SYSTEMATIC RISK DETERMINANTS AND VaR MODEL OF STOCK RETURNS IN THE PERIODS OF 2006-2015 WITH QUANTILE REGRESSION APPROACH: EVIDENCE FROM VIETNAM

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ABSTRACT

This study examines quantile regression method based on data about rate of return of stocks to evaluate the impact level of market risk, size and value of the company and risk for losing investment capital in period 2006-2015. Our empirical results confirm that rate of return can be explained by all of four factors, in which the explanation level of new factor representing for losing investment capital is high, only after market factor, over and above what value and size factors can do. Moreover, using quantile regression methods, portfolios have statistically significant much higher than when comparing with ordinary least square OLS. The study result opens up solutions to improve the rate of return and find out recommendations that help investors, as well as policies applying to the Vietnam stock market.

Keywords: *FF3F, FFVAR, quantile regression, $R_m – R_f$, SMB, HML, HVARL*

1. Introduction

In 2015, stock market capitalization is currently accounted for 34% of total gross domestic product, take an important part in Vietnam's economy. However, stock market in Vietnam is quite young, volatile and unsustainable. Currently, individual investors accounted for 99% on the stock market, nevertheless, they lack a lot of market information. Therefore, their investment are mainly based on the recommendations of the securities companies or on their sentiment. Besides, stock price is usually pricing by the

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discounted cash flow method. There are many potential risks from earnings and cash flow forecasted. From these reason, in order to help investors have suitable investment behavior and Vietnam's stock market can develop more stable, determining suitable pricing model for the Vietnamese stock market and study factors affecting this model is necessary.

FFVAR model includes four factors: market risk premium, size premium, value premium and risk premium for losing investment capital, regressed by quantile regression method instead of ordinary least squares method OLS. OLS is based on assumes that model has normal distribution, but in reality, it’s not. The regression model is not satisfied OLS assumptions, particularly the assumption about homogeneity of variance and no correlation between observations. Quantile regression overcomes the exaggeration of the impact of the abnormal observations, which needn’t have to remove these observations. In other words, this method overcomes data asymmetric or heterogeneous variance. Moreover, this study is regressed in both OLS and quantile regression to compare the advantages and disadvantages of each method.

2. Literature Review

In 1950s, by developing the basic portfolio model and portfolio selection theory Harry Markowitz laid down the foundation of modern portfolio management and furthermore, the foundation for the studies of asset pricing models. Markowit showed that it is importance for the investors to diversify the investments to reduce the total risk of a portfolio and indicated how to diversify effectively.

Not so long after Markowitz portfolio theory introduced, in the 1960s, William Sharpe (1964), John Lintner (1965) and Jan Mossin (1966) has continuously introduced the research about the capital market theory and developed the capital asset pricing model (CAPM), marking the birth of asset pricing theory. In this model, expected rate of return of a security is estimated by the sum of risk-free rate of return and the market risk premium basing on systematic risk of that security. The unsystematic risk is not considered in this model because it can be eliminated by diversifying portfolio.

The biggest advantage of the CAPM is the simplicity. It is very easy to apply in the reality, however, the simplicity is also its limitation. The CAPM uses only market beta to estimate the required rate of return, and it is definitely not enough. When applying the CAPM, many economists have discovered that there are othe factors (such as firm size, price-to-earning ratio, market-to-book value ratio, financial leverage...) affecting the return of security and the CAPM cannot explain that. Besides, the CAPM also has the problem of identifying the market portfolio, the problem of having too many unrealistic assumptions... Because of those disadvantages, the financial economist has begun to search for a more effective model which can fix the CAPM's limitations.

In 1992, Eugene F. Fama, together with Kenneth R. French, published a practical research showing that β, size, book-to-market equity, leverage, and earnings-price ratios have impacts on the cross-sectional variation in average stock return. Continuing the research, in the following year, they introduced the models with the common risk factors. The Fama-French three-factor model (FF3F) is the most widely used among them. Besides the market beta of the CAPM, they added two more factors in the FF3F, firm's capitalization (size) and book-to-market ratio.

$$R_i - R_f = \alpha_i + \beta_1\left(R_m - R_f\right) + \beta_2 SMB + \beta_3 HML + \varepsilon_i$$

Where:

R_i: Rate of return for portfolio i

R_f: Risk-free return model.

R_m: Return for the whole market

α_i:: Intercept of the regression

$\beta_1, \beta_2, \beta_3$: Regression coefficient of each factor.

ε_i: Residual of the regression

SMB: Return to a portfolio of small-cap stocks less return to a portfolio of large-cap stocks (small minus big)

HML: Return to a portfolio of stocks with high book-to-market values less return to a portfolio of low book-to-market value stocks (high minus low)

Market risk premium ($R_m - R_f$)

This factor is also called the market excess return. It measures the excess return received when investing in risky assets in the market instead of investing in risk-free assets. In the FF3F is similar to β in the CAPM. Both of them measure the impact of market risk to the risk of securities. However, because of the addition of two more factors in the model, will be smaller than β.

Size premium (SMB)

SMB captures elements of risk associated with firm size. It measures the excess return of investors when investing in small-capitalization firms. A positive SMB indicates that the small-cap stocks are better than the large-cap ones, and vice versa.

Value premium (HML)

HML is designed to distinguish risk differentials associated with “growth” firms (with low book-to-market ratio) and “value” firms (with high book-to-market ratio). It measures the excess return when investing in “value” firms. A positive HML shows that “value” stocks are better than “growth” stocks, and vice versa.

Although many practical researches have indicated that the FF3F is more applicable and effective than the CAPM in many stock markets in the world, especially in developed countries, this model still has limitations. The FF3F focuses on the sources of return more than the total risk. In an inefficient and non-transparent market like Vietnam stock market, the investment risk will be much higher and will have large effect on the stock return. Three factors of the FF3F are not enough, therefore, in order to apply a suitable model for Vietnam stock market, risk premium for losing investment capital (HVARL) factor was added into the FF3F for better measurement of risk.

$$R_i - R_f = c + \beta_1(R_m - R_f) + \beta_2(SMB) + \beta_3(HML) + \beta_4(HVARL) + \varepsilon_{it}$$

HVARL is calculated by the subtracting the average rate of return for portfolios having high VaR stocks to the average rate of return for portfolios having low VaR stocks. VaR is Value-at-Risk, one of the most advanced methods to measure risk. VaR describes the maximum expected loss over a given period at a confidence level for an asset or investment.

With a portfolio which probability and time period are given, VaR is considered as a threshold which the loss probability over the market value of that portfolio in a given period of time exceeds the current value (assuming the market evolutions is normal and there isn't any portfolio trading) is the given probability. Normally, the value variation of liquidity assets follows the normal distribution, with the required values are mean (expectation) and variance.

The advantage of the variance method is the investment portfolio has suitable amount so it is easy and quick to calculate mean, variance, covariance, operation steps, and to apply to investment portfolio including linear security (such as stock). Beside the advantage, this method also has disadvantages such as the VaR calculation is not suitable for non-linear securities, as well as it doesn't take account of the worst case scenario, hence doesn't prove the hypothesis of normal data distribution.

Previous studies of relationship between VaR and expected stock returns

Year	Author	Study	Finding
2004	G. Bali và Nusret Cakici	Value at Risk and Expected Stock Returns	Company size, liquidity, and value at risk explain the cross-sectional variation in expected returns on the NYSE, Amex and NASDAQ stocks for the period from January 1963 through December 2001. Beta and total volatility have almost no power to explain average stock returns at the stock level. All the risk factors considered... can capture the cross-sectional differences in portfolio returns but that VaR has the best performance in terms of R2 values. The relationship between VaR and expected stock return is not an effect of reversal in long-term returns, liquidity, or volatility

2009	Dar-Hsin Chen	VaR and the Cross-Section of Expected Stock Returns: An Emerging Market Evidence	VaR can explain the average stock returns at both 1% and 5% level. VaR shows the fluctuation on the stock market, especially with big firms. There is a negative relationship between actual returns and beta. Average return of large-cap firms is lower than that of small-cap firms. Firms with low evaluation (low stock price, high book-to-market ratio) have higher expected returns.

3. Data and methodology

This papers collect data including weekly close fixed prices of 247 nonfinancial companies listed on the Hochiminh Stock Exchange (HOSE) and market index represented by VN-Index, book value, the number of outstanding shares, stockholders' equity, event schedule of securities in 2^{nd} quarter annual audited financial statements and risk-free rate represented by bid-winning interest rates of 1-year government bonds for the period from July 2006 to June 2015. These collected data are calculated rate of return on each stock and market, company's size, book-to-market ratio and VaR of each stock.

Calculating weekly stock rate of return:

$$R_{i,t} = ln\frac{P_{i,t}}{P_{i,t-1}}$$

Where: $R_{i,t}$: Rate of return on stock i for week t

$P_{i,t}$: Closing price of stock i at the end of week t

$P_{i,t-1}$: Closing price of stock i at the end of week t-1

Company's size is calculated by market capitalization of equity at the end of 2^{nd} quarter annua from 2006 to 2015:

$$ME = Stock\ price\ x\ number\ of\ outstanding\ shares$$

Book value (or book common equity) of each company was calculated at the end of of 2nd quarter annual from 2006 to 2015:

$$BE = Stockholders' \ equity - preferred \ stocks \ value$$

Book-to-market ratio is calculated as:

$$\frac{BE}{ME} = \frac{BE \ at \ the \ end \ of \ 2nd \ quarter \ in \ year \ t}{ME \ at \ the \ end \ of \ 2nd \ quarter \ in \ year \ t}$$

Estimating VaR needs a large number of observations, so this research used daily returns to calculate mean (μ) and standard deviation (σ), and then estimate VaR at confidence level of 95%. Moreover, to be equivalent with yearly returns of stocks, the equation was multiplied with $\sqrt{260}$ (assuming 1 year have 260 trading days) to convert from daily VaR to yearly VaR

$$VaR_{yearly,1-\alpha} = -(\mu - 1.6449x\sigma)\sqrt{260}$$

Since then, using the data which are processed to classify into 8 portfolios and calculate 4 independent variables $R_m - R_f$, SMB, HML và HVARL.

3.1. Calculating independent variables of model:

Factor SMB (small minus big) was calculated as the difference, each week, between the simple average returns on the three small-stock portfolios and the simple average returns on the three big-stock portfolios:

$$SMB = \frac{S/L + S/M + S/H}{3} - \frac{B/L + B/M + B/H}{3}$$

Factor HML was measured by the difference, each week, between the simple average returns on the two "value" portfolios and the simple average returns on the two "growth" portfolios:

$$HML = \frac{S/H + B/H}{2} - \frac{S/L + B/L}{2}$$

Factor HVARL was estimated similarly, by the difference, each week, between the simple average returns of the high-VaR and the simple average returns of the low-VaR portfolios:

$$HVARL = HVAR - LVAR$$

3.2. Allocating stocks into eight portfolios

This FFVAR model use eight portfolios (S/L, S/M, S/H, B/L, B/M, B/H, HVAR, LVAR) to form portfolios mimicking the underlying risk factors in returns related to size, book-to-market equity and value at risk.

VaR portfolios were divided in the same way as size portfolios. In June of each year t from 2006 to 2012, all stocks were ranked on 5% VaR. The median 5% VaR was used to divide stocks into two groups, high VaR (HVAR) and low VaR (LVAR).

Company size was measured by the market value of equity as of June of each year. The median size was used to split stocks into two groups, small (S) and big (B).

Based on ranked values of BE/ME, stocks were assigned into three groups, low (L) for the bottom 30%, medium (M) for the middle 40% and high (H) for the top 30%.

From the intersections of the two ME groups and three BE/ME groups, six size-BE/ME portfolios were constructed:

- S/L: Stocks in both small-ME group and low-BE/ME group
- S/M: Stocks in both small ME group and medium BE/ME group
- S/H: Stocks in both small ME group and high BE/ME group
- B/L: Stocks in both big ME group and low BE/ME group
- B/M: Stocks in both big ME group and medium BE/ME group
- B/H: Stocks in both big ME group and high BE/ME group

3.3. Introduction to quantile regression

Quantile regression was first introduced by Koenker & Bassett in 1978. Instead of estimating the parameters of the average regression function by using OLS method, Koenker & Bassett (1978) suggested to estimate the parameters regression on each quantile of dependent variables so that the sum of absolute difference of the regression function at quantile τ of dependent variable is minimal. In other words, instead of identifying 9 marginal impacts of independent variables to the mean of dependent variables, quantile regression can identify the marginal impact of independent variables to dependent variables over their quantile.

Given Y is a random variable of a distribution function

$$F_\tau(\mathrm{y}) = \mathrm{P}(\mathrm{Y} \leq \mathrm{y})$$

τ – quantile, notation: Q(τ), is a reverse function of the distribution function $F_\tau(Y)$, is defined by: $Q(\tau) = \inf\{y: F(y) \geq \tau\}$

It can be interpreted as τ – quantile of data samples is the the value for τ.100% smaller observations and (1- τ).100% bigger observations of that quantile value.

4. Empirical Results

4.1. Descriptive statistics

Table 4.1: Descriptive statistics of independent and dependent variables

Variables		Mean	Standard Deviation	Min	Max	Total observations
Independent	**SMB**	0.1432	0.4199	-1.0033	2.0076	477
	HML	0.0133	0.5547	-1.6314	2.8418	477
	HVARL	-0,3069	1.5598	-0.6813	-5,5985	477
	$R_m - R_f$	-0.0017	0.0421	-.01778	0.1489	477
Dependent	**S/L**	-0.0022	0.0423	-0.1937	0.2202	477
	S/M	0.0041	0.0436	-0.1706	0.1681	477
	S/H	-0.0007	0.0436	-0.1863	0.1657	477
	B/L	-0.0021	0.0401	-0.1841	0.1666	477
	B/M	-0.0017	0.0422	-0.1799	0.1720	477

	B/H	-0.0023	0.0524	-0.2112	0.1859	477
	HVAR	0.0001	0.0510	-0.2123	0.3372	477
	LVAR	0.0016	0.0358	-0.1584	0.1694	477

This table shows that the average rate of return of the 8 portfolios from 7/2006 to 6/2015 is very low, the lowest is -0.23% (portfolio B/H) and the highest is 0.41 % (portfolio S/M).

Although the rate of return is low but the portfolio risk is quite high. This risk is identified by the deviation value of 8 portfolios, which is high, it varies between 3.58% (LVAR) to 5.24% (B/H).

Regarding the size, 2 over 3 portfolios of the small-size company group have higher rate of return than the large-size company group. (S/M = 0.41% > B/M = -0.17%, S/H = -0.07% > B/H = -0.23%). The average value of rate of return varies from -0.23% to 0.41% for small-size group and varies from -0.23% to -0.17% for large-size group. Variable SMB has a positive average value means the small-capitalized portfolio has higher return than the large-capitalized group. This is equivalent to the research result of Fama-French in 1992.

When considering BE/ME, book-to-market ratio, we can see that within the same small-size, the portfolio with high BE/ME has higher rate of return than the portfolio with low BE/ME (S/H > S/L), on the other hand within the same large-size portfolio with higher BE/ME has lower rate of return than the portfolio with low BE/ME (B/H < B/L). But the average value of HML is still positive, which shows that high BE/ME portfolio has higher rate of return than low BE/ME portfolio. This is equivalent to the research result of Fama-French in 1992. HVARL factor has positive average value, which proves high posibility of investment loss stock (HVAR) in the research period gives higher rate of return than low posibility of investment loss stock. Hence the stocks (portfolios) with higher posibility of investment loss will have higher rate of return to make up for the loss posibility.

One difference to the Bali-Cakici research, Fama-French is negative market factor in the research period. This has been explained above that in the research period from 7/2007 to 6/2015, the whole market affects by the decreasing tendency. On the other hand, risk-free rate increase anualy and maintain at high rate. Risk-free rate highly increased from 2006 to 2007 (about 0.34%/week), then decreased at the end of 2008, early 2009, then has been increasing gradually and maintain at a stable rate of 0.2%/week from 2010 until now. These are the reasons for the negative exceed rate of return during the research period.

4.2. Regression results

Table 4.2: Four-factor model: Regression of Excess Stock Returns on R_m- R_f, SMB, HML and HVARL

$R_i - R_f = c + \beta_1(R_m - R_f) + \beta_2(SMB) + \beta_3(HML) + \beta_4(HVARL) + \varepsilon_{it}$								
τ = 0.25	**S/L**	**S/M**	**S/H**	**B/L**	**B/M**	**B/H**	**LVAR**	**HVAR**
β_1	0.6204 ***	0.8049 ***	0.7638 ***	0.8607 ***	0.8442 ***	0.8729 ***	0.7410 ***	0.7928 ***
β_2	0.0226 ***	0.0355 ***	0.0186 ***	0.0005	0.0005	-0.0081 **	0.0076 ***	0.0293 ***
β_3	-0.0165 ***	-0.0061 ***	0.0174 ***	-0.0098 **	0.0031 **	0.0152 ***	0.0004	-0.0064 ***
β_4	0.0064 ***	0.0047 ***	0.0039 ***	0.0035 ***	0.0031 ***	0.0080 ***	0.0006	0.0093 ***
Adjusted R^2	0.2977	0.5073	0.5700	0.5723	0.5703	0.5473	0.5619	0.3941
τ = 0.5	**S/L**	**S/M**	**S/H**	**B/L**	**B/M**	**B/H**	**LVAR**	**HVAR**
β_1	0.5683 ***	0.8313 ***	0.7486 ***	0.8734 ***	0.8129 ***	0.8973 ***	0.7515 ***	0.7322 ***
β_2	0.0139 ***	0.0377 ***	0.0163 ***	0.0017	-0.0016	-0.0067 **	0.0060 ***	0.0189 ***
β_3	-0.0110 ***	-0.0038 *	0.0186 ***	-0.0077 ***	0.0039	0.0129 ***	0.0001	-0.0014

β4	0.0067 ***	0.0045 ***	0.0042 ***	0.0033 ***	0.0040 ***	0.0090 ***	0.0007	0.0097 ***
Adjusted R^2	0.2912	0.4780	0.5473	0.5189	0.5375	0.5278	0.5299	0.4180
τ = 0.75	**S/L**	**S/M**	**S/H**	**B/L**	**B/M**	**B/H**	**LVAR**	**HVAR**
β1	0.4719 ***	0.7693 ***	0.7867 ***	0.8385 ***	0.7879 ***	0.8317 ***	0.7474 ***	0.6913 ***
β2	0.0054 **	0.0281 ***	0.0156 ***	-0.0015	-0.0064 ***	-0.0104 ***	0.0017	0.01100 ***
β3	-0.0099 ***	-0.0013	0.0163 ***	-0.0083 ***	0.0034 **	0.0160 ***	0.0033 **	-0.0007
β4	0.0079 ***	0.0054 ***	0.0049 ***	0.0039 ***	0.0062 ***	0.0107 ***	0.0013 **	0.0113 ***
Adjusted R^2	0.3058	0.4301	0.5717	0.5532	0.5380	0.5523	0.5309	0.3934

Like the previous model when building regression models, FFVAR model regressed at quantile τ = 0.25, 0.5, 0.75 market factors are statistically significant at the α = 1% for all portfolios and slope coefficients ranged from 0.4719 to 0.8973. Meanwhile, new factors HVARL also have high statistical meaning when there are 7 portfolios with the level of statistical meaning is 1% at all three levels of quantile except LVAR porfolio. Most of the slope coefficient SMB and HML have statistical meaning at all three levels of quantile and HML is more dominant than SMB.

According to the table above, market factors at quantile τ = 0.25, τ = 0.5 and τ = 0.75 respectively have slope coefficient ranged from 0.6204 (porfolio S/L) to 0.8729 (porfolio B/H); from 0.5683 (porfolio S/L) to 0.8973 (porfolio B/H); in the range of 0.4719 (porfolio S/L) to 0.8385 (porfolio B/L). And all portfolios have statistical meaning at 1%.

SMB factor in quantile τ = 0.25 have slope coefficient ranged from -0.0081 (porfolio B/H) to 0.0355 (porfolio S/M) and 5 portfolios have statistical meaning at 1%

included 3 porfolios of group S and 2 porfolios of group VAR, 1 portfolio having significant at 5% is B/H. At quantile τ = 0.5, the slope coefficients ranged from -0.0067 (porfolio B/H) to 0.0377 (porfolio S/M) and the portfolios have statistical meaning at two levels 1% and 5% are similar at quantile τ = 0.25. Also at quantile τ = 0.75, the slope coefficients ranged from -0.0104 (porfolio B/H) to 0.0281 (S/M) and has 5 portfolios, which are significant at the 1% level (porfolio S/M , S/H, B/M, B/H, HVAR) and 1 porfolio are significant at the 5% level (porfolio S/L).

HML factor at quantile τ = 0.25 with slope coefficients ranged from -0.0165 (porfolio S/L) to 0.0174 (porfolio S/H) has portfolios which are the most significant porfolio included 5 portfolios have statistical meaning at 1% (porfolio S/L, S/M, S/H, B/H, HVAR) and 2 portfolios significant at the 5% level (porfolio B/L, B/M) except LVAR has no statistical significance at 3 meaning levels. For quantile τ = 0.5, HML has slope coefficient ranged from -0.0110 (porfolio S/L) to 0.0186 (porfolio S/H), the portfolios had a lower statistical meaning than quantile τ = 0.25 with 4 portfolios are significant at 1% (S/L, S/H, B/L, B/H), 1 porfolio having statistical meaning at 10% is S/M . Remaining at quantile τ = 0.75, HML factor has slope coefficient ranged from -0.0099 (porfolio S/L) to 0.0163 (porfolio S/H) and has 4 portfolios which have statistical meaning at 1% consists of S/L, S/H, B/L, B/H; 2 portfolios are significant at the 5% level is B/M and LVAR.

Finally, HVARL factor has slope coefficient at quantile τ = 0.25, τ = 0.5, τ = 0.75, respectively ranged from 0.0006 (porfolio LVAR) to 0.0093 (porfolio HVAR), from 0.0007 (porfolio LVAR) to 0.0097 (porfolio HVAR) and from 0.0013 (porfolio LVAR) to 0.0113 (porfolio HVAR). In 4 factors model, HVARL is just behind the market factors in the portfolio have a statistical meaning level. There are 7 specific portfolios are statistically significant at the level 1% except porfolio 2 at quantile level LVAR τ = 0.25 τ = 0.5, while at quantile τ = 0.75 LVAR has statistical meaning increase in the level of 5%. Therefore, HVARL factor is statistically significant higher at the lower quantile.

At the same time, the model also explains the change of profitability ratios at high levels through R^2 correction in each quantile level, specifically at τ = 0:25 model explains the changes of rate of returnshares from 29.77% (porfolio S/L) to 57.23% (porfolio B/L), at τ = 0.5 units from 29.12% (porfolio S/L) to 54.73% (porfolio S/H) and finally at τ = 0.75 explained from 30.58% 9 portfolios S/L) to 57.17% (porfolio S/H). Thus, when the model of 4 factors is being regressed by percentile method can help them have statistical meaning , and R^2 adjust is higher than the model of 3 factors with the same method.

5. Conclusions

The result leads to the conclusion that all four factors contribute to the explanation of rate of return during the research period. Most coefficients have values under 5%. Adjusted R^2 fluctuate between 29.12% and 54.73% with τ = 0.25; between 29.12% and 54.73% with τ = 0.5 and within 30.58% and 57.17% with τ = 0.75.

Simultaneously, this research also demonstrates that market factor is the best explanation for the fluctuation of expected rate of return of securities on HOSE in the period from July 2006 to June 2015 with the value of R^2 and coefficients significantly higher than that of other factors. Furthermore, market factor makes a biggest impact on big size portfolios. Therefore, HOSE is positive reflected the trend of market factor.

Both HML and SMB factor take part in the explanation of the change in rate of return of portfolios, the impact of HML is better than that of SMB. Rate of return has negative impact to company size and positive impact to book-to-market ratio. Specifically, SMB makes a strongest impact on small size portfolios and high risk portfolios are more impacted than low ones. HML factor make a greater effect on rate of return of portfolios which have higher BE/ME. Nevertheless, this factor have positive impact on low risk portfolios and negative impact on high ones. This result is also relevant to FF3F model validating result and Bili-Cakici’s 4 factors model valitating result.

Regarding HVARL factor, this is the second important factor in explaining the rate of return, after market factor. The result also indicates that this factor make a strongest effect on rate of return of high risk portfolios. This result is similar to Bali-Cakici result in 2004 and archive our research target.

In conclusion, the ability to forecast the rate of return of FFVAR is reliable however it still can't capture precisely all the change in stock profit, due to average R^2 value with high residual.

Following the research result which indicates that stocks are underevaluated. It can generate high rate of return in Vietnam market, the value investment strategy should be applied to Vietnam stock market. Furthermore, investors should consider invest in small size company instead of big one because it can bring more profit.

However, when investing in small company, investor should consider risk premium for losing investment capital due to its high impact on small company as can be seen in this research. Market factor greatly influent on rate of return, while Vietnam stock market is also affected by different factor, even some of these can't be estimated. Therefore, investor should behave carefully combine with tracking and monitoring the market for a while, avoid rush investment.

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Appendix 1: **Test results for FFVAR four-factor model on S/L portfolio**

```
. sqreg   rirfsm rmrf smb hml hvarl, q(.25 .5 .75)
(fitting base model)
(bootstrapping ....................)

Simultaneous quantile regression                    Number of obs =        472
  bootstrap(20) SEs                                 .25 Pseudo R2 =     0.5073
                                                    .50 Pseudo R2 =     0.4780
                                                    .75 Pseudo R2 =     0.4301
```

rirfsm	Coef.	Bootstrap Std. Err.	t	P>|t|	[95% Conf.	Interval]
q25						
rmrf	.8049648	.0266818	30.17	0.000	.7525336	.8573961
smb	.0355682	.0031314	11.36	0.000	.0294149	.0417215
hml	-.006186	.0018422	-3.36	0.001	-.0098061	-.002566
hvarl	.0047248	.0016371	2.89	0.004	.0015078	.0079418
_cons	-.0108256	.0009186	-11.79	0.000	-.0126306	-.0090206
q50						
rmrf	.8313991	.0462859	17.96	0.000	.7404447	.9223536
smb	.0377728	.0025301	14.93	0.000	.0328009	.0427446
hml	-.0038396	.0022269	-1.72	0.085	-.0082157	.0005365
hvarl	.0045928	.0011341	4.05	0.000	.0023642	.0068214
_cons	.0007335	.0009681	0.76	0.449	-.001169	.002636
q75						
rmrf	.7693148	.0645149	11.92	0.000	.6425393	.8960903
smb	.0281567	.0041903	6.72	0.000	.0199226	.0363909
hml	-.0013143	.0023413	-0.56	0.575	-.0059151	.0032864
hvarl	.0054128	.0011904	4.55	0.000	.0030735	.0077521
_cons	.0168252	.0020349	8.27	0.000	.0128266	.0208239

Appendix 2: **Test results for FFVAR four-factor model on S/M portfolio**

```
. sqreg   rirfsl rmrf smb hml hvarl, q(.25 .5 .75)
(fitting base model)
(bootstrapping ....................)

Simultaneous quantile regression                    Number of obs =        472
  bootstrap(20) SEs                                 .25 Pseudo R2 =     0.2977
                                                    .50 Pseudo R2 =     0.2912
                                                    .75 Pseudo R2 =     0.3058
```

rirfsl	Coef.	Bootstrap Std. Err.	t	P>|t|	[95% Conf.	Interval]
q25						
rmrf	.6204857	.0684372	9.07	0.000	.4860027	.7549687
smb	.0226948	.0043079	5.27	0.000	.0142295	.0311601
hml	-.0165829	.0028831	-5.75	0.000	-.0222483	-.0109175
hvarl	.0064749	.001409	4.60	0.000	.0037062	.0092436
_cons	-.0170605	.0023831	-7.16	0.000	-.0217435	-.0123775
q50						
rmrf	.5683013	.05939	9.57	0.000	.4515966	.685006
smb	.0139126	.0025423	5.47	0.000	.0089169	.0189082
hml	-.0110667	.0027689	-4.00	0.000	-.0165077	-.0056257
hvarl	.0067738	.0011315	5.99	0.000	.0045504	.0089972
_cons	-.0003553	.0015004	-0.24	0.813	-.0033037	.002593
q75						
rmrf	.4719573	.0436979	10.80	0.000	.3860884	.5578262
smb	.0054471	.0024464	2.23	0.026	.0006398	.0102544
hml	-.0099259	.002089	-4.75	0.000	-.0140309	-.0058208
hvarl	.0079263	.0009672	8.19	0.000	.0060255	.009827
_cons	.0161035	.0020826	7.73	0.000	.012011	.020196

Appendix 3: Test results for FFVAR four-factor model on S/H portfolio

```
. sqreg    rirfsh rmrf smb hml hvarl, q(.25 .5 .75)
(fitting base model)
(bootstrapping ....................)

Simultaneous quantile regression                    Number of obs =        472
  bootstrap(20) SEs                                 .25 Pseudo R2 =     0.5700
                                                    .50 Pseudo R2 =     0.5473
                                                    .75 Pseudo R2 =     0.5717

------------------------------------------------------------------------------
             |              Bootstrap
      rirfsh |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
q25          |
        rmrf |    .763838    .0512503    14.90   0.000     .6631283    .8645476
         smb |   .0186466    .0024443     7.63   0.000     .0138434    .0234498
         hml |   .0174825     .001691    10.34   0.000     .0141595    .0208054
       hvarl |   .0039809     .000744     5.35   0.000     .0025189     .005443
       _cons |  -.0122931    .0013465    -9.13   0.000     -.014939   -.0096471
-------------+----------------------------------------------------------------
q50          |
        rmrf |   .7486904    .0789937     9.48   0.000     .5934633    .9039174
         smb |   .0163458    .0027047     6.04   0.000      .011031    .0216606
         hml |   .0186848    .0026907     6.94   0.000     .0133974    .0239723
       hvarl |   .0042108    .0009217     4.57   0.000     .0023996    .0060219
       _cons |   3.36e-06    .0010203     0.00   0.997    -.0020016    .0020083
-------------+----------------------------------------------------------------
q75          |
        rmrf |   .7867666    .0792439     9.93   0.000     .6310478    .9424854
         smb |   .0156688    .0036502     4.29   0.000     .0084958    .0228417
         hml |   .0163318    .0022629     7.22   0.000     .0118852    .0207785
       hvarl |   .0049338    .0008415     5.86   0.000     .0032802    .0065873
       _cons |   .0103675    .0011595     8.94   0.000     .0080889     .012646
------------------------------------------------------------------------------
```

Appendix 4: Test results for FFVAR four-factor model on B/L portfolio

```
. sqreg     rirfbl rmrf smb hml hvarl, q(.25 .5 .75)
(fitting base model)
(bootstrapping ....................)

Simultaneous quantile regression                    Number of obs =        472
  bootstrap(20) SEs                                 .25 Pseudo R2 =     0.5723
                                                    .50 Pseudo R2 =     0.5189
                                                    .75 Pseudo R2 =     0.5532

------------------------------------------------------------------------------
             |              Bootstrap
      rirfbl |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
q25          |
        rmrf |   .8607865    .0352308    24.43   0.000      .791556    .9300171
         smb |   .0005831    .0033933     0.17   0.864     -.006085    .0072512
         hml |  -.0098308    .0033184    -2.96   0.003    -.0163516   -.0033099
       hvarl |   .0035516    .0007248     4.90   0.000     .0021274    .0049759
       _cons |  -.0093868    .0008779   -10.69   0.000    -.0111119   -.0076617
-------------+----------------------------------------------------------------
q50          |
        rmrf |   .8734036    .0252872    34.54   0.000     .8237127    .9230944
         smb |   .0017643    .0029037     0.61   0.544    -.0039417    .0074703
         hml |  -.0077205    .0029432    -2.62   0.009    -.0135041   -.0019369
       hvarl |     .00332     .000986     3.37   0.001     .0013824    .0052575
       _cons |   .0002756    .0007154     0.39   0.700    -.0011301    .0016813
-------------+----------------------------------------------------------------
q75          |
        rmrf |   .8385627    .0304291    27.56   0.000     .7787679    .8983576
         smb |  -.0015661    .0031371    -0.50   0.618    -.0077308    .0045985
         hml |  -.0083303    .0031877    -2.61   0.009    -.0145944   -.0020663
       hvarl |   .0039712    .0010731     3.70   0.000     .0018626    .0060798
       _cons |    .010889    .0011567     9.41   0.000     .0086161    .0131619
------------------------------------------------------------------------------
```

Appendix 5: **Test results for FFVAR four-factor model on B/M portfolio**

```
. sqreg      rirfbm rmrf smb hml hvarl, q(.25 .5 .75)
(fitting base model)
(bootstrapping ....................)

Simultaneous quantile regression                    Number of obs =        472
  bootstrap(20) SEs                                 .25 Pseudo R2 =     0.5703
                                                    .50 Pseudo R2 =     0.5375
                                                    .75 Pseudo R2 =     0.5380
```

rirfbm	Coef.	Bootstrap Std. Err.	t	P>|t|	[95% Conf.	Interval]
q25						
rmrf	.8442417	.0249609	33.82	0.000	.7951922	.8932913
smb	.0005639	.0025949	0.22	0.828	-.0045352	.005663
hml	.0031476	.0015622	2.01	0.044	.0000778	.0062173
hvarl	.003786	.0007608	4.98	0.000	.002291	.005281
_cons	-.0097416	.0008695	-11.20	0.000	-.0114501	-.0080331
q50						
rmrf	.8129058	.0384076	21.17	0.000	.7374326	.8883789
smb	-.0016389	.0035705	-0.46	0.646	-.0086551	.0053772
hml	.0039501	.0029518	1.34	0.181	-.0018504	.0097506
hvarl	.0040788	.0008982	4.54	0.000	.0023137	.0058438
_cons	.0002297	.0011563	0.20	0.843	-.0020426	.0025019
q75						
rmrf	.787956	.044552	17.69	0.000	.7004087	.8755033
smb	-.0064243	.0023754	-2.70	0.007	-.0110921	-.0017566
hml	.003407	.0016208	2.10	0.036	.0002221	.006592
hvarl	.0062978	.0011326	5.56	0.000	.0040721	.0085235
_cons	.0137703	.0015953	8.63	0.000	.0106355	.0169051

Appendix 6: **Test results for FFVAR four-factor model on B/H portfolio**

```
. sqreg      rirfbh rmrf smb hml hvarl, q(.25 .5 .75)
(fitting base model)
(bootstrapping ....................)

Simultaneous quantile regression                    Number of obs =        472
  bootstrap(20) SEs                                 .25 Pseudo R2 =     0.5473
                                                    .50 Pseudo R2 =     0.5278
                                                    .75 Pseudo R2 =     0.5523
```

rirfbh	Coef.	Bootstrap Std. Err.	t	P>|t|	[95% Conf.	Interval]
q25						
rmrf	.8729423	.04081	21.39	0.000	.7927484	.9531363
smb	-.0081215	.004051	-2.00	0.046	-.0160819	-.000161
hml	.015231	.0035727	4.26	0.000	.0082105	.0222516
hvarl	.0080148	.0007278	11.01	0.000	.0065846	.0094449
_cons	-.0111087	.0013435	-8.27	0.000	-.0137488	-.0084686
q50						
rmrf	.8973961	.0431526	20.80	0.000	.8125988	.9821934
smb	-.0067463	.002704	-2.49	0.013	-.0120598	-.0014327
hml	.0129609	.0049188	2.63	0.009	.0032953	.0226266
hvarl	.0090121	.0013928	6.47	0.000	.0062752	.0117491
_cons	.001615	.0012941	1.25	0.213	-.000928	.0041579
q75						
rmrf	.8317121	.0585806	14.20	0.000	.7165979	.9468263
smb	-.0104625	.0039745	-2.63	0.009	-.0182727	-.0026524
hml	.0160574	.0023259	6.90	0.000	.0114869	.0206279
hvarl	.01076	.0011398	9.44	0.000	.0085202	.0129997
_cons	.0178718	.0017647	10.13	0.000	.014404	.0213396

Appendix 7: Test results for FFVAR four-factor model on HVAR portfolio

```
. sqreg        lvar rmrf smb hml hvarl, q(.25 .5 .75)
(fitting base model)
(bootstrapping ....................)

Simultaneous quantile regression                    Number of obs =        471
  bootstrap(20) SEs                                 .25 Pseudo R2 =     0.5619
                                                    .50 Pseudo R2 =     0.5299
                                                    .75 Pseudo R2 =     0.5309
```

lvar	Coef.	Bootstrap Std. Err.	t	P>|t|	[95% Conf.	Interval]
q25						
rmrf	.7410987	.0346585	21.38	0.000	.6729925	.809205
smb	.007696	.0021524	3.58	0.000	.0034663	.0119257
hml	.0004478	.0014532	0.31	0.758	-.0024078	.0033033
hvarl	.0006096	.0009336	0.65	0.514	-.0012251	.0024442
_cons	-.0064382	.0009532	-6.75	0.000	-.0083112	-.0045651
q50						
rmrf	.7515421	.0375614	20.01	0.000	.6777313	.8253528
smb	.0060963	.0019845	3.07	0.002	.0021965	.0099961
hml	.000196	.0024033	0.08	0.935	-.0045267	.0049187
hvarl	.0007922	.0009579	0.83	0.409	-.0010901	.0026745
_cons	.0019396	.0006791	2.86	0.004	.0006051	.003274
q75						
rmrf	.7474813	.0423146	17.66	0.000	.6643302	.8306323
smb	.0017683	.0021662	0.82	0.415	-.0024885	.0060251
hml	.00334	.0015678	2.13	0.034	.0002592	.0064208
hvarl	.0013276	.0005141	2.58	0.010	.0003173	.002338
_cons	.0120944	.000906	13.35	0.000	.0103141	.0138748

Appendix 8: Test results for FFVAR four-factor model on LVAR portfolio

```
. sqreg        hvar rmrf smb hml hvarl, q(.25 .5 .75)
(fitting base model)
(bootstrapping ....................)

Simultaneous quantile regression                    Number of obs =        466
  bootstrap(20) SEs                                 .25 Pseudo R2 =     0.3941
                                                    .50 Pseudo R2 =     0.4180
                                                    .75 Pseudo R2 =     0.3934
```

hvar	Coef.	Bootstrap Std. Err.	t	P>|t|	[95% Conf.	Interval]
q25						
rmrf	.7928585	.0625309	12.68	0.000	.6699777	.9157394
smb	.0293922	.0033174	8.86	0.000	.0228731	.0359113
hml	-.0064149	.0021508	-2.98	0.003	-.0106415	-.0021882
hvarl	.0093032	.0012237	7.60	0.000	.0068984	.0117081
_cons	-.011019	.0018623	-5.92	0.000	-.0146786	-.0073594
q50						
rmrf	.7322697	.0637209	11.49	0.000	.6070502	.8574892
smb	.0189593	.0031667	5.99	0.000	.0127363	.0251822
hml	-.0014939	.0017771	-0.84	0.401	-.0049861	.0019982
hvarl	.0097996	.0012584	7.79	0.000	.0073266	.0122726
_cons	.0036585	.0015319	2.39	0.017	.0006482	.0066688
q75						
rmrf	.6913229	.0577769	11.97	0.000	.5777842	.8048617
smb	.0110311	.0029194	3.78	0.000	.0052942	.016768
hml	-.0007929	.0024624	-0.32	0.748	-.0056318	.004046
hvarl	.0113928	.0012197	9.34	0.000	.0089959	.0137897
_cons	.0181542	.0014359	12.64	0.000	.0153326	.0209759