the previous year will not be able to fur-

ther reduce the amount despite their environmental preservation efforts, so it puts them in a disadvantageous situation when people tend to avoid zero CO<sub>2</sub> reduction. Therefore, as people tend to avoid zero CO<sub>2</sub> reduction, their decision making could change depending on the way that companies disclose their environmental data.

## 6. Conclusion

While the international community has had difficulty reaching agreement on carbon dioxide emissions reductions, it has been hoped environmental preservation would be promoted through corporations' voluntary socially responsible investment in sustainable production activities under a theme of environment friendliness. However, it has not been clarified how people prefer one of the investment results, environmental performance. In this study, a questionnaire survey was conducted to investigate how environmental performance affected the people's investment decisions. In the survey, the environmental performance of virtual companies was expressed in terms of how much CO<sub>2</sub> the companies' emitted.

The results indicated that people's investment decisions could be classified into four clusters. It was also found that investors' attitudes toward environmental load risk depended on whether the yield was positive or negative, which in turn affected their decision making. Although there was no significantly meaningful result obtained on the relation between the respondents' awareness of environmental preservation and decision making, the respondents who were more strongly aware of environmental preservation tended to avoid investment in the companies that would emit the same volume of CO<sub>2</sub> as in the previous year.

This study used a new framework applying prospect theory to environmental issues in a questionnaire survey. The results confirmed that investors also focused on the social contribution of companies, as pointed out by Bollen [14] and Consolandi et al. [15]. The results also indicated the possibility that the economic performance and environmental performance interdependently interacted in the utility function of investors. Another indication obtained from the survey results was that, in designing eco funds or other environmentally-friendly investment products, it should be taken account of that customers prefer products with higher certainty of environmental load reduction, and, if yield is poor, they prefer products with lower risk of environmental load.

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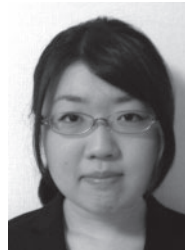
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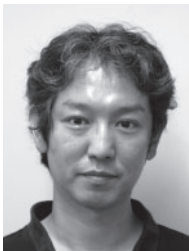
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