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The Impact of Asymmetric Risk on Expected Return

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The main goal of the present study is testing asymmetric risk pricing and comparing it with pricing of traditional risk measures in Tehran Stock Market. Accordingly, a sample consisting of 101 companies listed in Tehran Stock Market during 2002-2013 went under investigation. In order to test asymmetric risk pricing, regression model of panel data was applied. The results revealed a positive and significant relationship between traditional measures (Standard Deviation and Semi Standard Deviation) and asymmetric risk measures (parametric VaR, HR risk, historical VaR, and historical HR) and expected return. Therefore, in addition to the significant correlation between risk and return, pricing model based on asymmetric risk and traditional risk was approved, too. Again, it was shown that controlling the effect of variables such as financial leverage, firm size, book-to-market ratio of equity (B/M) and liquidity, momentum and inverse is not able to change the direction of the relationship. Furthermore, the explanatory power of traditional and asymmetric risk criteria are the same.

Keywords: Asymmetric risk, Traditional risk, Expected return
JEL Classification*:* G10, G17

1 Introduction

The assets pricing issue has always been one of the main challenges of financial knowledge that deals with the relationship between risk and expected return rate. In the framework of classical finance, it is supposed that stock with high volatility has higher expected return. Recently, some researchers found that there is an inverse relationship between risk and return; and stock with lower volatility has higher expected return compared to highly volatile stock. One of the issues leading to the inspection of the relationship between risk and return causes drawing attentions to the distribution of asset return. Considering normal distribution of asset return is one of the main assumptions of classic models of asset pricing. At the same time and in the real world, the distribution of asset return is not normal. The first study conducted by Fama (1968) in this area shows that return distribution is more elongated than

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normal distribution with skewness. In this regard, asset-pricing models with normality assumption of return distribution standard deviation, semi-standard deviation and beta have been used as risk measures. It was found that using such measures would incur many risks when return distribution is not normal. However, asymmetric risk measures such as VaR are the criteria measuring risk when the return is not normal. Value at risk is a new technique to evaluate and measure the potential risk in capital market that is from asymmetric risk measures risk group. Value at risk has a unique effect on financial institutions and it has changed the method of acquiring the risks in financial risks. For investors risk is defined as some happenings that cause a loss; there is the same definition for VaR in their point of view. To answer the issues such as the rate of a loss in an inappropriate time to invest, it is possible to calculate the investors' attention about a major loss happening. Value at risk, evaluating method, and risk diagnosing are the standard statistical techniques that are used in some other technical fields as a routine. Previously, some researchers have studied the relationship between asymmetric risk measures and the expected return by using Fama and Macbeth model. However, an argument shows that the obtained results are the results of the employed methodology (Fama-Macbeth model). Therefore, testing asymmetric risk pricing through panel data regression can confirm the validity of obtained results. Accordingly, the present study addresses asymmetric risk pricing using the regression model of panel data. Hence, in order to prevent the effect of other variables on the finality of the relationship between asymmetric risk measures and return, control factors are considered, whose effects on the return have been proved earlier.

2 Background of the Study

During the recent 40 years, assets pricing has been the subject of many empirical studies. Linter (1965) offers evidences showing that the variance of market model is strongly meaningful in explaining temporary stock return. In an article, Bali and Cakici (2004) studied VaR and expected return during 1958-2001. They found that portfolios with lower VaR have lower mean return and portfolios with higher VaR have higher mean return (Bali, 2004). In 2005, in a study they considered variance, standard deviation, and variance logarithm as risk measures and found a positive relationship containing an extra return (Baki, 2005). Gokcan et al. (2009) in a study entitled '*Downside Risk and Expected Return*', found a positive and significant relationship between expected return, non-systematic volatility, and VaR (Cokcan, 2009). Ang, Hodrick, Xing, and Zhang (2009) conducted their studies in the U.S.

Stock Market and G7 countries. The total volatility of daily returns and standard deviation of Fama-French three-factor model were considered as non-systematic risk measure; meanwhile, the negative relationship between non-systematic risk and future mean return of the stock was confirmed (Ang, 2009). Huang et al. (2007) and Fu (2009) showed that the findings of Ang et al., by using monthly data changes in the opposite direction, confirmed the positive significant relationship between non-systematic risk and expected return (Huang et al., 2007; Fu, 2009). Sullivan et al. (2013) confirmed a negative relationship between non-systematic risk and monthly returns and a positive relationship between systematic risk and monthly returns (Sullivan, 2013). Haffman and Moll (2012), studied the relationship between asymmetric risk measures and previous days return and expected return offered evidence showing that there is a significant positive relationship between asymmetric risk measures and expected return (Haffman, 2012). Raahat Achtani (2013), investigated low volatility anomaly, and showed that low volatility portfolios have higher returns in Indian market (Raahat Achtani, 2013). Forming portfolios in Pakistan market based on firms' size and book value to market value, Javed et al. (2014) found that high VaR portfolios have higher expected return (Javed, 2014).

3 Data and Sample

The present study is an applied research. The statistical population of the study included all companies listed in Tehran Stock Exchange Market in 2002-2013. The statistical sample includes all companies except those:

- That are financial intermediaries;
- That are inactive for more than 3 months;
- Their financial year is other than March 19th; and,
- Their financial information is not available.

Finally, the sample test involved 101 companies. The required data was collected from the database of Tehran Stock Exchange Market Fipiran Company.

4 Research Methodology

This survey uses traditional risk criteria and non-symmetric risk criteria. Traditional risk criteria including Standard Deviation (SD) and Semi-Standard Deviation, follows normal statistical distribution. Accordingly, risk criteria that are based on normal (supposed) of stock returns are called symmetric criteria; meaning that the dispersion of left and right sequence of distribution

is equal. In this study, value at risk of parametric and historical risk has been used to calculate non-symmetric risk criteria. This calculation is based on a theory that shows dispersion of daily returns of stocks is not normal. Therefore, distribution of returns in left and right sequences are not equal. Accordingly, some special criteria are used to calculate the distribution of each sequence; the value at risk and historical risk explain left and right sequences, respectively. Although it is not reliable to suppose non-symmetric risk criteria as normal data (because in real world data are not normal), its reliability is higher.

In order to test the relationship between asymmetric risk measures and the expected return, Panel Data Regression model was used. The details of using each of these models are presented as follows. First, using Limer F test, the pooled data regression is specified in the panel data regression. If the regressions are panel, using Hausman test, the fixed and random effects will be tested. Finally, by using model (1), the relationship between asymmetric risk measures and expected return is investigated.

$$\mathrm{R}_{it} = \alpha_{it} + \gamma_{it}(\text{Risk Measure}_{it-1}) + \varepsilon_{it} \quad (1)$$

Where, R_{it} is the expected return of the stock of company *i* on day *t*, and $\text{risk measure}_{it-1}$ are the risk measures of company *i* on day *t-1*. Such measures are standard deviation, semi-standard deviation, parametric VaR, parametric HR risk, historical VaR, and historical HR risk. In previous studies, such as Fama and French (1992), and Haffman and Moll (2012), the effect of variables such as financial leverage, firm size, equity book value to market value (B/M), and liquidity on the relationship between volatility and expected return has been confirmed. Accordingly, like Haffman and Moll (2012), the present research studies the effect of the mentioned variables on the relationship between asymmetric risk measures and expected return through Panel Data Regression model. Hence, the research model is completed as relation (2):

$$\mathrm{R}_{it} = \alpha_t + \gamma_t(\text{Risk Measure}_{it-1}) + \delta_t \ln(size)_{it-1} + \lambda_t \ln({}^{B}/_{M})_{it-1} + \eta_t \mathrm{tda}_{it-1} + \varphi_t \mathrm{LIQ}_{it} + \varepsilon_{it} \quad (2)$$

Where, *size*, *B/M* and *tda* are firm size, equity book value to market value, and the ratios of total debt to total asset of company *i*, respectively. LIQ is the liquidity measure. In the present study, the momentum and reversal effect on the relationship between asymmetric risk measures and expected return is also controlled. Hence, the research model is completed in relation (3):

$$R_{it} = \alpha_t + \gamma_t(\text{Risk Measure}_{it-1}) + \delta_t \ln(\text{size})_{it-1} + \lambda_t \ln(B/M)_{it-1} + \eta_t \text{tda}_{it-1} + \varphi_t \text{LIQ}_{it} + \partial_t \text{RetPOS}_{it-1} + \emptyset_t \text{RetNEG}_{it-1} + \varepsilon_{it} \quad (3)$$

Where, RetPOS is equal to one, when yesterday's return is positive, otherwise, it would be equal to zero. In addition, RetNEG is equal to one, when yesterday's return is negative, otherwise, it would be equal to zero.

5 Research Variables

The variables of the present study are defined as follows:

1) **Expected return:** Expected return is the estimated return of the asset that investors expect to gain in the future. It is measured as follows:

$$\overline{R}_{it} = \text{Ln}(\frac{P_{it}}{P_{it-1}}) \quad (4)$$

Where, P_{it} and P_{it-1} are the final adjusted price for cash return and capital increase, respectively.

2) **Standard deviation:** Using daily returns of 100 last transactional days, is calculated according to formula (5):

$$\text{Stdev}_{it} = (\sqrt{252})\sqrt{(\frac{1}{n-1})\sum_{t=-1}^{n}(R_{it} - \bar{R}_{it})^2} \quad (5)$$

Where, n is the number of returns of 100 last transactional days, R_{it} is the stock return of company i on day t, $\overline{R}_{it}$ is the mean stock returns of company i during 100 last transactional days.

3) **Semi Standard deviation:** Using daily returns of 100 last transactional days, is calculated according to formula (6):

$$\text{Semi} - \text{Dev}_{it} = \left(\sqrt{252}\right)\sqrt{\left(\frac{1}{n_B - 1}\right)\sum_{t=-1}^{n}([\text{Min}[0, R_{it} - \bar{R}_{it}])^2} \quad (6)$$

Where, n=100, n_B is the number of negative returns in 100 last transactional days, R_{it} is the stock return of company i on day t, $\overline{R}_{it}$ is the mean stock returns of company i during 100 last transactional days.

4) **VaR:** It is the maximum loss, which is expected to occur during a defined period with a given probability. In this study, two methods are used to measure VaR: Parametric and Historical.
   1) **Parametric VaR:** When measuring parametric VaR, we assume the distribution of returns as normal, and based on mean and standard deviation, it is defined as relation (7):

$$\mathrm{VaR}_{it} = \bar{\dot{R}}_{it} - S_{it}Z \quad (7)$$

Where, S_{it} is the standard deviation of company *i* on day *t*, and *Z* is the confidence level. For example, in 95% level of confidence, *Z* is equal to 1.65.

2) **Historical VaR:** Historical VaR is one of the non-parametric risk measures that is estimated according to historical observations. Historical VaR is measured by assuming non-normality in returns distribution. For example, if an investor is willing to measure their maximum loss at 95% level of confidence, they will classify the returns of 100 last transactional days from the highest to the lowest. The fifth return from the last end is the maximum loss of investor during the next investment period at 95% level of confidence.

5) **HR risk:** It is the maximum interest, which is expected to be lost during a specific period with a given probability. To measure HR, two measures of parametric and historical HR are used:

1) **Parametric HR:** When measuring parametric HR, we assume the distribution of returns as normal, and based on mean and standard deviation, it is defined as relation (8):

$$\mathrm{HR}_{it} = \bar{\dot{R}}_{it} + S_{it}Z \quad (8)$$

Where, S_{it} is the standard deviation of company *i* on day *t*, and *Z* is the level of confidence. For example, in 95% level of confidence, *Z* is equal to 1.65.

2) **Historical HR:** Like historical VaR, measuring historical HR is based on only previous observations of stock return. HR is measuring with the assumption of non-normality of return distribution. For example, if an investor is willing to measure his maximum loss at 95% level of confidence, he will classify the returns of 100 last transactional days from the highest to the lowest. The fifth return from the first end is the maximum loss of investor during the next investment period at 95% level of confidence.

6) **Financial leverage:** It is calculated by dividing total debts by total assets.

7) **Firm size:** In this study, firm size is measured using natural log of total stock market of the firm.

8) **Equity book value to market value (B/M):** It is measured by dividing book value of equity by its market value.

9) **Liquidity:** To calculate liquidity, Amihud illiquidity measure (2002) is used.

$$\frac{|t\text{daily stock return}|}{t\ daily\ stock\ transactions\ volume} = \text{Amihud illiquidity measure} \quad (9)$$

10) **Momentum:** RetPOS is a virtual variable that, if yesterday's return is positive, it equals one, otherwise, it equals zero.
11) **Reversal:** RetNEG: is a virtual variable that, if yesterday's return is negative, it equals one, otherwise, it equals zero.

6 Findings

In the present study, the relationship between asymmetric and symmetrical risk measures and expected return was investigated using regression model of panel data; meantime, the effect of variables like financial leverage, firm size, book value to market value, liquidity, momentum and reversal of the relationship between asymmetric risk and expected return were controlled.

6.1 Descriptive statistics

Some descriptive statistics including mean, median, SD, minimum and maximum observations, skewness and kurtosis are presented in Table (1) to show a general view of the major characteristics of tested variables.

Table 1
Descriptive Statistics

Variables	Mean	Med.	Max.	Min	SD	Kurt	Skew
Liquidity	0.0001	0.0001	0.001	0	0	3.988	18.004
Book value to market value	0.424	0.378	1.552	0.073	0.261	1.206	4.866
Firm size	-12.113	-12.142	-11.314	-13.171	0.628	-0.136	1.605
Financial Leverage	-0.571	-0.647	-0.202	-0.88	0.226	0.498	1.826
Historical HR	3.415	3.972	4.97	0.67	1.17	-0.437	2.131
Historical VaR	-3.403	-3.499	-0.87	-4.83	0.997	0.402	2.281
Parametric HR	5.238	4.832	9.38	1.434	2.129	0.493	2.458
Parametric VaR	5.28	4.578	9.65	1.646	2.236	0.695	2.374
Semi SD	48.46	42.312	88.333	14.2	21.012	0.653	2.373
SD	50.45	45.263	88.333	15.987	20.357	0.558	2.346
Return	0.049	-0.003	3.99	-3.98	2.178	0.089	2.457

Source: Research findings.

It is shown that the maximum daily-expected return is 3.99, and the minimum is -3.98, its mean, median, and SD are -0.027, 0.000, and 2.37, respectively. Its VaR is between -1.48 and -9.65. The HR risk is 1.3-9.38 and the standard deviations of these two variables are 2.15 and 2.13, respectively. The mean VaR is -4.8 and HR risk on the average is 4.63. The medians of these two variables are -4.6 and 4.43, respectively.

In order to ensure that the regression model is not false, the reliability of the variables was estimated by IPS test in Table (2).

6.2 Reliability Analysis

According to Table (2), and considering the fact that the level of significance is less than 0.05 for all variables, all variables are reliable at 95% level of significance.

Table 2
Reliability

Variables	Value (IPS)	Level of significance
Expected return	-259.337	(0.001)
SD	-20.4026	(0.001)
Semi SD	-21.8536	(0.001)
VaR	-20.2783	(0.001)
risk HR	-17.8321	(0.001)
Historical VaR	-9.1887	(0.001)
risk HR Historical	-7.6545	(0.001)
Financial leverage	-3.2121	(0.007)
Firm size	-4.5220	(0.001)
Book value to market value	-14.4790	(0.001)
Liquidity	-272.74	(0.001)

Source: Research findings.

6.3 Limer F test

The panel nature of the data is specified by using Limer F-test. The results of Limer F-test are reported in Table (3)

Table 3
Limer F-Test of Panel Data

Models	F value	Level of significance
Model 1	0.9828	0.7392
Model 2	0.9897	0.6476
Model 3	0.9793	0.7806
Model 4	0.9867	0.6895
Model 5	0.9809	0.7630
Model 6	0.9824	0.7446

Source: Research findings.

According to Table (3), since the significance level of F value is higher than 10%, the assumption of panel data is rejected and the regression model of pooled data is tested.

6.4 Heteroscedasticity test

In order to diagnose heteroscedasticity in the regression model, White-test was employed. The results of this test are presented in Table (4).

Table 4
The Results of Heteroscedasticity

Models	F value	Level of significance
Model 1	47.866	0.001
Model 2	64.639	0.001
Model 3	36.299	0.001
Model 4	47.811	0.001
Model 5	112.79	0.001
Model 6	137.72	0.001

Source: Research findings.

In Table (4), the F value is higher than 2 and the relevant probabilities are less than 0.05, so all models are heteroscedastic. Therefore, in order to remove heteroscedasticity, EGLS test was used.

In Table (4), the results of testing asymmetric and traditional risk pricing are presented by using panel data.

According to Table (5), considering t-values of SD, semi-SD, parametric VaR, parametric HR, historical VaR, historical HR, there is a significant positive relationship between the above measures and expected return which shows that the investors are risk-aversive, as risk-aversive investors will accept extra risk only if they can gain extra return. The adjusted coefficients of determination of the models show that the explanatory power of traditional

and asymmetric risk measures of the expected return are equal. The significance of all coefficients of the risk measures point to pricing of asymmetric and traditional risk measures. However, it can be argued that this pricing is because of disregarding other variables affecting stock return. Accordingly, in Table (3), the variables of financial leverage, firm size, book value to market value, and liquidity were added to model 1 to control their effects on risk pricing.

Table 5
The Relationship Between risk Measures and Expected Return

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Intercept	0.081*	-0.248*	0.047**	-0.188*	0.125*	-0.026*
	(-3.348)	(-11.010)	(2.012)	(-8.208)	(4.485)	(-2.643)
SD	0.001**					
	(2.478)					
Semi SD		0.004**				
		(10.952)				
VaR Parametric			0.015*			
			(3.477)			
HR Parametric				0.035*		
				(7.832)		
VaR Historical					0.049*	
					(8.805)	
HR Historical						0.316*
						(7.312)
Adjusted R^2	0.262	0.263	0.265	0.264	0.267	0.265

*, **, and *** show level of significance at 90%, 95%, and 99%, the numbers in parentheses are t values, respectively. *Source:* Research findings.

According to the results of Table (6), the significant negative relationship between financial leverage and firm size and expected return is confirming the findings of Barber and Lion (1997), Fama, and French (1992). In addition, the significant positive relationship between book value to market value and expected return confirms the findings of Fama and French (1992). Amihud illiquidity has a significant relationship with the expected return, so it can be concluded that there is a positive relationship between liquidity and expected return. By adding the above variables to model (1), it is observed that there is a significant positive relationship between SD, semi SD, VaR, HR risk, historical VaR, historical Hr, and expected return. The effect of momentum and reversal on the relationship between risk measures and expected return is investigated in Table 7.

Model 13 in Table (7), shows the relationship between control variables of financial leverage, firm size, book value to market value, liquidity and expected return. Adjusted R^2 of the model 13 is 0.136. In model 14, the explanatory power of the model raised to 0.207 by adding momentum and reversal. In addition, it is observed that the positive relationship between risk measures and expected return still remains by addition of momentum and reversal. Hence, it is shown that the effect of control variables cannot eliminate asymmetric risk pricing.

Table 6
The Relationship between Risk Measures and Expected Return after Considering Control Variables

Variable	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
Intercept	1.259* (5.416)	1.235* (5.176)	1.290* (5.552)	1.161* (4.997)	1.368* (5.864)	1.285* (5.538)
Financial leverage	-0.133** (-2.349)	-.196* (-3.441)	-0.093* (-1.638)	-0.139* (-2.474)	-0.105* (-1.866)	-0.110** (-1.962)
Firm size	-0.089* (-4.969)	-0.099* (-5.378)	-0.083* (-4.667)	-0.089* (-4.977)	-0.085* (-4.776)	-0.086* (-4.822)
Book value to market value	0.238* (9.736)	0.236* (9.518)	0.235* (9.570)	0.224* (9.146)	0.232* (9.486)	0.238* (9.739)
Liquidity	-528.13* (-27.957)	-514.21* (-26.761)	-525.40* (-27.813)	-530.65* (-28.096)	-522.54* (-27.627)	-527.16* (-27.916)
SD	0.001* (3.324)					
Semi SD		0.005* (11.956)				
VaR Parametric			0.010** (2.316)			
HR Parametric				0.036* (8.035)		
VaR Historical					0.032* (3.826)	
HR Historical						3.330* (7.641)
Adjusted R^2	0.270	0.269	0.270	0.271	0.271	0.271

*, **, and *** show level of significance at 90%, 95%, and 99%, the numbers in parentheses are t value, respectively.
Source: Research findings.

Table 7
The Relationship between Risk Measures and Expected Return after Consideration of the Effect of Momentum and Reversal

Variable	Model 13	Model 14	Model 15	Model 16	Model 17	Model 18	Model 19	Model 20
Intercept	-0.3** (-2.1)	-0.3** (-2.16)	-0.22** (-2.15)	-0.21** (-2.23)	-0.20** (-1.96)	-0.23** (-2.21)	-0.05 (-0.71)	-0.04 (-0.64)
Financial leverage	-0.4** (-2.35)	-0.4** (-2.3)	-26.60* (-2.59)	-26.61* (-2.60)	-26.60* (-2.598)	-26.61* (-2.59)	-26.0* (-2.65)	-26.51* (-9.54)
Firm size	-13.0* (-12.4)	-12.5* (-12.2)	-19.92* (-2.68)	-19.92* (-2.69)	-19.933* (-2.678)	-19.92* (-2.68)	-20.9* (-3.04)	-20.43* (-15.7)
Book value to market value	0.429* (2.713)	0.413* (2.669)	0.343** (2.473)	0.308** (2.155)	0.331** (2.367)	0.363* (-3.49)	0.370* (2.655)	0.36** (2.50)
Liquidity	-799.* (-4.91)	-795.* (-4.99)	-709.* (-3.568)	-741.3* (-3.739)	-716.69* (-3.605)	-697.3* (-3.49)	-675.3* (-3.39)	-689.1* (-4.49)
Momentum		0.347* (2.594)	0.368* (3.974)	0.368* (3.991)	0.367* (3.973)	0.367* (3.972)	0.369* (3.985)	0.377* (2.860)
Reversal		-0.46* (-3.57)	-0.438* (-4.572)	-0.437* (-4.578)	-0.436* (-4.571)	-0.438* (-4.576)	-0.41* (-4.47)	-0.428* (-3.31)
SD			0.003** (2.040)					
Semi SD				0.004** (2.324)				
VaR Parametric					0.0325** (1.954)			
HR Parametric						0.036** (2.148)		
VaR Historical							1.311* (2.889)	
HR Historical								0.655** (1.901)
Adjusted R^2	0.136	0.207	0.286	0.287	0.285	0.286	0.286	0.287

*, **, and *** respectively show level of significance at 90%, 95%, and 99%, the numbers in parentheses are t value.
Source: Research findings.

7 Summary and Conclusion

In this study, the issue of asymmetric risk pricing was under consideration. This issue gains importance because of using traditional (symmetrical) risk measures in the classical pricing models. Therefore, one can relate some

contradictory empirical evidence of asset pricing to the use of traditional measures, so accordingly, asymmetric risk measures are used; and again, some anomalies can be explained. The findings of this study revealed a significant positive relationship between traditional measures (SD, semi SD) and asymmetric risk measures (parametric VaR, parametric HR risk, historical VaR, historical HR), and expected return by using the regression model of panel data. These findings confirm the results of Gopal et al. (2003), Haffman, and Moll (2012). Hence, the results of asset pricing test, regardless of risk measure, still are open to investigation. Therefore, we cannot relate contradictory evidence about the relationship between risk and return to the use of a measure inappropriate to the distribution of asset return. Furthermore, the findings of this study indicates that the explanatory power of traditional measures is similar to asymmetric risk measures.

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