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Original Paper

Higher-Order Moment Risk and ESG Sentiment: Evidence from China's Options Market

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Abstract

The relationship between risk and return is an important topic in financial research. In this paper, we investigate the factors affecting the higher-order moment risk premiums. The results indicate that there is a significant interaction between variance, skewness and kurtosis when considering risk premiums. This implies that there are both common and independent sources of risk information. In addition, ESG news sentiment has a significant positive effect on volatility risk premium.

Keywords

Higher-order moment risk, Return predictability, ESG sentiment, Investor behavior

1. Introduction

Higher-order moment risks have significant time-varying features. The analysis involves the decomposition and examination of higher-order moment risk. Ghysels et al. (2016) and Bali et al. (2019) classify higher-order moment risk into systematic and idiosyncratic risk. Neuberger (2012) and Neuberger and Payne (2021) differentiate higher-order moment risk into short-term higher-order moments and leverage effects. The main sources of risk and relationships among the higher-order moments are examined. Amaya et al. (2015) discovered an interaction between skewness and variance. Kozhan et al. (2013) and Chang et al. (2013) identified an interaction between skewness and kurtosis, although Neuberger and Payne (2021) contended that short-term skewness and kurtosis are uncorrelated. Certain intellectuals in China have also examined this subject. Nevertheless, from a holistic perspective, existing research on higher-order moments predominantly centers on developed financial markets, with limited scholarly attention given to comparative analyses of higher-order

moments in Chinese financial markets within a cohesive framework.

The determinants influencing volatility risk are also important topics for research. Carr and Wu (2009) identified that the determinants of volatility risk premium include market, size, value, price-earnings ratio, and turnover ratio. Londono and Zhou (2017) suggested that macroeconomic elements influencing volatility are classified into domestic and foreign uncertainties, including consumption ratios, industrial manufacturing values, and international exchange rates. Cao et al. (2022) contend that volatility risk includes both fundamental information and uncertainty shocks. Furthermore, the volatility risk premium needs to account for investor sentiment and attitudinal preferences. The volatility risk premium serves as an indicator of investor sentiment. Bollerslev and Todorov (2011) and Bollerslev et al. (2015), using U.S. stock research, determined that investor sentiment influences the volatility risk premium. The volatility risk premium quantifies investors' risk tolerance. Liu et al. (2022) contend that investors in developed markets, including Europe, the United States, and Hong Kong and Taiwan, exhibit relative rationality, a preference for predictability, and a tendency to forfeit a portion of their excess returns in exchange for less volatile assets. Conversely, investors in emerging markets are predominantly inexperienced, containing a significant ratio of retail investors and a small ratio of institutional investors. Their investment approach is generally aggressive, exhibiting a propensity to assume risks in an attempt for higher returns. Consequently, examining investor sentiment and volatility risk premium in the Chinese market through the framework of behavioral finance is valuable.

2. Literature Review

2.1 Interaction of Higher-Order Moment Risk

Higher-order moment risk is time-varying. Carr and Wu (2009), Bollerslev et al. (2009) and Neuberger (2012) find that the variance and skewness of the U.S. market fluctuate with time. Since that time, researchers have extensively studied the sources of higher-order moment risk and its influences.

Bakshi et al. (2003) investigated the effects of skewness and kurtosis risk on volatility and further investigated the effects of skewness and kurtosis risk on option structures and volatility slopes. Kozhan et al. (2013) investigated the effects of higher-order moment risk on skewness. In addition, Bakshi et al. (2003), Ghysels et al. (2016) and Bali et al. (2019) investigated the decomposition of market systematic risk and idiosyncratic risk for higher-order moment risk based on the U.S. option market and found that both systematic and unsystematic risks of volatility are associated with return. Only the unsystematic risks of skewness and kurtosis are connected to returns. Because China's option market lacks individual stock option products for higher-order moment systematic risk and idiosyncratic risk decomposition, this paper refers to the study based on the interrelationships of each higher-order moment risk factor in China's market and examines whether they are driven by homogenous risk.

2.2 Factors Affecting the Volatility Risk Premium

The factors affecting the volatility risk premium are an important element of higher-order moments research. Black (1986), Bali and Zhou (2016) and Dew-Becker et al. (2021) argued that changes in

volatility risk over time are affected by macroeconomic uncertainty and micro-market structure. Ben-David (2018) argues that a higher proportion of ETFs in the capital market leads to stocks with significant volatility premiums and tail risks.

In the study of financial market phenomena, in addition to asset pricing theories in the traditional finance perspective, scholars such as Baker and Wurgler (2006), Bollerslev and Todorov (2011) and Fassas (2020) argue that it is also possible to analyze the impact of investor sentiment and beliefs based on the behavioral finance perspective and preferences on asset pricing. Chen et al. (2021) found that investor attention based on high-variance stocks significantly predicts stock market risk premium. Chen et al. (2021) identified that tail risk, catastrophic events, and investors' anxiety regarding these factors significantly impact market volatility in the U.S. Additionally, they noticed that lottery sentiment has a spillover effect on stock market volatility. Liu et al. (2022) argue that Chinese investors are different from Western investors, with a lower average age, a relative lack of investment experience, a higher proportion of retail investors and a lower proportion of institutions, and the overall investment behavior style is characterized by emotional characteristics.

On the other hand, the impact of investors' ESG sentiment should be considered. ESG, which includes three dimensions of environmental, social, and governance, assesses the sustainability and risk of investment targets and has gradually become an essential topic in finance and investment in recent years. Pastor et al. (2021) found that the higher returns of green assets reflect investors' environmental concerns and hedging of climate risks as well as preferences. Dyck et al. (2019) and Chen et al. (2020) based on stakeholder theory, argued that institutional ownership is positively correlated with environmental and social performance and that institutions are motivated by social and financial rewards. Broadstock et al. (2021) found that firms with higher ESG ratings are more focused on building long-term corporate value and have more stable stock price performance during crises. Cao et al. (2022) found that ESG premium can hedge stock option implied volatility and jump risk. However, Masulis and Reza (2015) suggested that the value of the firm decreases when the CEO misuses resources based on agency theory. Clementino and Perkins (2021) examined that company managers may exaggerate ESG ratings to build up a favorable image of the company and to attract the attention of investors. Chinese green finance research has also been deepening and developing in recent years. However, it is still difficult to determine its impact on asset pricing and risk management in the Chinese market. In this paper, the authors investigate the relationship between volatility risk premium and investor ESG sentiment in the Chinese market by using news-based ESG sentiment as a proxy variable for firm performance and investor preference to strengthen the link between these two types of literature.

3. Research Design

3.1 Interaction of Higher-Order Moment Risk

Following Bakshi et al. (2003) and Kozhan et al. (2013), we examine and model the relationship

between the higher-order risk premiums as follows:

$$VRP_t = a + \beta_{skew} SRP_t + \beta_{kurt} KRP_t + \varepsilon_t \quad (1)$$

$$SRP_t = a + \beta_{\text{var}} VRP_t + \beta_{kurt} KRP_t + \varepsilon_t \quad (2)$$

$$KRP_t = a + \beta_{\text{var}} VRP_t + \beta_{skew} SRP_t + \varepsilon_t \quad (3)$$

where VRP_t, SRP_t and KRP_t are the second-order moments and third- and fourth-order moments risk premiums, respectively.

3.2 The Impact of ESG Sentiment on Volatility Risk Premiums

Following Liu et al. (2022), we adopt models (4)-(5) to investigate the effect of ESG sentiment on log volatility risk premium. In order to further analyze the ESG sentiment effect, we conduct additional tests on environmental and social factors (E&S) and corporate governance factors (G), respectively. The regression model is as follows:

$$LVOLRP_t = \alpha + \beta_{esg} ESG_t + \beta_{turn} TURN_t + \beta_{value} VALUE_t + \varepsilon_t \quad (4)$$

$$LVOLRP_t = \alpha + \beta_{es} ES_t + \beta_g G_t + \beta_{turn} TURN_t + \beta_{value} VALUE_t + \varepsilon_t \quad (5)$$

where *LVORP* is the logarithmic volatility risk premium, *ESG* is the news sentiment variable, *TURN* is the daily turnover rate of the SSE 50 index, which represents investor idiosyncratic beliefs and liquidity, and *VALUE* is the price-earnings ratio, which represents the value effect. The data source of the news sentiment indicator is DATAGO database. The indicator ranges from 1 to -1, where 1 is the most positive and -1 the most negative. The data is available until December 2020, there are a total of 1,156 daily observations in this empirical study.

4. Empirical Results

4.1 Relationship between Higher-Order Moment Risk

Table 1 presents the results of the univariate regression. Firstly, we discuss the effect of the second-order moment risk premium on the future third- and fourth-order moment risk premiums. The t-value for the variance risk premium in column (1) is only 1.5313, which means that the variance risk premium does not have a statistically significant effect on the future skewness risk premium. The regression coefficient of variance risk premium is larger in column (2) and has a t-value of -5.6775. This means that the variance risk premium has a negative effect on future kurtosis risk premiums.

Second, we discuss the impact of the skewness risk premium factor on future variance and kurtosis risk premium. In column (3), the regression coefficient of skewness risk premium is only 0.0003 and the t-value is 1.1425, which indicates that the skewness risk premium does not have a significant effect on the future variance risk premium in terms of both economics and statistical significance. The t-value of

the regression coefficient of skewness risk premium in column (4) is 1.0727. This means that the skewness risk premium does not have a statistically significant effect on the future kurtosis risk premium.

Finally, we discuss the effect of the kurtosis risk premium factor on the future variance and skewness risk premium factors. In column 5, the regression coefficient of the kurtosis risk premium is -0.002, and the t-value is -1.6355, which indicates that there is no economically and statistically significant effect of the kurtosis risk premium on the future variance risk premium. In column (6), the regression coefficient of kurtosis risk premium is 0.0295, and the t-value is 2.7922, which is significant at the 1% level. Also, the intercept terms are not zero, which means that there are other risk factors affecting each of the higher-order moments risk premiums.

Table 1. Univariate Regression Results

h=20	(1) SRP_{t+h}	(2) KRP_{t+h}	(3) VRP_{t+h}	(4) KRP_{t+h}	(5) VRP_{t+h}	(6) SRP_{t+h}
VRP_t	2.7624	-27.5010***				
	(1.5313)	(-5.6775)				
SRP_t			0.0003	0.0840		
			(1.1425)	(1.0727)		
KRP_t					-0.0002	0.0295***
					(-1.6355)	(2.7922)
α	0.3261***	-0.3911***	0.0160***	0.0775	0.0161***	0.2734***
	(7.3461)	(-3.2797)	(5.3970)	(0.9033)	(5.4702)	(8.9781)
$Adj.R^2$	0.0011	0.0250	0.0003	0.0001	0.0014	0.0056
Obs.	1217	1217	1217	1217	1217	1217

Note. t-values are represented in parentheses. *, **, *** indicate significant at the 10%, 5%, and 1% levels, respectively.

Table 2 reports the multivariate regression results. First, we discuss the joint prediction model of the third- and fourth-order moment risk premiums for future second-order moment risk premiums. In column (1), the prediction coefficient of the skewness risk premium is 0.003 with a t-value of 1.1451, and the coefficient of the kurtosis risk premium is -0.002 with a t-value of -1.6370. The joint prediction results are the same as the univariate regression results. This means that neither the skewness risk premium nor the kurtosis risk premium has a big impact on future variance risk premiums in a way that is economically or statistically important.

Second, we examine the joint predictive effect of second- and fourth-order moments risk on future third-order moments risk. In column (2), the prediction coefficient of the variance risk premium is

4.0770 with a t-value of 2.2123, which is significant at the 5% level. The prediction coefficient of the kurtosis risk premium is 0.0348 with a t-value of 3.2175, which is significant at the 1% level. The joint prediction results indicate that both variance and kurtosis risk premium factors have an effect on the future skewness risk premium.

Finally, we examine how the predictions of variance and skewness risk premiums affect the future kurtosis risk premium. In column (3), the prediction coefficient of variance for the risk premium is large with a t-value of -5.8024, which is significant at the 1% level. The regression coefficient of the skewness risk premium is 0.1245, with a t-value of 1.6044. It indicates that there is a statistically significant negative effect of the variance risk premium on the future kurtosis risk premium, while there is no statistically significant effect of the skewness risk premium on the future kurtosis risk premium.

The results show that the variance risk premium has significant explanatory power for the kurtosis risk premium, but kurtosis has insufficient effect on variance. The correlation between variance risk premium and skewness risk premium is not significant. The kurtosis risk premium has some explanatory power for the skewness risk premium, but skewness has insufficient influence on kurtosis. In addition, each higher-order moment risk premium has its own significantly independent source of risk.

Table 2. Bivariate Regression Results

h=20	(1) VRP_{t+h}	(2) SRP_{t+h}	(3) KRP_{t+h}
VRP_t		4.0770**	-28.2115***
		(2.2123)	(-5.8024)
SRP_t	0.0003		0.1245
	(1.1451)		(1.6044)
KRP_t	-0.0002	0.0348***	
	(-1.6370)	(3.2175)	
α	0.0160***	0.3457***	-0.4383***
	(5.4577)	(7.7441)	(-3.5710)
$Adj.R^2$	0.0016	0.0087	0.0263
Obs.	1217	1217	1217

Note. t-values are represented in parentheses. *, **, *** indicate significant at the 10%, 5%, and 1% levels, respectively.

4.2 ESG Sentiment and Volatility Risk Premiums

Table 3 reports the results of the impact of ESG sentiment on the volatility risk premium. The results in column (1) indicate that there is a positive relationship between the log volatility risk premium and

ESG sentiment. Higher ESG sentiment indicates higher potential volatility risk in the market, consistent with the agency theory proposed by Masulis and Reza (2015). The idea behind this theory is that investors think ESG investments are managers misusing the company's resources, which raises the risk of unmeasured uncertainty.

Table 3. ESG Sentiment and Volatility Risk Premiums

	(1)	(2)	(3)
ESG	0.1249***		
	(3.8283)		
E&S		0.1548***	
		(3.4374)	
G			0.0288
			(1.5896)
TURN	-0.0896**	-0.0872**	-0.0968**
	(-2.0326)	(-1.9745)	(-2.1855)
VALUE	0.0004	-0.0008	0.0019
	(0.1091)	(-0.2010)	(0.4559)
α	-0.1461***	-0.1742***	-0.0971***
	(-3.4164)	(-3.6767)	(-2.4025)
Adj.R²	0.0140	0.0116	0.0037
Obs.	1156	1156	1156

Note. t-values are represented in parentheses. *, **, *** indicate significant at the 10%, 5%, and 1% levels, respectively.

ESG is a multidimensional concept, and overall ESG and each sub-dimension may have different degrees of influence on potential volatility risk. Table 3 presents the regression findings using E&S and G factors as independent variables to further examine the impact of ESG. The E&S coefficients are statistically significant, which means that environmental and social factors are more likely to explain future volatility risk premiums. However, there is no statistically significant relationship between the governance factor and the volatility risk premium. The correlation between E&S and potential volatility risk is also significantly positive. The potential rationale is the significant presence of individual investors in China and other developing countries, who typically ignore the environmental and social risks related to firms. This evidence also supports the theory of sustainability as proposed by Dyck et al. (2019) and Chen et al. (2020), which suggests that institutional ownership is positively correlated with ESG, especially with environmental and social values. Institutional investors emphasize the correlation between the firm's environmental and social risks and the volatility of future stock prices.

5. Conclusion

This paper investigates the factors affecting higher-order moment risk premiums. On the one hand, there is a common source of risk across higher-order moments. Therefore, there is a correlation between the higher-order moments risk premiums. On the other hand, macro uncertainty and investor sentiment in microstructure also have an impact on higher-order moment risk. Therefore, we extend the above two types of literature based on the Chinese financial market. The results indicate that variance, skewness, and kurtosis, as higher-order moments, significantly interact with each other considering risk premiums. This means that there are both shared sources of risk and separate sources of risk information. Moreover, ESG news sentiment exerts a significant positive effect on the volatility risk premium. Regulators have to incorporate additional market factor data into regulations, standardize information flow between markets, including spot and derivatives, and enhance regulatory technology.

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