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Risk preference and risk perception and their interactions with risk choices in the stock market

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Abstract

This paper's main focus is on risk preference and risk perception and their interactions to the investors' risk choices. By the mean of the questionnaire, the present study collects 105 samples in total. Risk preference is measured by context-less lottery experiment and risk perception is elicited by psychometric paradigm. Moreover, investor's risk decisions are extracted from the repeated stock investment experiment to find the interactions with investors' risk preference and risk perception. The economic statuses are added in the time dimension in order to detect investor's risk choices in different circumstances. The final data would be conducted with panel regressions to verify the correctness of the hypotheses. The regression results suggest that risk preference has more impact on investor's risk selections, while risk perception has more influence on investor's risk adjustments.

Keywords: Risk preference, Risk perception, Stock market, Risk choice

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1. Introduction

The behavioral economic emerged from the late 20th century; the rationale behind individuals' actions have become popular topics in the economics field. From psychological, social to cognitive standpoints, many studies try to investigate individuals' process of thinking. There are numerous studies researching the topic of risk preference and risk perception. However, these studies show little interests in the interactions between risk preference and risk perception. Risk preference was first found in 1738 by Bernoulli; he studied human decision-making process under uncertainty. Later studies focus on the probabilities of situations and people's tendency of choices. The most prestigious theory is the *prospect theory* proposed by Kahnman and Tversky in 1979, investigating individuals' decisions when the probabilities of all outcomes are known. On the other hand, risk perception has developed from different directions. Two of the most well-known theories are *psychometric paradigm* and *culture theory*. *Psychometric paradigm* was proposed by Slovic in 1992, which focuses on the role of emotions influence on people's risk perception. In addition, *culture theory* was first published by Douglas and Wildavsky in 1982, which mainly concentrates on the cultural background, the main distinction of people's risk perception.

Until this point, risk preference and risk perception's interactions did not receive many academic attentions; most of the studies conduct the researches upon these two concepts separately. Weber and Milliman have conducted a repeated financial investment decisions experiment in 1997, which finally has collected risk preference and risk perception data together and investigated the relations to the investors' risk decisions in the stock market. The present study designs the questionnaire based on Weber and Milliman's experiment, along with the risk preference elicitation method from *prospect theory* and risk perception detection method from the *psychometric paradigm*. Compared to Weber and Milliman's experiment, the present study focuses on bigger sampling by use of an online questionnaire. With bigger sampling, the present study expects to see more significant results.

The main research question in the present study is: How do individual investors react in the stock market based on their risk preferences and risk perceptions? To this end, the hypotheses are set as follow:

1. Risk preference has more influence on investors' risk selection compare to risk perception and
2. Risk perception has more influence on investors' risk adjustment compared to risk preference

The results will be investigated by way of panel regressions, and the rest of the paper is organized as follows. Section 2 describes the past literature review regarding risk preference, risk perception and their interactions with investors' risk decisions, and state the hypotheses. Section 3 shows the research methodology including the design of the questionnaire. Section 4 summarizes the collection of data and data summary. Section 5 presents the results of the study and makes the conclusion in section 6. Section 7 comprises of the necessary appendices.

2. Theory and Hypotheses

2.1. Literature Review

Lots of studies research the concept of risk preference and risk perception. However, how individuals' risk preferences and risk perceptions affect their risky choices are rarely the main researching topic. More specifically, the present study focuses on how investors' risk preferences and risk perceptions would affect their risky choices in the stock market. To start, this paragraph illustrates why to choose risk preference and risk perception as independent variables instead of other variables. Wen et al. (2014) study the effects of prior outcomes on risky choices in the stock market. They point out that the prior gains and losses will induce changes in individuals' current risk attitudes toward different risky choices. However, as suggested by *Sitkin and Pablo (1992)* and Weber and Milliman (1997), prior outcome history would act as a situational variable to affect on investors' risk perceptions first, then have the impact on investors' risk choices. Also, Knetsch (1989) finds out that subjects' exhibited perceptions and preferences varied systematically with their initial reference entitlements in this experiment. This indicates that the endowment effect would be incorporated into the effect from risk perception and risk preference. Therefore, the present study adopts prior outcome history and endowment as situational variables to affect risk perception. And further, the present study analyzes the influence of risk perception on risky choice.

Baker and Wurgler (2007) set the investor sentiment as the independent variable and find the correlation to the risky choices investors made in the stock market. However, as mentioned by Baker and Wurgler, their investor sentiment approach faces a number of challenges: it cannot characterize and

measure uninformed demand or investor sentiment or understanding the foundations and variations in investor sentiment over time. Hence, the present study set risk preference and risk perception as independent variables to investors' risky choices in the stock market further.

As the independent variables are set, the differences between risk preference and risk perception become crucial in the present study. These two notions are easily confused and yet have drastic different characteristics. The following section addresses the detailed definitions of risk preference and risk perception.

2.1.1. Risk Preference

Dyer and Sarin (1982) define risk preference as relative risk attitude, which was first raised in the expected utility framework. *Expected utility theory* was proposed by Daniel Bernoulli (1738), which summarizes the expected utility taking the weighted average of all the possible outcomes under certain circumstances (such as the size of the payout or different situations), while the weight being sorted by the probabilities of any particular event might occur.

In the expected utility framework, risk preference is referred as risk attitudes which are derived from people's choices. Risk preference can describe the shape of the utility function derived from a series of choices. This means in the expected utility model, the curvature of the utility function u(x) reflects whether decision makers are risk averse (a concave utility function) or risk seeking (a convex utility function). Most of the individuals' utility functions appear to be concave, meaning most of the individuals are risk averse. When individuals are more willing to put money into bank accounts to receive meager interests, instead of investing in stocks or real estate market to get higher but risky dividends, they are defined as risk averse. Individuals with risk neutral preference would weigh the expected outcomes and choose the better outcome, and their utility function would depict a straight line function. Individuals with risk seeking preference would usually choose the risky options and have a convex utility function, while risk averse individuals would have a concave utility function.

On the other hand, loss aversion, as defined by Rabin and Thaler (2001) describes individuals who have the tendency to feel the pain of a loss more intensively than the pleasure of an equal-sized gain. The concept of loss aversion is incorporated into Kahneman and Tversky's *prospect theory* (1979), which models the decision makers reaction to changes in the amount of wealth rather than the level of wealth. Also, Kahneman and Tversky propose that individuals are roughly twice as sensitive to perceived losses

as to gains. Hence, by incorporating loss aversion, *prospect theory* directly explains why people turn down even very small gambles with positive expected value to escape the possibility of losses.
To prove the existence of loss aversion, in reality, Thaler et al. (1997) conducted an experiment by adding a constant amount to the returns of stocks and bonds only to increase the attractiveness of stocks by decreasing the frequency of losses. The amount needs to be large enough to assure that the returns on stocks over the shortest evaluation period are always positive. The results show that the subjects prefer stocks over bonds after removing the loss evaluation from stocks. This result verifies the existence of loss aversion in reality.

2.1.2. Risk Perception

Risk perception, defined by Slovic (1987), is the subjective judgment that people make when they are asked to characterize and evaluate risky activities and technologies. Several theories have been proposed to explain why different people make different estimates of the dangerousness of risks. This matter is tackled in three major ways: the psychology approach (heuristics and cognitive), the sociology approach (*cultural theory*) and the interdisciplinary approach (social amplification of risk framework). Edwards (1961) indicates that psychological research on risk perception originated in empirical studies of probability assessment, utility assessment, and decision-making process. In the early studies about risk perception, the researchers were prone to believe that it can be highly biased and skewed from reality, so the results show difficulties in understanding subjects' real risk perceptions. Kahneman, Slovic, and Tversky (1982) propose a theory that says people employ sets of mental strategies in order to make sense out of an uncertain world. Although these rules are valid in some circumstances, in others they lead to large and persistent biases, with serious implications for risk assessment. That means it is impossible to capture real risk perception without biases.

Later on, different arguments were proposed on why risk perception biases should not be ignored nor should one forego the possibility to capture people's risk perceptions in the presence of biases. Nisbett and Ross (1980) claim that strong initial views are resistant to change because they influence the way that subsequent information is interpreted. New evidence appears reliable and informative if it compounds on one's initial beliefs; contrary evidence tends to be dismissed as unreliable, or unrepresentative. Furthermore, Tversky and Kahnman (1992) indicate that when people lack strong prior opinions, the opposite situations tend to alter their original beliefs. For instance, presenting the

same information about risk in different ways (e.g. mortality rates versus survival rates) would alter people's perspectives and actions. Therefore, these studies suggest that people's bias and prior information are at the core of the forming process of their risk perception.
Weinstein (1989) concludes that risk perception goes beyond the individual, and it is a social and cultural construct reflecting values, symbols, history and ideology.

2.1.3. Interactions and Difference between Risk Preference and Risk Perception

Risk preference and risk perception may be two distinctive notions, defining how subjects' choosing among risky options and evaluations towards risky options. However, they have influences over each other to some extent. Weber and Hsee (1999) suggest that the differences in risk perceptions are the driving force behind differences in risk preferences. They argue that the differences are mainly psychological, cognitive. Therefore, the data in the present study shall gather about how the other individual defines and perceives the risk of different options.

Markowitz (1959) constructs a similar model, it comprises people's willingness to pay (WTP) for risky option X depending on the option's return or value (V) and its risk (R). The model assumes that decision makers seek to minimize the risk of a portfolio for a given level of expected return: $WTP(X) = V(X) – bR(X)$. The equation implies that the difference in risk preference measured by willingness to pay comes primarily from two sources. They may result either from the differences in the risk perception of option X (i.e., from differences in the value of R(X)) or from differences in the risk-return tradeoff (i.e., from differences in coefficient b), which provides a measure of attitude towards perceived risk (with a negative coefficient indicating perceived risk aversion, and a positive coefficient indicating perceived-risk seeking).

Since these two notions are easily confused from one another, it is essential to draw a fine line between risk preference and risk perception. Brockhaus (1982) finds that the differences in risk preferences and risk perceptions can be seen in the risk attitudes in entrepreneurs. Contrary to popular belief, the entrepreneurs do not have greater willingness to take on extra risks, despite their risk-seeking propensity compared to other managers. Instead, entrepreneurs merely demonstrate overly optimistic perceptions of the risks if the tasks involve risky options. In other words, in spite of entrepreneurs' risk seeking propensity, it does not necessarily come with risk seeking preference. The study shows that the differences in propensity lie in the differences in risk perceptions. Without the differences in risk

perceptions, entrepreneurs would demonstrate moderate risk preferences for tasks just as other managers.

The same difference can also illustrate Kahneman and Tversky (1979)'s *reflection theory*, which indicates that subjects have the tendency to be risk-averse in the gain domain and risk-seeking in the loss domain. In an experiment designed by Weber and Millian (1997), it is observed that not only participants' are changing their choices but also changing their perceptions of alternative options. The result shows that when participants choose different choices, they simultaneously change their perceptions of alternatives' relative risk. The change in alternatives' perceptions and the change in the original subject's perception are highly correlated, which indicates that changing options contribute to changing risk perception but not changing risk preference. As a result, risk preferences are deemed as a stable personal trait and risk perception is highly affected by situational factors like alternatives' perceptions.

Sitkin and Pablo (1992) define the main difference between risk perception and risk preference. They define the risk perception as the observed likelihood of a person taking or avoiding risk. Risk perception can be altered when subjects' alternatives are influenced by situational factors such as outcome framing or prior outcome history. Therefore, subjects' risk perceptions are affected under different circumstances. On the other hand, risk preferences are defined as the character trait of being attracted or repelled by risks, which is classified as a stable personal trait and cannot be influenced by situational factors.

Table 1: Summary of the Literature Review

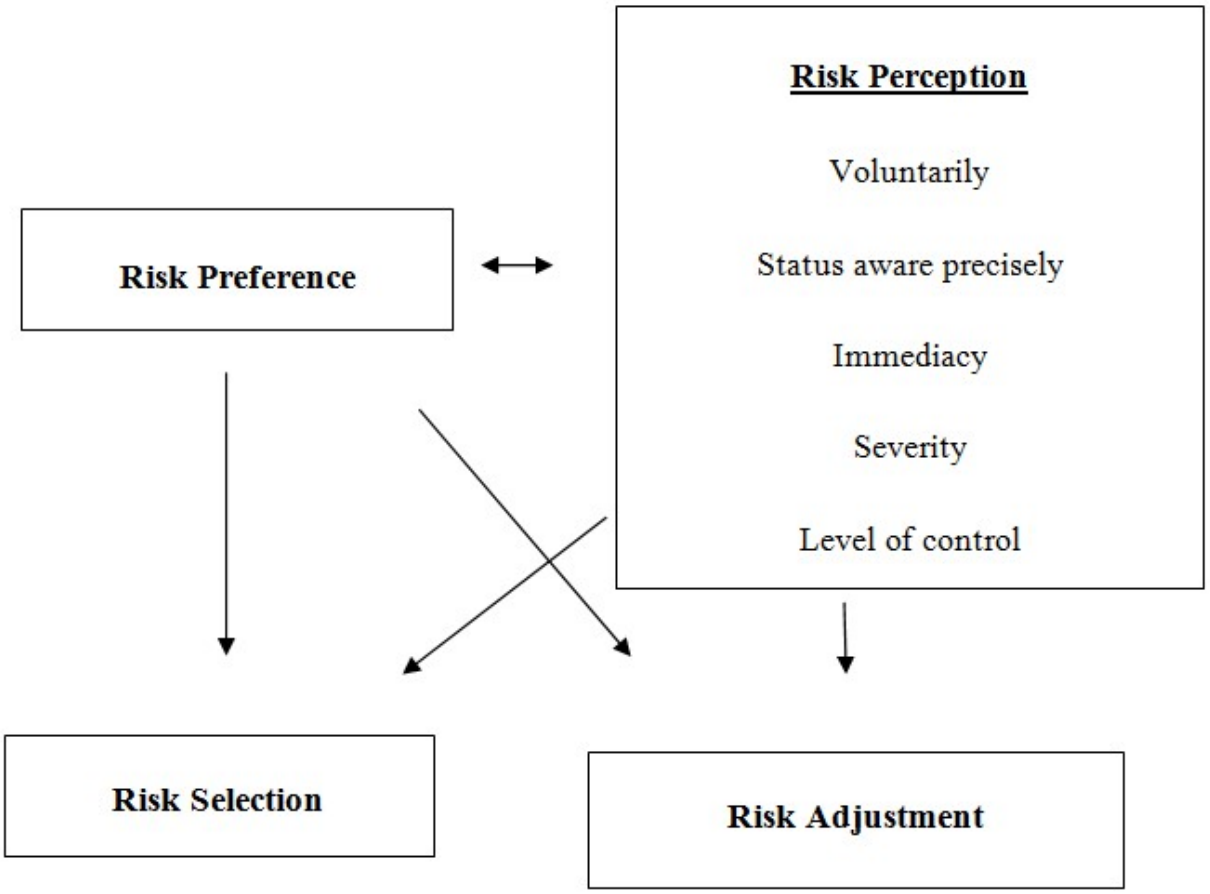
Paper	Key independent variable	Number of observations	Timeframe	Main insights
Wen et al. (2014)	Prior outcomes	14 representative stocks around	1/1/2001-31/9/2009	Under the influence of prior gains, the extent of risk aversion in most of the stock market will

		the world		decrease
Sitkin and Pablo (1992)	Problem framing, Social influence, Problem domain familiarity…etc	Not applicable	Not applicable	Risk perception as the observed likelihood of a person taking or avoiding risk, Risk perception can be altered by situational factors
Weber and Milliman (1997)	"Success" and "Failure" sessions	24 participants, from MBA to PHD	Laboratory simulation	Prior outcome history would affect on investors' risk perceptions first, and then have the impact on investors' risk choices.
Knetsch (1989)	None	245 households	Telephone interviews	Perceptions and preference varied systematically with the initial reference entitlement (endowment effect)
Dyer and Sarin (1982)	Strength of preference	Not applicable	Not applicable	Define risk preference as relative risk attitude
Thaler et al. (1997)	None	80 Berkeley undergraduate students	Laboratory experiment	Adding a constant to the returns of stocks and bonds only increase the attractiveness of stocks

Slovic (1987)	Unknown risk, Dread risk	30 activities and technologies	Not applicable	Risk perception is the subjective judgments for individual evaluate hazardous activities and technologies
Weinstein (1989)	Personal experience	Not applicable	Not applicable	Risk perception goes beyond the individual, and it is a social and cultural construct
Kahneman, Slovic, and Tversky (1982)	Judgmental heuristics	100 professionals	Laboratory experiment	People employ sets of mental strategies, or heuristics in order to make sense out of an uncertain world.
Nisbett and Ross (1980)	Accuracy of prediction, Lack of bias	100, including 70 engineers and 30 lawyers	Laboratory experiment	Strong initial views are resistant to change because they influence the way that subsequent information is interpreted
Tversky and Kahnman (1992)	Risk attitude	Not applicable	Not applicable	People lack strong prior opinions, the opposite situations tend to alter

				their beliefs.
Weber and Hsee(1999)	Culture difference	Unknown, combination of American and Chinese students	Laboratory experiment	The differences in risk perception are the driving force behind differences in risk preference
Brockhaus(1982)	Psychological characteristics, Effects of previous experience, Personal characteristics	Not applicable	Not applicable	Entrepreneurs demonstrate an overly optimistic perception of the risks if the tasks involved in risky choice options
Kahneman and Tversky(1979)	Prospect	Not applicable	Not applicable	Reflection theory
Weber and Millian (1997)	Riskless marginal value	54 members of University of Chicago	Laboratory experiment	Participants choose different choices, they simultaneously change their perceptions of alternatives' relative risk

2.2. Conceptual Framework



This figure above depicts the interactions among risk preference, risk perception and risky choices in the stock market. The present study set risk preference and risk perception as two independent variables, and separate risky choices into two dependent variables: risk selection and risk adjustment.

2.3. Dependent Variable

The key dependent variable in the present study is the risky choices investors made in the stock market. Prior studies have used many different independent variables to examine the correlations to investors' risky choices. Guiso, Sapienza, and Zingales (2008) suggest that trust can be the issue why investors are reluctant to invest in the stock market comparing to bonds, or real estate market.

According to Earle, Siegrist and Gutscher(2010) trust in risk management is negatively related to risk perception. Kumar (2009) studies that how individual choose stocks, and it discovers that investors invest disproportionately in stocks that have state lottery features, which is considered as a safer option when the economic worsen. Baker and Wulger (2007) shows that investor's sentiment wave is highly correlated to investors' risky choice in the stock market. Compared to the prior studies, the present study focuses on the psychological perspective, investigating how investors react based on their risk preferences and risk perceptions, looking in-depth at what is the driving force behind investors buying and selling patterns based on their risk attitudes.

Some investor's characteristics would also be used as control variables in the present study, including gender, age, and education level. Barber and Odean (2001) suggest that gender can be another factor influencing investors' choices. Their results show that men and women differ in both overconfidence and risk aversion. Men are more overconfident but not more risk averse than women. Because of men's overconfidence, they show over-trading activities in the stock market. Guiso, Haliassos, and Jappelli (2003) discover that households' investment portfolios do not vary with age. Hong, Kubik, and Stein (2001) also find age does not significantly affect investors' stock market participation, however, years of education does increase the participation rate in the stock market.

2.4. Independent Variable

The key independent variables in the present study are risk perception and risk preference. Since the two notions have drastic different characteristics, one expects they would have different impacts on investors' risky choices when they select stocks to fit in their portfolio. The following section puts together a stream of past literature to explain what influences risk preference and risk perception have on risky choice investors made.

MacCrimmon and Wehrung (1986) and Schoemaker (1990) indicate that individuals do not show as consistently risk-seeking or risk-avoiding across different domains and situations. They propose that in the expected utility framework, comparing to risk perception, the subjects have shown little consistency in risk preference across domains and situations. According to Schoemaker (1993), this phenomenon may be influenced by situational factors, for instance, portfolio considerations or intertemporal effects. Weber (2010) also indicates that risk preference appears to be domain specific because domains of risky decisions can differ in familiarity or perceived controllability. The concept of ambiguity aversion needs

to be mentioned when it comes to familiarity. The risk aversion occurs in the situation where all the probabilities are known and expected value can be calculated while people choose the less risky one. On the other hand, ambiguity aversion happens when people need to choose between risky and ambiguous options and people would rather choose the risky option. Weber, Blais, and Betz (2002) experiment and conclude that ambiguity aversion is a personality trait; it affects subjects' risk perception but has little effect on risk preference

On the other hand, Weber and Milliman (1997) hypothesize that situational variables such as outcome framing or prior outcome history would affect people's risk perceptions but not their inherent risk preferences, and situational variables have effects on risk perceptions solely. In their experiment, risk perceptions were found to be different for risky prospects with positive outcomes and negative outcomes. Hoffmann, Post, and Pennings (2012) research investors' risk perceptions and behaviors during the financial crisis in 2008 to 2009. They also discover that substantial swings in trading and risk-taking behavior during the crisis are driven by changes in investor perceptions.

In an experiment, Weber and Milliman (1997) try to figure out the relationships among risk preference and risk perception and the risky choices investors made in the stock market. They find out that even though choices, as well as risk perceptions, differed substantially in different economic situations, risk preference remains unchanged across all circumstances for most of the subjects. 83% of the participants showed the same perceived risk attitude across different economies, even though their choices and risk perceptions varied substantially in response to the different outcome feedback. Risk preference is defined as perceived risk attitude in Weber and Milliman's study.In all, both stock choice and investors' risk perception change as the result of outcome feedback (i.e., investment success versus failure). Yet risk preference is deemed as inherent and remains constant.

Due to the different methods of eliciting risk preferences and risk perceptions, the comparability of risk preference and risk perception needs to be verified. According to "Comparability of survey measurements", the measurements' invariance can be established by invariance testing. (Oberski, 2012) Confirmatory factor analysis is a common invariance testing method to establish measurements invariance, especially for observable variables and latent variables. (Brown, 2014) The goodness of fit test would be conducted to test if the model in the present study is a good model fit. (Shcoot and Hox, 2012)

Hypothesis 1	Risk preferences has more influence on investors' risk selections
Hypothesis 2	Risk perceptions has more influence on investors' risk adjustments

3. Research Methodology

3.2. Questionnaire Design

This paper extracts people's risk preferences and risk perceptions in the form of a questionnaire, analyzing the relationships between risk preferences and risk perceptions to their risky choices, by random sampling the general population with a finance background, the results are expected to exhibit similar relationships to the stock market investors. Furthermore, to retrieve subjects' risk preferences and risk perceptions accurately is essential for this paper. The following passage describes the design of the questionnaire, and how the questions were formed to obtain subjects' risk preference and risk perception appropriately. The questionnaire is divided into three sections: risk preference, risk perception, and risk behavior in the stock market.

3.2.1. Risk Preference Questionnaire

Lusk and Coble (2005) start by investigating the relationship between risk preference elicitation experiment and consumer behavior. They line up a series of choices between two options, so the participants need to choose between two lottery options without any further instructions. This method is called context-less lottery experiment. The result of context-less lottery experiment is significantly related to consumer's real risk preference. This finding shows results from context-less lottery experiment can be representative of investors' behaviors. Also, Holt and Laury (2002) conduct another experiment to detect subjects' risk aversion attitude. By connecting all the choices subjects have made, they can draw subjects' utility function, and further detect subjects' risk aversion attitude. Moreover, Weber (2010) indicates that since risk preference is domain specific, the ostensibly 'content-free' lotteries experiment is appropriate for extracting risk preference in the monetary domain. This makes Holt and Laury's lottery experiment suitable for being predictors of risk preference in monetary

gambling choices. Therefore, in this research, the questionnaire combines the context-less lottery from Lusk and Coble (2005) and simple lottery-choice experiment from Holt and Laury (2002) to measure investors' risk preference.

However, Domènech and Silvestre (1999) find that in Holt and Laury's method, subjects tend to change to riskier options if the latter pair of lotteries is eliminated. For example, the original questionnaire has ten pairs of lotteries, and most of the subjects would put their risk choice in the tenth question. But, if the experiment decreases the number of lotteries to eight, most of the subjects would still put their risky options at the end of the questionnaire, as in the eighth question. This would change the structure of subjects' utility functions and create bias. This shows a certain type of embedding bias and overestimates the extent of risk aversion. Since the present study also adopts the method from Holt and Laury, this bias can affect this research. Nevertheless, based on Halt and Laury's(2002) experiment, Domènech and Silvestre (2006) propose a new experiment, which would not affect by embedding bias as the original lottery experiment design. In the new design, the participants are told that they would be randomly assigned to different questions in the experiment.

Therefore, the questionnaire in the present study adopts Domenech and Silvestre's new method to shuffle the order of the risk preference questions to avoid the embedding bias from occurring. This part of the questionnaire is divided into two domains: investment and gambling.

Investment question: The participants are informed that they would have 1,000 euro, but they need to invest 500 euro for the investment. And they can choose between the following scenarios: A. Receive 500 Euros back for sure or B. 80% (The following questions consist with the probability of 60%, 40%, and 20%) chance they will receive 1,000 euro, 20% (The corresponding probabilities are 40%, 60%, and 80%) chance they will get nothing. The participants are given the same amount of payouts in the questionnaire while the probabilities varied across questions and decreased steadily (the corresponding probability is increasing steadily). The participants need to choose between a safe and a lottery option, while the expected values are easy to calculate by multiplying the probabilities to the outcomes. By the results from the participants' choices, the study can elicit every individual participant's risk preference towards investment.

Gambling question: The participants are informed that they would only have 500 euro, but they need to put all 500 euro into the gamble. They can choose between the following scenarios: A. receives

500 euro back for sure and B. 80% (The following questions consist with the probability of 60%, 40%, and 20%) chance they will receive nothing, 20% (The corresponding probabilities are 40%, 60%, and 80%) chance they will receive 1,000 euro. The participants still need to choose between a breakeven and a lottery option. The only difference between gambling and investment questions is the endowment participants obtain in the beginning, while the outcomes are identical in both sections. The comparison between the two groups of results can lead to the conclusion on whether the endowment would affect participants' risk preference. The detailed questions regarding risk preference are included in appendix A from investment 1 to gambling 4.

The questionnaire is deliberately designed without the 100 percent possibility to prevent the certainty effect from taking place. The certainty effect implies that subjects have a tendency to choose the certain option even if the alternative options have higher estimated values.

This section of risk preference questionnaire aims to elicit participants' general risk preference. The following part of risk choices questionnaire can also elicit participants' risk preference which would be used to find out if the participants have consistent risk preference across different domain, namely, investment, gambling and in the stock market.

According to Domènech and Silvestre (2006), the questionnaire cannot be put in the original order (80%, 60%, 40% and 20%) or the embedding bias would occur. Therefore, the order of this part of the questionnaire is shuffled to prevent embedding bias. The complete questionnaire is attached in the appendix.

3.2.2. Risk Perception Questionnaire

Since risk perception is the subjective assessments participants make when they face risk. Hence, this part of questionnaire uses a psychological approach to measuring risk perception. In the present study, the questionnaire adapts the psychometric paradigm (Fishhooff et al., 1978) to measure subjects' risk perception. The psychometric paradigm consists of nine dimensions including voluntarily, status awareness precision, immediacy, severity, the level of control, chronic versus catastrophic potential, common versus dread, the extent of risks known by science, newness of the risk. (Fishhooff et al., 1978) However, because the present study only examines subjects' financial decisions in the stock market, only five dimensions are selected in the questionnaire.

The first dimension is voluntary, representing whether the subjects face the risks voluntarily or not.

Voluntary dimension has a positive correlation with risk perception; when the respondents rate higher on the scale of voluntary, they will also score higher on the scale of risk perception. The second dimension is about the extent to which the risk is known precisely by the subject who is exposed to the specific risk. Status awareness precision also has a positive relation with risk perception; when the respondents score higher on the scale of status awareness precision, they will rate themselves higher on the risk perception scale. The third dimension concerns the immediacy of the effect and whether the respondents experience any delay. The higher on the scale in immediacy, the more risk perception is perceived by the respondents. The fourth dimension is the severity of the consequences from the risk. A high position on the scale in severity also indicates the higher risk perception is perceived by the respondent. The final dimension is about the level of control, in terms of personal skill or diligence, whether the subjects would have motivations to take more risk if they have the ability to control the risk to a certain extent. Level of control dimension, on the other hand, has a negative correlation to risk perception, which means that unlike in the above dimensions, the lower the participants score on the scale of level of control, the higher risk perception they will experience. All the factors have the same portion of influence on subjects' risk preferences, therefore, the distribution of the entire factors stand equal to represent risk preference. The result would be classified into 5 scales, from 1 for not being affected by the factor at all, to 5 for completely affected by the factor. The risk perception questions are distributed into a different part of the questionnaire. Only the level of control dimension is set at the end of the risk preference questionnaire to examine whether the ability of control would affect investors' willingness to take risks. The rest of risk perception questions are dispersed into the following risky choice questionnaire to test different dimensions would influence investors' investing choices.

Weber, Blais, and Betz (2002) point out that the psychometric scale is designed to measure risk perception in two ways. First, risk perception is measured in the way that it is typically conceived, as a descriptive label of the degree to which an individual appears to avoid or seek out risk options or behaviors. Secondly, it is measured as an attitude towards perceived risks, which takes into consideration individual or situational differences in the way risks (and/or benefits) are perceived before labeling a particular choice or behavior as risk-seeking or risk-averse.

The following sub-variables are taken from psychometric paradigm (Fishhooff et al., 1978). The present study only adopts 5 dimensions as variable to fit into the financial risk setting in this

questionnaire.

Level of control: This question gives the participants the opportunity to adjust the probabilities in the risk preference questionnaire by their will. In this question, the participants can adjust the probability by 5%, while all questions have 20% probability interval, the participants can adjust by a fourth of the total probability. For example, in the gambling question, the subjects can change the probability as such: 15% chance you will receive nothing, 85% chance you will receive 1000 euro. The question is meant to test if, when the subjects have the power of adjusting probability, whether they have higher risk perception. Since this question aims to adjust the probabilities in risk preference questionnaire, therefore, it should follow after risk preference questionnaire.

Voluntary: This question intends to test if the participants can invest voluntarily and if that would be a factor to motivate them to invest more in the stock market. The question gives the subjects the freedom to choose between different financial markets. For example: if the subjects can invest their money in the stock market, real estate market or bank accounts, would this freedom of choice stimulate the subjects to invest more in the stock market? This question is set after the first risk assessment question, so the participants can evaluate the stock market and think upon if the voluntary would be a motivation.

Status awareness precision: This question aims to understand if the participants have a better understanding of how their financial status can be a motivation to invest more in the stock market. For example, if the subjects realize how much money sits in their accounts and how many investments they have currently, would this be the factor to stimulate their risk perception? This question is put after the second risk assessment question.

Immediacy: This question aims to tell if when the participant can know the results of their investments and how the results affect their financial status, would that be a factor of motivation for investors to invest more in the stock market. For example, when the subjects can learn the investment results after their investment decisions are made immediately, would this be the factor to motivate their investment in the stock market? This question is placed after the third risk assessment question.

Severity: This question aims to understand if the investments have bigger impacts to the participants' financial status, would that be a factor of motivation to invest more in the stock market. For example, the impact of losing 1,000 euro is different for the subjects earn 5000 euro and the

participants earn 2,000 euro per month. This question is set after the fourth risk assessment question. All the five sub-variables need to do a factor analysis to represent the participants' risk perception for further analysis. The complete questionnaire is included in appendix A.

3.2.3. Risk Choices in the Stock Market Questionnaire

The last part of the questionnaire is regarding subjects' risky choices and in particular, the adjustments participants made in the stock market are the main objective here. In the results, we see the interactions with subjects' risk preference and risk perception from the previous part of the questionnaire. The subjects are given five charts separately, which consist of five stocks from five different periods. The example chart can be seen as follow:

Company	A	B	C	D	E
Current price	73	96	343	9	37
Beta	0.3	1.2	1.1	2.3	0.6
52 weeks high	75	97	345	13	38
52 weeks low	50	51	240	9	27
EPS(year)	5	6	16	4	1
PE ratio	16	16	20	2	50
Trade volume	6M	92M	4M	28M	20M

Table 2. Example questionnaire table of stock information

This experiment's stock information is based on real stock, and their characteristics are taken from Google Finance in five different periods. But the names of the stocks are not be revealed to the participants to prevent them judge by the stock's' name instead of their merits. Participants can only see the ticker symbol as A, B, C, D, and E. Furthermore, since Dow Jones Industrial Average Index (DJI) works as a representation of the 30 major companies, therefore, the time periods are based on DJIs highs and lows divided into five stages: The worst time, down time, neutral time, uptime and the best time. The 7 characteristics offered in the questionnaire include current price, beta, the highest price in 52 weeks, the lowest price in 52 weeks, EPS(year)(Earning per share per year), PE ratio (price/earnings) and trade volume. From the start of the questionnaire, it states specifically that this questionnaire only targets at people with economics or finance backgrounds, or with a general understanding of the stock market (who have either invested in the stock market or traded stocks…etc.). This measure is to eliminate from

the sample subjects who would be confused about the stock's' characteristics. Also, all the questions with stock information would provide detailed explanations about every stock characteristic. The full example of stock characteristic explanation can be found in appendix A.

In the beginning, the participants are asked to rate the risk of five stocks by putting them into order; from 1 equals the least risky to 5 equals the riskiest. The results contain two pieces of information. First, from the ranking order, it can detect participants' stock rating criteria. Secondly, the results can also determine which stock characteristic is the first consideration for stock investors. The following question is regarding which stock participants would choose. Comparing to the risk order they have listed before, the selection of stocks can result in the appropriate risk preference investors have in the stock market. Also, the selection of stocks will be analyzed with participants' risk preferences and risk perceptions to prove the hypotheses. The complete questionnaire is attached in appendix A.

3.3. Methodology of Evaluating Risk Preference, Risk Perception, and Risk Choices

According to Weber and Milliman (1997), participants' risk preference can be extracted from the risk choices questionnaire. Risk preference of each investor can be assessed by point-biserial correlations between their risk ratings for five stocks and their selection of stock. The point-biserial correlation is suitable when one variable is dichotomous, and the other is continuous. (Linacre,2008) Since the stock's risk rating is continuous and the selection of stock is dichotomous (whether the stock is selected or not), thus the point-biserial correlation is appropriate. By comparing the stock risk rating and selection of stock, the participants' risk preference can be elicited. When the participants choose the stock they rated as high risk, it demonstrates the participants are risk-seeking; and if they choose the stock rated as low risk, then they are risk averse. Moreover, to test whether the risk preferences from risk choices are not significantly different from the original risk preference questionnaire, a paired sample T-test is performed. Because the two sets of risk preferences elicitations come from risk preference questionnaire and risk choices questionnaire, both represent the same risk preference from identical participants, therefore, the results are dependent. As a result, the paired sample t-test can help see a comparison between the two groups of risk preferences. In addition, if the T-test does not prove that two sets of risk preferences are highly correlated, a dominance analysis (Budescu, 1993) needs to be conducted in order to test which set of risk preference is more suitable for the following panel

regressions.

On the other hand, comparing to risk preference can be scaled in one variable; risk perception is constructed by 5 sub-variables. In order to run the following regressions, risk perception needs to be merged into one variable. A factor analysis is designed for the situation when there are numbers of observed and correlated sub-variables, and the studies need to merge those sub-variables into a lower number of unobservable main variables. In the present study, the 5 sub-variables from *psychometric paradigm* are highly correlated to risk perception. A factor analysis can combine the five sub-variables into one risk perception variable. (Siegrist, Keller, and Kiers, 2005)

Nevertheless, the creation of risk perception only contains part of characteristics of all the 5 sub-variables; therefore, the risk perception should not act as an independent variable directly. Two-stage least square (2SLS) regression is suitable for risk perception acting as an exogenous variable, while the 5 sub-variables act as instrumental variables. In the 2SLS analysis, instrumental variables do not have a direct effect on dependent variables, but they have impacts on independent variable and influence the dependent variables indirectly. As the result, the first stage regression takes risk perception as the dependent variable and 5 sub-variables as explanatory variables. The second stage regression analyzes the main correlations between independent variables, including risk perception and risk preference, and dependent variables. The 2SLS model allows the present study to detect the causal effect of the independent variable on the dependent variable. (Bollen, 1996)

Furthermore, the collected data contains time essence; therefore, it would be easier to run the panel regressions to test independent variables' influences on dependent variables. There are two types of model for panel regression, including random effects model and fixed effects model. The fixed effects model specializes in analyzing the influence of variables that vary over time, it examines the relationship between independent variables and dependent variables within an entity (in the present study it is the individual subjects). Fixed effects model assumes some variations within the individual may impact or bias either independent or dependent variables. The fixed effects model eliminates the time correlated characteristics so the studies can explore the net effect of independent variable on dependent variables. The important assumption in the fixed effects model is that on average there is no difference between individual but only time-invariant characteristics uncorrelated across individuals. On the other hand, the random effects model assumes that variations exist within the intercept parameter, and the variations

are random and uncorrelated with the independent variables. The random effect is especially suitable when the differences across individuals have an influence on dependent variables. (Hedges,1998; Hill, Griffiths, & Lim, 2008). Since the present study focuses on the risk preference and risk perception, which are the differences across the individuals and have potential impacts on subjects' risk-taking behaviors, it seems befitting to choose the random effects model for the following panel regressions. Yet as a precaution, there are tests which can be carried out to specify which model is more suitable. The Hausman test is appropriate to examine which model should be used in the panel regression, it has the null hypothesis that random effect model is the preferred model. Also, a Breusch-Pagan Lagrange multiplier test can decide between a random effects model regression and a simple OLS regression. Both tests are conducted to test whether the random effects model is suitable for the following panel regressions.

The comparability test is used to examine whether different elicitation methods in the present study would affect the results of the following panel regressions. First, the confirmatory factor analysis maps out the correlations of 5 sub-variables and risk perception, and the covariance between risk preference and risk perception. The goodness of model fit tests include a Chi-square test of model fit, root mean square error of approximation(RMSEA) and Standardized root mean square residuals(SRMR). The Chi-squared test is to examine the association of variables, which is the sum of differences between observed data and expected outcomes. (Cheung and Rensvold, 2002) Root mean square error of approximation analyzes the discrepancy between the hypothesized model, with optimally chosen parameter estimates, and the population covariance matrix. (Hooper, Coughlan and Mullan, 2008) Standardized root means square residuals is an absolute measure of fit and is defined as the standardized difference between the observed correlation and the predicted correlation.(Hu & Bentler, 1999)

The time periods in the questionnaire are divided into 5 groups from the worst economic situation to the best. In the collected data, the time remains constant within groups, but it would alter the stock characteristic variables across different groups. Therefore, in the panel data, time is set as the control variable to help the panel regressions assess the net impact of independent variables on dependent variables.

Furthermore, in the present study defines the subjects' risk selection by their corresponding rated

risk. For example, when the subject chooses stock A while he rated A's risk as 4, his risk selection would be 4. On the other hand, the subjects' risk adjustment is defined by the risk difference between two periods, which implies that when the subjects have a high-risk adjustment, they are willing to take more risk even when the expected returns remain the same. For instance, when the subject chooses stock A in time 1 and rated as 2, and he chooses stock B in time 2 and rated as 1, the difference would be -1(the risk from later time minus the risk in earlier time), which also suggests the subject is willing to accept less risk when he/she expects the same return.

The present study uses two-stage least squares (2SLS) regression to include the risk perception's 5 sub-variables. The regressions include stock characteristic variables since the subjects' decisions are not only influenced by their risk preference and risk perception, but also by the stocks' characteristic variables (Weber and Milliman, 1997). The first part of the 2SLS regression is as follow:

$$\overline{\text{Risk perception}}_{i,t} = \alpha_0 + \alpha_1 \text{Level of control} + \alpha_2 \text{Voluntary} + \alpha_3 \text{Fully aware} + \alpha_4 \text{Immediacy} + \alpha_5 \text{Severity} + \varepsilon_{i,t}$$

This part of the regression focuses on the instrumental variables' influence on risk perception. The estimated risk perception can function as an independent variable in the second regression. The second part of the 2SLS model regression is as follow:

$$\text{Risk selection}_{i,t} = \beta_0 + \beta_1 \text{Risk preference} + \beta_2 \overline{\text{Risk perception}}_{i,t} + \beta_3 \text{Stock characteristics} + \varepsilon_{i,t}$$

The stock characteristics include price, beta, 52 weeks high, 52 weeks low, EPS (earning per share), PE ratio (price/earnings), and trade volume. In this regression, we see the influence of both subject and stock characteristics. Therefore, we can check which side of the characteristic variables has more impact on dependent variables. However, the present study concentrates on the influence of risk preference and risk perception, and an individual 2SLS regression can show more details on risk preference and risk perception. The regressions are as follow:

$$\overline{\text{Risk perception}}_{i,t} = \alpha_0 + \alpha_1 \text{Level of control} + \alpha_2 \text{Voluntary} + \alpha_3 \text{Fully aware} + \alpha_4 \text{Immediacy} + \alpha_5 \text{Severity} + \varepsilon_{i,t}$$

$$\text{Risk selection}_{i,t} = \mu_0 + \mu_1 \text{Risk preference} + \mu_2 \overline{\text{Risk perception}}_{i,t} + \varepsilon_{i,t}$$

Without the stock characteristics, these regressions have better insights of the impacts from risk preference and risk perception, which can prove or reject the hypotheses in the present study.

4. Data

4.2. Data Collection

The present study uses surveys to collect all the data. The survey is distributed both online and in the paper. The complete survey is built on online survey software: SurveyPlanet. The main reasons for choosing SurveyPlanet include unlimited surveys, questions, and responses, and most importantly, it has the feature of questions branching. This feature allows the risk preference part of the questionnaire to shuffle the order of questions to prevent embedding bias. The online survey is distributed through various social media, including Facebook, WhatsApp, and Line. On the other hand, the paper survey is distributed in the Leiden University College in The Hague. The total sample count is 105, consisting of 94 samples from an online survey and 11 samples from the paper survey.

4.3. Definition of Measures

The present study consists of two independent variables: risk preference and risk perception; and two dependent variables: risk adjustment and risk selection. In the eight risk preference questions, they all consist of two options: one safe option and one risky lottery option. The safe option is coded as 1 and the risky option is coded as 2. Therefore, the risk preference variable is the cumulative points from the risk preference questionnaire. When the participants choose more safe options and have lower risk preference points, it indicates that they are more risk averse, while the participants who choose more risky lottery options and have higher risk preference points are more risk-seeking. The risk preference is divided into 9 scales,1 being the most risk-averse and 9 being the most risk-seeking, and 5 means risk neutral. The risk preference dimension is ordered from risk-averse to risk-seeking; therefore, this dimension is ordinal.

Risk perception dimension comprises of 5 sub-variables, including Level of control, Voluntary, Status awareness precision, Immediacy, and Severity. All the sub-variables are separated in the questionnaire, and they are measured by the level of influence in the participants' risk choices. The scale goes from 1, when the sub-variable has no influence on the participants' risk choices, to 5 when the sub-variable has the biggest influence on the participants' risk choices.

Risk assessments are the participants' judgments on the relative risk of all stocks. At 1, the participants consider the stock as relatively the least risky and at 5 the participants deem the stock as

relatively the riskiest. While risk adjustments are the differences between two risk assessments from two adjacent time periods. The full summary of variable measurements is presented in table 3.

Variable name	Description	Measurement	Type
Assessment1-Assessment5	Risk assessment from time 1 to 5, represent risk selection	1= The least risky : 5= The riskiest	Ordinal
Adjustment1-Adjustment4	Adjustment from time n to n+1, represent risk rating	The difference between two risk assessments from two times	Ordinal
Preference	Cumulative risk preference points	1 = The most risk averse : 5= Risk neutral : 9= The most risk-seeking	Ordinal
Perception	Risk perception	Factor analysis	
Levelofcontrol	Level of control	1=No influence at all : 5=The strongest influence	Ordinal
Voluntary	Voluntary	1=No influence at all : 5=The strongest influence	Ordinal
Fullyaware	Status awareness precision	1=No influence at all : 5=The strongest influence	Ordinal

Immediacy	Immediacy	1=No influence at all : 5=The strongest influence	Ordinal
Severity	Severity	1=No influence at all : 5=The strongest influence	Ordinal
Gender	Gender	0=Female 1=Male	Dummy
Age	Age	1=Below 20 2=21~25, 3=26~30 4=31~35, 5=36~40 6=Above 40	Ordinal
Education	Level of education	1=Below high school 2=High school, 3=University, 4=Master 5=Above master	Ordinal

Table 3.Variable definitions and measurements

4.4. Data Description

This is a financial questionnaire aims to capture participants risk preference, risk perception and subsequent risk choices in the stock market. Therefore, the questionnaire is targeted at people with financial or economic backgrounds or who have a general understanding of the stock market. Most of the online questionnaires are distributed to financial or economic related associations, including Erasmus Financial Study Association Rotterdam, National Taiwan University Economic Student Association and National Ilan University Economic Department. The rest of the online questionnaires are distributed to individuals with a general understanding of the stock market. On the other hand, the paper version of surveys is distributed to the students from Leiden University College (The Hague)

majoring in Governance, Economics, and Development. The following tables from table 4 to table 6 summarize data collected from the questionnaire. Table 4 is the summary of every variable from mean to standard deviation. And table 5 and 6 are the correlations between dependent variables and independent variables. More detailed descriptions will be written in the following sections.

Table 4: Data Summary

Variable	Obs	Mean	Std. Dev.	Min	Max
Assessment1	105	2.41	1.41	1	5
Assessment2	105	2.11	1.32	1	5
Assessment3	105	2.10	1.33	1	5
Assessment4	105	2.17	1.34	1	5
Assessment5	105	2.16	1.39	1	5
Adjustment1	105	-0.30	1.48	-4	4
Adjustment2	105	-0.01	1.40	-4	4
Adjustment3	105	0.07	1.19	-3	3
Adjustment4	105	-0.01	1.16	-3	3
Preference	105	4.31	1.92	1	9
Perception	105	0	1	-3.10	2.28
Gender	105	0.43	0.50	0	1
Age	105	2.76	0.98	1	6
Education	105	3.24	0.51	2	5

Table 4 is the data summary. The assessments 1 to 5 have similar means around 2.1 and range from the least risky 1 to the riskiest 5. The adjustments 1 to 4 have means from -0.3 to 0.07 and have bigger adjustment range in time 1 and 2. Risk preference has mean 4.31, which suggests the questionnaire

subjects are averagely risked neutral to a slightly risk averse. Risk perception has means 0, which indicates on average the questionnaire subjects have no particularly high or low-risk perceptions. The average of gender is 0.43, it means the questionnaire participants have a little more female subjects. The average of age level is 2.76, which implies the average age of the subjects is around 20 to 25. Finally, the average of education level is 3.24, which suggests the subjects mostly have an academic degree higher than a university degree.

	1	2	3	4	5	6	7	8	9	10
1.Assessment1	-									
2.Assessment2	0.41***	-								
3.Assessment3	0.43***	0.44***	-							
4.Assessment4	0.43***	0.38***	0.60***	-						
5.Assessment5	0.44***	0.49***	0.60***	0.64***	-					
6.Preference	0.27***	0.23**	0.17*	0.16*	0.15	-				
7.Perception	-0.13	0.30***	0.16	-0.01	0.18*	0.29***	-			
8.Gender	-0.12	0.07	-0.05	0.00	-0.03	0.00	0.08	-		
9.Age	0.06	0.10	0.08	-0.02	0.01	-0.07	-0.01	0.03	-	
10.Education	0.04	-0.04	0.18	0.11	0.15	0.04	0.00	-0.07	-0.02	-

Table 5.Risk selection variables (Risk assessment 1-5) and investor characteristic variables correlation table (N=105)

*p<.05, **p<.01, ***p<.001

Table 5 is the correlation table between risk assessments and investor characteristics. All of the assessments are significantly correlated, and it shows consistency in subjects' risk assessments. Risk preference is mostly significant to all the assessments, while risk perception only has two significant correlations. The noteworthy part is, the correlation between risk preference and risk perception is 0.29, and the result is significant at 1% level. This result verifies Weber and Hsee's (1999) theory that risk preference and risk perception are correlated.

	1	2	3	4	5	6	7	8	9
1.Adjustment1	-								
2.Adjustment2	-0.49***	-							
3.Adjustment3	-0.06	-0.35***	-						
4.Adjustment4	0.11	-0.12	-0.47***	-					
5.Preference	-0.06	-0.05	-0.01	0.00	-				
6.Perception	0.39***	-0.13	-0.19*	0.23**	0.29***	-			
7.Gender	0.17*	-0.12	0.07	-0.04	0.00	0.08	-		
8.Age	0.04	-0.02	-0.11	0.03	-0.07	-0.01	0.03	-	
9.Education	-0.07	0.21**	-0.07	0.05	0.04	0.00	-0.07	-0.02	-

Table 6.Risk adjustment variables (Adjustment 1-4) and investor characteristic variables correlation table (N=105)

*p<.05, **p<.01, ***p<.001

Table 6 is the correlation table between risk adjustments and investor characteristics. All the adjustments only have significant correlations to their next adjustment. Risk preference does not have any significant results, yet risk perception has mostly significant correlations to all the adjustments.

5. Analysis and Results

Before conducting the panel regression, some preliminary tests need to be carried out to determine the panel regression specification. The preliminary tests are described in the methodology section, they are designed to confirm the assumptions of which panel regression model is more suitable for the present study, so the conclusions can be elicited from the panel regressions.

5.2. Model Specification Tests

There are two ways of eliciting risk preference as mentioned in the methodology section, the point-biserial correlation, and the original risk preference questionnaire. These two sets of risk preferences need to be compared to see if the subjects have shown the same risk preferences. The most intuitive way is to find the correlation between two sets of risk preferences. However, the correlation between the two sets of risk preferences is only -0.19, which indicates the relationship is not strong enough. The possible explanations might be first that the subjects could be expressing the opposite risk preferences

between default questionnaire questions and investment decisions. Second, the point-biserial correlation method might not be valid, since not all of the correlations are significant. As a result, to test which set of risk preferences is more suitable for the following regressions, a dominance analysis (Budescu, 1993) is conducted. The dominance analysis is based on different predictors' R-square values to test which one is the most suitable independent variable. The dominance analysis result is as follow:

	Dominance Stat.	Standardized Domin. Stat.	Ranking
Point-biserial	0.0003	0.034	2
Preference	0.0073	0.966	1

Table 7. Dominance analysis, Point-biserial represents Point-biserial correlation, and Preference represents Risk preference questionnaire.

As the results showed in table 7, the point-biserial correlation's dominance statistic is smaller than risk preference questionnaire's dominance statistic. The ranking also shows that a risk preference questionnaire is more suitable for the later panel regressions. In conclusion, the results from the risk preference questionnaire are used as risk preference variable throughout the whole study.

Moreover, table 8 summarizes the results of the model specification tests. The full statistical method is presented in appendix B.

Test	Null rejected	Result
Hausman	No	Random effects model is applicable
Breusch-Pangan LM	yes	Random effects model is applicable

Table 8. Summary of model specification tests

	Value	Result
Chi-squared test	P=0.572	Cannot reject null hypothesis
RMSEA	0.000	Good fit
SRMR	0.054	Good fit

Table 9. Summary of comparability tests (Goodness of fit)

Table 9 summarizes the comparability test results. The Chi-square test of model fit has a p-value of 0.572, which is not significant and cannot justify the rejection of the null hypothesis. However, the null hypothesis of Chi-squared test is there is no difference between the patterns observed in the data and the model specified. Therefore, the non-significant results show the model is a good fit. The root means square error of approximation (RMSEA) test has the value of 0. MacCallum, Browne, and Sugawara (1996) have used 0.01, 0.05, and 0.08 to indicate excellent, good, and mediocre fit, respectively. Therefore, the RMSEA test also demonstrates the model in the present study is a good fit model. The measure based on residuals has the standardized root mean square residual (SRMR) value of 0.054. Accord to Hu and Bentler (1999) the SRMR value below 0.08 is considered as a good fit. In conclusion, the model in the present study is a good fit based on all the comparability test results. The full statistical results can be found in appendix C.

5.3. Panel Regression with Stock Characteristic Variables

	Risk Assessment					
Time	1	2	3	4	5	Random Effect
Perception	-0.22*	0.34***	0.09	-0.04	0.16	0.06
Preference	0.15**	0.04	0.09	0.12*	0.07	0.10**
Gender	-0.06	0.03	-0.09	0.26	-0.06	0.00
Age	0.07	0.08	0.09	-0.04	0.05	0.07
Education	0.13	-0.10	0.41*	0.28	0.36	0.18
Price	-0.13	0.33	0.03	0.11*	0.39	0.00
Beta	-0.80	1.09***	-0.28	-0.22	-0.19	0.47***
weekhigh	0.22*	-0.33	0.02	0.10	-0.39	0.02
weeklow	-0.17**	-0.01	-0.07	-0.29*	0.03	-0.02
Constant	1.06	0.89	-0.25	1.15	-0.16	-0.37
R^2	0.296	0.293	0.198	0.291	0.191	0.169
Num. obs	105	105	105	105	105	525

Table 9. Panel regression table of risk assessment with stock characteristics

*p<.05, **p<.01, ***p<.001

Table 9 is the summary of 2SLS regressions across 5 different times; each represents different economic situations respectively, from the worst to the best economy. The last column uses random effects model to sum up the total effect of the independent variables on risk assessment. In the ordinary 2SLS model, several stocks characteristic variables are omitted due to collinearity, including EPS (earning per share), PE ratio (Price/ Earning) and Volume (trade volume). Starting with risk perception, from time 1 to time 5, subjects' risk perceptions do not show a consistent pattern or direction. It has the highest and significant coefficient in time 2. Based on random effects model sums up, risk perception has no significant coefficient, which means that risk perception does not have enough impact on risk assessment. On the other hand, risk preference has salient and positive correlation on risk assessment. It indicates that risk seekers would rate their investment risks higher, while the risk avoiders would rate their investment risks lower. It also demonstrates that risk preference has more influence on risk assessment than risk perception. The investor characteristic variables include gender, age, and education level. The investor characteristic variables are all not significant. These results suggest that subjects' individual characteristics do not make enough influences on their risk assessments in the

present study. The rest independent variables are stock characteristic variables. Among stock characteristic variables, only Beta has a significant result in the random effects model. Beta has a salient and positive coefficient, this result is intuitive when the subjects see the higher beta, and they would raise their risk assessments. Since beta is a common risk indicator in the stock market, its significant result is appropriate. The rest of the stock characteristic variables do not have salient results, which implies that the subjects only take little considerations on these variables when they evaluate the stock market.

Risk Adjustment					
Time	1	2	3	4	Random Effect
Perception	0.59***	-0.24*	-0.16	0.24*	0.12*
Preference	-0.12*	0.01	0.01	-0.06	-0.03
Gender	-0.07	-0.19	0.16	-0.10	0.01
Age	0.06	0.01	-0.16	0.11	-0.01
Education	-0.23	0.50**	-0.09	0.13	0.08
Price	0.00	-0.02	-0.25***	0.00	0.00
Beta	0.49**	0.24	3.28***	0.44	0.37***
weekhigh	-0.03	0.01	0.13***	0.01	0.00
weeklow	0.03	0.03	0.05	-0.03	0.00
EPS	0.30	-0.12	1.45***	0.24	0.08**
PEratio	0.03	-0.01	0.43***	0.02	0.01
Volume	0.02	0.01	-0.06***	0.00	0.00
Constant	1.71	-2.30*	-1.37	0.06	0.10
R^2	0.378	0.173	0.206	0.163	0.084
Num. obs	105	105	105	105	420

Table 10. Panel regression table of risk adjustment with stock characteristics

*p<.05, **p<.01, ***p<.001

Table 10 presents the panel regressions of risk adjustment with investor and stock characteristics. The definition of risk perception in the present study is that subjects' level of concern about their investment risks; it can be either optimism or pessimism. For example, when the subject is more optimistic about his investments, he would be defined as a subject with a high level of risk perception in the present study. As random effects model in table 10 described, risk perception has a significant and positive coefficient with risk assessment, which implies that subjects with high-risk perception would

have a high-risk adjustment. For example, when the subjects are optimistic about their investments, they would adjust their investments to higher risk, i.e. invest in higher beta stocks or more volatile stocks; they take more risk and expect a higher return. And the risk preference has no significant correlation. Also, the investor characteristics of gender, age, and education level are still not significant, which indicates these investor characteristic variables do not have enough influences on risk adjustment as well. On the other hand, among stock characteristic variables, only Beta and EPS show both salient and positive coefficients. It suggests that investors would adjust their risk-taking in the stock market mainly based on these two risk signals. The positive results demonstrate that subjects would adjust their risk taking along with Beta and EPS. When Beta or EPS increases, the investors would have high-risk adjustments in the stock market. For example, when the subjects are aware of the fact that a certain company's stock has high EPS or beta, the subjects are willing to have high-risk adjustment; they would have higher risk-taking on the company. The rest of stock characteristic variables are not significant, which implies these risk indicators are not the most important risk indicators for the subjects when they make the risk adjustments over time.

5.4. Panel Regression without Stock Characteristic Variables

Risk Assessment						
Time	1	2	3	4	5	Random effect
Perception	-0.35**	0.30**	0.11	-0.10	0.12	0.06
Preference	0.25***	0.11*	0.10	0.13*	0.09	0.13***
Constant	-0.45	0.84	0.96	0.72	1.12	0.70
R^2	0.124	0.110	0.041	0.030	0.040	0.041
Num. obs	105	105	105	105	105	525

Table 11. Panel regression table of risk assessment

*p<.05, **p<.01, ***p<.001

Table 11 above focuses mainly on the investor characteristic variables, namely risk preference and risk perception. Without the stock characteristic variables, this table demonstrates which investor characteristic is more influential to the subjects' risk assessment. In this table, risk perception does not have a persistent direction of influence, and only the first two periods have the significant coefficients with the different signal of positive and negative. Therefore, the random effect model can summarize

the total impact risk perception has on subjects' risk assessments clearly. The result shows risk perception does not have a salient correlation. This suggests that risk perception does not have a major impact on risk assessments. On the other hand, risk preference has a significant and positive coefficient, which demonstrates that risk preference has an important influence on subjects' risk assessments. The positive result shows that risk seekers would take more risk over time, while risk avoiders would take less risk. Comparing the results of risk perception and risk preference from the table above, it shows that risk preference has more influence on risk assessments than risk perception, which confirms hypothesis 1 that risk preference has more influence on investors' risk selection compare to risk perception.

Risk Adjustment					
Time	1	2	3	4	Random effect
Perception	0.64***	-0.18	-0.22*	0.23*	0.13**
Preference	-0.14**	-0.01	0.03	-0.04	-0.04
Constant	1.29	0.12	-0.23	0.39	0.42
R^2	0.185	0.017	0.038		0.010
Num. obs	105	105	105	105	420

Table 12. Panel regression table of risk adjustment

*p<.05, **p<.01, ***p<.001

Table 12 summarizes risk preference' and risk perception respective impacts on risk adjustments over time. As the random effect model in the last column sums up, the risk perception has a positive and significant coefficient, which demonstrates that the subjects with high-risk perceptions would have high-risk adjustments. In other words, subjects with more concerns about risk and have the propensity to rate investments with higher risk would have high-risk adjustment; and they would adjust their risk-taking to a higher level and expect higher returns. On the other hand, the risk preference does not have a salient coefficient. In all, by the comparison of the significance of risk preference and risk perception on risk adjustment, it is clear that risk perception has more influence on risk adjustment than risk preference. This result also proves hypothesis 2 that risk perception has more influence on investors' risk adjustment compared to risk preference.

In conclusion, risk preference has more impact on the first risk selection processing, and risk perception has more power on risk adjustment in the later stage of investment.

6. Conclusion

6.2. General Discussion

In the present study, the questionnaire form is conducted in order to obtain the first-hand information about investors' risk preference, risk perception and their investment decisions in the stock market. In the design of the questionnaire, different economic states are set through the different periods, so the study can explore the interactions between investors' characteristics and their risk decisions in different settings. In order to elicit risk preference and risk perception, point-biserial correlations, and two-stage least squares regression analysis and factor analysis are utilized. Also, because the questionnaire contains the time dimension, a panel regression is used to summarize the time effect throughout the whole questionnaire. A random effects model is selected to execute the panel regression because it focuses on individual differences correlated to dependent variables. In the present study, risk preference and risk perception both belong to the individual difference and correlate to risk decisions, therefore, random effects model is suitable for the present study.

Panel data are referring to data collected from the same individuals at different points in time; it is usually used for describing changes over time, for instance, changing attitude, social relationships, or risk attitude in the present study. Panel data usually include a time-invariant identifier for each individual (the questionnaire participants), a time-varying outcome (participants' risk choices), and an indicator for time (five evaluating periods). In all, panel data focus on analyzing changes over time. (Hsiao, 2007)

The significant results of the panel regressions prove the correctness of both hypotheses. Risk preference has a significant coefficient in risk assessment regression while risk perception does not, which indicates risk preference is more influential to risk assessment than risk perception. On the other hand, risk perception has a significant coefficient in risk adjustment regression and its correlation is bigger than risk preference's correlation, which also suggests risk perception has a strong impact on risk adjustment than risk preference. As a result, both hypotheses are proven to be correct.

6.3. Academic Contribution

In the academic field, there are plenty of studies about risk preference and risk perception. However, most of these studies approach these two concepts separately. The present study builds the bridge between risk preference and risk perception and seeks to explain how they influence the risk decisions investors make in the stock market. The study with the closest concept was done by Weber and Milliman (1997), they have done a repeated financial experiment to elicit subject's risk preference and risk attitude. The present study builds on Weber and Milliman's concepts to build the questionnaire. Yet there is much more sampling in the present study, and the hypotheses are both subsequently proven. Therefore, the present study fills the gap between risk preference and risk perception regarding their influence on investors risk choices.

6.4. Managerial Implications

From a corporation's standpoint, the present study shows which stock characteristic would be deemed as the most important indicator when investors consider in investing in the stock market. For instance, Beta and EPS in the present study have shown significant coefficients in risk assessment and risk adjustment regressions, which demonstrate these two risk characteristics are important references for investors. On the other hand, the present study also shed light on what is the driving force behind investors' risk decisions. For example, the high-beta company would attract more risk seekers. The company can take into account their investors' risk preference and risk perception to make improve their financial strategies.

6.5. Limitations and Directions for future Research

To start, any questionnaire faces bias issues, especially in an online questionnaire with a large sampling; some biases are almost inevitable, including selection bias and response bias. The subjects can still create further biases. They might be too busy to finish reading the instructions or explanation sections thoroughly and fill in the questionnaire randomly. They might also answer the questions based on instincts. These issues can form certain types of bias or produce skewed results and cannot be detected reliably.

Furthermore, the design of the questionnaire in the present study is complicated for the layman, especially for subjects without any knowledge regarding the stock market; the common stock risk indicators like PE ratio are unfamiliar to them. A number of subjects have expressed difficulties to finish

the questionnaire might drop out of the questionnaire results. That is a surprising outcome since the present study is already targeting individuals with economic or finance backgrounds. Yee some polled subjects still had troubles finishing the questionnaire. This suggests the questionnaire could be more streamlined, especially with a large sampling. Additionally, the stock market is not only approached by sophisticated dealers or finance background investors, the majority of investors have limited knowledge about stock and market functions yet are still trading stocks. Therefore, it is important for future studies to adopt a simpler questionnaire design which a majority investors can fully comprehend and subsequently capture a picture closer to the reality of the stock market.

Finally, even as the present study has found significant results that can prove the setting hypotheses, the low value of R-square indicates that the model's explanatory power is not sufficient. Especially without the stock characteristics, R-square drops rapidly.

In subsequent research, more variables could be added to create a more robust model. For instance, the comparison of regressions between *with* and *without* stock characteristics shows these have a large explanatory power of subjects' risk choices in the stock market, suggesting that adding more stock characteristics variables could improve the quality of future studies.

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8. Appendix

8.2. Appendix A. Complete Questionnaire

Risk Preference

The part of the questionnaire has been divided into two domains: investment and gambling. In the investment area, you would have 1,000 euro as an endowment. On the other hand, when you face the gambling questions, you would have only 500 euro as an endowment.

Investment 1

You have 1,000 euro, but you need to invest 500 euro first. Which option would you choose?

A. Receive 500 euro back for sure

B. 80% chance you will receive 1,000 euro, 20% chance you will get nothing

Investment 2

You have 1,000 euro, but you need to invest 500 euro first. Which option would you choose?

A. Receive 500 euro back for sure
B. 60% chance you will receive 1,000 euro, 40% chance you will get nothing

Investment 3

You have 1,000 euro, but you need to invest 500 euro first. Which option would you choose?

A. Receive 500 euro back for sure
B. 40% chance you will receive 1,000 euro, 60% chance you will get nothing

Investment 4

You have 1,000 euro, but you need to invest 500 euro first. Which option would you choose?

A. Receive 500 euro back for sure
B. 20% chance you will receive 1,000 euro, 80% chance you will get nothing

Gambling 1

You have 500 euro, but you need to pay all of them to gamble. Which option would you choose?

A. Receive 500 euro back for sure
B. 80% chance you will receive nothing, 20% chance you will receive 1,000 euro

Gambling 2

You have 500 euro, but you need to pay all of them to gamble. Which option would you choose?

A. Receive 500 euro back for sure
B. 60% chance you will receive nothing, 40% chance you will receive 1,000 euro

Gambling 3

You have 500 euro, but you need to pay all of them to gamble. Which option would you choose?

A. Receive 500 euro back for sure
B. 40% chance you will receive nothing, 60% chance you will receive 1,000 euro

Gambling 4

You have 500 euro, but you need to pay all of them to gamble. Which option would you choose?

A. Receive 500 euro back for sure
B. 20% chance you will receive nothing, 80% chance you will receive 1,000 euro

P.S. This part of the questionnaire order would be shuffled by the survey program survey planet, while the paper survey would be shuffled manually to prevent embedding bias.

Level of control

If you can adjust the probability of winning (or not losing money) for 5% in each scenario, would you be more willing to do this investment/gamble? (For example, in the gamble 4 question, you can change the probability as such: 15% chance you will receive nothing, 85% chance you will receive 1,000 euro, would you be more willing to do this investment/gamble?)

A. Not at all
B. Slightly
C. Moderately
D. Very
E. Extremely

Risk choices

The following questionnaire gives you 5 stocks from different companies and periods, please rate their risk based on the given information, and choose which stock you would choose.

Risk Judgment 1

Company	A	B	C	D	E
Current price	53	54	267	11	28
Beta	0.3	1.3	1.1	2.4	0.6
52 weeks high	58	58	321	19	32
52 weeks low	48	34	224	10	26
EPS(year)	4	4	15	2	2
PE ratio	11	15	19	7	9
Trade volume	12M	86M	5M	64M	38M

Given the information, please base on your own judgment to rate these stocks' comparative risk.(1=Least risky, 5=Most risky, different stocks would not have the same ranking. For example, A and B would not have ranked as 1=least risky together.)

Beta= the stock's volatility in comparison to the whole market, if beta>1 means this stock is more volatile than the market.
52 weeks high/low=the highest and lowest price the stock has traded during the previous year.
EPS (year) = Earnings per Share during the year.
PE ratio=Price/Earnings ratio. In general, higher PE ratio suggests higher earnings growth.
Trade volume=the total quantity of shares or contracts traded for the stock.

	1	2	3	4	5
A	○	○	○	○	○
B	○	○	○	○	○
C	○	○	○	○	○
D	○	○	○	○	○
E	○	○	○	○	○

Stock Selection 1

Company	A	B	C	D	E
Current price	53	54	267	11	28
Beta	0.3	1.3	1.1	2.4	0.6
52 weeks high	58	58	321	19	32
52 weeks low	48	34	224	10	26
EPS(year)	4	4	15	2	2
PE ratio	11	15	19	7	9
Trade volume	12M	86M	5M	64M	38M

Given the **same information as the last question**, which stock would you choose?

○ A ○ B ○ C ○ D

○ E

Voluntary

If you can choose to invest in the stock market, real estate, and the bank voluntarily, would you be more willing to take this investment?

A. Not at all

B. Slightly

C. Moderately

D. Very

E. Extremely

Risk Judgment 2

Company	A	B	C	D	E
Current price	73	96	343	9	37
Beta	0.3	1.2	1.1	2.3	0.6
52 weeks high	75	97	345	13	38
52 weeks low	50	51	240	9	27
EPS(year)	5	6	16	4	1
PE ratio	16	16	20	2	50
Trade volume	6M	92M	4M	28M	20M

Given the information, please base on your own judgment to rate these stocks' comparative risk. (1=Least risky, 5=Most risky, different stocks would not have the same ranking. For example, A and B would not have ranked as 1=least risky together.)

Beta= the stock's volatility in comparison to the whole market, if beta>1 means this stock is more volatile than the market.
52 weeks high/low=the highest and lowest price the stock has traded during the previous year.
EPS (year) = Earnings per Share during the year.
PE ratio=Price/Earnings ratio. In general, higher PE ratio suggests higher earnings growth.
Trade volume=the total quantity of shares or contracts traded for the stock.

	1	2	3	4	5
A	○	○	○	○	○
B	○	○	○	○	○
C	○	○	○	○	○
D	○	○	○	○	○
E	○	○	○	○	○

Stock Selection 2

Company	A	B	C	D	E
Current price	73	96	343	9	37
Beta	0.3	1.2	1.1	2.3	0.6
52 weeks high	75	97	345	13	38
52 weeks low	50	51	240	9	27
EPS(year)	5	6	16	4	1
PE ratio	16	16	20	2	50
Trade volume	6M	92M	4M	28M	20M

Given the **same information as the last question**, which stock would you choose?

○ A ○ B ○ C ○ D

○ E

Status Awareness Precision

If you are aware of your own financial status clearly, would you be more willing to take this investment?

A. Not at all

B. Slightly

C. Moderately

D. Very

E. Extremely

Risk Judgment 3

Company	A	B	C	D	E
Current price	73	70	424	16	34
Beta	0.4	0.8	0.9	2.3	0.4
52 weeks high	80	101	464	18	39
52 weeks low	67	55	318	9	33
EPS(year)	5	6	16	1	1
PE ratio	14	12	29	11	25
Trade volume	6M	83M	4M	40M	20M

Given the information, please base on your own judgment to rate these stocks' comparative risk. (1=Least risky, 5=Most risky, different stocks would not have the same ranking. For example, A and B would not have ranked as 1=least risky together.)

Beta= the stock's volatility in comparison to the whole market, if beta>1 means this stock is

more volatile than the market.
52 weeks high/low=the highest and lowest price the stock has traded during the previous year.
EPS (year) = Earnings per Share during the year.
PE ratio=Price/Earnings ratio. In general, higher PE ratio suggests higher earnings growth.
Trade volume=the total quantity of shares or contracts traded for the stock.

	1	2	3	4	5
A	○	○	○	○	○
B	○	○	○	○	○
C	○	○	○	○	○
D	○	○	○	○	○
E	○	○	○	○	○

Stock Selection 3

Company	A	B	C	D	E
Current price	73	70	424	16	34
Beta	0.4	0.8	0.9	2.3	0.4
52 weeks high	80	101	464	18	39
52 weeks low	67	55	318	9	33
EPS(year)	5	6	16	1	1
PE ratio	14	12	29	11	25
Trade volume	6M	83M	4M	40M	20M

Given the **same information as the last question**, which stock would you choose?

○ A ○ B ○ C ○ D

○ E

Immediacy

If you can know the investment results immediately and understand how the investment affects your finance, would you be more willing to take the investment?

A. Not at all

B. Slightly

C. Moderately

D. Very

E. Extremely

Risk Judgment 4

Company	A	B	C	D	E
Current price	64	108	630	14	32
Beta	0.4	0.9	0.9	1.3	0.4
52 weeks high	91	135	713	18	36
52 weeks low	62	92	491	10	31
EPS(year)	5	9	23	1	1
PE ratio	13	12	30	25	30
Trade volume	13M	77M	3M	50M	33M

Given the information, please base on your own judgment to rate these stocks' comparative risk. (1=Least risky, 5=Most risky, different stocks would not have the same ranking. For example, A and B would not have ranked as 1=least risky together.)

Beta= the stock's volatility in comparison to the whole market, if beta>1 means this stock is more volatile than the market.
52 weeks high/low=the highest and lowest price the stock has traded during the previous year.
EPS (year) = Earnings per Share during the year.
PE ratio=Price/Earnings ratio. In general, higher PE ratio suggests higher earnings growth.
Trade volume=the total quantity of shares or contracts traded for the stock.

	1	2	3	4	5
A	○	○	○	○	○
B	○	○	○	○	○
C	○	○	○	○	○
D	○	○	○	○	○
E	○	○	○	○	○

Stock Selection 4

Company	A	B	C	D	E
Current price	64	108	630	14	32
Beta	0.4	0.9	0.9	1.3	0.4
52 weeks high	91	135	713	18	36
52 weeks low	62	92	491	10	31
EPS(year)	5	9	23	1	1
PE ratio	13	12	30	25	30
Trade volume	13M	77M	3M	50M	33M

Given the **same information as the last question**, which stock would you choose?

○ A ○ B ○ C ○ D

○ E

Severity

If this invest affect your financial status more greatly, would you be more willing to take this investment?

A. Not at all

B. Slightly

C. Moderately

D. Very

E. Extremely

Risk Judgment 5

Company	A	B	C	D	E
Current price	76	103	589	18	35
Beta	0.5	0.9	1.2	1.5	0.5
52 weeks high	81	104	614	18	37
52 weeks low	72	64	421	14	32
EPS(year)	5	6	19	3	3
PE ratio	16	16	31	6	10
Trade volume	5M	54M	2M	19M	13M

Given the information, please base on your own judgment to rate these stocks' comparative risk. (1=Least risky, 5=Most risky, different stocks would not have the same ranking. For example, A and B would not have ranked as 1=least risky together.)

Beta= the stock's volatility in comparison to the whole market, if beta>1 means this stock is

more volatile than the market.
52 weeks high/low=the highest and lowest price the stock has traded during the previous year.
EPS (year) = Earnings per Share during the year.
PE ratio=Price/Earnings ratio. In general, higher PE ratio suggests higher earnings growth.
Trade volume=the total quantity of shares or contracts traded for the stock.

	1	2	3	4	5
A	○	○	○	○	○
B	○	○	○	○	○
C	○	○	○	○	○
D	○	○	○	○	○
E	○	○	○	○	○

Stock Selection 5

Company	A	B	C	D	E
Current price	76	103	589	18	35
Beta	0.5	0.9	1.2	1.5	0.5
52 weeks high	81	104	614	18	37
52 weeks low	72	64	421	14	32
EPS(year)	5	6	19	3	3
PE ratio	16	16	31	6	10
Trade volume	5M	54M	2M	19M	13M

Given the **same information as the last question**, which stock would you choose?

○ A ○ B ○ C ○ D

○ E

8.3. Appendix B. Regression Specification Tests

Appendix B1. Determination of fixed effect or random effect model: Hausman test

Appendix B1. Determination of fixed effect or random effect model: Hausman test

	Fixed (b)	Random (B)	Difference (b-B)	S.E. sqrt(diag(V_b-V_B))
Price	-0.0031201	-0.0031990	0.0000789	0.0005209
Beta	0.4586888	0.4848891	-0.0262003	0 0.313873
weekhigh	0.0067333	0.0068318	-0.0000985	0 .0012209
weeklow	-0.0062359	-0.0063607	0.0001248	0.0015082
EPS	0.0405932	0.0495858	-0.0089925	0.0078389
PEratio	0.0024280	0.0046146	-0.0021866	0 .0012118
volume	0.0028287	0.0034651	-0.0006364	0 .0006073

H0: Both estimators are consistent, but B has the smallest variance

H1: b is consistent and B is inconsistent

$\chi^2(7)=(b-B)'[(V_b-V_B)^{-1}](b-B)=12.57$, Prob>$\chi^2$ =0.0832

Thus, under 95% confidence interval, it cannot reject the null hypothesis. This means a random effect model would be used for this analysis.

Appendix B2. Model assumption: Breusch-Pagan Lagrange Multiplier test

	Var	σ
Risk	1.84269	1.357457
e	0.868185	0.931764
u	0.730472	0.854676

χ2(01) =207.85

Prob> χ2=0.000

The Breusch-Pagan LM test performed rejects the null hypothesis that equal variance of the residual. Rejecting the null hypothesis implies that there are random effects within the data.

8.4. Appendix C. Comparability Tests

	Value
Likelihood ratio	
Chi^2_ms(9)	7.624
p> chi^2	0.572
Population error	
RMSEA	0.00
90% CI, lower bound	0.00
upper bound	0.098
pclose	0.743
Size of residuals	
SRMR	0.054
Coefficient of determination	0.229

The Chi-square test of model fit cannot reject the null hypothesis, which indicates the model is a good fit. And Root means square error of approximation (RMSEA) and Standardized root mean squared residual (SRMR) are both under good fit level.