LIQUIDITY AS AN INVESTMENT STYLE: EVIDENCE FROM STOCK EXCHANGE OF THAILAND

BY

MR. WATCHARIT WORASITTHIKORN

AN INDEPENDENT STUDY SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE PROGRAM IN FINANCE (INTERNATIONAL PROGRAM)
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THAMMASAT UNIVERSITY
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was approved as partial fulfillment of the requirements for
the degree of Master of Science (Finance)

on 11 MAY 2018

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Independent study title	LIQUIDITY AS AN INVESTMENT STYLE: EVIDENCE FROM STOCK EXCHANGE OF THAILAND
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Academic year	2017

ABSTRACT

This paper finds the relationship between liquidity of stocks which use turnover ratio of stock as a proxy and excess returns explained by four factors from Scherer (2011) consisting of market return, size-effect, value-effect, volatility-effect. I use simple linear regression to find the relationship in 2x3 portfolios and check robustness by split time period into 3 periods and forming more 3x3 portfolios. The datasets that use in this research are from the Stock Exchange of Thailand (SET) during January 2006 to December 2017 which excluding some stocks that least liquid until that can't be traded.

The result show that the intercept term of low liquid stocks also less abnormal return than high liquid stocks with significant also close to zero and R-square in model of high liquid stocks also significantly higher than low liquid stocks. I conclude that high liquid stocks can generate abnormal return in term of individually but I cannot find the significant alpha in the different basis and better explain by four-factor model than low liquid stocks which mean it is good enough for being one of the investment style.

Keywords: Liquidity, Turnover ratio, Asset pricing model, Factor, Abnormal return, R-square

ACKNOWLEDGEMENTS

I would like to express my deep gratitude to my advisor, Associate Professor Pantisa Pavabutr, Ph.D., who give me invaluable guidance and encouragement to do this research. Without her guidance I cannot complete my paper within scheduled. Moreover, I would like to grateful thanks to my committee member for grateful comments to improve my research paper. My special thanks are also extended to my classmate especially Mr. Nuthakamol Panjarojanakul and Mr. Pongkhun Noinate for their help in implementation SAS codes and many advices for this research. Finally, I would like to express gratitude to my family for their encouragement and unlimited supporting me.

Mr. Watcharit Worasitthikorn

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CHAPTER 1
INTRODUCTION

In the theory of capital asset pricing model (CAPM), all investors are risk averse and rational. In equilibrium, all investors hold the same Markowitz mean variance efficient portfolio. No investor can do better than holding the market portfolio (We can call this portfolio is "cap-weighted index"). However, many academic studies for example Stambaugh (1982) have denied the concept that the equity market portfolio is good representative the CAPM portfolio because the CAPM portfolio should include all of financial instrument not only stocks but also corporate bonds, commodities and real estate. Moreover, the study by Roll and Ross (1994) showed that cross-sectional relation between expected return and betas does not hold when using market index as a proxy.

With the market portfolio and single factor model rejected in a number of empirical findings, factors investing have increased popularity among equity investors which not only focus on individual stock selection, but also view their portfolio as a bundle of factor that be drivers of security return and manage portfolio based on view of factors (Ang 2014). William F. Sharpe (1978, 1988, 1992) also defined four criteria that can be element an investment style : 1) "identifiable before the fact, 2) "not easily beaten", 3) "a viable alternative", and 4) "low in cost" There are many factors or styles that widely used in factors investing such as size (Banz 1981), value (Lakonihok 1994 and Fama and French 1992), momentum (Jegadeesh 1993), low volatility (Baker 2011) factors and etc. which can be applied in other asset classes not only in equity (Clarke 2017). Factors investing are important part of portfolio managers for analyzing return and risk characteristics of an individual security and portfolio, managing portfolio exposure based on source of portfolio risk, and reducing error of estimation in an individual stock return (Fabozzi 2017).

Ibbotson (2013) introduced liquidity factor as an investment style. They used previously data in stock turnover in US equity market dataset during 1972-2011 to measure and represent liquidity of stocks which "identifiable before the fact" and added regression analysis by using Carhart four-factor model (1997). They ranked stocks into quartiles by each style and found that return in quartile 1st of each style are outperformed equally weighted market portfolio. Comparing with other style, low-liquidity quartile can beat size, value, and momentum style which mean "not easily beaten". They inspect double-sorted portfolio, comparing liquidity with size, value and momentum in 4x4. Then the impact of liquidity also stronger than other style by roughly which can be "a viable alternative". Finally, they run regression analysis by using each asset pricing model and the result was show that low liquidity factor has positive alpha with high significant. Then they claim that low-turnover stocks can generate higher return than high-turnover stocks due to liquidity premium. Liquidity premium come from less liquid assets will have higher cost of trading so investors want to have more risk premium to compensate for taking liquidity risk. Moreover, stocks migrating between liquid and low liquid also another reason for liquidity premium.

This paper follows in some part of the research by Ibbotson (2013) who propose liquidity as an investment style that construct portfolio in each factor such as size, value, momentum, and liquidity factor to comparing performance to see how liquidity style is hardly to be beaten and also explain the relationship of stock return by using four factors model by Cahart (1997) which include momentum factor. In this paper, I also use volatility factor instead of momentum factor because it quite sensitive with estimation period to explain relationship of liquidity and stock return. Moreover, I compare long only index in best performance of each other factor to test the strength of each factor. However, this paper aim to study in Thai stock market which may have different market structure such as type of investors which high portion of retail investors, stocks characteristics which driven by large cap stocks, or portion of free-float which impact to liquidity of stocks that can dominate the market in the different ways from developed market or other developing market. Hence the result of factors, and portfolios return may be not same from other markets which will be attractiveness of this paper. In conclusion, I will inspect the relationship between liquidity and stock return with four-factor pricing model to check how much model explanation by examine intercept term and coefficient whether they are significant. In this research will use data in stock exchange of Thailand (SET) during 2006 to 2017.

The key findings of research are that in Thailand stock market, the result is quite different as expectation in theory and developed stock market. For example, the result in volatility and liquidity of stocks show that high volatility and high liquid stocks can outperform the low volatility and low liquid stocks while small size and high value stocks still outperform the large size and low value stocks as same as in theory. Moreover, to be focus on liquidity stocks, from regression result by four factor I found that the high liquid stocks have abnormal return with significant value in term of individually but I cannot find the significant alpha in the different basis (highest minus lowest) and R-square is high rather than low liquid stocks obviously which we may use high liquid stock as stock selection and investment style.

This paper is comprised of 6 part. In Chapter 2, I review the literature. In literature review section, I review the roots of relationship between liquidity and stock return which study by Amihud (1986), Subrahmanyam (1996), Radcliffe (1998), and G. Ibbotson (2013). All of research also support that there is liquidity premium in developed equity market. They use many proxy for liquidity such as bid-ask spread, and stock turnover but I choose turnover rate to be proxy because it's simple and less complexity in collecting data. Moreover, I review factor analysis to be use in asset pricing model and I use Fama-French three factor plus low volatility factor from Scherer (2011) without low beta factor because it high correlate with low volatility factor and directly contradict with CAPM and drop momentum factor from Jegadeesh (1993) because it quite sensitive with estimation period and not match with my rebalancing period. In Chapters 3 and 4, I describe the data description and methodology. Finally, Chapter 5 and 6, empirical results and concludes.

CHAPTER 2
LITERATURE REVIEW

2.1 Liquidity and Stock Returns

Amihud and Mendelson (1986) was the first who studied the relationship between liquidity and stock returns. They used the bid-ask spread as a proxy of liquidity to examine relationship. The bid-ask spread is the difference between bid and ask price quoted by dealer which include premium to buy or sell stocks immediately so that bid-ask spread may be the demand from dealer for providing liquidity and immediate execution. They ranked stocks by percentage bid-ask spread into seven portfolios which represent each liquidity level. Then they estimated beta coefficient of each portfolio by running regression portfolio's monthly excess return. The result of their research which use data from NYSE during 1960 -1980 showed that percentage bid-ask spread had high correlation with stock returns. Moreover, the monthly excess return of stocks with 1.5 percent spread is 0.45 percent more than excess return with 0.5 percent spread but the monthly excess return of stocks with 5 percent spread is only 0.09 percent more than excess return with 4 percent spread. It implied that the return on high spread higher, the sensitivity of spread is less than the return on low spread stocks. Then they concluded that low liquidity stocks should generate higher return due to cost of trading. Because investors consider their return as net of trading cost, then required higher return for stocks which have higher bid-ask spread to compensate their cost of trading. Then Brennan and Subrahmanyam (1996) tried to use other proxy for liquidity by subtracting cost of transaction into a variable and a fixed component and extending analysis by using Fama-French's three factor model. They couldn't find significant evidence to support liquidity premium, they found only the concave relationship between stock return and transaction cost with variable cost component but fixed cost component wasn't consistent result.

Then Datar, Naik, and Radcliffe (1998) used turnover ratio of stocks (number of shares traded divided by the number of shares outstanding) as a proxy for liquidity which different from Amihud and Mendelson (1986). They proposed two reasons for use new proxy for liquidity. First, data on bid-ask spread is difficult to obtain in monthly basis over the long time. Second, there is supported by Peterson and Fialkowski (1994) show that quoted spread is poor proxy for actual transaction cost occurred with investors then should be find another proxy. So Datar, Naik, and Radcliffe (1998) used datasets in NYSE during 1962 – 1991 and cut off the lowest 1% and highest 1% turnover rate of observations to reduce outliers. Then they consider datasets both with and without the month of January for excluding January's effect. They find the relationship between turnover rate and stock returns by running regression Fama-French's three factor model and the result showed that stock returns are strong negatively compared to turnover rate which significant with and without the month of January. Finally, they concluded that low turnover rate stocks can generate higher return than high turnover stocks.

Ibbotson et al. (2013) introduced that liquidity should be treated like other style such as size (Banz 1981), value (Lakonihok 1994 and Fama and French 1992), momentum (Jegadeesh 1993), low volatility (Baker 2011). They used stock turnover in US equity market dataset during 1972-2011 to measure and represent liquidity of stocks like Datar et al. (1998)'s research but also added regression analysis by using Carhart four-factor model (market, size, value, and momentum factor). They ranked stocks into quartiles by each style and found that return in quartile 1 of each style (size, value, momentum, and liquidity) are outperformed equally weighted market portfolio. Comparing with other style, low-liquidity quartile can beat size, value, and momentum style. They inspect double-sorted portfolio, comparing liquidity with size, value and momentum in 4x4. Then the impact of liquidity also stronger than other style by roughly. Finally, they construct liquidity factor by deduct quartile 4 return from quartile 1 return like low liquidity minus high liquidity then run regression analysis by using Carhart four-factor, Fama French three factor and CAPM model then the result was show that low liquidity factor has positive alpha with high significant or as low liquidity long only portfolio regress with all factor models also have significant positive alpha. Then they claim that low-turnover stocks can generate higher return than high-turnover stocks due to liquidity premium. Liquidity premium come from less liquid assets will have higher cost of trading so investors want to have more risk premium to compensate for taking liquidity risk. Moreover, stocks migrating between liquid and low liquid also another reason for liquidity premium. For instance, they found that in lowest liquidity quartile 75 percent remain a year later, and 25 percent move into higher liquidity quartiles. When stocks migrate to higher liquidity quartiles, they gain a lot of returns. On the other hand, the most liquid quartile may be drop to into lower quartiles then they usually get negative returns.

From previous studies as mention before, I can summarize that liquidity premium is existed in developed equity market which strongly impact more than other factors. Moreover, the most widely used as a proxy for liquidity are bid-ask spread and turnover rate. To be simple and reduce complexity in collecting data, I use turnover rate as a proxy for liquidity.

2.2 Factor analysis

Banz (1981) state that small firms can generate higher risk adjusted return than large firm due to size effect because small firms have more opportunities to growth than large firms. Moreover, small firms tend to highly volatile in running business, and the correction from problems such as declining from lacking of fund which can lead stocks to have more upside. Eventually, prices of small stocks tend to decline, and declining prices mean that upside of small stocks tend to be larger than large cap stocks.

Lakonihok (1994) found the significant evidence that there is value premium (HML) in average return between value stocks (high book to market ratio) and growth stocks (low book to market ratio) due to value effect because there is a market mispricing that investors can take advantages from other investors over-reaction which extremely expect stocks that have large past earning growth too high so stocks price tend to overvalue. Moreover, stocks which recently bad earning growth are underestimated and tend to undervalue. Then undervalue stocks should attractive to investors and revert to the mean which can lead value stocks to be outperform.

Jegadeesh (1993) and Gutierrez (2008) found the momentum effect in stock market which mean stock that high relative strength or high return in recently will continue generate higher return than stocks with low relative strength or low return in previously. They give explanation of momentum effect that market is underreact in firm-specific information in very short term by conservatism investors when market realize they have to chase stocks to capture exposure. Moreover, there are interaction between momentum traders and new watchers, momentum traders want to earn profit, they may have to push up price to above fundamental price to take profit and let another momentum trader to join which can lead momentum stocks outperform in short period.

Scherer (2011) show that stocks with low volatility can be outperform high volatility stock due to low volatility anomaly. Because in real world there are leverage and short selling constraint. So many investors who demand high return may increase their expected return by overweighting to high volatility stocks. When there are high demands on high volatility stocks, their prices will raise, then their future return will be decline. There are more explanations that the professional investors such as analyst and portfolio managers have to compensate their own incentive in their career which rely on how much they can generate return to their clients so they tend to invest in more risky stocks with expected high return that stimulate higher demand in high volatility stocks and market mispricing. Moreover, they also use low beta as a factor to explain return of stock which Thomas and Shaprio (2009) show that low beta stocks outperform high beta which contradict with CAPM theory that stocks' return should be compensate with high beta due to high risk high expected return that why it's call low beta anomaly.

From previous studies in factor analysis all of them claim that their factors can be outperform than market with significant and using them for asset pricing model extending from original CAPM. Scherer (2011) use low volatility and low beta factor which the result show that there is more than 60% correlation between low beta and low volatility factor. Moreover, low beta factor is similar to market factor but in opposite way which contradict with CAPM and Fama French 3 factors so I will drop low beta factor to not take into account the similar factors which can reduce the process of works. And I also drop momentum factor from Jegadeesh (1993) and Gutierrez (2008) because it quite sensitive with estimation period with strong reversal will strongly occur in first two week then disappear in third week and momentum effect will occur in after third week to week 52 which not match with my rebalancing period like other factors. In my research will use Fama-French three factor plus low volatility factor in asset pricing model.

CHAPTER 3
RESEARCH METHODOLOGY

This study use data from SET index from January 2006 to December 2017 which be the period that pass through the financial crisis in 2008 to ensure that these strategies will be work even encounter the crisis. The estimation period is one quarter historical data because some accounting information such as book value, earning, and etc. will be release in quarterly and stocks return tend to reflex the information then the rebalance of portfolio will be quarterly as well. Moreover, in Thailand stock market, there are some stocks that can't be traded in some amount because they're too illiquid that no traded in someday which can be problem when rebalance stocks in each quarter that in practical will be effect stock price significantly. To eliminate this problem I cut off the lowest liquidity quintile of stock universe from ranking turnover ratio which equal to trading value of stocks in 90 days divide by market capitalization of stocks. This ratio means how much times each stock be traded in each period comparing with their market capitalization which can be simple method to represent liquidity of each stocks. Then I left 405 stocks in my universe from 593 stocks that I collected in SET. The weekly prices which used from Bloomberg platform. This study use log return to calculate the historical return and three month Thai Treasury bill rate is a benchmark for risk free rate which match with rebalancing period.

To construct model, I separate data into two parts. First liquidity data, After I screen out some data that don't use, I rank stocks into quintile (5 groups) based on turnover rate and rebalance quarterly which Liq1 means lowest liquidity and Liq5 means highest liquidity, then I will obtain around 60-80 stocks in each period. Moreover, I also add the different between highest and lowest liquid stocks (Liq5-Liq1) into model. Descriptive statistics and correlation of excess return and cumulative excess return of liquidity portfolio shown as follows Tables 3.1, 3.2, and figure 3.1.

Table 3.1 Descriptive statistics of excess return of each liquidity quintile portfolios by weekly

	Liq5 (Highest)	**Liq4**	**Liq3**	**Liq2**	**Liq1 (Lowest)**	**Liq5-Liq1**
Minimum	-26.16%	-19.95%	-17.50%	-11.86%	-9.29%	-16.87%
Maximum	12.44%	11.26%	7.95%	5.65%	4.08%	12.49%
Mean	0.42%	0.26%	0.23%	0.23%	0.23%	0.19%
Median	0.72%	0.58%	0.44%	0.34%	0.25%	0.30%
Standard Deviation	3.40%	2.50%	2.04%	1.52%	1.06%	2.85%
Number of observation	626	626	626	626	626	626

Table 3.2 Correlation of excess return of each liquidity portfolios

	Liq5 (Highest)	**Liq4**	**Liq3**	**Liq2**	**Liq1 (Lowest)**	**Liq5-Liq1 (Diff)**
Liq5	1.00000					
Liq4	0.91715	1.00000				
Liq3	0.87115	0.92826	1.00000			
Liq2	0.81221	0.86418	0.87593	1.00000		
Liq1	0.62787	0.68070	0.71846	0.72710	1.00000	
Liq5-Liq1	0.95675	0.83839	0.76933	0.69602	0.37513	1.00000

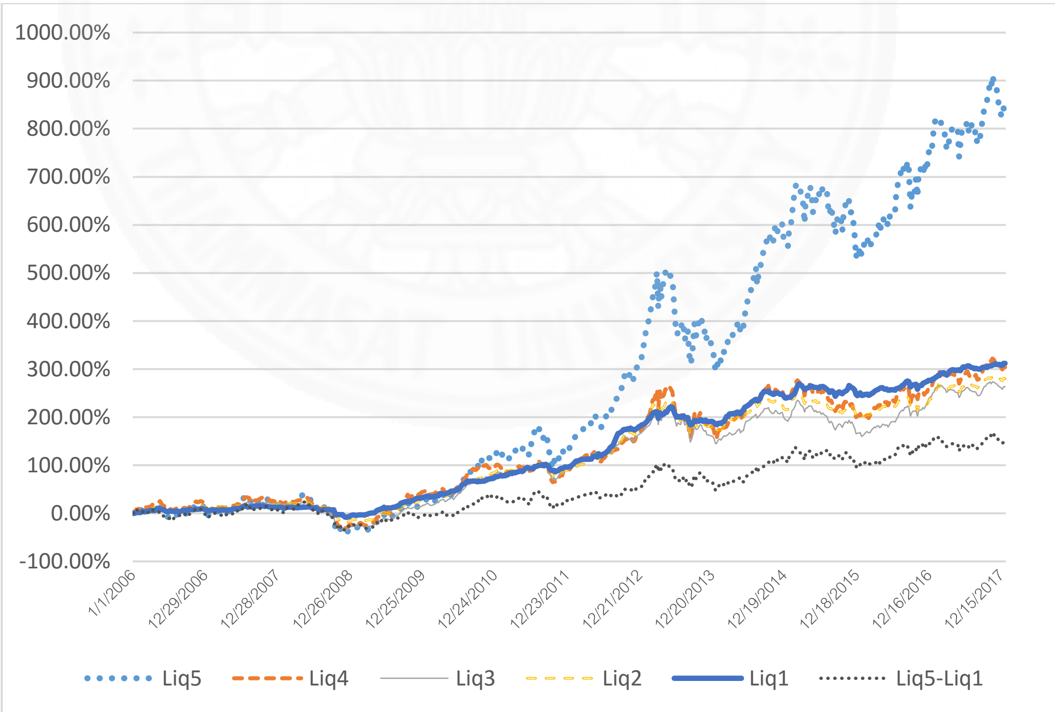

Figure 3.1 Cumulative excess return of liquidity portfolios

From return of liquidity portfolios, the highest liquidity portfolio (Liq = 5) has average return 0.42% per week and the standard deviation is equal to 3.40% per week. On the lowest liquidity portfolio (Liq = 1) has average return 0.23% per week and the standard deviation is equal to 1.06% per week. Moreover, in cumulative return of liquidity portfolio show that if you long highest liquidity portfolio during January 2006 to December 2017, you will get return almost 900% comparing with other liquidity portfolio returns are around 300%. These information also contradict from many research in term of liquidity and stock return low liquid stocks mostly outperform high liquid stocks.

Moreover, I try to check more robustness in liquidity factor by comparing high liquid stocks with the best performance in each factor measuring by cumulative return that I study in this research such as size (ranking by market capitalization), value (ranking by book to market ratio), and volatility (ranking by 90 days annualized volatility) and I also show each best performance in each factor and comparing as following in the figure 3.2 to 3.5.

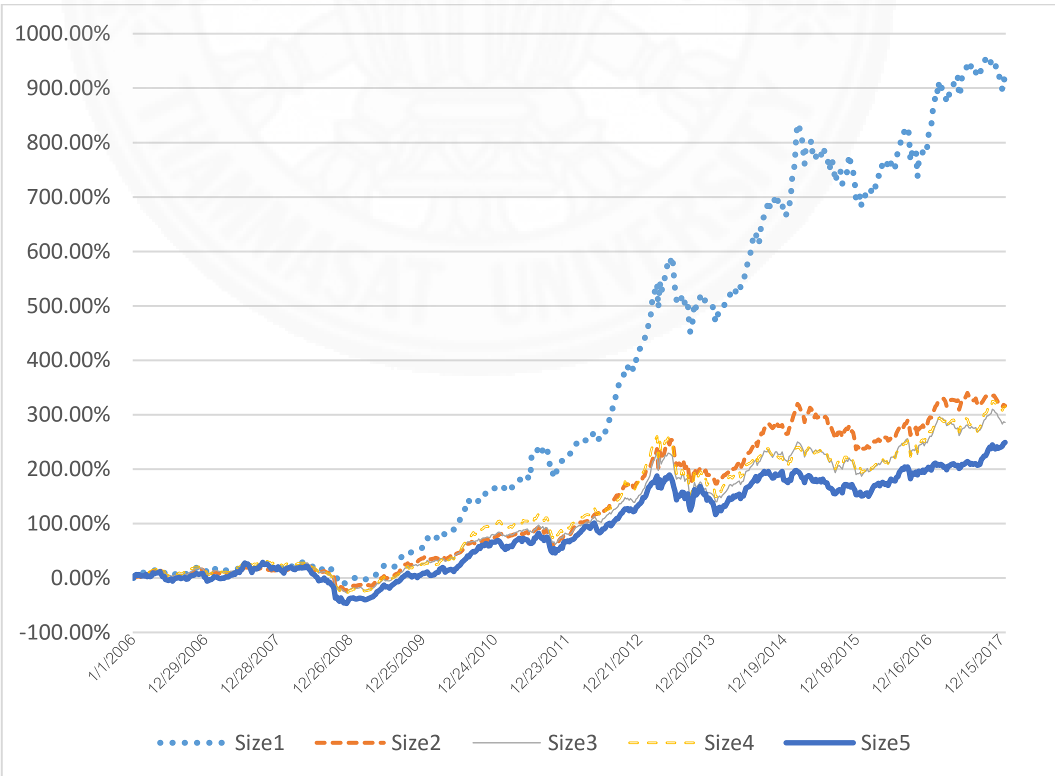

Figure 3.2 Cumulative excess return of size portfolios

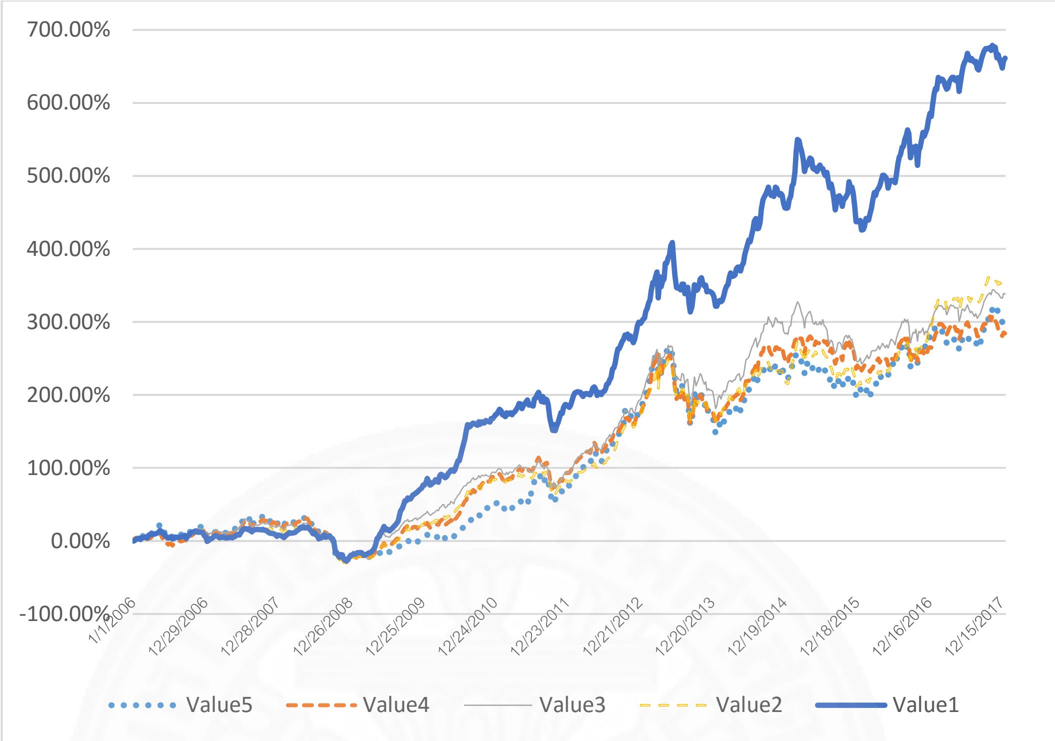

Figure 3.3 Cumulative excess return of value portfolios

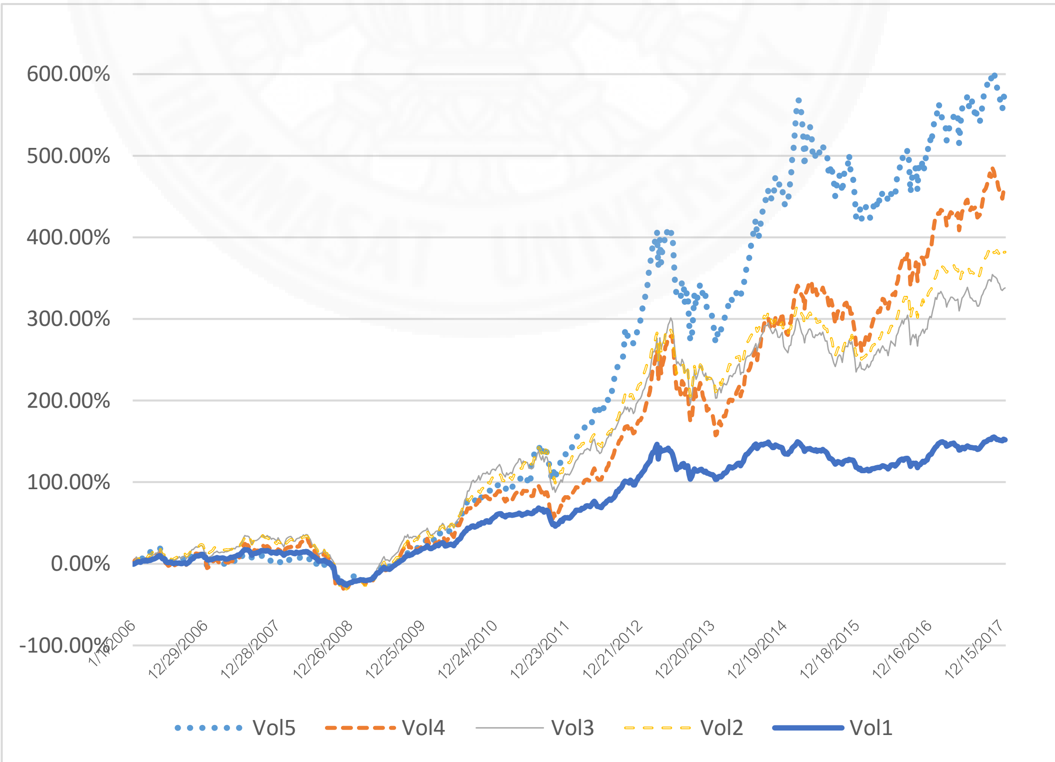

Figure 3.4 Cumulative excess return of volatility portfolios

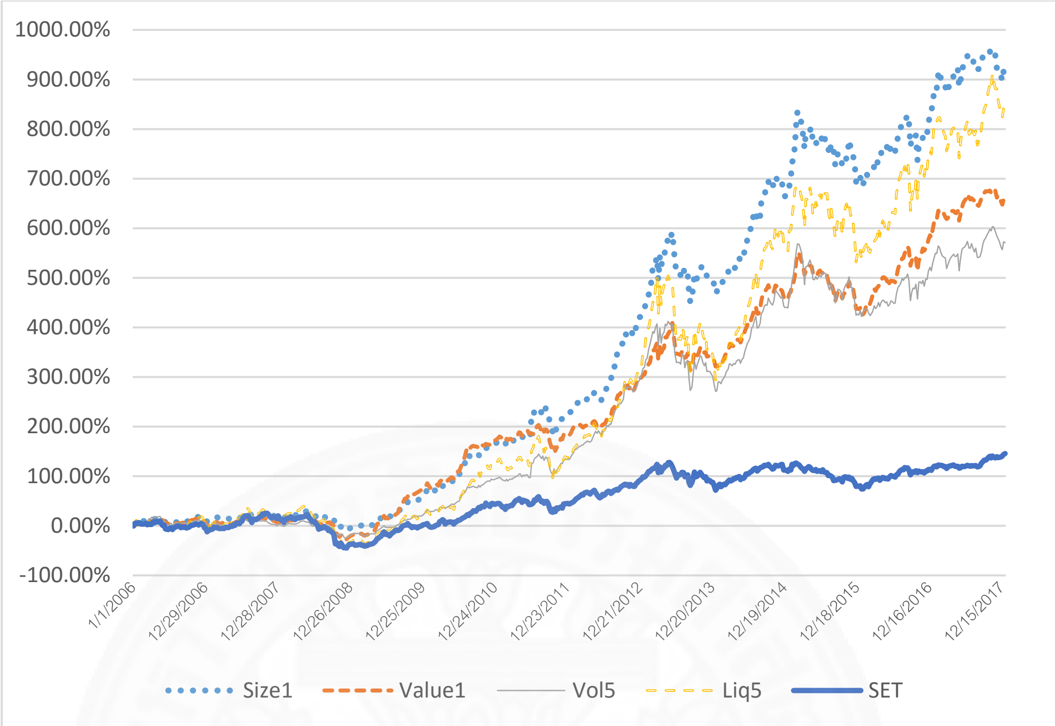

Figure 3.5 Cumulative excess return of best performance of each factor portfolio

From cumulative return of size portfolios during January 2006 to December 2017 show that the smallest portfolio (Size = 1) have highest cumulative return around 900% comparing with other size returns are around 300% which small size outperform large size stocks and rely on Banz (1981)'s result. In cumulative return of value portfolios, the highest cumulative return is lowest market to book ratio stocks (Value = 1) with almost 700% comparing other value portfolio returns are around 300% which low book to market ratio portfolios outperform high book to market ratio and contradict with Lakonihok (1994)'s evidence. In volatility factor portfolios, the result is clearly that highest volatility portfolio (Vol = 5) has highest return with almost 600% and comparing with lowest volatility portfolios (Vol = 1) is just only 150% return and other volatility portfolios also vary but sequentially return by volatility. Lastly, the robustness check in best performance of each factor portfolios are shown that the highest return is smallest portfolio (Size = 1), secondly highest liquid portfolio (Liq = 5), following with low value (Value = 1), high volatility portfolios (Vol=5) and SET index. From the result, I imply that liquid factor is hard to beat that I can use to consider as a factor investment style and to more check robustness in the next section.

In addition, I will show the turnover ratio data in descriptive statistics and example of data to see how different liquidity among highest (Liq=5) and lowest liquid stocks (Liq=1) as following in the table 3.3 and 3.4.

Table 3.3 Descriptive statistics of turnover ratio of highest and lowest liquidity quintile portfolios by quarterly

	Liq5 (Highest)	**Liq1 (Lowest)**	**Universe**
Minimum	0.0002	2.9024	0.0002
Maximum	1.5093	2,584.6545	2,584.6545
Mean	0.1115	61.1496	14.9702
Median	0.0609	30.1956	2.8009
Number of observation	3,174	3,170	15,973

Table 3.4 The example of turnover ratio of highest and lowest liquidity quintile portfolios

	Ranking 1		**Ranking 5**	
Date	**Stock**	**Turnover**	**Stock**	**Turnover**
10/6/2017	BAY	0.1620	TTCL	42.4309
10/6/2017	BTNC	0.1667	SMT	42.6781
10/6/2017	KWC	0.1667	SINGER	43.0324
10/6/2017	SVH	0.1813	SF	43.5332
10/6/2017	BAT3K	0.2088	BCP	43.6674
10/6/2017	PB	0.2292	MTLS	45.7262
10/6/2017	TCOAT	0.2435	PTG	46.0546
10/6/2017	MAKRO	0.2467	GIFT	46.7898
10/6/2017	PMTA	0.2822	TCJ	47.9138
10/6/2017	SNP	0.2934	SPALI	48.1923
10/6/2017	TNL	0.2967	AMATA	50.2474
10/6/2017	STANLY	0.3072	SSI	51.3824
10/6/2017	OISHI	0.3085	THCOM	52.0190
10/6/2017	TPCORP	0.3089	TASCO	52.1920
10/6/2017	FE	0.3166	COM7	55.2258
10/6/2017	PG	0.3568	UV	57.5173
10/6/2017	UOBKH	0.3662	SPCG	60.5408
10/6/2017	LRH	0.3669	SGP	60.6617
10/6/2017	TOG	0.3714	PM	61.6991
10/6/2017	TCCC	0.3953	TPOLY	64.1253
10/6/2017	SSF	0.4035	ASIMAR	72.3924
10/6/2017	SHANG	0.4104	TEAM	76.6434

From turnover of liquidity portfolios, the highest liquidity portfolio (Liq = 5) has average turnover 61.15 times per quarter and the lowest liquidity portfolio (Liq = 1) has average return turnover 0.11 times per quarter which the different turnover of both quintile is around 555.91 times which convey that how different of each liquid they are. Although comparing of the universe which include almost stock in SET index, the turnover of lowest liquid quintile also so far. Another point that I detect that there are some well-known stocks which have good earning performance also include in lowest liquid group such as BAY (Bank of Ayudhya), PB (President Bakery), MAKRO (Siam Makro), and SHANG (Shangri-La Hotel).

CHAPTER 4
METHODOLOGY

4.1 Factor forming methods

For market return I use SET index as a proxy, and for risk free rate I use three months T-bill. In asset pricing model I use four-factor model from regression model Scherer (2011) which extend low volatility factor from original three factor model by Fama and French (1993). The equation is shown as follows equation 1.

$$R_{i,t} - RF_t = \alpha_i + b_i(RM_t - RF_t) + s_i(SMB_t) + h_i(HML_t) + lv_i(LVMHV_t) + e_{it} \quad (1)$$

$R_{i,t}$ The return of stock at time t

RF_t The risk-free rate at time t

RM_t The return of market at time t

SMB_t The difference of return between small and large stocks

HML_t The difference of return between high and low book to market stocks

$LVMHV_t$ The difference of return between low and high volatility stocks

Where b_i, s_i, h_i, and lv_i are coefficients of each factors RM-RF, SMB, HML, and LVMHV.

The details in forming loading factor is as follow Table 4.1 and method to form loading factor is from Fama-French's method. I divide value and volatility into three group by 30^{th} and 70^{th} percentile and 50^{th} percentile for size. Then I get 6 portfolios in each pair of Size-Value and Size-Volatility. Moreover, I also create another factor, liquidity factor which represent by LLMHL and construct pair of Size-Liquidity but not including in factor model in equation 1. Finally, I get SMB, HML, LVMHV, and LLMHL factor from combination of each portfolio as follow table 4.2.

Table 4.1 The relationship of Size-Value, Size-Volatility, and Size-Liquidity Portfolios

	High B/M (30th Pr)	**Neutral B/M**	**Low B/M (70th Pr)**
Small Size (<50th percentile)	SH	SN	SL
Big Size (>50th percentile)	BH	BN	BL

	Low Volatility (30th Pr)	**Neutral Volatility**	**High Volatility (70th Pr)**
Small Size (<50th percentile)	SLV	SNV	SHV
Big Size (>50th percentile)	BLV	BNV	BHV

	Low Liquidity (30th Pr)	**Neutral Liquidity**	**High Liquidity (70th Pr)**
Small Size (<50th percentile)	SLL	SNL	SHL
Big Size (>50th percentile)	BLL	BNL	BHL

Table 4.2 Method to find the loading factors, SMB, HML, and LVMHV

Sort	**Breakpoints**	**Factors and components**
2x3 sorts on Size and B/M, or Size and volatility	Size : mean	SMB,B/M = (SH+SN+SL)/3 – (BH+BN+BL)/3
		SMB,Vol = (SHV+SNV+SLV)/3 – (BHV+BNV+BLV)/3
		SMB = (SMB,B/M+ SMB,Vol)/2
	B/M : 30th and 70th in percentile	HML = (SH+BH)/2 – (SL+BL)/2
	Vol : 30th and 70th in percentile	LVMHV = (SLV+BLV)/2 – (SHV+BHV)/2
	Liq : 30th and 70th in percentile	LLMHL = (SLL+BLL)/2 – (SHL+BHL)/2

Before that I also review the average return of each sub factor portfolios which forming in table 4.1 and result is in table 4.3

Table 4.3 The average return of each Size-Value and Size-Volatility Portfolios

	High B/M (30th Pr)	**Neutral B/M**	**Low B/M (70th Pr)**
Small Size (<50th percentile)	0.35%	0.28%	0.29%
Big Size (>50th percentile)	0.24%	0.23%	0.24%

	Low Volatility (30th Pr)	**Neutral Volatility**	**High Volatility (70th Pr)**
Small Size (<50th percentile)	0.22%	0.32%	0.37%
Big Size (>50th percentile)	0.18%	0.27%	0.25%

	Low Liquidity (30th Pr)	**Neutral Liquidity**	**High Liquidity (70th Pr)**
Small Size (<50th percentile)	0.25%	0.28%	0.39%
Big Size (>50th percentile)	0.17%	0.20%	0.33%

From the Fama-French (1993), Scherer (2011), and Ibbotson (2013), beginning with size-value, return from small cap stocks suppose to outperform large cap stocks due to size effect because small firms have more opportunities to growth than large firms and return from high book to market should be higher than low book to market due to value effect. Because high book to market means equity value is high comparing with market value which means that firms are undervalue. On the other hand, low book to market stocks suggests overvaluation so if market is rational, the undervalue stocks should be bought and the overvalue stocks should be sold until they are equilibrium which lead undervalue stocks should be outperform than overvalue stocks. From the result in table 3.5 is quite along with theory which small cap stocks outperform large cap stocks and high book to market stocks outperform low book to market. Then considering with size-volatility, I expect that return from low volatility stocks will be higher than return from high volatility stocks due to volatility anomalies. However, the results are different. The return in high volatility stocks is higher than return in low volatility stocks. For the last, size-liquidity, low liquidity stocks should outperform high liquidity stocks due to cost of trading. But the result also opposite as expect.

4.2 Descriptive Statistics of loading factors

The descriptive statistics and correlation of loading factors, market return (Mkt), small size (SMB), and high value (HML), low volatility (LVMHV), and low liquidity (LLMHL) are shown as following in table 4.4 and 4.5.

Table 4.4 Descriptive statistics of loading factors, Mkt, SMB, HML, LVMHV, and LLMHL by weekly

	Mkt	**SMB**	**HML**	**LVMHV**	**LLMHL**
Minimum	-23.47%	-4.37%	-9.00%	-8.61%	-9.81%
Maximum	11.29%	5.97%	6.12%	4.57%	12.97%
Mean	0.14%	0.07%	0.03%	-0.11%	-0.15%
Median	0.32%	0.06%	-0.03%	-0.09%	-0.25%
Standard Deviation	2.66%	1.07%	1.04%	1.28%	2.11%
Number of observation	626	626	626	626	626

Table 4.5 Correlation of loading factors, Mkt, SMB, HML, LVMHV, and LLMHL

	MKT	**SMB**	**HML**	**LVMHV**	**LLMHL**
MKT	1.00000				
SMB	-0.65401	1.00000			
HML	-0.08474	0.08308	1.00000		
LVMHV	-0.57926	0.21362	0.26479	1.00000	
LLMHL	-0.83773	0.49415	0.25205	0.67975	1.00000

From the result of descriptive statistics with 626 observations in weekly within 12 years, the average excess market return (market return minus risk free rate) is equal to 0.14% per week and standard deviation is equal to 2.66% per week which most volatile among each factor loading. SMB, the return of small size stocks minus return on large stocks also equal to 0.07% per week and standard deviation is equal to 1.07% per week. HML, the return of high book to market stocks minus return on low book to market stocks is equal to 0.03% per week while its median is -0.03% per week which mean this factor is not consistent and standard deviation is equal to 1.04% per week. LVMHV, the return on low volatility stocks minus return on high volatility stocks is equal to -0.11% per week and standard deviation is equal to 1.28% per week. For the last LLMHL, the return on low liquidity stocks minus return of high liquidity stocks is -0.15% per week and standard deviation is equal to 2.11% per week which quite volatile like market return.

Finally, I obtain weekly data on each factor loading in the right hand side in regression model which include Mkt, SMB, HML, and LVMHV. For the left hand side are each liquidity portfolio (Liq = 5 to 1) and I also add LLMHL and Liq5-Liq1 as the left hand side to see the relationship in both pure liquidity portfolio, liquidity factor, and different in highest and lowest liquidity portfolio with each factor loading. The example of forming each factor is following as table 4.6.

Table 4.6 The example of forming factors loading

Date	Liq5	Liq4	Liq3	Liq2	Liq1	LLMHL	Liq5-Liq1	MKT	SMB	HML	LVMHV
1/6/2006	0.0711	0.0371	0.0103	0.0026	-0.0004	-0.0581	0.0715	0.0463	-0.0282	-0.0030	-0.0262
01/13/2006	0.0326	0.0393	0.0244	0.0150	0.0122	-0.0208	0.0204	0.0105	-0.0053	0.0082	-0.0046
01/20/2006	-0.0280	-0.0040	0.0006	0.0034	0.0060	0.0234	-0.0340	-0.0114	0.0068	-0.0004	0.0134
01/27/2006	0.0144	0.0142	0.0043	0.0035	-0.0046	-0.0152	0.0190	0.0174	-0.0040	-0.0133	0.0009
2/3/2006	-0.0266	-0.0134	-0.0173	-0.0051	-0.0018	0.0165	-0.0249	-0.0194	0.0058	-0.0059	0.0038
2/10/2006	-0.0037	0.0155	0.0160	0.0082	0.0100	0.0059	-0.0137	-0.0128	0.0154	0.0134	-0.0089
02/17/2006	0.0118	0.0198	0.0130	0.0101	0.0181	-0.0093	-0.0063	0.0010	0.0098	-0.0076	-0.0036
02/24/2006	0.0105	-0.0011	-0.0019	0.0022	-0.0144	-0.0177	0.0250	0.0026	-0.0017	-0.0017	0.0048
3/3/2006	0.0044	0.0083	0.0122	0.0228	0.0092	0.0101	-0.0048	0.0149	-0.0020	-0.0101	-0.0052
3/10/2006	-0.0356	-0.0155	-0.0228	-0.0096	0.0015	0.0230	-0.0371	-0.0342	0.0134	0.0137	0.0034
03/17/2006	0.0245	0.0217	0.0356	0.0186	0.0061	-0.0147	0.0183	0.0174	0.0128	0.0086	-0.0189
03/24/2006	-0.0093	-0.0028	-0.0021	0.0047	0.0122	0.0125	-0.0215	-0.0151	0.0068	-0.0082	-0.0040
03/31/2006	0.0028	0.0197	0.0236	0.0111	-0.0017	-0.0091	0.0045	0.0024	0.0033	-0.0024	-0.0114
4/7/2006	0.0479	0.0294	0.0168	-0.0026	-0.0069	-0.0429	0.0548	0.0497	-0.0287	-0.0272	-0.0075
04/14/2006	-0.0122	-0.0043	-0.0037	0.0101	-0.0003	0.0112	-0.0119	-0.0202	0.0133	-0.0067	0.0080
04/21/2006	-0.0059	0.0124	0.0174	0.0052	0.0038	0.0059	-0.0097	0.0224	-0.0065	-0.0175	0.0025
04/28/2006	-0.0024	0.0128	-0.0066	-0.0080	0.0265	0.0120	-0.0288	-0.0071	-0.0068	0.0034	-0.0013

4.3 Forming Asset pricing model

From forming factor methods section, I obtain each factor loading and liquidity portfolios for forming asset pricing model. Then I set apart each liquidity portfolios and factor in left hand side into vary regression so I will have 7 portfolios in the left hand side. Next, I run ordinary linear regressions described below to examine the relationship between liquidity portfolios and each factor with regards to beta, alpha, overall test, individual t-test and R-square.

Equation for Liq = 5

$$R_{5,t} - RF_t = \alpha_5 + b_5(RM_t - RF_t) + s_5(SMB_t) + h_5(HML_t) + lv_5(LVMHV_t) + e_{5t} \quad (2)$$

Equation for Liq = 4

$$R_{4,t} - RF_t = \alpha_4 + b_4(RM_t - RF_t) + s_4(SMB_t) + h_4(HML_t) + lv_4(LVMHV_t) + e_{4t} \quad (3)$$

Equation for Liq = 3

$$R_{3,t} - RF_t = \alpha_3 + b_3(RM_t - RF_t) + s_3(SMB_t) + h_3(HML_t) + lv_3(LVMHV_t) + e_{3t} \quad (4)$$

Equation for Liq = 2

$$R_{2,t} - RF_t = \alpha_2 + b_2(RM_t - RF_t) + s_2(SMB_t) + h_2(HML_t) + lv_2(LVMHV_t) + e_{2t} \quad (5)$$

Equation for Liq = 1

$$R_{1,t} - RF_t = \alpha_1 + b_1(RM_t - RF_t) + s_1(SMB_t) + h_1(HML_t) + lv_1(LVMHV_t) + e_{1t} \quad (6)$$

Equation for LLMHL

$$R_{L,t} - RF_t = \alpha_L + b_L(RM_t - RF_t) + s_L(SMB_t) + h_L(HML_t) + lv_L(LVMHV_t) + e_{Lt} \quad (7)$$

Equation for Liq 5 – Liq1

$$R_{5-1,t} - RF_t = \alpha_L + b_L(RM_t - RF_t) + s_L(SMB_t) + h_L(HML_t) + lv_L(LVMHV_t) + e_{Lt} \quad (8)$$

Then I will inspect alpha of each portfolio to check whether portfolios have abnormal return, if alpha is positive it means portfolio has abnormal return. Overall test use to check significant of overall result, and individual t-test to check significant in each beta or factor. If p-value of overall test and t-test are less than 0.05, it means that the model is significant at confident level 95%. Moreover, I use R-square to measure how much percentage that model can be explained. If R-square is close to 100%, it means model can be completely explained and credible.

CHAPTER 5
EMPIRICAL RESULTS

After I run linear regression of liquidity portfolio and factor loading 2X3 from methodology in previous section, I get the result of intercept term and coefficient of each factor, market, size, value, and volatility. Then, I show the regression result of each liquidity portfolio (Liq = 5 to 1), liquidity factor (LLMHL), and different (Liq5-Liq1) portfolio in Appendix A.

First, I check in intercept term of each portfolio, the intercept term of portfolios which significant mostly to zero are Liq = 5, and 1 portfolio. Alpha of highest liquidity portfolio (Liq = 5) is equal to 0.14% per week, alpha of lowest liquidity portfolio (Liq =1) is equal to 0.10% per week. The result is surprised that if I separate each liquidity portfolio, I can see significant abnormal return of high liquid stock above low liquid stocks individually (Liq=5 has higher alpha significantly than Liq=1 portfolio) but I can't find the alpha of different portfolio (Liq5-Liq1) and liquidity factor (LLMHL). This may be occurred because data of two group are very different and correlation of them are low which mean their movement are not together and consistent. Moreover, the models' R-square in highest liquid portfolio is 85.51% and gradually decrease R-square in lower liquid portfolio which lowest liquid portfolio is only 50.51% R-square but LLMHL and Liq5-Liq1 is quietly high R-square with 77.43% and 76.68%.

Then, I also forming another 3x3 portfolio in factor loading to check more robustness in intercept term and R-square. The regression result of 3x3 portfolio will be showed in Appendix B, and it tell that the result in intercept term and R-square of 3x3 portfolio also have same pattern as 2x3 portfolio. I conclude that the model which contain market, size effect, value effect, and volatility effect variable with high liquid stocks can be better explained than low liquid stocks due to higher R-square.

Moreover, I also summarize the regression result in coefficient term in follow table 5.1 for 2x3 portfolios and table 5.2 for 3x3 portfolios. In level of significant, I will use star to stand for any confident level beginning with 90%, 95%, and 99%. Moreover, I also show t-statistic in below row of each component. The number of observation and R-square of model are in the bottom of table.

Table 5.1 Summary of coefficient of each regression result (2x3 portfolios)

	LLMHL	Liq5-Liq1	Liq5	Liq4	Liq3	Liq2	Liq1
Alpha	-0.00033 (-0.82)	0.00045 (0.81)	0.00141*** (2.69)	0.00056 (1.34)	0.00042 (1.01)	0.00063* (1.72)	0.00096*** (3.15)
Mkret	-0.56046*** (-22.28)	0.70244*** (20.33)	0.97869*** (30.15)	0.81728*** (31.90)	0.70860*** (27.71)	0.51269*** (22.71)	0.27625*** (14.67)
SMB	-0.05961 (-1.14)	-0.04749 (-0.66)	0.31936*** (4.74)	0.19821*** (3.73)	0.40602*** (7.62)	0.46193*** (9.86)	0.36685*** (9.39)
HML	0.26495*** (6.53)	-0.42454*** (-7.62)	-0.23920*** (-4.57)	-0.01403 (-0.34)	0.01436 (0.35)	0.05509 (1.51)	0.18534*** (6.10)
LVMHV	0.40075*** (9.59)	-0.56865*** (-9.91)	-0.78159*** (-14.49)	-0.28615*** (-6.72)	-0.16137*** (-3.80)	-0.14320*** (-3.82)	-0.21295*** (-6.81)
N	626	626	626	626	626	626	626
R-square	0.7743	0.7668	0.8551	0.8327	0.7500	0.6486	0.5051

T statistic in parentheses

*p <0.1, **p<0.05, ***p<0.01

Table 5.2 Summary of coefficient of each regression result (3x3 portfolios)

	LLMHL	Liq5-Liq1	Liq5	Liq4	Liq3	Liq2	Liq1
Alpha	-0.00018 (-0.39)	0.00052 (0.89)	0.00148* (2.63)	0.00056 (1.31)	0.00041 (0.98)	0.00055 (1.56)	0.00096*** (3.14)
Mkret	-0.60109*** (-20.90)	0.78018*** (21.82)	1.11273*** (32.07)	0.91114*** (34.93)	0.79170*** (31.01)	0.60757*** (27.70)	0.33255*** (17.63)
SMB	-0.15694*** (-3.46)	0.03536 (0.63)	0.37994*** (6.94)	0.25144*** (6.11)	0.38510*** (9.56)	0.46358*** (13.39)	0.34457*** (11.58)
HML	0.32859*** (8.23)	-0.39561*** (-7.97)	-0.24064*** (-4.99)	-0.02261 (-0.62)	-0.00910 (-0.26)	0.03811 (1.25)	0.15497*** (5.92)
LVMHV	0.24508*** (5.90)	-0.36886*** (-7.14)	-0.46354*** (-9.25)	-0.08112** (-2.15)	0.02242 (0.61)	0.03408 (1.08)	-0.09468*** (-3.48)
N	626	626	626	626	626	626	626
R-square	0.7022	0.7485	0.8333	0.8254	0.7492	0.6661	0.5000

T statistic in parentheses

*p <0.1, **p<0.05, ***p<0.01

For coefficient result, I start with market return, all of result show that coefficient in market return of all liquidity portfolios are all significant with highest level (confident level more than 99%). It's almost positive value except in LLMHL portfolio which has negative value, it means that return in LLMHL portfolios are moving in opposite way of market return around 56% and 60%. Moreover, in other liquidity portfolio, I see the trend of correlation of portfolio to market is increasing from lowest liquid portfolios to highest liquid portfolios which mean higher liquid portfolio return will be more correlated with market return.

For size effect, the result is almost significant with highest level and positive value except LLMHL in 3x3 portfolio which has negative value (-0.16), LLMHL in 2x3 portfolio and different portfolio (Liq5-Liq1) have not size effect. For value effect, the result in LLMHL, different portfolio (Liq5-Liq1), lowest liquid (Liq=1), and high liquid (Liq=5) portfolios also have high significant but the rest (Liq = 2,3,4 portfolios) don't have value effect. Moreover, in low liquid portfolios (LLMHL and Liq = 1) also have positive coefficient with 0.26 and 0.19, respectively while high liquid portfolio (Liq=5) and different portfolio (Liq5-Liq1) also negative coefficient value. Finally, volatility effect, the result of mostly portfolios are high significant except in medium liquid portfolios (Liq = 2,3) in 3x3 portfolios don't have volatility effect. Then I check in sign of coefficient and found that only LLMHL portfolios have negative coefficient. All of liquidity portfolios (Liq = 5 to 1) and different portfolio (Liq5-Liq1) have positive coefficient. I also find increasing negative trend in liquidity portfolios that the more stocks liquid, the more negative in coefficient of volatility effect which that why LLMHL portfolios have negative coefficient.

Moreover, I also check more by cutting period of time from 12 years (2006 to 2017) with 626 observations to 8 years (2010 to 2017) with 418 observations and 4 years (2014 to 2017) with 206 observations to ensure that the result is not change much in different period of time. The results are as following in table 5.3 and 5.4.

Table 5.3 Sumary of coefficient of each regression result (2x3 portfolios) (2010 - 2017)

	LLMHL	**Liq5-Liq1**	**Liq5**	**Liq4**	**Liq3**	**Liq2**	**Liq1**
Alpha	0.00001 (0.03)	0.00030 (0.49)	0.00155*** (2.59)	-0.00002 (-0.03)	0.00044 (0.95)	0.00065 (1.54)	0.00125*** (3.59)
Mkret	-0.54943*** (-16.37)	0.66951*** (14.62)	0.95468*** (21.67)	0.91941*** (26.23)	0.75528*** (21.89)	0.56028*** (18.06)	0.28517*** (11.17)
SMB	-0.15156*** (-2.66)	0.04931 (0.63)	0.36498*** (4.89)	0.20345*** (3.42)	0.34605*** (5.92)	0.41366*** (7.87)	0.31567*** (7.29)
HML	0.36903*** (7.26)	-0.59881*** (-8.63)	-0.38814*** (-5.81)	-0.08582 (-1.62)	0.03002 (0.57)	0.02679 (0.57)	0.21067*** (5.44)
LVMHV	0.39407*** (8.12)	-0.58178*** (-8.78)	-0.83048*** (-13.04)	-0.27152*** (-5.36)	-0.24146*** (-4.84)	-0.18540*** (-4.13)	-0.24869*** (-6.73)
N	418	418	418	418	418	418	418
R-square	0.7577	0.7585	0.8467	0.8279	0.7533	0.6607	0.5137

T statistic in parentheses

*p <0.1, **p<0.05, ***p<0.01

Table 5.4 Summary of coefficient of each regression result (2x3 portfolios) (2014 - 2017)

	LLMHL	Liq5-Liq1	Liq5	Liq4	Liq3	Liq2	Liq1
Alpha	-0.00023 (-0.46)	0.00054 (0.78)	0.00119* (1.84)	-0.00000 (-0.01)	0.00002 (0.03)	0.00020 (0.42)	0.00065 (1.60)
Mkret	-0.39527*** (-7.76)	0.49477*** (6.94)	0.72321*** (10.85)	0.76538*** (15.71)	0.70798*** (13.85)	0.54288*** (11.08)	0.22844*** (5.46)
SMB	-0.01056 (-0.15)	-0.10896 (-1.10)	0.19954** (2.16)	0.07991 (1.18)	0.34854*** (4.91)	0.48726*** (7.16)	0.30850*** (5.31)
HML	0.33064*** (4.96)	-0.56689*** (-6.08)	-0.47375*** (-5.43)	-0.08419 (-1.32)	-0.08194 (-1.22)	-0.04707 (-0.73)	0.09314* (1.70)
LVMHV	0.67019*** (9.98)	-0.87352*** (-9.30)	-1.11368*** (-12.68)	-0.48566*** (-7.57)	-0.31759*** (-4.71)	-0.16986*** (-2.63)	-0.24017*** (-4.36)
N	209	209	209	209	209	209	209
R-square	0.8038	0.7902	0.8721	0.8619	0.7917	0.6745	0.5079

T statistic in parentheses

*p <0.1, **p<0.05, ***p<0.01

From the result in 8 years and 4 years, there are not see major different among alpha and coefficients, I can see that the less number of observations the less significant in intercept term and coefficients.

CHAPTER 6
CONCLUSION

This research finds the relationship between liquidity of stocks which use turnover ratio of stock as a proxy and excess returns explained by four factors from Scherer (2011). I use simple linear regression to find the relationship and check robustness by split time period into 3 periods and forming more 3x3 portfolios. The datasets that use in this research are from the Stock Exchange of Thailand (SET) which excluding some stocks that least liquid until that can’t be traded. The market and financial data are from Bloomberg platform which included return of stock, market return, risk free rate, market capitalization, book to market ratio, and value of stock traded. The datasets that I use in during January 2006 to December 2017.

To answer the research question, I expect that low liquid stocks should have abnormal return with strong confident level and higher intercept term than high liquid stocks due to cost of trading. I check the result of intercept term and R-square to be main objective for model testing. I think R-square of low liquid stocks should be higher than high liquid stocks because lowest liquid stocks can be more explain by asset pricing model than high liquid stocks.

In conclusion, I detect that the intercept term of low liquid stocks also less abnormal return than high liquid stocks which only 0.96% per week comparing with 1.41% per week from high liquid stocks which significant also close to zero in individually. But I can’t find the significant alpha of different portfolio (Liq5-Liq1) and liquidity factor (LLMHL). Because data of two group are very different and correlation of them are low which mean their movement are not together and consistent. In R-square result, I see declining trend in R-square from high liquid stocks to low liquid stocks which beyond my expectation. The reason may be because in Thai stocks market low liquid stocks are abandoned and no one interest which lead stocks to underperform in the long time and there is something missing in lower liquid stocks causing low liquid stock cannot be explain by market factor compare to high liquid stock. I conclude that high liquid stock can generate abnormal return with significantly closely to zero in term of individually but I cannot find the significant alpha in the different basis and can better explain by four-factor model which contain market, size effect, value effect, and volatility effect variables than low liquid stocks which mean it can be good enough for being one of the investment style.

Finally, this research can contribute on applying liquidity as an investment style by using four-factors model for explanation in Thai stock market which the result to be not same as developed market. Moreover, this research also illustrate the problem of developing market such as Thai market that there are some stocks with well-known and good earning performance are illiquid and non-investable.

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APPENDICES

APPENDIX A
THE REGRESSION RESULT OF 2x3 METHOD

The REG Procedure

Model: MODEL1

Dependent Variable: Liq5

Number of Observations Read 626

Number of Observations Used 626

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	0.61760	0.15440	916.15	<.0001
Error	621	0.10466	0.00016853		
Corrected Total	625	0.72226			

Root MSE	0.01298	R-Square	0.8551
Dependent Mean	0.00374	Adj R-Sq	0.8542
Coeff Var	347.09839		

Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	0.00141	0.00052462	2.69	0.0073
MKT	1	0.97869	0.03246	30.15	<.0001
SMB	1	0.31936	0.06735	4.74	<.0001
HML	1	-0.23920	0.05237	-4.57	<.0001
LVMHV	1	-0.78159	0.05394	-14.49	<.0001

The REG Procedure

Model: MODEL1

Dependent Variable: Liq4

Number of Observations Read 626

Number of Observations Used 626

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	0.32459	0.08115	772.93	<.0001
Error	621	0.06520	0.00010499		
Corrected Total	625	0.38978			

Root MSE	0.01025	R-Square	0.8327
Dependent Mean	0.00211	Adj R-Sq	0.8317
Coeff Var	485.46997		

Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	0.00055503	0.00041406	1.34	0.1806
MKT	1	0.81728	0.02562	31.90	<.0001
SMB	1	0.19821	0.05316	3.73	0.0002
HML	1	-0.01403	0.04133	-0.34	0.7344
LVMHV	1	-0.28615	0.04257	-6.72	<.0001

The REG Procedure

Model: MODEL1

Dependent Variable: Liq3

Number of Observations Read 626

Number of Observations Used 626

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	0.19490	0.04873	465.72	<.0001
Error	621	0.06497	0.00010462		
Corrected Total	625	0.25988			

Root MSE	0.01023	R-Square	0.7500
Dependent Mean	0.00183	Adj R-Sq	0.7484
Coeff Var	557.59710		

Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	0.00041553	0.00041335	1.01	0.3152
MKT	1	0.70860	0.02557	27.71	<.0001
SMB	1	0.40602	0.05307	7.65	<.0001
HML	1	0.01436	0.04126	0.35	0.7279
LVMHV	1	-0.16137	0.04250	-3.80	0.0002

The REG Procedure

Model: MODEL1

Dependent Variable: Liq2

Number of Observations Read 626

Number of Observations Used 626

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	0.09346	0.02337	286.49	<.0001
Error	621	0.05065	0.00008156		
Corrected Total	625	0.14411			

Root MSE	0.00903	R-Square	0.6486
Dependent Mean	0.00181	Adj R-Sq	0.6463
Coeff Var	498.69345		

Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	0.00062696	0.00036495	1.72	0.0863
MKT	1	0.51269	0.02258	22.71	<.0001
SMB	1	0.46193	0.04685	9.86	<.0001
HML	1	0.05509	0.03643	1.51	0.1310
LVMHV	1	-0.14320	0.03752	-3.82	0.0001

The REG Procedure

Model: MODEL1

Dependent Variable: Liq1

Number of Observations Read 626

Number of Observations Used 626

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	0.03593	0.00898	158.42	<.0001
Error	621	0.03521	0.00005670		
Corrected Total	625	0.07114			

Root MSE	0.00753	R-Square	0.5051
Dependent Mean	0.00188	Adj R-Sq	0.5019
Coeff Var	400.55558		

Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	0.00095961	0.00030429	3.15	0.0017
MKT	1	0.27625	0.01883	14.67	<.0001
SMB	1	0.36685	0.03906	9.39	<.0001
HML	1	0.18534	0.03037	6.10	<.0001
LVMHV	1	-0.21295	0.03128	-6.81	<.0001

The REG Procedure

Model: MODEL1

Dependent Variable: LLMHL

Number of Observations Read 626

Number of Observations Used 626

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	0.21564	0.05391	532.50	<.0001
Error	621	0.06287	0.00010124		
Corrected Total	625	0.27851			

Root MSE	0.01006	R-Square	0.7743
Dependent Mean	-0.00149	Adj R-Sq	0.7728
Coeff Var	-675.08251		

Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	-0.00033464	0.00040661	-0.82	0.4108
MKT	1	-0.56046	0.02516	-22.28	<.0001
SMB	1	-0.05961	0.05220	-1.14	0.2539
HML	1	0.26495	0.04059	6.53	<.0001
LVMHV	1	0.40075	0.04180	9.59	<.0001

The REG Procedure

Model: MODEL1

Dependent Variable: Liq5-Liq1

Number of Observations Read 626

Number of Observations Used 626

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	0.38989	0.09747	510.60	<.0001
Error	621	0.11855	0.00019090		
Corrected Total	625	0.50844			

Root MSE	0.01382	R-Square	0.7668
Dependent Mean	0.00186	Adj R-Sq	0.7653
Coeff Var	742.70122		

Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	0.00045151	0.00055835	0.81	0.4190
MKT	1	0.70244	0.03454	20.33	<.0001
SMB	1	-0.04749	0.07168	-0.66	0.5079
HML	1	-0.42454	0.05573	-7.62	<.0001
LVMHV	1	-0.56865	0.05740	-9.91	<.0001

APPENDIX B
THE REGRESSION RESULT OF 3X3 METHOD

The REG Procedure

Model: MODEL1

Dependent Variable: Liq5

Number of Observations Read 626

Number of Observations Used 626

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	0.60183	0.15046	775.90	<.0001
Error	621	0.12042	0.00019392		
Corrected Total	625	0.72226			

Root MSE	0.01393	R-Square	0.8333
Dependent Mean	0.00374	Adj R-Sq	0.8322
Coeff Var	372.32178		

Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	0.00148	0.00056298	2.63	0.0088
MKT	1	1.11273	0.03470	32.07	<.0001
SMB	1	0.37994	0.05477	6.94	<.0001
HML	1	-0.24064	0.04818	-4.99	<.0001
LVMHV	1	-0.46354	0.05012	-9.25	<.0001

The REG Procedure

Model: MODEL1

Dependent Variable: Liq4

Number of Observations Read 626

Number of Observations Used 626

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	0.32172	0.08043	733.85	<.0001
Error	621	0.06806	0.00010960		
Corrected Total	625	0.38978			

Root MSE	0.01047	R-Square	0.8254
Dependent Mean	0.00211	Adj R-Sq	0.8243
Coeff Var	496.02481		

Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	0.00055593	0.00042325	1.31	0.1895
MKT	1	0.91114	0.02609	34.93	<.0001
SMB	1	0.25144	0.04118	6.11	<.0001
HML	1	-0.02261	0.03622	-0.62	0.5327
LVMHV	1	-0.08112	0.03768	-2.15	0.0317

The REG Procedure

Model: MODEL1

Dependent Variable: Liq3

Number of Observations Read 626

Number of Observations Used 626

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	0.19471	0.04868	463.84	<.0001
Error	621	0.06517	0.00010494		
Corrected Total	625	0.25988			

Root MSE	0.01024	R-Square	0.7492
Dependent Mean	0.00183	Adj R-Sq	0.7476
Coeff Var	558.44212		

Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	0.00040605	0.00041416	0.98	0.3273
MKT	1	0.79170	0.02553	31.01	<.0001
SMB	1	0.38510	0.04029	9.56	<.0001
HML	1	-0.00910	0.03544	-0.26	0.7975
LVMHV	1	0.02242	0.03687	0.61	0.5434

The REG Procedure

Model: MODEL1

Dependent Variable: Liq2

Number of Observations Read 626

Number of Observations Used 626

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	0.09600	0.02400	309.77	<.0001
Error	621	0.04811	0.00007748		
Corrected Total	625	0.14411			

Root MSE	0.00880	R-Square	0.6661
Dependent Mean	0.00181	Adj R-Sq	0.6640
Coeff Var	486.05088		

Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	0.00055475	0.00035585	1.56	0.1195
MKT	1	0.60757	0.02193	27.70	<.0001
SMB	1	0.46358	0.03462	13.39	<.0001
HML	1	0.03811	0.03045	1.25	0.2113
LVMHV	1	0.03408	0.03168	1.08	0.2825

The REG Procedure

Model: MODEL1

Dependent Variable: Liq1

Number of Observations Read 626

Number of Observations Used 626

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	0.03557	0.00889	155.24	<.0001
Error	621	0.03557	0.00005728		
Corrected Total	625	0.07114			

Root MSE	0.00757	R-Square	0.5000
Dependent Mean	0.00188	Adj R-Sq	0.4968
Coeff Var	402.59859		

Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	0.00096112	0.00030597	3.14	0.0018
MKT	1	0.33255	0.01886	17.63	<.0001
SMB	1	0.34457	0.02977	11.58	<.0001
HML	1	0.15497	0.02618	5.92	<.0001
LVMHV	1	-0.09468	0.02724	-3.48	0.0005

The REG Procedure

Model: MODEL1

Dependent Variable: LLMHL

Number of Observations Read 626

Number of Observations Used 626

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	0.21045	0.05261	480.10	<.0001
Error	621	0.06805	0.00010959		
Corrected Total	625	0.27851			

Root MSE	0.01047	R-Square	0.7556
Dependent Mean	-0.00149	Adj R-Sq	0.7541
Coeff Var	-702.36503		

Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	-0.00040649	0.00042322	-0.96	0.3372
MKT	1	-0.61202	0.02609	-23.46	<.0001
SMB	1	-0.07839	0.04117	-1.90	0.0574
HML	1	0.24530	0.03622	6.77	<.0001
LVMHV	1	0.25233	0.03768	6.70	<.0001

The REG Procedure

Model: MODEL1

Dependent Variable: Liq5-Liq1

Number of Observations Read 626

Number of Observations Used 626

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	0.38056	0.09514	462.03	<.0001
Error	621	0.12787	0.00020592		
Corrected Total	625	0.50844			

Root MSE	0.01435	R-Square	0.7485
Dependent Mean	0.00186	Adj R-Sq	0.7469
Coeff Var	771.36529		

Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	0.00051836	0.00058014	0.89	0.3719
MKT	1	0.78018	0.03576	21.82	<.0001
SMB	1	0.03536	0.05644	0.63	0.5312
HML	1	-0.39561	0.04965	-7.97	<.0001
LVMHV	1	-0.36886	0.05165	-7.14	<.0001

BIOGRAPHY

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