Professor Fenghua WEN, PhD (Corresponding author)
E-mail: wenfenghua54321@sina.com
School of Business, Central South University, China
Zhifang HE, PhD Student
E-mail: hezfang@126.com
School of Business, Central South University, China
Professor Zhifeng DAI, PhD
E-mail: zhifengdai823@163.com
School of Economics and Management
Changsha University of Science & Technology, China
Professor Xiaoguang YANG, PhD
E-mail: xgyan@iss.ac.cn
Academy of Mathematics and Systems Science
Chinese Academy of Sciences, China

CHARACTERISTICS OF INVESTORS' RISK PREFERENCE FOR STOCK MARKETS

Abstract. *Based on the characteristics of investors' risk preference, which is considered to change with the two opposite outcomes (gain/loss), we build a D-GARCH-M model by dividing investors' return into gains and losses. Then we introduce a reference return which is used to measure the value of gains and losses into the model to allow the reference return controlling the characteristics of investors' risk preference to change. The top ten market value stock composite indexes in Global Stock Exchange are adopted to make the empirical analysis. Results show that investors become risk averse when they gain and risk seeking when they lose, which effectively explains the inconsistent risk-return relationship. And with the different distribution of the error item in the D-GARCH-M model, there are also differences between the extent of risk aversion in gains and that of risk-seeking in losses. Considering the influence of the magnitude of gains/losses on the risk preference, we find the degree of investors' risk aversion and risk-seeking is in direct proportion to the value of gains and losses respectively. What's more, for the same size of gains and losses, the extent of risk seeking with losses is greater than that of risk aversion with gains.*

Keywords: *risk preference, prospect theory, GARCH-M Model.*

JEL Classification: D13, E14

1. Introduction

Investing behavior under risk in financial market is an important topic in asset valuation research area. Expected return will rise with risk (uncertainty) as investors hold a risky asset only if they are compensated with proportionally higher returns. In the capital asset pricing model (Sharpe, 1964), asset risk can be measured as the covariance of asset return with the market return. Merton's (1973) ICAPM suggests that the conditional expected excess return on the stock market should vary positively with the market's conditional variance, that is, $E(r_{t+1}) = \mu + \gamma h_t(r_{t+1})$, where $E(r_{t+1})$ refers to the conditional return, γ is the coefficient of relative risk aversion of the representative agent, $h_t(r_{t+1})$ is asset's variance conditioned on the information set at period *t*. And according to the equation, μ should be equal to zero, and parameter γ should be in positive correlation with return. Some other authors also expressed the similar viewpoints that the relationship between risk and return is statistically significant positive (Ghysels, 2005; Guo and Whitelaw, 2006). However, there is a great argument about the empirical evidence of this relevant fact in financial literature. Some studies show a significantly negative risk-return relation (Ang et al.,2006; Bali et al., 2009). In researches studied by Christensen and Nielsen (2007), they discover both positive and negative relations which are depended on the method used. Besides, some even find no relation between return and risk (Campbell and Hentschel, 1992; Goyal and Santa-Clara et al., 2003).

Many authors attempted to explain the conflicting empirical evidence with different methods. Lanne and Luoto (2008) emphasize that only if the constant term in the conditional mean equation equals zero, can risk and return be in positive correlation. While Kanas (2012) insists that the role of the conditional distribution of excess market returns has great effects on the relation, therefore he considers alternative distribution, that is, the Normal Distribution, the Student's t Distribution and the Generalized Error Distribution. Wen and Yang (2009) make an empirical research on 33 stock markets composite indexes and hold that risk premium coefficients of the same market in different phases are different, that is, investors' risk preference is time-varying. Christensen et al. (2012) conclude that only in financial crisis times is there a significant positive correlation between risk and return, whereas in normal times there isn't significant relation. Some other factors also have attracted considerable attention. For instance, Guo and Neely (2008) find that there is a significant positive relation between long-term volatilities and return but insignificant relation between short-term volatilities and return. The delayed behavior is also investigated (Qin et al., 2013, Cui et al., 2013, Huang et al., 2013a). Despite these suggestions, a robust answer for the risk-return relation is still being investigated.

This paper examines the relation between risk and return on the basis of Behavioral Finance Theory, considering investors themselves' irrational behaviors in stock trading may be largely responsible for the inconsistent empirical evidence.

According to prospect theory (Kahneman and Tversky, 1979), people pay much more attention to the changes of wealth, rather than final asset positions which include current wealth. Their experiments suggest that individuals tend to be risk-seeking with respect to losses and risk averse with respect to gains. Many studies have found that people's risk attitudes would change with circumstances, and the outcomes with gains or losses will affect the subsequent risk-taking behaviors of investors (Hsu and Chow, 2013; Huang and Chan, 2014). Therefore, investors' different attitudes toward gains and losses will affect their relationship between risk and return, and we believe it is an important reason for the existence of both positive and negative relation between risk and return. Moreover, given the results in Anderson (1999) that the risk premium has relation to investors' return and people's degree of risk aversion varied with return. Wen et al. (2014a) have also expressed similar viewpoints. In fact, it can be described that people's risk preference changes with return. In this paper, we also focus on the influence of the value of return on risk preference by introducing a reference return and dividing it into gains and losses. However, based on the Behavioral Finance Theory, most of these empirical researches on the relationship between the outcome and risk preference are done with the help of psychological experiments and data from investors' transaction accounts. On the premise of investors' limited rationalities, real market scenes can hardly be simulated through experiment, while data from investors' transaction accounts is often not representative because it is difficult to obtain. What's more, the sample size obtained through the two means is not large enough. To solve these problems, this paper takes the behavior of the whole stock market as the research object, and adopts composite index of 10 representative stocks markets around the world as samples to verify the characteristics of investors' risk preference.

On the basis of previous studies and theories, the paper divides investors' return into gains and losses to examine the change of the risk preference with different outcomes, and builds a D-GARCH-M model. Then the model is extended to DR-GARCH-M model with further consideration of the influence of the value of return on risk preference. The remainder of the paper is organized as follows: Section 2 presents the model; Section 3 provides the empirical analysis; Robustness test is presented in Section 4 and Section 5 is the conclusion of this paper.

2. The Model

2.1 The outcome and risk preference

As the financial market volatility is typically featured in time-varying and clustering, and GARCH-M model can characterize these features. The model also takes conditional variance in the conditional mean equation to explain return, which had been widely used to study the relationship between risk and return. The main idea in GARCH-M model allows the conditional variance to have an impact on the conditional mean of the return. This is stated formally as:

$$\begin{cases} r_t = c + \gamma h_t + \varepsilon_t \\ \varepsilon_t = \sqrt{h_t}\eta_t \\ h_t = \alpha_0 + \alpha\varepsilon_{t-1}^2 + \beta h_{t-1} \end{cases} \tag{1}$$

where $E(\eta_t)=0,\ D(\eta_t)=1$, daily stock return is $r_t = 100*\ln(p_t / p_{t-1})$, h_t is conditional variance, $\alpha_0 > 0,\ \alpha \geq 0,\ \beta \geq 0$, and $\alpha+\beta<1$ guarantee the stationarity of return process. Defined in model (1), return can be divided into three parts: the constant term c, the return γh_t based on risk compensation, and the return ε_t from external impact. Parameter γ reflecting the risk-return relationship is called risk premium, which can also be used to measure investors' risk preference (Wen and Yang, 2009; Wen et al., 2014b), and its sign represents investors' risk attitude. $\gamma = 0$ indicates that investors' expected returns are not sensitive to the risk they take, so they are risk-neutral. $\gamma < 0$ is the negative risk premium that means investors can sacrifice certain interests to take some risks, which suggests that investors like pursuing risk and are risk seeking. The neoclassical interpretation of a negative risk premium is risk-seeking preferences. $\gamma > 0$ means investors require more risk compensation for taking higher risks, which denotes people are risk averse. Despite the importance of the risk-return relationship and the apparent theoretical appeal of Merton's result, the empirical asset pricing literatures have not yet reached an agreement on the existence of such a positive risk-return trade-off for stock market indexes. Some find positive correlation and some show negative correlation or no clear relationship between risk and return.

In most previous studies on the risk-return relation, such a hypothesis is implied, that is, in certain period, the risk premium coefficient γ remains constant, which means the required risk compensation for each unit of risk is unchanged. However, according to prospect theory, investors are risk aversion when they gain, and risk-seeking when they lose, which denotes that they have different risk preferences towards the condition of gains and losses. In other words, the parameter γ should be different with respect to gains and losses. So this paper holds that investors' gains and losses can make great influence on their attitude towards risk.

Therefore, we take traditional GARCH-M model as basic model, and introduce two indicative variables which are used to make a distinction between gains and losses to reflect the change of investors' risk preference. We call it D-GARCH-M model and it is expressed as:

$$\begin{cases} r_t = c + \gamma h_t + \varepsilon_t \\ \gamma = \gamma_1 \cdot Du_t + \gamma_2 \cdot Dd_t \\ \varepsilon_t = \sqrt{h_t}\eta_t \\ h_t = \alpha_0 + \alpha\varepsilon_{t-1}^2 + \beta h_{t-1} \end{cases} \tag{2}$$

where Du_t and Dd_t are dummy variables for gains and losses respectively. Specifically, Du_t equals 1 if $p_t > rp_t$, otherwise it equals zero; Dd_t equals 1 if $p_t < rp_t$, otherwise it is zero. Where, p_t is the stock price and rp_t represents investors' reference price. According to the Prospect theory, investors are in gains when the stock price is higher than the reference price, and losses otherwise. So the dummy variables Du_t and Dd_t can represent investors' state of gain and loss respectively.

It should be pointed out that the reference price is a critical factor to the judgment of gain and loss. It determines whether the outcome is judged as gain or loss and significantly affects subsequent risk preference. When making decisions, investors often refer to the reference price intentionally or unintentionally. Reference price, as a kind of investors' psychological price, is determined by subjective individual, and there is no normative and definite unified criterion. In stock markets, investors' practical operations during the process of investment when choose reference price should be taken into consideration. In terms of consumer behavior, a class of consumers base buying decisions on the past prices and recent price (Huang et al., 2013b). In fact, the moving average process of the stock price, a key trend indicator in stock technological analysis, attracts considerable attention when investors make their decisions to buy or sell and they often make analysis on the trend lines (the 5-day, 10-day, 30-day moving average). In analysis of these trend lines, investors concern much more with the daily average trend of 5-day-moving average, Huang et al. (2013c) propose a series of new reference prices according to the expression of moving average, so we choose the 5-day moving average as the reference price determining investors' gains and losses. The reference price is estimated as $rp_t = \frac{p_t + p_{t-1} + p_{t-2} + p_{t-3} + p_{t-4}}{5}$ (p_{t-1}, p_{t-2}, p_{t-3}, p_{t-4} are the stork price at period t-1, t-2, t-3, t-4 respectively).

Therefore, parameter γ_1 represents the required compensation for each unit of risk when obtain gains, and γ_2 can denote the required risk compensation when obtain losses. Their signs reflect investors' risk preference in gain or loss situation. According to prospect theory, γ_1 should be greater than zero, and γ_2 should be less than zero, namely, investors are risk aversion when gain and risk-seeking when lose.

2.2 The value of return and risk preference

As discussed above, many previous studies have considered the magnitude of return will affect investors' demanding compensation for risk taking. We further examine whether the magnitude of current return will cause investors' risk preference which is changed with the division of their gain and loss. According to prospect theory, decision makers evaluate outcomes in terms of gains and losses relative to a reference point, so when estimate the magnitude of the return that influence investors' risk preference in stock market, the reference price should also be taken into consideration. We estimate the magnitude of investors' return related to reference return, which is defined as: $dr_t = (p_t - rp_t) / rp_t$. p_t and rp_t are stock price and investors' reference price respectively. To be consistent with the logarithm form of return, we adopts the logarithm form of reference return and dr_t is adjusted as: $dr_t = 100 * \ln(p_t / rp_t)$. Therefore, the value of investors' gain and loss can be denoted by positive and negative referenced return respectively, and the prior D-GARCH-M model can be extended to the following model, which is called DR-GARCH-M model:

$$\begin{cases} r_t = c + \gamma h_t + \varepsilon_t \\ \gamma = \gamma_1 \cdot dr_t \cdot Du_t + \gamma_2 \cdot (-dr_t) \cdot Dd_t \\ \varepsilon_t = \sqrt{h_t}\eta_t \\ h_t = \alpha_0 + \alpha\varepsilon_{t-1}^2 + \beta h_{t-1} \end{cases} \tag{3}$$

Where, $dr_t \cdot Du_t$ stands for the magnitude of gains that influence investors' risk preference, and $(-dr_t) \cdot Dd_t$ can be viewed as the magnitude of losses that influence investors' risk preference. Parameter γ_1 reflects investors demanding compensation for each unit of risk when obtain each unit of gain. $\gamma_1 \cdot dr_t$ describes that the required compensation varies with the value of gains for each unit of risk, and if γ_1 does not change, the total required compensation for risk rises with the increasing value of gains. Similarly, γ_2 represents the compensation investors demanded for each unit of risk when occur each unit of loss, and $\gamma_2 \cdot (-dr_t)$ illustrates that the required compensation is varied with the magnitude of losses for each unit of risk. What's more, just as we explained in model (2), the sign of γ_1 and γ_2 can also reflect people's different preferences.

3. Empirical Analysis

3.1 Samples and statistics

This paper takes the composite index of the top ten market capitalizations in stock markets according to the global stock exchange in 2012 as samples[1], including NYSE, NASDAQ, N225, FTSE, SSE, HIS, TSX, DAX, AORD and BSE. We choose the daily closing price of each index for study and the time span is from March 1st of 2002 to March 30th of 2012. Those data are from RESSET database and the basic statistics of the daily return of the above indexes are presented in Table 1:

Table1. Descriptive Statistics of returns

Index	Mean	Std.Dev.	Skewness	Kurtosis	JB statistic	ADF Test
NYSE	0.011092	1.417882	-0.319853	11.71722	8072.841	-54.66
NASDAQ	0.020059	1.540381	-0.073165	7.778844	2405.885	-54.16
N225	-0.005840	1.574768	-0.519431	10.91186	6553.403	-51.26
FTSE	0.003464	1.331208	-0.118303	9.447372	4410.472	-24.43
SSE	0.014062	1.702013	-0.181743	6.516299	1263.707	-48.98
HSI	0.025817	1.624365	0.055671	11.81611	7984.151	-50.69
TSX	0.018383	1.227107	-0.627351	12.55346	9504.789	-51.87
DAX	0.010606	1.641213	0.065995	7.537473	2206.568	-51.76
AORD	0.009815	1.069175	-0.532882	8.904713	3831.159	-51.75
BSE	0.062190	1.645750	-0.066960	10.60485	6011.757	-46.49

In table 1, it can be seen that return of each index has a very small mean and negative skewness; the kurtosis exceeds that of the normal distribution, and thus each return distribution is heavily tailed. The J-B statistic rejects the null hypothesis at the 1% confidence level, indicating each return don't follow normal distribution. As the GARCH-type model requires stationary series, we adopt ADF test. And the ADF results indicate that all the index return series are stationary. So we can use the GARCH models to study.

3.2 Estimation and Results

3.2.1 Risk preference varies with the state of gain/loss

The paper firstly employs GARCH-M model to study the relationship between risk and return, then adopts the newly built D-GARCH-M model to further study the characteristic of investor's risk preference in the state of gain and

[1] The ranking of the market capitalization in stock market is from the World Federation of Exchanges. Data of NYSE Euronext (Europe), the top 5, is not accessible and is replaced by the top 11, BSE.

loss; and the results of the two models are compared and analyzed. Since previous empirical results are very sensitive to the constant term in the mean equation and the conditional distribution of error term. So we estimate the GARHC-M model and D-GARCH-M model both with and without constant term as well as the different error distribution, and the results are shown in Table 2 and table 3.

Table 2. Estimation of GARCH-M model

Index		**Normal Distribution**		**T-Distribution**		**Generalized Error Distribution**	
		With constant	**Without constant**	**With constant**	**Without constant**	**With constant**	**Without constant**
NYSE	c	0.050204**		0.068119***		0.070190***	
	γ	0.006149	0.030820**	0.005308	0.038085***	0.008760	0.041752***
	AIC	2.964878	2.966049	2.939700	2.942558	2.934391	2.938082
NASDAQ	c	0.053696*		0.081593***		0.089752***	
	γ	0.009484	0.032214***	-0.001580	0.032799***	-0.002118	0.035773***
	AIC	3.320519	0.032214***	3.307396	3.309271	3.304216	3.306754
N225	c	0.054453		0.057206		0.051487	
	γ	0.001645	0.022561*	0.004099	0.026152**	0.006238	0.026604**
	AIC	3.423698	3.423816	3.414401	3.414617	3.413969	3.413982
FTSE	c	0.027922		0.040120*		0.039036*	
	γ	0.023516	0.038555***	0.017039	0.039008***	0.017491	0.038559***
	AIC	2.909959	2.909841	2.900891	2.901471	2.900531	2.901024
SSE	c	-0.037153		-0.060144		-0.060319	
	γ	0.023108	0.010606	0.037030*	0.017274*	0.045830***	0.024760**
	AIC	3.704944	3.704342	3.650088	3.649909	3.642185	3.642070
HSI	c	0.041957		0.056972*		0.048084*	
	γ	0.013204	0.028199**	0.006606	0.027258**	0.011282	0.029138**
	AIC	3.348424	3.348376	3.333787	3.334444	3.324840	3.325237
TSX	c	0.057381**		0.069765***		0.063352***	
	γ	0.001061	0.039614**	0.006613	0.052634***	0.011611	0.053907***
	AIC	2.732591	2.734353	2.718430	2.721596	2.718011	2.720584

DAX	c	0.074403**		0.096381***		0.098139***	
	γ	0.005832	0.033431***	-0.004178	0.031515***	-0.003291	0.033221***
	AIC	3.385546	3.387258	3.369113	3.372661	3.364106	3.368068
AROD	c	0.059150***		0.066081***		0.066527***	
	γ	-0.001446	0.045459**	-0.003545	0.049068***	-0.005906	0.048131***
	AIC	2.516047	2.519478	2.504516	2.509143	2.506270	2.510976
BSE	c	0.113830***		0.132535		0.133270***	
	γ	0.003999	0.042796***	0.003965	0.050488***	0.002336	0.048924***
	AIC	3.493813	3.496946	3.467631	3.472018	3.475332	3.479821

Note: *,**and*** indicate significance at the 10%, 5% and 1% level, respectively.

Table 2 shows the results of GARCH-M model in different specifications. We find that no matter which distribution the error term follows, the normal distribution, the student *t* distribution or Generalized Error Distribution (GED), the parameter γ fails to achieve statistical significance across almost all of the stock indexes when there is a constant term in the mean equation; while for the model without the constant term, the parameter γ is strongly statistically significant and positive. It illustrates that the constant term of the mean equation in GARCH-M model indeed has great effect on the relation between risk and return. And only when the constant is restricted to zero can the relationship between risk and return be significant positive, which means the risk compensation increases with the risk and investors are risk averse. After comparing the AIC values in alternative distribution, we found that the AIC in normal distribution is the largest, and in student *t* distribution and the GED are roughly equal.

According to the prospect theory, investors' risk attitude towards risk in the state of gain is not consistent with that in the state of loss, which means that there is some difference between their risk preferences in different situation. So we estimate the D-GARCH-M model to investigate investors' risk preference under the two opposite positions. Meanwhile, the inclusion or not of the constant term and the alternative error distribution also has attracted considerable attention, the results are shown in Table 3.

Table 3. Estimation of D-GARCH-M model

Index		Normal Distribution		T-Distribution		GED	
		With constant	Without constant	With constant	Without constant	With constant	Without constant
NYSE	c	-0.0392*		0.0006		0.0248	
	γ_1	0.7464***	0.6476***	0.4862***	0.4867***	0.2847***	0.3617***
	γ_2	-0.5553***	-0.5750***	-0.4988***	-0.4984***	-0.2636***	-0.3286***
	AIC	2.7652	2.7699	2.6656	2.6648	2.7256	2.7052
NASDAQ	c	-0.0225		-0.0284		0.0058	
	γ_1	0.5261***	0.5097***	0.5417***	0.5189***	0.3338***	0.3355***
	γ_2	-0.3846***	-0.3991***	-0.5459***	-0.5642***	-0.2714***	-0.2726***
	AIC	3.2011	3.1969	2.9628	2.9623	3.0310	3.0307
N225	c	-0.0303		-0.1074**		-0.0900*	
	γ_1	0.4724***	0.4739***	0.5686***	0.4901***	0.5081***	0.4476***
	γ_2	-0.4326***	-0.4398***	-0.4535***	-05241***	-0.4156***	-0.4706***
	AIC	3.2649	3.2851	3.0941	3.0949	3.1156	3.1127
FTSE	c	-0.8334		-0.0458		-0.0315	
	γ_1	0.5520***	0.5453***	0.5414***	0.4938***	0.4778***	0.3668***
	γ_2	-0.4798***	-0.3981***	-04578***	-0.4902***	-0.3675***	-0.2790***
	AIC	2.8139	2.8148	2.6385	2.6388	2.6529	2.6780
SSE	c	-0.0044		-0.1139		-0.0256	
	γ_1	0.4467***	0.4254***	0.6096*	0.5340**	0.4342***	0.4210***
	γ_2	-0.4086***	-0.4280***	-0.3010	-0.4232**	-0.4279***	-0.4429***
	AIC	3.6676	3.6139	3.3426	3.3407	3.3233	3.3223
HSI	c	0.0022		-0.0571		0.0122	
	γ_1	0.2332***	0.4712***	0.4768***	0.4372***	0.2040***	0.2058***
	γ_2	-0.1653***	-0.3633***	-0.4033***	-0.4343***	-0.1659***	-0.1635***
	AIC	3.3412	3.3425	3.0456	3.0457	3.1499	3.1488
TSX	c	-0.0096		-0.0130		-0.0277	
	γ_1	0.5843***	0.5831***	0.6506***	0.6334***	0.6766***	0.6334***
	γ_2	-0.4767***	-0.4796***	-0.6424***	-0.6568***	-0.5937***	-0.6470***
	AIC	2.6088	2.6029	2.4155	2.4147	2.4245	2.4217
DAX	c	-0.1352		-0.0267		-0.0352	
	γ_1	0.4763***	0.4478***	0.4620***	0.4430***	0.4600***	0.4346***
	γ_2	-0.3727***	-0.4266***	-0.4482***	-0.4611***	-0.4405***	-0.4570***

	AIC	3.7837	3.0930	3.0678	3.0672	3.0728	3.0725
AORD	c	-0.0161		-0.008012		0.0428**	
	γ_1	0.7524***	0.7927***	0.6546***	0.6417***	0.3851***	0.4223***
	γ_2	-0.0161***	-0.7457***	-0.6675***	-0.6764***	-0.3550***	-0.3177***
	AIC	2.4067	2.3801	2.2237	2.2229	2.2859	2.2838
BSE	c	0.1009**		0.1304		0.0442*	
	γ_1	0.3553***	0.4212***	0.3211	0.3580	0.1844***	0.1884***
	γ_2	-0.4979***	-0.4539***	-0.3499	-0.3146	-0.1687***	-0.1597***
	AIC	3.3786	3.2185	3.2200	3.2175	3.2954	3.2989

Note: *,**and*** indicate significance at the 10%, 5% and 1% level, respectively.

In Table 3, we can see that, regardless of whether the distribution assumptions of the error term is the normal distribution, the student *t* distribution, or the Generalized Error Distribution, there exist $\gamma_1 > 0$, and $\gamma_2 < 0$, That is to say, the investor's demand increasing compensation for higher risk when obtain gains, which means that investors are risk averse in gain condition; on the other side, investor's required compensation could be less than zero for taking certain risks in loss position, which indicates that investors are risk-seeking in losses. At the same time, $\gamma_1 > 0$ implies a negative relationship between risk and return, while $\gamma_2 < 0$ means a negative risk-return trade-off. Therefore, it also effectively explains the phenomenon that the relation between risk and return is inconsistent. Specifically, investors are risk aversion in the state of gain, reflecting a positive risk-return relationship; while risk-seeking in the loss situation, implying a negative risk-return relationship. Unlike the GARCH-M model, in which the risk premium coefficient γ is significantly positive only when the constant term is excluded, the parameter γ_1 in D-GARCH-M model is significantly positive and γ_2 is significantly negative no matter whether there is a constant term or not. Therefore, it is clear that the estimation for the D-GARCH-M model in this paper is not influenced by the constant term in the mean equation.

As to the AIC values under different distribution, we find that the AIC in the normal distribution is still the largest. What is different from GARCH-M model is that the AIC in the D-GARCH model with the student *t* distribution is relatively smaller, which indicates that the D-GARCH-M model with the student *t* distribution fits best.

With reference to the value function in prospect theory, which is generally steeper for losses than for gains, implies that equal-magnitude gains and losses do not have the same impacts on risk-taking, and that losses hurt more than gains satisfy, which means investors' risk preference is more sensitive to loss than to gain. To further explore whether there is significant discrepancy between γ_1 and $|\gamma_2|$, the paper uses the Wald test. As the constant term is insignificant in the model, here we just give the Wald test result about whether there is significant difference in D-GARCH-M model without the constant term in alternative distributions in Table 4.

Table 4 . Wald test in D-GARCH-M model

Index	**The null hypothesis** $H_0: \gamma_1 = \|\gamma_2\|$					
	Normal Distribution		**T-Distribution**		**GED**	
	Chi-square	**Probability**	**Chi-square**	**Probability**	**Chi-square**	**Probability**
NYSE	4.315167	0.0378	0.128283	0.7202	1.7E+165	0.0000
NASDAQ	10.95543	0.0009	2.130183	0.1444	1.2E+184	0.0000
N225	0.743529	0.3885	1.181219	0.2771	0.576921	0.4475
FTSE	4.345624	0.0371	0.01134	0.9160	6.608236	0.0102
SSE	0.004683	0.9454	0.181025	0.6705	0.633658	0.4260
HSI	10.61845	0.0011	0.010761	0.9174	7.3E+162	0.0000
TSX	6.339906	0.0118	0.352496	0.5527	0.118798	0.7303
DAX	0.528462	0.4673	0.400323	0.5269	0.603183	0.4374
AORD	8.041535	0.0046	0.692413	0.4053	6.075570	0.0137
BSE	1.268205	0.2601	0.023540	0.8781	1.5E+198	0.0000

Table 4 shows that the distribution of error term has great influence on the significant difference between γ_1 and $|\gamma_2|$, that is to say, whether there is significant difference between investors' magnitude of risk aversion with a gain and that of risk-seeking with a loss, it is depended by the distribution of error term. Under normal distribution, some indexes cannot reject the null hypothesis of $\gamma_1 = |\gamma_2|$, whereas others reject it. It suggests that the degree of risk aversion in gains and that of risk-seeking in losses has no obvious size rule when the error term in normal distribution. Under *t*-distribution, according to the result of Wald test, each index can't reject the null hypothesis of $\gamma_1 = |\gamma_2|$, so there is no significant difference between the degree of risk aversion with gains and that of risk-seeking with losses. While in GED distribution, we find that the indexes (N225, SSE, TSX, DAX) can not reject the null hypothesis of $\gamma_1 = |\gamma_2|$, there exists $\gamma_1 < |\gamma_2|$ referring to the GED in Table 3. However, for other indexes which can reject the null hypothesis, there exists the value of γ_1 are greater than $|\gamma_2|$ in table 3. Therefore, it is known that, in Generalized Error Distribution, the degree of risk aversion with gain is greater than that of risk-seeking with loss as a whole.

In a word, different distributions of error term result in difference in investors' sensitivity to risk compensation when get gains and losses. In normal distribution, there is no obvious relationship between investors' extent of risk aversion in gain and that of risk-seeking in loss. And investors' sensitivity to gain and loss are basically similar in *t*-distribution. However, under Generalized Error Distribution, investors are more sensitive to gain than to loss, that is, when investors are in gain, their extent of risk aversion for each unit of risk are equal to or greater than that of risk-seeking when in loss, which is the opposite to that in the prospect theory.

3.2.2 Risk preference varies with the magnitude of gains/losses

Confirming the risk preference changes with the return of investors, we go further to observe the influence of current value of gains or losses on the compensation demanded by investors for risk taking. In consistent with former study, we divide the reference return into gains (the positive reference return) and losses (the negative reference return) to measure the magnitude of the gains and losses of investors, which is expressed in the DR-GARCH-M model. In the empirical study of DR-GARCH-M model, we find the constant terms in conditional mean equation of most indexes are insignificant, so we remove the constant term when estimate. Being the same with the estimation of D-GARCH-M model, we also estimate the DR-GARCH-M model in alternative error distribution. The results under normal distribution, *t*-distribution and Generalized Error Distribution are shown in table 5, table 6 and table 7 respectively.

Table 5． Estimation of DR-GARCH-M model and Wald Test under normal distribution

Index	Coefficient			The null hypothesis $H_0: \gamma_1 = \|\gamma_2\|$	
	γ_1	γ_2	AIC	Chi-square	Probability
NYSE	0.585453***	-0.619240***	2.682564	2.587687	0.0991
NASDAQ	0.540432***	-0.530506***	2.864085	0.421944	0.5160
N225	0.516576***	-0.540558***	2.957096	3.856828	0.0495
FTSE	0.649162***	-0.694566***	2.602357	6.393670	0.0115
SSE	0.460943***	-0.483038***	3.103326	2.905098	0.0883
HSI	0.412594***	-0.461543***	2.988079	16.52418	0.0000
TSX	0.812179***	-0.848423***	2.374981	2.982864	0.0868
DAX	0.431244***	-0.440906***	2.978197	0.502728	0.4783
AORD	1.173192***	-1.177361***	2.178916	0.019305	0.8895
BSE	0.455234***	-0.474466***	3.020727	3.310190	0.0689

Note: *,**and*** indicate significance at the 10%, 5% and 1% level, respectively.

Table 6. Estimation of DR-GARCH-M model and Wald Test under *t*-distribution

Index	Coefficient			The null hypothesis $H_0: \gamma_1 = \lvert\gamma_2\rvert$	
	γ_1	γ_2	AIC	Chi-square	Probability
NYSE	0.455025***	-0.510445***	2.486871	14.40075	0.0001
NASDAQ	0.541486***	-0.553685***	2.784623	0.477034	0.4898
N225	0.588256***	-0.667422***	2.809791	16.27459	0.0001
FTSE	0.628135***	-0.702586***	2.440700	14.03917	0.0002
SSE	0.447989***	-0.484669***	3.024645	6.037580	0.0140
HSI	0.526312***	-0.613573***	2.794066	27.28228	0.0000
TSX	0.883891***	-0.978900***	2.171686	10.95779	0.0009
DAX	0.453089***	-0.495840***	2.879920	8.874705	0.0029
AORD	1.152340***	-1.324354***	2.001990	23.40481	0.0000
BSE	0.453674***	-0.510500***	2.865390	15.41796	0.0001

Note: *,**and*** indicate significance at the 10%, 5% and 1% level, respectively.

Table 7. Estimation of DR-GARCH-M model and Wald Test under GED

Index	Coefficient			The null hypothesis $H_0: \gamma_1 = \lvert\gamma_2\rvert$	
	γ_1	γ_2	AIC	Chi-square	Probability
NYSE	0.703314***	-0.811284***	2.510504	26.19639	0.0000
NASDAQ	0.575850***	-0.639820***	2.799233	11.32371	0.0008
N225	0.591877***	-0.659322***	2.846239	13.16044	0.0003
FTSE	0.410966***	-0.402008***	2.597147	0.191441	0.6617
SSE	0.454034***	-0.499005***	3.038135	8.907550	0.0028
HSI	0.515815***	-0.600024***	2.819351	28.40579	0.0000
TSX	0.978756***	-1.093919***	2.197929	17.36549	0.0000
DAX	0.487270***	-0.527526***	2.898888	6.905063	0.0086
AORD	1.232745***	-1.406603***	2.027608	22.97222	0.0000
BSE	0.496904***	-0.565619***	2.889231	22.57013	0.0000

Note: *,**and*** indicate significance at the 10%, 5% and 1% level, respectively.

As expected, risk premium parameter $\gamma_1 > 0$ and $\gamma_2 < 0$ in table 5, table 6 and table 7 also indicate that investors' risk preference vary with the state of gain/loss, and they tend to become risk aversion in the state of gain while risk-seeking in the state of loss, which is consistent with the result in D-GARCH-M model. Moreover, we can find that investors' risk preference is changed with the value of gains/losses. Specifically, investors become more risk averse with the increasing gains, and more risk-seeking with the increasing losses. In other words, the more gains the investors get, the stronger their tendency to risk averse is, and the more losses investors obtain, the stronger their tendency to risk seeking is.

According to the result of Wald test in table 5, table 6 and table 7, most of the indexes can reject the null hypothesis of $\gamma_1 = |\gamma_2|$ under the significance level of 10%, and basically there exist $\gamma_1 < |\gamma_2|$, showing that no matter the error term is in normal distribution, *t*-distribution, or GED, investors show more risk seeking for each unit of their loss than that of their risk aversion for each unit of their gain. This is in line with the conclusion in prospect theory but different from the D-GARCH-M model in which the gain and loss's value is not considered. Additionally, comparing the size of AIC in table 5, table 6 and table 7, we also find the AIC under *t*-distribution is the smallest, which is inconsistent with D-GARCH-M model.

4. Robustness Test

4.1 Sub-sample analysis

To examine the sensitivity of our findings we perform the robustness analysis. In particular, we will test whether there are qualitative changes in the preference due to variations in the sample period and reference price. First we split the whole sample into two sub-samples with the same length, namely March 2002 - March 2007 and March 2007 - March 2012, and repeat all estimations for the two sub-samples. Since the size of AIC under *t*-distribution in D-GARCH-M model and DR-GARCH-M model is the smallest, we only report the results with *t*-distribution. The results for both sub-samples are very similar to those reported for the whole sample with the estimations of D-GARCH-M model as well as that of Wald test showed in table 8 and table 9, while for that of DR-GARCH-M model, whose results and Wald test shows in table 10 and Table 11.

From the table 8 and table 9, the D-GARCH-M results, it can be seen that for both sub-samples there are $\gamma_1 > 0$, $\gamma_2 < 0$. And the Wald test shows no significant difference between the value of γ_1 and $|\gamma_2|$, which is consistent with previous finding. Table 10 and table 11 display the result of DR-GARCH-M model, in which we present $\gamma_1 > 0$ and $\gamma_2 < 0$ in both samples, and the Wald test implies that if investors get the same unit of gain and loss, their degree of risk-seeking with losses is greater than that of risk aversion with gains, which is the same as those observed in the whole sample. Therefore, it can be said that the choice of sample will not produce great effect on the effectiveness of our models.

Table 8. Results of D-GARCH-M model for two sub-samples

Index	**Sub-sample (March 2002-March 2007)**		**Sub-sample (March 2007-March 2012)**	
Index	γ_1	γ_2	γ_1	γ_2
NYSE	0.849551***	-0.926102***	0.385817***	-0.408278***
NASDAQ	0.669323***	-0.707473***	0.425736***	-0.472116***
N225	0.586953***	-0.651957***	0.426794***	-0.457051***
FTSE	0.769737***	-0.873013***	0.420743***	-0.477385***
SSE	0.531413***	-0.539258***	0.379364***	-0.396414***
HSI	0.730216***	-0.788321***	0.339182***	-0.351449***
TSX	1.014179***	-1.054803***	0.459633***	-0.494136***
DAX	0.533487***	-0.542894***	0.389531***	-0.448092***
AORD	1.211814***	-1.308278***	0.530664***	-0.605386***
BSE	0.503331*	-0.567247**	0.396521***	-0.449989***

Note: *,**and*** indicate significance at the 10%, 5% and 1% level, respectively.

Table 9. The Wald Test of D-GARCH-M model for two sub-samples

Index	**The null hypothesis $H_0: \gamma_1 = \|\gamma_2\|$**			
	Sub-sample (March 2002-March 2007)		**Sub-sample (March 2007-March 2012)**	
	Chi-square	**Probability**	**Chi-square**	**Probability**
NYSE	1.066547	0.3017	0.392399	0.5310
NASDAQ	0.508973	0.4756	1.532247	0.2158
N225	1.425718	0.2325	0.636033	0.4252
FTSE	2.468100	0.1162	1.866313	0.1719
SSE	0.026297	0.8712	0.25552	0.6132
HSI	0.740608	0.3895	0.150486	0.6981
TSX	0.224599	0.6356	0.626543	0.4286
DAX	0.046783	0.8288	2.429360	0.1191
AORD	0.894564	0.3442	2.455935	0.1171
BSE	0.038847	0.8438	2.414553	0.1202

Table 10. Results of DR-GARCH-M model for two sub-samples

Index	**Sub-sample (March 2002-March 2007)**		**Sub-sample (March 2007-March 2012)**	
	γ_1	γ_2	γ_1	γ_2
NYSE	1.580469***	-1.727723***	0.426052***	-0.468403***
NASDAQ	0.776349***	-0.847870***	0.448670***	-0.499539***
N225	0.842898***	-0.884209***	0.443514***	-0.507933***
FTSE	1.198024***	-1.307962***	0.535976***	-0.606466***
SSE	0.721676***	-0.787944***	0.321726***	-0.358227***
HSI	1.282913***	-1.408623***	0.208130***	-0.248085***
TSX	2.147790***	-2.256202***	0.502886***	-0.572122***
DAX	0.505979***	-0.549545***	0.434412***	-0.490427***
AORD	3.164362***	-3.533803***	0.735286***	-0.822262***
BSE	0.736529***	-0.903248***	0.340511***	-0. 372523***

Note: *,**and*** indicate significance at the 10%, 5% and 1% level, respectively.

Table 11. The Wald Test of DR-GARCH-M model for two sub-samples

Index	**Null hypothesis :** $\gamma_1 = \lvert \gamma_2 \rvert$			
	Sub-sample (March 2002-March 2007)		**Sub-sample (March 2007-March 2012)**	
	Chi-square	**Probability**	**Chi-square**	**Probability**
NYSE	4.002201	0.0454	5.977236	0.0145
NASDAQ	3.337128	0.0677	6.454280	0.0111
N225	0.829626	0.3624	9.513635	0.0020
FTSE	4.905081	0.0268	7.522958	0.0061
SSE	3.431868	0.0639	4.752411	0.0293
HSI	4.042643	0.0444	12.25793	0.0005
TSX	0.997379	0.3179	7.903276	0.0049
DAX	4.030174	0.0447	7.676733	0.0056
AORD	5.509377	0.0189	6.244253	0.0125
BSE	22.44038	0.0000	4.510299	0.0337

4.2 Different reference price

The use of reference price that determines investors' gains and losses will make the difference in risk preference for gains and losses. We will consider an alternative reference price that tests the sensitivity of our findings. To construct a new reference, instead of using the average trend of 5 days, here we take the average trend of 10 days to be the alternative reference price. In the same way, the same models with the *t*-distribution and no constant are estimated. The result of D-GARCH-M model is shown in Table 12, and that of DR-GARCH-M model which considers the influence of value of gain and loss on risk premium coefficient is shown in Table 13.

Results in Table 12 also reveal that investors tend to be risk aversion with gains and risk-seeking with losses for the coefficient $\gamma_1 > 0$ and $\gamma_2 < 0$. The Wald test shows investors' degree of risk aversion for gains is not greatly different from that of risk-seeking for losses, which is the same in table 3 with *t*-distribution.

According to Table 13, we can also get $\gamma_1 > 0$ and $\gamma_2 < 0$, which shows investors' degree of risk aversion when they gain and that of risk-seeking when they loss are in direct proportion to the return size. Moreover, the results in Wald test of most indexes reject the null hypothesis, and the phenomenon $\gamma_1 < \lvert \gamma_2 \rvert$ indicates investors tend to exhibit more risk-seeking for gains than risk averse for the same gains and losses. Therefore, we conclude that the relation between the outcome and risk preference we investigated is not an artifact of the reference price we have selected.

Table 12. Results of D-GARCH-M Model and Wald Test

Index	**Coefficient**		**Null hypothesis:** $\gamma_1 = \lvert\gamma_2\rvert$	
	γ_1	γ_2	Chi-square	Probability
NYSE	0.253169***	-0.253945***	0.00689	0.9791
NASDAQ	0.311429***	-0.336575***	0.777589	0.3779
N225	0.280006***	-0.257354***	0.667937	0.4138
FTSE	0.274568***	-0.280512***	0.035252	0.8511
SSE	0.272508***	-0.265663***	0.076368	0.7832
HSI	0.026725***	-0.019838***	15.99856	0.0001
TSX	0.307038***	-0.282957***	0.483615	0.4868
DAX	0.273317***	-0.304224***	1.395347	0.2375
AORD	0.408292***	-0.336575***	3.174208	0.0748
BSE	0.259506***	-0.269354***	0.156988	0.6919

Note: *,**and*** indicate significance at the 10%, 5% and 1% level, respectively.

Table 13. Results of DR-GARCH-M Model and Wald Test

	Coefficient		**Null hypothesis:** $\gamma_1 = \lvert\gamma_2\rvert$	
Index	γ_1	γ_2	**Chi-square**	**Probability**
NYSE	0.091959***	-0.069915***	6.002678	0.0143
NASDAQ	0.173035***	-0.183897***	1.006364	0.3158
N225	0.184379***	-0.205608***	3.862966	0.0494
FTSE	0.220018***	-0.273832***	17.23784	0.0000
SSE	0.126629***	-0.130807***	0.306910	0.5796
HSI	0.0137070***	-0.174011***	19.13855	0.0000
TSX	0.296119***	-0.313184***	1.146849	0.2842
DAX	0.185004***	-0.213455***	3.286738	0.0698
AORD	0.311003***	-0.344658***	3.302935	0.0692
BSE	0.137516***	-0.167448***	14.81174	0.0001

Note: *,**and*** indicate significance at the 10%, 5% and 1% level, respectively.

5. Conclusions

This paper, based on the prospect theory, makes a study on the characteristics of investors' risk preference at the whole market level. First, considering investors have different preference towards risk in the circumstance of gain/loss, we build the D-GARCH-M Model to study the risk preference for gains and losses under alternative distribution and with/without constant. The estimated results indicate that investors manifest risk aversion when obtain gains (the risk premium coefficient is above zero) and risk seeking when obtain losses (the risk premium coefficient is under zero), which effectively explain the inconsistent risk-return relationship in neoclassical finance. Error terms in different distribution have certain effect on the investors' degree of risk aversion with gain and risk-seeking with loss. To be specific, under Generalized Error Distribution, the degree of risk aversion in gains is greater than that of risk-seeking in losses. In *t*-distribution, there is no obvious difference between the intension of risk aversion and that of risk-seeking, while in normal distribution, there is no distinct relationship between them. The existence of constant term has no effect on the study of relationship between risk and return in the D-GARCH-M model. This is different from the finding in GARCH-M Model that risk and return will be obviously in positive correlation only when there is no constant.

Then, we give further insight into the relationship between the risk preference and the magnitude of gain/loss with DR-GARCH-M model established, and find that the extent of investors' risk aversion improves with the increasing magnitude of gains, and that of risk-seeking rises with the increasing magnitude of losses. Moreover, for the same magnitude of gains and losses, investors show greater tendency to risk-seeking with losses than the tendency to risk averse with gains.

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