Stock returns and stock market liquidity: An analysis on Ho Chi Minh Stock Exchange

Pham, Quoc Khang[1]; Katarzyna Kuziak[2]; Marcin Hernes[2]

[1] University of Economics, Hue University, Hue City, Vietnam

[2] Wroclaw University of Economics and Business, Wroclaw City, Poland

Chronicle

Article history

Received 23th Sep 2022

Revised 14th Nov 2022

Accepted 22nd Nov 2022

Keywords

asset pricing models, stock market liquidity, stock returns, Ho Chi Minh Stock Exchange

JEL classification

Abstract

The study investigates the relationship between liquidity and returns on a stock exchange in a frontier market. The paper applies three asset pricing models, including Capital Asset Pricing Model (CAPM), the Fama-French three-factor model, liquidity-augmented three-factor model. To measure the liquidity in the study, five measures: quoted spread, trading volume, trading value, Amihud measure, and turnover ratio were applied. The empirical research is carried out in 179 non-financial companies on the Ho Chi Minh Stock Exchange in Vietnam from 2011 to 2019. The study documents that liquidity is an essential source of effect on stock returns on the Ho Chi Minh stock exchange. Using the GRS-test, the models were compared and assessed. The result shows that the liquidity-augmented three-factor model with liquidity factor is the most significant model to capture the impact of liquidity on stock returns on the Ho Chi Minh Stock Exchange

1. Introduction

Liquidity is a determinant of investment decisions on stock exchanges; it affects the stock returns on investment through the cost of trading to transfer the ownership of stocks. Amihud and Mendelson (1986) conducted an early empirical study and documented a positive relationship between illiquidity and stock returns. Since then, several studies have worked on the relationship of the liquidity-stock return, including Brennan and Subrahmanyam (1996), Datar et al. (1998), Chordia et al. (2001), Amihud (2002), Pastor and Stambaugh (2003), and many other researchers. However, the empirical evidence shows the different results of the relationship of the liquidity-stock return. Some studies provided a strong positive liquidity-stock returns relationship, others presented contrasting evidence, or no evidence of therelationship. Leirvik et al. (2017) did not find any evidence of the relationship between liquidity and stock returns. Jun et al. (2003) found that stock returns in emerging markets positively affect aggregate market liquidity.

The power of liquidity's impact on asset pricing has attracted much attention in the literature. However, most studies focus on the stock market in developed countries. This paper refers to a stock exchange in a frontier market in Vietnam. The Vietnamese stock market differs from developed markets and emerging markets. It is characterized by a limited number of transactions, which are also relatively small. Listed companies trade infrequently,

* Corresponding author.

E-mail address: pqkhang@hce.edu.vn (Pham, Q.K.)

ISSN 2734 - 9853

and the trading volume is low. Vietnam has a lower development level than the existing "mainstream" emerging markets but has been developing fast for the last few years. Therefore, an analysis of the stock market liquidity and stock returns on the Vietnamese stock market is justified and essential. This study implements research on the Ho Chi Minh Stock Exchange in Vietnam, focusing on the recent years- from 2011 to 2019. This study investigates the relationship between liquidity and stock returns using five measures: spread, trading volume, trading value, turnover ratio, and Amihud measure. The study analyzes the relationship during the period from 2011 to 2019. The study applies three asset pricing models to examine the relationship between market liquidity and stock returns instead of analysis of the firm-specific characteristic by panel data regression, which is applied in Batten and Vo (2014). This paper uses the Generalized Method of Moments (GMM) approach, which has not been applied in previous studies on the same topic in Vietnam. The GMM approach is an estimated method that Hansen (1982) formalized for linear or non-linear economic and finance models. The remainder of the paper is structured as follows. Section 2 provides the literature in the relationship between liquidity and stock returns. Section 3 describes the data and methodology for this study. Section 4 analyzes the empirical results of the regression models; section 5 is the conclusion.

2. Literature review

Narayan & Zheng (2011) document the impact of liquidity on returns on the stock exchanges in China: Shanghai stock exchange (SHSE) and Shenzhen stock exchange (SZSE). Authors find evidence that liquidity has a negative effect on returns on the SHSE more than on SZSE. However, the result does not illustrate strong evidence of the impact of market liquidity on stock returns across three liquidity proxies: the trading volume, the turnover rate, and the trading probability.

Leirvik et al. (2017) investigate the impact of market liquidity on stock returns in the Norwegian stock market during the period 1983-2015. The study does not indicate any evidence of the relationship between liquidity and stock returns in Norway. Leirvik et al. (2017) compute four different measures of liquidity: the bid-ask spread derived by Amihud and Mendelson (1986), the simple high-low ratio by Corwin and Schultz (2012), and the turnover measure.

Chang et al. (2010) execute a study concerning the liquidity-stock return relationship on the Tokyo Stock Exchange (TSE) from February 1975 to December 2004. The paper computes five liquidity proxies, including two liquidity proxies (share turnover, dollar trading volume) and four illiquidity proxies (Amihud ratio (2002), two measures derived by Lesmond et at. (1999) and Liu (2006)). The study indicates a negative effect of market liquidity on stock returns on TSE. Ahn et al. (2007) find that companies on the TSE have stock returns relating positively to illiquidity measures.

Li et al. (2014) apply the Liquidity- adjusted capital asset pricing model, derived by Acharya and Pedersen (2005), to investigate the relationship between liquidity, liquidity risk, and stock returns in Japan from period 1975-2006. Li et al. (2014) follow Amihud (2002), Hasbrouck (2009), employ daily stock illiquidity as liquid proxy, computed as the ratio of absolute daily returns over daily trading value. The study shows that liquidity is a determinant of stock returns.

Sterenczak (2017) analyzes the impact of stock liquidity on stock returns on the Warsaw Stock Exchange during the period 2011-2015. The study employs a cross-sectional, time-series, and pooled cross-sectional time-series model to estimate the relationship between liquidity and stock returns. Sterenczak (2017) uses the Amihud ratio (2002) as the liquidity measure and documents that liquidity negatively affects on stock returns.

Most empirical research on the relationship of liquidity-stock return has focused on developed stock markets. Amihud and Mendelson (1986) pointed out the negative relationship by us-

ing the NYSE data from 1961 to 1980 and the bid-ask spread as a liquidity proxy. Brennan and Subrahmanyam (1996) found a negative relationship on the NYSE from 1984 to 1991. Datar et al. (1998) also found a similar empirical result for the NYSE between 1963 and 1991.

Lam and Tam (2011) examined the relationship in the Hong Kong stock market during the 1981-2004 period. These authors indicate that the liquidity-augmented four-factor model best explains the variations in stock returns.

Liu et al. (2020) investigate the liquidity returns around the financial crisis of 2007-2009 on stock markets in four countries U.S., UK, Germany, and China. The study splits the sample into three subperiods: pre-crisis, during-crisis, and post-crisis. They identify significant evidence that the German and UK stock markets exhibit a positive liquidity pattern concerning stock returns.

There are several studies on the liquidity of the Vietnamese stock market. Batten and Vo (2014) analyze the relationship between liquidity and stock returns on the Ho Chi Minh Stock Exchange from January 2007 to June 2010. Batten and Vo (2014) employed multivariate linear regression to estimate the relationship and used the turnover ratio as a liquidity measure. The result documents a positive correlation concerning liquidity- stock return relationship. Vo and Bui (2016) studied the relationship between liquidity and stock returns on Ho Chi Minh Stock Exchange from 2007 to 2012. Vo and Bui (2016) follow the literature of Chan et al. (1991), Chordia et al. (2001), and Chang et al. (2010), who applied the capital asset-pricing model in their study. The article shows the positive correlation between liquidity measures and stock returns; and the negative correlation between illiquidity measures and stock returns. These previous studies only considered one or two liquidity measures and small sample size.

Overall, the above discussion highlights a growing body of research conducted to capture the relationship between stock-market liquidity and stock returns. However, there has been limited studies on the liquidity of the frontier markets. The impact of liquidity on stock returns has gained our significant interest in investigating this relationship in the Vietnamese stock market. Moreover, the study contributes to the literature because it is different from previous studies in Vietnam. This study uses data sets with a larger sample size, and adopts a diversified approach that considers multiple asset pricing models simultaneously. Therefore, this study provides a more comprehensive perspective on this relationship.

3. Data and methodology

3.1. Data

The primary source for the data in this study is obtained from Thomson Reuter Datastream. The authors gather daily closing prices data from the Securities State Commission of Vietnam. First, the authors calculate the monthly data for each stock from daily data, then calculate the value-weighted average for whole market. We use monthly data for 179 companies on the Ho Chi Minh Stock Exchange covering January 2011 to December 2019. For the risk-free monthly rate, we calculate the equivalent interest rates from the 1-year Vietnamese Government Bonds during the same period, which was gathered from IMF data.

3.2. Methodology

This section presents the time-series models to explore the link between stock market liquidity and rates of return. This part illustrates the framework of the asset pricing models, e.g., the Capital Asset Pricing Model, Fama-French (1993) three-factor model, and liquidity-augmented three-factor model. These models have supported valid pricing models in contemporary research and have taken a crucial role in literature. Specifically, the paper applies to investigate the power of liquidity in explaining rates of return on stock markets. The authors analyze the regression models by using Stata 15.1 software.

The paper starts by analyzing the traditional

CAPM, which is described in Sharpe (1964) and Lintner (1965) as follows

$$R_{pt} - R_{ft} = \alpha_p + \beta_p MER_t + \varepsilon_{pt} \quad (1)$$

where $R_{pt} - R_{ft}$ is portfolio excess returns, the difference between portfolio returns (R_{pt}) and risk-free rate (R_{ft}). MER_t is the market excess returns, which is calculated as the difference between market returns and the risk-free rate of return.

Fama and French (1993) emphasize that size and book-to-market equity are significant variables in explaining stock returns. The authors suggest that the size and book-to-market equity relate to economic fundamentals that proxy for common risk factors in returns. They note that size refers to profitability and has effects on earnings. Large companies have higher earnings on assets than small companies. Regarding the book-to-market equity ratio, Fama and French (1993) argue that companies with high book-to-market equity (a high book value relative to stock price) have persistently low earnings on assets. On the other hand, a low book-to-market value ratio (a low book value relative to stock price) is associated with high earnings. They illustrate a model to estimate variation in returns associated with a size and book-to-market equity.

$$R_{pt} - R_{ft} = \alpha_p + \beta_p MER_t + s_p SMB_t + h_p HML_t + \varepsilon_{pt} \quad (2)$$

where MER_t is the market factor, SMB_t is the mimicking portfolio for the size factor, HML_t is the mimicking portfolio for the book-to-market factor.

The proxy for the market factor, MER_t, is the market excess return, the difference between market portfolio return (R_{mt}) and risk-free rate (R_{ft}), $MER_t = R_{mt} - R_{ft}$. The value-weighted return calculates the market portfolio return in the sample stocks on the HOSE, representing the market portfolio on stock exchange. The market portfolio contains all stocks in the sample for the HOSE.

The daily returns of stocks are computed by the difference between logarithm stock prices as

$$R_{i,t} = \log(P_{i,t}) - \log(P_{i,t-1}) \quad (3)$$

in which $P_{i,t}$, $P_{i,t-1}$ are closing prices on day t and t-1, respectively. The log returns have an advantage that is a continuously compounded rate over time.

At the beginning of each year, Fama and French (1993) construct five portfolios to mimic the underlying risk factors in returns associated with a size and book-to-market value (BM). They divide the companies into two size groups, according to market capitalization, referring to them as small (*S*) and big (*B*) groups, in which the median is the dividing point. They also sort companies in the original sample into three book-to-market equity groups based on the breakpoints of the ranked values of the book-to-market equity ratio, defining them as the bottom 30% (Low - *L*), the middle 40% (Medium - *M*), and the top 30% (High - *H*). Fama and French (1993) divide the companies into three groups based on book-to-market equity and two groups based on market value (size), arguing that "book-to-market equity has a stronger role in average stock returns than size" (Fama and French 1993, p.9).

Fama and French (1993) form six portfolios from the intersections between two size groups and three BM groups: *S/L, S/M, S/H, B/L, B/M,* and *B/H*. For instance, the B/H portfolio contains companies in both the large-size and high-BM groups. Similarly, the S/H portfolio consists of the companies in the small-size group and the high-BM group. Then, Fama and French (1993) separately calculate value-weighted returns for the six portfolios each month in a given year.

SMB (small minus big) is the common risk factor in returns associated with the size. *SMB* is the difference between the simple average of small portfolios' returns (*S/L, S/M,* and *S/H*) and big portfolios' returns (*B/L, B/M,* and *B/H*) each month. The *SMB* considers controlling the influence of BM, concentrating on the different performance in returns of small and big companies. *SMB* is calculated for each month *t*, as follows: (4)

$$SMB_t = \frac{(S/H + S/M + S/L) - (B/H + B/M + B/L)}{3}$$

HML (high minus low) is the common risk factor in returns associated with book-to-market equity- that is, the difference between the average returns of two high-BM portfolios (*S/H* and *B/H*) and the average returns of low-BM portfolios (*S/L* and *B/L*). Fama and French (1993) control the size factor and calculate *HML,* focusing only on the difference in returns of high- and low-BM companies.

$$HML_t = \frac{(S/H + B/H) - (S/L + B/L)}{2} \quad (5)$$

MER is the market excess return, used as a proxy for the market factor. Fama and French (1993) define *MER* as the difference between market returns and the risk-free rate. The market rate of return is computed on the value-weighted market capitalization of all stocks in the sample.

Similarly, other factors usually augment the three-factor model of Fama and French (1993). For instance, Fama and French (2015) expand their three-factor model with the profitability and investment factors. In another common addition, Pastor and Stambaugh (2003) extend the liquidity factor. The four-factor model that includes liquidity are estimated as follows:

$$R_{pt} - R_{ft} = \alpha_p + \beta_p MER_t + s_p SMB_t + h_p HML_t + \psi_p IMV_t + \varepsilon_{pt} \quad (6)$$

where SMB_t is the return on a "small minus big" mimicking portfolio in month t; HML_t is the return on a "high minus low" mimicking portfolio in month t; and IMV_t is the return on an "illiquid minus very liquid" mimicking portfolio in month t. ε_{pt} is the residuals assumed to have a zero mean, which does not correlate with other explanatory variables. α_p, β_p, s_p, h_p and ψ_p are the intercept and coefficients in the above regression models.

Amihud et al. (2015) propose the following method to calculate the liquidity factor, *IMV* (illiquid minus liquid). The original sample separates companies into three groups based on the liquidity measure, the most illiquid group (*I*), the moderate liquid group (*T*), and the most liquid group (*V*), in a 30%:40%:30% proportion (Chan and Faff 2005). The study constructs six portfolios based on the intersection between size and liquidity measures (*S/I, S/T, S/V, B/I, B/T, and B/V*). Then, the value-weighted average monthly returns of each portfolio are computed for each month in the given year. The liquidity factor (*IMV*) is constructed in the same way as *HML.* The monthly liquidity factor is the difference between the average returns of low liquid portfolios (*I*) and those of high liquid portfolios (*V*) as follows:

$$IMV_t = \frac{(S/I + B/I) - (S/V + B/V)}{2} \quad (7)$$

Fama and French (1993) argue that they construct the mimicking portfolios for the common risk factors for returns (*SMB* and *HML*) to diminish the variance of firm-specific factors. The returns in six intersection size-BM portfolios are computed by value-weighted market capitalization. Because the return variances relate negatively to size, applying value-weighted components is beneficial in minimizing variance. Moreover, they indicate that "using value-weighted components results in mimicking portfolios that capture the different return behaviors of small and big stocks, or high- and low-BM stocks, in a way that corresponds to realistic investment opportunities" (Fama and French 1993, p.10). Chan and Faff (2005) indicate an advantage in mimicking portfolios, namely, that SMB, HML and IMV are orthogonalized with respect to each other. The orthogonality feature occurs because construction method controls the other factors while forming each mimicking portfolio. For instance, the IMV mimicking portfolio is formed from illiquid portfolio and a matching liquid portfolio (e.g., S/I and S/V). In particular, the mimicking portfolios' construction in Fama and French (1993) ensures that a mimicking portfolio is distinguished by another factor. For example, the liquidity factor (*IMV)* is separated from the value factor (*HML)* by controlling the possible noise of the book-to-market ratio. Following Fama and French (1993), the paper uses the Gibbons, Ross, and Shanken (1989) (GRS-test) method to assess the models. The

factor slopes β_p, s_p, h_p and ψ_p capture the variation in rates of return when the intercept α_p should be equal to zero. The liquidity factor does not affect stock returns when the GRS-test cannot reject the hypothesis. The GRS-test follows an *F*-distribution and computed as follows:

$$F - \text{statistic} = (A' \Sigma^{-1} A) \frac{N-K-L+1}{L \times (N-K) \times \omega_{1,1}}$$

$$\sim F(L, N-K-L+1) \quad (8)$$

where *N* denotes the time-series observations, and *L* is the number of portfolios. In the formula (3.10), *K-L* is the number of explanatory variables (excluding the intercept). *A* is the column vector of the regression intercepts. ∑ is the variance-covariance matrix of the residuals of the regressions (Brennan and Subrahmanyam 1996). The *F-statistic* presents the result of the GRS-test on the null hypothesis that the intercepts in the regressions are jointly equal to zero.

The paper constructs five portfolios for each year *y* during the period 2011 to 2019 by sorting stock with liquidity. Monthly liquidity measures for stocks in the sample are computed. The eligible stocks are sorted into five equal portfolios (P1, P2, P3, P4, and P5), which are associated with their liquidity based on the liquidity measurement in January at each year. Portfolio P1 contains the most liquid stocks, while portfolio P5 includes the most illiquid stocks. It benefits in examination effects of liquidity measures in a standard specification. For each portfolio, the return in month *t* as is calculated as follows:

$$R_{p,t} = \sum_{i \; in \; p} w_{i,t} x R_{i,t} \quad (9)$$

where $w_{i,t}$ is the value-based weights, depending on the proportion of market equity value. Liquidity is characterized by multi-dimension, i.e., tightness, depth, resilience, and cannot be represented by one measure. The research considers multidimensional liquidity; thus, the research applies a comparably wide range of liquidity measures. In the paper five liquidity measures, i.e., SPRD, VOL, VAL, TO, and AMIHUD are used. Quoted spread (SPRD) is the the difference between the best ask price and the best bid price. Traded volume (VOL) is the number of traded shares for stock i on day d. Traded value (VAL) is the amount of traded value for stock i on day d. And the turnover ratio (TO) is a ratio of the traded volume over the number of shares outstanding. Amihud measure (AMIHUD) is an illiquid measure, a ratio of the absolute of return and the trading value.

The regression models in equations (1), (2) and (6) are estimated by using the Generalized Method of Moments (GMM). It is similar to other forms, such as ordinary least squares, pooled regression or Fama-Macbeth's (1973) method but does not require strict data distribution assumptions. Moreover, the GMM estimation is more efficient because it can adjust for issues like heteroskedasticity and autocorrelation. Specifying the regression models is verified by using the GRS test statistic. Gibbons, Ross, and Shanken (1989) derived the GRS F-test to test the hypothesis, in which the intercepts in the regressions are jointly equal to zero. The explanation power of the liquidity factor is addressed by comparing the specification of regression (1), (2), and (6), which is without the liquidity factor in the regression and liquidity-augmented three-factor regression.

4. Empirical results and discussion

The section presents the empirical results of relationship between stock market liquidity and stock returns on the Vietnamese stock market. The study applies the models to investigate liquidity's power of explaining stock returns on the HOSE. The time-series regressions used in the study are the traditional CAPM (see Equation 1), the three-factor model developed by Fama and French (1993) (see Equation 2), the liquidity-augmented three-factor model (see Equation 6). This section reports the descriptive statistics of the variables on the HOSE in the first part. Then, the research describes the correlation between variables in the regres-

sion models. The dependent variables are excess portfolio returns as P1_measure, P2_measure, P3_measure, P4_measure and P5_measure. The stocks on the HOSE are sorted and distributed in five equal portfolios, which are associated with the liquidity measures. The first portfolio P1_measure contains the most liquid stocks, and the fifth portfolio P5_measure includes the most illiquid stocks relating to a particular liquidity measure. The independent variables include MER, SMB, HML and IMV_measure (see Annex 1).

Table 1 illustrates descriptive statistics of the explanatory variables on the HOSE.

In Table 1, the average market excess return (MER) value is -0.0031 per month and varies from -0.0666 to 0.0663. The second factor in the Fama-French models, SMB has an average return 0.0004. The book-to-market factor (HML) has a higher average than SMB at 0.0006. Simultaneously, the largest value of the HML is 0.0399, more than three times as large as the largest value of SMB. Most of the liquidity factors, IMV_measure, are positive except for the SPRD proxy at -0.0001. The liquidity factor represented by the turnover ratio has the highest average of return at 0.0017. On the other hand, all the excess portfolio returns have negative values. Generally, two less illiquid portfolios P4_measure and P5_mea-

Table 1. Descriptive statistics of the variables on the HOSE

Variables	Mean	Std. Dev.	Minimum	Maximum
MER	-0.0031	0.0237	-0.0666	0.0663
SMB	0.0004	0.0035	-0.0087	0.0093
HML	0.0006	0.0092	-0.0231	0.0339
IMV_SPRD	-0.0001	0.0107	-0.0443	0.0205
IMV_VOL	0.0008	0.0108	-0.0380	0.0239
IMV_VAL	0.0014	0.0091	-0.0261	0.0240
IMV_TO	0.0017	0.0104	-0.0355	0.0232
IMV_AMIHUD	0.0010	0.0091	-0.0316	0.0225
P1_SPRD	-0.0049	0.0329	-0.0953	0.1294
P2_SPRD	-0.0063	0.0270	-0.0759	0.0760
P3_SPRD	-0.0037	0.0226	-0.0687	0.0614
P4_SPRD	-0.0047	0.0180	-0.0657	0.0317
P5_SPRD	-0.0058	0.0155	-0.0586	0.0311
P1_VOL	-0.0069	0.0321	-0.0900	0.1007
P2_VOL	-0.0054	0.0270	-0.0815	0.0910
P3_VOL	-0.0042	0.0236	-0.0761	0.0657
P4_VOL	-0.0028	0.0179	-0.0610	0.0441
P5_VOL	-0.0059	0.0145	-0.0557	0.0339
P1_VAL	-0.0079	0.0297	-0.0919	0.0794
P2_VAL	-0.0042	0.0272	-0.0887	0.0899
P3_VAL	-0.0047	0.0227	-0.0638	0.0771
P4_VAL	-0.0044	0.0191	-0.0766	0.0420
P5_VAL	-0.0038	0.0167	-0.0603	0.0395
P1_TO	-0.0082	0.0326	-0.0986	0.1071
P2_TO	-0.0050	0.0273	-0.0787	0.0941
P3_TO	-0.0034	0.0225	-0.0722	0.0592
P4_TO	-0.0035	0.0174	-0.0659	0.0354
P5_TO	-0.0052	0.0148	-0.0582	0.0312
P1_AMIHUD	-0.0074	0.0294	-0.0859	0.0935
P2_AMIHUD	-0.0053	0.0285	-0.0926	0.0967
P3_ AMIHUD	-0.0052	0.0224	-0.0652	0.0704
P4_ AMIHUD	-0.0031	0.0195	-0.0694	0.0585
P5_ AMIHUD	-0.0043	0.0156	-0.0512	0.0295

Notes: see explanation of the variables in Annex 1.

Source: Own study

Table 2. Dickey-Fuller tests of variables on the HOSE

Variables	z(t)	p-value	Variables	z(t)	p-value
MER	-6.756	0.000	P1_VAL	-8.725	0.000
SMB	-10.336	0.000	P2_VAL	-8.518	0.000
HML	-8.698	0.000	P3_VAL	-7.146	0.000
IMV_SPRD	-8.556	0.000	P4_VAL	-7.456	0.000
IMV_VOL	-9.751	0.000	P5_VAL	-7.691	0.000
IMV_VAL	-10.872	0.000	P1_TO	-8.429	0.000
IMV_TO	-9.031	0.000	P2_TO	-7.904	0.000
IMV_AMIHUD	-10.328	0.000	P3_TO	-7.285	0.000
P1_SPRD	-8.282	0.000	P4_TO	-7.613	0.000
P2_SPRD	-7.471	0.000	P5_TO	-8.175	0.000
P3_SPRD	-7.601	0.000	P1_AMIHUD	-8.932	0.000
P4_SPRD	-7.257	0.000	P2_AMIHUD	-8.068	0.000
P5_SPRD	-8.845	0.000	P3_ AMIHUD	-7.701	0.000
P1_VOL	-8.493	0.000	P4_ AMIHUD	-7.309	0.000
P2_VOL	-8.126	0.000	P5_ AMIHUD	-7.162	0.000
P3_VOL	-7.677	0.000			
P4_VOL	-6.831	0.000			
P5_VOL	-8.320	0.000			

Notes: see explanation of the variables in Annex 1.

Source: Own study

sure, have the largest average returns in five sorted portfolios in each liquidity measure. The average returns in most liquid portfolios (P1_measure) in most liquidity proxies are the smallest.

The stationarity is the first requirement for the time-series regression, which does not cause a major problem in the regression results. The results in Table 2 show that all variables on the HOSE reject the null hypothesis (the time-series data has a unit root). It implies that all the variables on the HOSE are stationary and meet the criteria for time-series regression.

Table 3 provides the regression results from the CAPM model on the HOSE. The results show that all the intercepts are negative, most of which are statistically significant at the 1% level. Several intercepts are significant at the 5% level in the regressions of liquidity measures VOL and AMIHUD. The coefficients of MER are positive and vary closely to 1.0 and statistical significance at the 1% level. The coefficient of SMB increases as liquidity decreases and decreases as size increases. The most liquid portfolios P1 in five liquidity measures have coefficients above 1.0. They suggest that the average return in these portfolios is more volatile than the market portfolios. The coefficients decrease with the decrease of the portfolios' liquidity level. The most illiquid portfolios have the smallest coefficients, about 0.5.

The result indicates that the higher the illiquidity of the portfolio, the higher the β_p the author observers. Besides, the paper proves a strong relationship between the market factor and the average portfolio excess returns on the HOSE. The results indicate that the regression models should contain other factors in the asset pricing

Table 3. Results from the CAPM regressions on the HOSE

Slope	Portfolio	SPRD	VOL	VAL	TO	AMIHUD
α	P1	-0.001 (-3.42)***	-0.003 (-2.44)**	-0.004 (-4.43)***	-0.005 (-2.99)***	-0.004 (-3.86)***
	P2	-0.003 (-2.40)**	-0.002 (-2.72)**	-0.001 (-4.32)***	-0.003 (-3.13)***	-0.002 (-3.37)***
	P3	-0.002 (-3.69)***	-0.002 (3.38)***	-0.002 (-4.01)***	-0.002 (-3.61)***	-0.003 (-2.38)**
	P4	-0.003 (-2.99)***	-0.001 (-3.57)***	-0.002 (-2.10)**	-0.002 (-3.39)***	-0.002 (2.11)**
	P5	-0.004 (-4.05)***	-0.004 (-4.62)***	-0.002 (-2.06)**	-0.003 (-3.27)***	-0.002 (2.73)***
β	P1	1.233 (14.32)***	1.253 (24.84)***	1.181 (33.42)***	1.229 (18.70)***	1.169 (28.78)***
	P2	0.998 (19.74)***	1.023 (17.97)***	1.031 (18.03)***	1/052 (21.35)***	1.063 (15.63)***
	P3	0.829 (16.40)***	0.874 (16.22)***	0.827 (15.36)***	0.833 (14.81)***	0.813 (16.61)***
	P4	0.651 (24.57)***	0.581 (10.17)***	0.631 (9.81)***	0.597 (11.32)***	0.646 (10.20)***
	P5	0.465 (7.89)***	0.446 (9.01)***	0.499 (8.75)	0.463 (9.74)***	0.482 (10.42)***
	GRS	0.000***	0.001***	0.000***	0.001***	0.000***

Notes: The table presents the results from the time-series regression R_{pt}-$R_{ft} = \alpha_p + \beta_p MER_t + \varepsilon_p$. *MER denotes the market factor. The research sorts the stocks into five liquidity portfolios associated with five liquidity measures. P1, P2, P3, P4 and P5 are the portfolio excess returns in five sorted liquidity portfolios, in which P1 denotes the most liquid portfolio, and P5 is the most illiquid portfolios. The GRS is F-value for the Gibbons, Ross and Shanken test that the jointly intercepts equal to zero. Number in the parentheses denotes the t-statistic. *, **, *** denote the significance levels of 10 percent, 5 percent, and 1 percent, respectively.*

Source: Own study

model to explain the variation of stock returns effectively.

Table 4 reports the results from Fama-French three-factor regressions for five liquidity portfolios with five alternative liquidity measures on the HOSE. The intercepts in the Fama-French three-factor models are negative. The results show that three intercepts are not significantly different from zero at the 5% level in VOL, TO.

The Fama-French three-factor models have MER coefficients similar to the CAPM models that β are positive and significantly different from zero at the 1% level. MER coefficients in the portfolios P1 are higher than 1.0 and decrease across the liquidity portfolios. All the MER slopes in five portfolios are less than 1.0 and the smallest MER slope is in the P3 portfolio. It indicates the stock returns in the higher liquid portfolios are more volatile than the market while the more illiquid portfolios are less volatile than the market.

The SMB coefficients are mostly significantly different from zero at the 5% level. Several coefficients in the portfolios P1 and P2 are at the 10% level or not statistically significant. In contrast, all the SMB slopes in the portfolios P3, P4 and P5 are significantly different from

Table 4. Results from the three-factor model regressions on the HOSE

Slope	Portfolio	SPRD	VOL	VAL	TO	AMIHUD
α	P1	-0.002 (-2.31)**	-0.004 (6.35)***	-0.005 (-5.53)***	-0.005 (-4.70)***	-0.004 (-4.88)***
	P2	-0.004 (-4.61)***	-0003 (-3.38)***	-0.002 (-1.72)*	-0.003 (-3.10)***	-0.003 (-2.84)***
	P3	-0.002 (-1.91)**	-0.002 (-2.42)**	-0.003 (-3.23)***	-0.001 (-1.50)	-0.003 (-3.87)***
	P4	-0.003 (-3.58)***	-0.002 (-1..61)	-0.003 (-3.31)***	-0.002 (-2.50)**	-0.002 (-1.79)*
	P5	-0.004 (-4.27)***	-0.005 (-5.56)***	-0.003 (-3.28)***	-0.004 (-4.46)***	-0.003 (-3.81)***
β	P1	1.135 (20.13)***	1.070 (22.66)***	1.059 (22.91)***	1.145 (18.39)***	1.051 (23.07)***
	P2	0.901 (21.48)***	1.033 (21.16)***	1.043 (17.38)***	1.022 (23.92)***	1.044 (18.09)***
	P3	0.887 (19.43)***	0.947 (17.54)***	0.897 (18.66)***	0.873 (17.21)***	0.875 (19.56)***
	P4	0.768 (16.47)***	0.691 (11.62)***	0.696 (10.53)***	0.701 (13.25)***	0.736 (11.20)***
	P5	0.596 (9.80)***	0.551 (11.04)***	0.593 (11.03)***	0.537 (10.07)***	0.584 (12.69)***
s	P1	0.741 (1.74)*	-1.087 (-3.01)***	-0.919 (-2.61)***	0.435 (0.98)	-0.904 (-2.50)**
	P2	0.365 (1.05)	1.414 (4.02)***	1.146 (2.90)***	1.001 (3.46)***	1.167 (2.81)***
	P3	1.707 (4.26)***	1.977 (5.61)***	1.970 (5.54)***	1.453 (4.08)***	1.861 (5.32)***
	P4	1.768 (4.69)***	2.173 (5.30)***	1.854 (4.36)***	2.007 (5.04)***	2.095 (5.52)***
	P5	1.617 (3.67)***	1.732 (4.18)***	2.234 (5.16)***	1.294 (3.07)***	1.983 (4.77)***
h	P1	1.078 (7.32)***	1.157 (8.49)***	0.704 (5.54)***	0.854 (5.47)***	0.680 (4.90)***
	P2	0.933 (7.38)***	0.390 (3.13)***	0.293 (1.85)	0.504 (3.91)***	0.555 (2.81)***
	P3	0.096 (0.67)	0.626 (0.38)	0.077 (0.46)	0.158 (1.06)	0.121 (0.83)
	P4	-0.386 (-2.60)***	-0.183 (-1.00)	0.878 (0.51)	-0.183 (-1.19)	-0.031 (-0.19)
	P5	-0.573 (-3.47)***	-0.279 (-1.90)*	-0.027 (-0.17)	-1.184 (-1.13)	-0.176 (-1.11)
	GRS	0.001***	0.008***	0.000**	0.000***	0.003***

Notes: The table presents the results from the time-series regression Rpt-Rft = αp + βpMERt +spSMBt+hpHMLt + εp. MER, SMB and HML denote the market, size, book-to-market

*factor. The research sorts the stocks into five liquidity portfolios associated with five liquidity measures. P1, P2, P3, P4 and P5 are the portfolio excess returns in five sorted liquidity portfolios, in which P1 denotes the most liquid portfolio, and P5 is the most illiquid portfolios. The GRS is F-value for the Gibbons, Ross and Shanken test that the jointly intercepts equal to zero. Number in the parentheses denotes the t-statistic. *, **, *** denote the significance levels of 10 percent, 5 percent, and 1 percent, respectively.*

Source: Own study

zero at the 5% level.

The HML factor in the Fama-French three-factor models have several statistically significant coefficients less than the SMB factor. The SMB slopes significantly differ from zero at the 5% level, with the biggest difference in P1 and P2. Four coefficients in the P4 portfolios and three coefficients in the P5 portfolios are not statistically significant. The P3 portfolios have no statistically significant coefficients. The GRS tests indicate the Fama-French regression models reject the null hypothesis. The intercepts in five regressions of alternative liquidity measures are jointly substantially different from zero at the 1% level.

This evidence presents a similar result to Table 3 that market factor's coefficients decrease as the illiquidity of the portfolio is higher. The results in five alternative liquidity measures are consistent with the discussion. These coefficients positively impact the average portfolio excess returns on the HOSE. The impact of size factor is bigger than the value factor HML. Thus, the market factor and market capitalization effects on the variation of rates of return in portfolios on the HOSE are more predominant than the value factor. The GRS-test demonstrates that the Fama-French three-factor model should extend other factors to explain stock returns better.

Table 5 presents the results from the liquidity augmented Fama-French model R_{pt}-$R_{ft} = \alpha_p + \beta_p MER_t + s_p SMB_t + h_p HML_t + \psi_p IMV_t + \varepsilon_{pt}$ on the HOSE. The results are similar to the Fama-French three-factor models; all intercepts are negative. However, the number of intercepts is statistically significantly less than in Table 3. Eight intercepts in the regression results are not significantly different from zero. The intercepts in the regressions of the measure VOL are more statistically significant than in other measures. The MER coefficients are positive and statistically significant at the 1% level. The coefficients in different liquidity portfolios with alternative liquidity measures are under 1.0. Regarding the liquidity factor, the regression results show that the coefficients in the two first portfolios are negative and increase as the liquidity decreases across the portfolios. The portfolios P5 have the highest coefficients, while the coefficients in the P1 portfolios are the smallest. The liquidity factor negatively influences the stock returns in the most liquid portfolios. On the other hand, in illiquid portfolios, the liquidity changes positively impact the stock returns in portfolios. The medium liquidity portfolios' results cannot reject the null hypothesis that the coefficients are equal to zero. The liquidity factor does not explain the variation of stock returns in P3. The IMV coefficients in other portfolios are statistically significant at the 5% level.

The results of the GRS tests show that the intercepts are significantly different from zero at the 10% level in three measures SPRD and AMIHUD. The remaining results reject the null hypothesis in GRS tests. The intercepts are jointly significantly different from zero at the 5% level.

The results indicate the portfolio excess returns increase with the increase of illiquidity. It is worth noting that there is a certain pattern of liquidity premium on the HOSE. The presence of liquidity factor in the liquidity-augmented three-factor model assists the powerful explanation in a variation of stock returns.

The study evaluates the regressions, specifically, the CAPM, three-factor, and liquidity-augmented three-factor models. The comparison among these regressions was done by

checking the number of insignificant intercepts and the GRS-tests. All intercepts in the three-factor models and the five-factor models are negative. The GRS F-stats in the liquidity-

Table 5. Results from liquidity-augmented three-factor model on the HOSE

Slope	Portfolio	SPRD	VOL	VAL	TO	AMIHUD
α	P1	-0.003 (-1.41)	-0.004 (-5.45)***	-0.004 (-6.22)***	-0.003 (-4.54)***	-0.002 (-1.40)
	P2	-0.002 (-0.80)	-0.003 (-3.49)***	-0.001 (-1.54)	-0.002 (-2.58)**	-0.004 (-1.49)
	P3	-0.002 (-1.79)*	-0.002 (-2.42)**	-0.003 (-3.25)***	-0.001 (-1.33)	-0.003 (-3.88)***
	P4	-0.003 (-3.34)***	-0.001 (-1.68)*	-0.003 (-3.69)***	-0.002 (-2.73)***	-0.002 (-1.90)*
	P5	-0.003 (-4.08)***	-0.005 (-6.12)***	-0.003 (-4.12)***	-0.005 (-5.79)***	-0.003 (-4.86)***
β	P1	0.935 (14.30)***	0.784 (14.78)***	0.811 (16.07)***	0.754 (11.29)***	0.834 (14.65)***
	P2	0.786 (12.12)***	0.927 (13.69)***	0.911 (12.81)***	0.879 (16.37)***	0.951 (12.86)***
	P3	0.940 (14.82)***	0.963 (12.20)***	0.904 (13.21)***	0.831 (11.70)***	0.891 (14.49)***
	P4	0.882 (15.49)***	0.839 (12.37)***	0.827 (10.60)***	0.754 (13.53)***	0.879 (11.75)***
	P5	0.792 (11.51)***	0.762 (14.13)***	0.813 (14.03)***	0.736 (11.75)***	0.839 (18.00)***
s	P1	1.501 (3.26)***	0.234 (0.60)	0.436 (1.20)	1.249 (3.04)***	0.348 (0.97)
	P2	0.804 (2.37)**	1.904 (4.61)***	1.864 (3.93)***	1.318 (4.47)***	1.706 (3.60)***
	P3	1.502 (3.71)***	1.899 (4.49)***	1.935 (4.98)***	1.541 (4.29)***	1.767 (4.660***
	P4	1.336 (3.16)***	1.488 (3.58)***	1.140 (2.25)**	1.895 (4.48)***	1.273 (3.15)***
	P5	0.879 (1.96)**	0.756 (1.81)*	1.032 (2.22)**	0.881 (1.35)	0.512 (1.46)
h	P1	0.179 (0.73)	0.435 (2.89)***	0.382 (3.44)***	0.086 (0.46)	0.298 (2.64)***
	P2	0.415 (2.05)**	0.121 (0.73)	0.122 (0.72)	0.204 (1.51)	0.390 (2.23)**
	P3	0.337 (1.38)	0.105 (0.54)	0.086 (0.49)	0.073 (0.45)	0.149 (0.99)
	P4	0.124 (0..49)	0.191 (1.02)	0.257 (1.58)	-0.077 (-0.40)	0.219 (1.62)
	P5	0.298 (1.30)	0.254 (1.49)	0.258 (1.82)*	0.206 (1.35)	0.272 (2.48)**

Slope	Portfolio	SPRD	VOL	VAL	TO	AMIHUD
ψ	P1	-1.037 (-4.77)***	-1.154 (-7.38)***	-1.119 (-7.99)***	-1.494 (-9.05)***	-1.028 (-6.56)***
	P2	-0.598 (-2.85)***	-0.431 (-2.47)**	-0.592 (-2.88)***	-0.584 (-4.13)***	-0.443 (-2.23)**
	P3	0.279 (1.28)	0.067 (0.36)	0.029 (0.15)	-0.164 (-0.94)	0.077 (0.46)
	P4	0.587 (2.67)***	0.598 (3.41)***	0.589 (3.09)***	0.205 (1.41)	0.674 (3.50)***
	P5	1.004 (4.98)***	0.853 (5.26)***	0.992 (6.23)***	0.759 (5.60)***	1.207 (8.51)***
	GRS	0.062*	0.008***	0.002**	0.028**	0.057*

Notes: The table presents the results from the time-series regressions R_{pt}-$R_{ft} = \alpha_p + \beta_p MER_t + s_p SMB_t + h_p HML_t + \psi_p IMVt + \varepsilon_{pt}$. *MER, SMB, HML and IMV denote the market, size, book-to-market and liquidity factor. The liquidity factor IMV is separately calculated from five liquidity measures: SPRD, VOL, VAL, TO, and AMIHUD. The research sorts the stocks into five liquidity portfolios associated with five liquidity measures. P1, P2, P3, P4 and P5 are the portfolio excess returns in five sorted liquidity portfolios, in which P1 denotes the most liquid portfolio, and P5 is the most illiquid portfolios. The GRS is F-value for the Gibbons, Ross and Shanken test that the jointly intercepts equal to zero. Number in the parentheses denotes the t-statistic. *, **, *** denote the significance levels of 10 percent, 5 percent, and 1 percent, respectively.*

Source: Own study

augmented three-factor models are higher than in the three-factor models and the CAPM models. Most of the intercepts in the three-factor models are significant statistics at the 5% level. This result is the same in the CAPM model. It indicates that the liquidity-augmented three factor models have more insignificant intercepts.

The study will conduct regression diagnostics and specification tests to ensure the regression models are correctly specified in the next part. We apply the likelihood ratio test to select the regression model. Table 12 presents the likelihood ratio test results to evaluate the difference between nested models. Firstly, the study uses the three-factor model as the unrestricted model, and the CAPM model is the nested model. Secondly, Fama-French (1993) 's three-factor model is the nested model within the liquidity-augmented three-factor model. The likelihood ratio tests reject the null hypothesis that the parameters are equal to zero. The liquidity-augmented three-factor model (with liquidity factor) is a significant model for estimating the relationship between stock market liquidity and returns.

5. Conclusions

The empirical evidence on the relationship between stock market liquidity and rates of

Table 6. Result of the likelihood-ratio test on the HOSE

Model	LR Chi^2	Prob > Chi^2	Remark
The CAPM model and the three-factor model	14.83	0.0001	SMB, HML are not equal to 0
The three-factor model and the liquidity-augmented three-factor model	9.97	0.0016	LIQ is not equal to 0

Source: Own study

return related to the time-series regression was proved. Liquidity plays a crucial role in explaining rates of return on the HOSE. The result is consistent with Batten and Vo (2014), Vo and Bui (2016). Regarding the role of liquidity in the explanation of rates of return of the stock, the AMIHUD measure is the best measure for liquidity measurement in the Vietnamese stock market. This analysis provided the features of the relationship between stock-market liquidity and rates of stock return on the HOSE. Specifically, the stock returns increase with the increase of illiquidity. The liquidity-augmented three-factor model (with liquidity factor) is the most appropriate asset pricing model to explain the changes in stock market liquidity on the HOSE. Stock exchange managers are expected to benefit from the findings of this study. The study provided a better understanding of stock market liquidity. Stock exchange managers should conduct daily news research referring to the liquidity for each stock and each sector. Investors should evaluate the liquidity risk of the stock market and enhance their returns. Although the thesis has several implications for investors, and researchers, it also has a limitation. The paper has analyzed in a particular frontier market. Thus, the findings in this research cannot be applied to other emerging or frontier stock markets. ■

References

Acharya, V. V., & Pedersen, L. H. (2005), 'Asset pricing with liquidity risk', Journal of financial Economics, 77(2). 375-410.

Ahn, H. J., Cai, J., Chan, K., Hamao, Y. (2007), 'Tick size change and liquidity provision on the Tokyo Stock Exchange', Journal of the Japanese and International Economies, 21(2). 173-194.

Amihud, Y., and Mendelson, H. (1986), 'Liquidity and stock returns', Journal of Financial Economics, 17. 223-249

Amihud, Y. (2002), 'Illiquidity and Stock Returns: Cross Section and Time Series Effects', Journal of Financial Markets, 5, No.2. 31-56.

Batten, J. A., Vo, V. X. (2014), 'Liquidity and Return Relationships in an Emerging Market', Emerging Markets Finance and Trade, 50(1). 5-21.

Brennan, M. J., Subrahmanyam, A. (1996), 'Market microstructure and asset pricing: On the compensation for illiquidity in stock returns', Journal of Financial Economics, 41(3). 441-464.

Chan, H. W., & Faff, R. W. (2005), 'Asset pricing and the illiquidity premium', Financial Review, 40(4). 429-458.

Chan, L. K. C., Hamao, Y., Lakonishok, J. (1991), 'Fundamentals and stock returns in Japan', The Journal of Finance, 46(5). 1739-1764.

Chang, Y. Y., Faff, R., Hwang, C.Y. (2010), 'Liquidity and stock returns in Japan: New evidence', Pacific-Basin Finance Journal, 18(1). 90-115.

Chordia, T., Subrahmanyam, A., Anshuman, V.R. (2001), 'Trading activity and expected stock returns', Journal of Financial Economics, 59(1). 3-32.

Datar, V. T., Naik, N. Y., & Radcliffe, R. (1998), 'Liquidity and stock returns: An alternative test', Journal of financial markets, 1(2). 203-219.

Fama, E. F., French, K. R. (1993), 'Common risk factors in the returns on stocks and bonds', Journal of Financial Economics, 33(1). 3-56.

Fama, E. F., MacBeth, J. D. (1973), 'Risk, return, and equilibrium: Empirical tests', Journal of political economy, 81(3). 607-636.

Gibbons, M. R., Ross, S. A., & Shanken, J. (1989), 'A test of the efficiency of a given portfolio', Econometrica: Journal of the Econometric Society. 1121-1152.

Hansen, L. P. (1982), 'Large sample properties of generalized method of moments estimators', Econometrica: Journal of the econometric society. 1029-1054.

Hasbrouck, J. (2009), 'Trading costs and returns for US equities: Estimating effective costs from daily data', The Journal of Finance, 64(3). 1445-1477.

Jun, S. G., Marathe, A., Shawky, H. A. (2003), 'Liquidity and stock returns in emerging equity markets', Emerging Markets Review, 4(1). 1-24.

Lam, K. S. K., Tam, L.H.K. (2011), 'Liquidity and asset pricing: Evidence from the Hong Kong stock market', Journal of Banking & Finance, 35(9). 2217-2230.

Leirvik, T., Fiskerstrand, S. R., Fjellvikas, A. B. (2017), 'Market liquidity and stock returns in the Norwegian stock market', Finance Research Letters, 21. 272-276.

Lesmond, D. A., Joseph, P. O., and Charles, A. T. (1999), 'A new estimate of transaction costs', The review of financial

studies, 12(5). 1113-1141.

Li, B., Sun, Q., Wang, C. (2014), 'Liquidity, Liquidity Risk and Stock Returns: Evidence from Japan', European Financial Management, Vol. 20, No. 1. 12 6-151.

Lintner, J. (1965), 'Security Prices, Risk, and Maximal Gains from Diversification', The Journal of Finance, 20(4). 587-615.

Liu, W. (2006), 'A liquidity-augmented capital asset pricing model', Journal of financial Economics, 82(3). 631-671.

Liu, G., Gregoriou, A., Bo, Y. (2020), 'How do markets value stock liquidity? Comparative evidence from the UK, the US, Germany and China', Economics Letters, 186, 108500.

Narayan, P. K., Zheng, X. (2011), 'The relationship between liquidity and returns on the Chinese stock market', Journal of Asian Economics, 22(3). 259-266.

Pastor, L., Stambaugh, R.F. (2003), 'Liquidity Risk and Expected Stock Returns', The Journal of Political Economy, 111, no.3. 642-684.

Sharpe, W. F. (1964), 'Capital Asset Prices: A Theory of Market Equilibrium Under Conditions of Risk', The Journal of Finance, 19(3). 425-442.

Stereńczak, S. (2017), 'Stock market liquidity and returns on the Warsaw Stock Exchange: An introductory survey', Finanse, Rynki Finansowe, Ubezpieczenia, 86. 363-374.

Vo, X. V., Bui, H. T. (2016), 'Liquidity, liquidity risk and stock returns: Evidence from Vietnam', 'Int. J. Monetary Economics and Finance, Vol 9(1). 67-89

Annex 1

Variables	Explanation	Calculation
MER	The market excess return (MER_t) is the difference between market portfolio return (R_{mt}) and risk-free rate (R_{ft}),	$MER_t=R_{mt}- R_{ft}$
SMB	*SMB* (small minus big) is the common risk factor in returns associated with the size.	See Equation 4
HML	*HML* (high minus low) is the common risk factor in returns associated with book-to-market equity.	See Equation 5
IMV_ SPRD	IMV_SPRD is the liquidity factor in returns associated with stock liquidity, which measured by quoted spread (SPRD)	See Equation 7
IMV_VOL	IMV_VOL is the liquidity factor in returns associated with stock liquidity, which measured by trading volume (SPRD)	See Equation 7
IMV_VAL	IMV_VAL is the liquidity factor in returns associated with stock liquidity, which measured by trading value (VAL)	See Equation 7
IMV_TO	IMV_TO is the liquidity factor in returns associated with stock liquidity, which measured by turnover ratio (TO)	See Equation 7
IMV_ AMIHUD	IMV_AMIHUD is the liquidity factor in returns associated with stock liquidity, which measured by amihud measure (AMIHUD)	See Equation 7
P1_SPRD	Portfolio includes stocks in the highest liquidity group, measured by quoted spread	Difference of portfolio return and risk-free rate
P2_SPRD	Portfolio includes stocks in the second highest liquidity group, measured by quoted spread	Difference of portfolio return and risk-free rate
P3_SPRD	Portfolio includes stocks in the third highest liquidity group, measured by quoted spread	Difference of portfolio return and risk-free rate
P4_SPRD	Portfolio includes stocks in the fourth highest liquidity group, measured by quoted spread	Difference of portfolio return and risk-free rate
P5_SPRD	Portfolio includes stocks in the lowest liquidity group, measured by quoted spread	Difference of portfolio return and risk-free rate
P1_VOL	Portfolio includes stocks in the highest liquidity group, measured by trading volume	Difference of portfolio return and risk-free rate
P2_VOL	Portfolio includes stocks in the second highest liquidity group, measured by trading volume	Difference of portfolio return and risk-free rate
P3_VOL	Portfolio includes stocks in the third highest liquidity group, measured by trading volume	Difference of portfolio return and risk-free rate

Variables	Explanation	Calculation
P4_VOL	Portfolio includes stocks in the fourth highest liquidity group, measured by trading volume	Difference of portfolio return and risk-free rate
P5_VOL	Portfolio includes stocks in the lowest liquidity group, measured by trading volume	Difference of portfolio return and risk-free rate
P1_VAL	Portfolio includes stocks in the highest liquidity group, measured by trading value	Difference of portfolio return and risk-free rate
P2_VAL	Portfolio includes stocks in the second highest liquidity group, measured by trading value	Difference of portfolio return and risk-free rate
P3_VAL	Portfolio includes stocks in the third highest liquidity group, measured by trading value	Difference of portfolio return and risk-free rate
P4_VAL	Portfolio includes stocks in the fourth highest liquidity group, measured by trading value	Difference of portfolio return and risk-free rate
P5_VAL	Portfolio includes stocks in the lowest liquidity group, measured by trading value	Difference of portfolio return and risk-free rate
P1_TO	Portfolio includes stocks in the highest liquidity group, measured by trading value	Difference of portfolio return and risk-free rate
P2_TO	Portfolio includes stocks in the second highest liquidity group, measured by trading value	Difference of portfolio return and risk-free rate
P3_TO	Portfolio includes stocks in the third highest liquidity group, measured by trading value	Difference of portfolio return and risk-free rate
P4_TO	Portfolio includes stocks in the fourth highest liquidity group, measured by trading value	Difference of portfolio return and risk-free rate
P5_TO	Portfolio includes stocks in the lowest liquidity group, measured by trading value	Difference of portfolio return and risk-free rate
P1_ AMIHUD	Portfolio includes stocks in the highest liquidity group, measured by amihud measure	Difference of portfolio return and risk-free rate
P2_ AMIHUD	Portfolio includes stocks in the second highest liquidity group, measured by amihud measure	Difference of portfolio return and risk-free rate
P3_ AMIHUD	Portfolio includes stocks in the third highest liquidity group, measured by amihud measure	Difference of portfolio return and risk-free rate
P4_ AMIHUD	Portfolio includes stocks in the fourth highest liquidity group, measured by amihud measure	Difference of portfolio return and risk-free rate
P5_ AMIHUD	Portfolio includes stocks in the lowest liquidity group, measured by amihud measure	Difference of portfolio return and risk-free rate

Source: own study

continued from page **29**

Stock Market Return, and Temperature in G7 Countries: Novel Insights From Partial and Multiple Wavelet Coherence", Retrieved 14 May 2022, from https://www.frontiersin.org/articles/10.3389/fenvs.2021.772783/full

Tursoy, T. (2017), "The impact of gold and crude oil prices on stock market in Turkey: Empirical evidences from ARDL bounds test and combined cointegration", Retrieved 14 May 2022, from https://sci-hub.se/10.1016/j.resourpol.2017.10.014

Wahyudi, S., Hersugondo, H., Laksana, R. D., & Rudy, R. (2017), "Macroeconomic Fundamental and Stock Price Index in Southeast Asia Countries A Comparative Study", International Journal of Economics and Financial, Issue 7/2, pp. 182-187 .

Wongbangpo, P., & Sharma, S. (2001), "Stock market and macroeconomic fundamental dynamic interactions: ASEAN – 5 countries", Retrieved 14 May 2022, from https://sci-hub.se/10.1016/s1049-0078(01)00111-7

Yousef, I., & Shehadeh, E. (2020), "The impact of COVID – 19 on Gold Price Volatility", Retrieved 14 May 2022, from https://www.researchgate.net/publication/341281901_The_Impact_of_COVID-19_on_Gold_Price_Volatility

Websites: International Monetary Fund (IMF)'s database (https://data.imf.org/?sk=4C514D48-B6BA-49ED-8AB9-52B0C1A0179B); U.S. Energy Information Administration (EIA) (https://www.eia.gov/); S&P global (www.spglobal.com); Investing.com